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BUILDING A CAREER IN MARKETING COMMUNICATION IN A SUSTAINABLE DEVELOPMENT ERA: WHICH KEY COMPETENCIES ARE REQUIRED?*

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Abstract. The paper focuses on identifying which key competencies the higher educated graduates need to succeed at entry-level jobs in the field of marketing communication in the current sustainable development marketing approaches era and create a competency model for such jobs. The resulting competency model, based on data collected from 194 SMEs operating in the Czech Republic, defines an optimal set of the six most critical key competencies as well as the expected behavior that a competent higher educated graduate should possess to be successfully hired for different marketing communication-related jobs and be able to perform work tasks well. The proposed competency model can bring more transparency to the selection process for both recruiters and job candidates by establishing standards for desirable key competencies in such marketing positions.

Keywords: competency model; marketing communication; reputation; graduates

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1. Introduction

One of the essential challenges of the 21st century the world is facing now is undoubtedly sustainable development, i.e. development that should meet the current needs without compromising the future generation's ability to meet their own needs (Brundtland Report, 1987; Zaidi, Ahmed & Raza, 2022; Oláh et al., 2023). From the perspective of marketing management, sustainable development is often perceived as a new socio-economic

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order with mechanisms that are forcing rational behaviour of all market participants as well as transition to a circular economy (Šimková et al., 2023; Androniceanu & Sabie, 2023). To meet these requirements, enterprises must find mechanisms to improve their performance in this area, which demands strategic flexibility (Yousuf et al., 2021). As essential market participants, small and medium-sized enterprises should focus on producing and offering products which ensure the highest utility of households' finance (Skowron & Szymoniuk, 2014; Čera et al., 2020). The way to establish a positive reputation in this new era is to cleverly use various marketing communication tools to communicate products and brands that respect the environment, social responsibility as well as rational needs and problems of consumers (Hao et al., 2020; Horvathova et al., 2020; Konečný, Kostiuk & Ruschak, 2022). However, the level of competition among SMEs is so high nowadays that no company can succeed in this competitive environment without a skilled and competent marketing department to provide operational flexibility that highly affects business performance (Yousuf et al., 2019; Soltes & Gavurova, 2014). In such a situation, the marketing communication specialists should have high competencies to adapt quickly to the market's changing and often unpredictable conditions (Akhtar et al., 2018).

For that reason, to start a successful career in the field of marketing communication nowadays in various sectors of the economy, it is all the more critical for graduate or entry-level candidates to possess and demonstrate the desired level of required vital competencies, as determined by employers (Rivera, 2020; Midhat et al., 2021; Petrovský et al., 2023). These requirements are usually no longer based only on theoretical knowledge but especially on the various personal abilities that provide a generic framework for the behaviour and skills expected of competent workers in various marketing communication specializations (Hay, 2008; Tomlinson, 2008). Modern higher education should undoubtedly aim to achieve the closest match between the key competencies required by the labour market and the key competencies that future graduates can acquire and develop during their study of marketing, business or economics degree (Tkacova et al., 2023). Therefore, universities have made some efforts over the past decade to prepare their students better to meet current requirements and expectations for entry-level positions related to marketing communication, such as junior marketing communication specialist, social media manager junior or promotions coordinator. A suitable unifying manual based on current employers' requirements should be the starting point for future efforts to apply the competency-based approach in higher education, including marketing degrees. Unfortunately, in most cases, it is either based on outdated information, improper assumptions or, worse still, it does not exist. Also, HR managers and recruiters, especially in smaller companies, should consider competency-based approach tools based on the current studies' recommendations when hiring competent employees for marketing departments (Gavurova et al., 2020).

In terms of HR management, one of the key personnel activities in small and medium-sized enterprises (SMEs) is the employee selection process, which is currently based mainly on assessing the critical competencies of candidates for offered positions (Malik, Froese & Sharma, 2020; Rivera, 2020; Gavurova et al. 2016). Therefore, to succeed in the selection process, candidates for jobs in the field of marketing communication, including university graduates of marketing, business or economics degrees, should have the desired level of required key competencies rather than theoretical knowledge. This paper aims to identify which key competencies the higher educated graduates need to succeed at entry-level jobs in marketing communication in the current sustainable development marketing approaches era. Subsequently, create a competency model for such jobs based on requirements and behaviour expectations of small and medium-sized enterprises operating in the Czech Republic. The developed competency model should define an optimal set of the vital competencies that a competent, higher-educated graduate should possess to be successfully hired for different marketing communication-related jobs and be able to perform work tasks well.

To achieve the goal, the following research questions are formulated:

RQ₁: Which key competencies of higher-educated graduates are the most important (and in what order) for entry-level positions in marketing communication?

RQ₂: Which ideal behaviour of a competent job candidate is expected for such positions by employers?

2. Theoretical background

The selection of suitable employees is becoming increasingly complicated and demanding because of the increasing number of job applicants for marketing-related jobs. Due to the requirements for matching the needs of companies, including SMEs, with individual employee abilities, human resource managers currently use a competency-based approach to select the most suitable candidate. The competency-based approach consists of the specification of the desired framework of the individuals' key competencies for specific positions utilizing a competency model as a basis for the selection of suitable applicants for a given position (Dubois & Rothwell, 2004; Gonsalvez & Calvert, 214; Campion & Fink, 2011). In 1973, American psychologist David McClelland published an innovative article entitled Testing for competency rather than for intelligence (McClelland, 1973), where he recommended considering especially the competencies when hiring new employees, that is, their capability, abilities, and skills, not only their intelligence, as it had been so far. His assumption was based on the hypothesis that simply testing individuals' knowledge does not enable predicting their ability to perform the required tasks resulting from a given job. According to the research conducted by McClelland's consulting company, the competencies critical for the successful performance of a managerial position included e.g. sufficient entrepreneurial and work maturity skills, interpersonal skills, or intellectual maturity (Raven, 2001).

The key competencies in terms of the individuals' employability in the job market and their personal development were first defined by Mertens (1974) as the abilities that help individuals cope with the reality around them and thus respond better to ever-changing requirements and new challenges of the labour market as well as political stability (Androniceanu et al., 2022). In the early 1980s, Richard E. Boyatzis, an expert in emotional intelligence, made a significant contribution to the popularization and subsequent application of the competency-based approach in human resources management. According to Boyatzis (1982), competency is one of the components contributing to the efficiency of work performance within a digital environment (Androniceanu, 2023).

In the 21st century studies, the authors agree (Belz, Siegrist, 2001; Armstrong, 2011; Bunker, Wakefield, 2004; Mitchell, Skinner & White, 2010) that key competencies can be defined as abilities, skills, knowledge, attitudes, and values that enable individuals to act adequately in various situations of personal and professional life. Moreover, they enable them to perform multiple positions, including a wide range of long-term qualifications and prerequisites for flexible responses to changing requirements of the global labour market. Thus, the key competencies are not directly dependent on the requirements of a specific position but represent certain universal abilities for coping with constant changes. Key competencies reflect the ability of people to use various skills in parallel and act adequately in a given (problem) situation (Belz & Siegrist, 2001). The competencies, however, are content-neutral since they apply in any life or professional situation. Their acquisition and development are always associated with solving a specific task or a problem (Weiss & Kolberg, 2010; Klaus, 2007; Wiek, Withycombe & Redman, 2011). Individual competency to the desired or required ideal behaviour of an individual is created by the interaction of the following specific groups of crucial competencies (Weber, Finley, Crawford, 2009; Rao, 2010; Stevens, 2012; Hadrich, 2020; Rieckmann, 2012; Gajdzik & Stverková, 2023):

- 1) *competencies related to problem-solving*: e.g., creative problem solving, negotiating, presenting, information processing;
- 2) *social competencies (relational, interpersonal)*: e.g., ability to communicate, empathy, ability to work in a team, ability to lead and motivate people, establish contacts and relationships, etc.,
- 3) *self-management*: e.g., ability to work independently, flexibility, willingness to learn, self-motivation, assertiveness.

The competency model defines a combination of prior skills, abilities, and knowledge necessary to effectively perform the tasks related to a specific position within an organization. Competency models can thus be characterized simply as a strategic tool of human resources management, which helps meet the defined objectives of a company by defining measurable levels of the required behaviour, thus improving the preparedness of the

company for constant changes in global markets (Dubois, Rothwell, 2004; Vazirani, 2010; Szostek, Balcerzak, Rogalska, 2020). Specific models serve as a basis for hiring, evaluating, motivating, and rewarding human resources and their education and development. On the one hand, competency models provide employees with clearly defined tasks and objectives; on the other hand, they represent a specific assessment tool for the employees' superiors (Emery, 2002; Soltes & Gavurova, 2015).

Based on the objectives companies use as a platform for creating and applying competency models, competency models can be divided into two basic types – generic and specific. When defining a generic model, emphasis is put on creating a universally applicable and proven competencies model that would reflect the requirements essential for any organization regardless of the position performed. It is often a model of required key competencies in such a case. These generally applicable models represent a company's first step to successfully implementing a competency-based approach in relation to the development of human resource management. Unlike the generic model, a specific competency model defines competencies that are a prerequisite for the required performance of a given employee occupying a particular position in a company. This kind of model, which is used mainly for managerial positions, describes in detail the expected behaviour of an individual when performing activities to achieve the set objectives, which are closely related and matched with the company strategy in this case (Dubois, Rothwell, 2004; Sanghi, 2004; Liebenow et al., 2020; Aisha et al., 2019).

3. Data and methods

Based on the analysis of relevant secondary resources (Weber, Finley & Crawford, 2009; Xin & Zhao, 2009; Mitchell, Skinner & White, 2010; Wiek, Withycombe & Redman, 2011; Rieckman, 2012; Stevens, 2012; Humburg, Velden & Verhagen, 2013; Loveland et al., 2015), as well as the employer's (SMEs operating in Czech Republic) often recurring requirements (described in many job advertisements published online) a set of priority critical competencies for the research was defined. The most common offered open positions in the field of marketing communication suitable for graduates with marketing, business or economics degrees, whose advertisements were analyzed, are as follows: marketing communication assistant; marketing communication specialist (junior); media assistant; social media specialist (junior); public relations coordinator/assistant; event planner; promotions coordinator; brand marketing specialist (junior); (junior) copywriter.

The chosen competencies for the research are as follows:

1. Creative thinking;
2. Ability and willingness to learn;
3. Ability to communicate;
4. Ability to cooperate;
5. Ability to find, select and analyze information;
6. Ability to solve problems;
7. Ability to work independently;
8. Ability to work under pressure;
9. Flexibility;
10. Public speaking.

Within the next step – the questionnaire survey- each selected competence's degree of significance was subsequently determined. The following criteria were defined for the selection of the target population from among SMEs:

- a) companies with 25 - 249 employees;
- b) companies with a marketing (communication) department;
- c) companies operating in the Czech Republic.

The minimum number of 25 employees was set due to the assumed existence of a more sophisticated marketing communication strategy and processes strategy and the possible presence of the marketing (communication) department in such SMEs. Based on the information provided by several online organizations databases (Firmy.cz; RES, Merk, B2Bdata), SMEs from all 14 regions of the Czech Republic were addressed via phone and emails in 2018 – 2021. While respecting the condition of equal representation of all regions of the Czech Republic in the sample, valid quantitative data was finally obtained by questionnaire from 194 companies ($n = 194$) that met the specified characteristics. The data was primarily collected from employees responsible for the recruitment process – HR managers, recruiters, or directors in some cases. Using a 5-point scale (from 1 to 5, where 1 = most important competency and 5 = totally unimportant competency), the respondents rated the importance of 10 key competencies that job candidates should have to successfully perform duties of a marketing communication-related job suitable for graduates. In the second part of the questionnaire, respondents were asked to define their description of the optimal and expected behaviour of a competent graduate for each specific key competency from the set.

The data obtained was statistically analyzed using the STATISTICA 9 software. As the collected data is ordinal and thus does not follow the normal (Gaussian) distribution, only non-parametric tests were used for its analysis. To test the hypotheses on the corresponding significance of an individual key competencies, the Friedman test (Friedman ANOVA) was used. Kruskal-Wallis test with subsequent Post-hoc analysis was applied to identify the individual clusters of competencies with similar importance levels for the surveyed companies. By comparing the correspondence of the medians of each pair of quantities, the post-hoc analysis determines the p-value in the interval $<0,1>$. Medians correspondence is confirmed if p-value is > 0.05 . The closer the p-value is to 1, the stronger the relation of the individual competencies is in terms of their significance, and the competencies can be included in one specific group. Based on the data analysis results, a generic fundamental competency model for entry-level positions in marketing communication was created.

4. Results

4.1 Significance of Individual Key Competencies

The first step in developing the competency model of the desired candidate for the marketing department is to determine the significance of each of the examined key competencies. The objective is to determine which competencies could be potential parts of the resulting model. Using the Friedman ANOVA, the following hypotheses were tested at the significance level of $\alpha = 0.05$:

H_0 : The significance of individual key competencies determined by the surveyed employers is identical.

H_A : non H_0

Results: ANOVA = 362.1802; df = 9; N = 194; p-value = 0.000

At the significance level of $\alpha = 0.05$, the null hypothesis about the correspondence of the significance of individual key competencies from the employers' points of view was tested using Friedman ANOVA. Considering the obtained p-value = 0.000, the null hypothesis is thus rejected. This means statistically significant differences were identified in the surveyed SMEs' perception of the individual key competencies' significance

when hiring suitable candidates with higher education for the open positions in the field of marketing communication. The average importance of personal key competencies based on the requirements of the surveyed companies is shown in Table 1 and is represented by means. The closer the individual means are to 1, the higher the significance of a specific key competency is for surveyed companies.

Table 1. Average significance of individual key competencies for employers

Key competencies	Mean	St. dev.
creative thinking	1.19	0.46
ability to find, select and analyze information	1.27	0.59
ability to work independently	1.33	0.62
ability to work under pressure	1.41	0.66
ability to solve problems	1.49	0.75
ability to communicate	1.55	0.71
ability to cooperate	1.62	0.73
ability and willingness to learn	1.80	0.84
flexibility	2.04	0.90
public speaking	2.59	0.86

Source: Application and own processing

In terms of the key competencies (based on the results in Table 1), it is possible to describe the skills characteristics of the desired candidate/graduate with higher education for the jobs in the field of marketing communication as a very creative individual with the ability to effectively find and analyze relevant information both independently. To achieve the job duties, the graduate should be able to work under pressure and solve all kinds of possible problems when completing tasks as assigned. The advantage is the ability to communicate and cooperate with others and a willingness to learn. On the other hand, the desired graduate can be a flexible person with developed public speaking skills.

4.2 Identification of Homogeneous Groups of Key Competencies

Kruskal-Wallis test was used to test the following hypotheses at the significance level of $\alpha = 0.05$:

H_0 : Medians of individual key competencies are identical.

H_A : non H_0

Results of Kruskal-Wallis test: $Q = 301.4927$; $df = 9$; $N = 194$; $p\text{-value} = 0.000$

The null hypothesis about the correspondence of the medians was rejected. By subsequent application of the post-hoc analysis, three groups of key competencies were based on the statistically significant medians correspondence of the individual competencies (i.e. $p\text{-value} > 0.05$; see Table 2). The closer the $p\text{-value}$ is to 1, the stronger the relation of the individual competencies is in terms of their significance level for questioned companies. It can be included in one specific group of competencies. Each of the groups below is characterized by a mutual relation of the competencies in terms of the similar high significance for surveyed employers. This means that the key competencies included in Group 1 are more significant for respondents than those in Group 2 and Group 3.

Group 1: creative thinking; ability to find, select and analyze information; ability to work independently; ability to work under pressure.

Group 2: ability to solve problems; ability to communicate; ability to cooperate.

Group 3: ability and willingness to learn; flexibility; public speaking.

Table 2. Official YouTube profiles of destinations and their activity

Key competencies	creative thinking	ability and willingness to learn	ability to communicate	ability to cooperate	ab. to find, select and analyze information	ab. to solve problems	ab. to work independently	ab. to work under pressure	flexibility	public speaking
creative thinking		0	0	0	1.00	0	1.00	1.00	0	0
ability and willingness to learn	0		0	0	0	0	0	0	0.85	0.81
ability to communicate	0	0		0.92	0	0.94	0	0	0	0
ability to cooperate	0	0	0.92		0	0.91	0	0	0	0
ab. to find, select and analyze information	1.00	0	0	0		0	1.00	1.00	0	0
ability to solve problems	0	0	0.94	0.91	0		0	0	0	0
ability to work independently	1.00	0	0	0	1.00	0		1.00	0	0
ability to work under pressure	1.00	0	0	0	1.00	0	1.00		0	0
flexibility	0	0.85	0	0	0	0	0	0		0.86
public speaking	0	0.81	0	0	0	0	0	0	0.86	

Source: Application and own processing

4.3 Competency Model of Competent Graduate

Based on the data analysis results, a generic competency model of a university graduate of marketing or a business or economics degree was developed in accordance with the requirements of SMEs operating in the Czech Republic for their entry-level jobs in the field of marketing communication suitable for the graduates. This competency model determines a set of key competencies that a competent graduate as a job candidate should have to be a desirable potential employee for surveyed SMEs' marketing departments. The significance of each key competency is directly proportional to its position in the graphical representation of the model (see Figure 1). So, the competencies listed in the lowest levels within the model are more significant than those listed in the upper part of the proposed model. The statistical tests mentioned above were used to determine the priority key competencies, which subsequently became individual components of the model. The Friedman and Kruskal-Wallis test with post hoc analysis was used to assess the significance of specific competencies. In developing the model, emphasis was put on its generality, mainly to ensure its easier transferability and subsequent applicability for diverse marketing communication-related positions a competent graduate may occupy in the SMEs.

The final form of the competency model consists of two components:

- 1) graphical representation of the model (see Figure 1)
- 2) Table that contains more detailed characteristics of a competent graduate's required/desired behaviour in terms of the individual key competencies. This was created based on merging and subsequent generalization of desired characteristics of ideal behaviour most frequently mentioned by the respondents (managers responsible for the recruitment process) for each competency in the proposed model (see Table 3).

The generic competency model defines the basic skills requirements for entry-level positions – that means clarity of the selection process for both recruiters and job candidates because of established standards regarding desirable

knowledge and skills for such positions. HR managers, recruiters or owners of smaller companies can take a competency-based approach and the results of this study into account when hiring new employees for entry-level marketing positions.

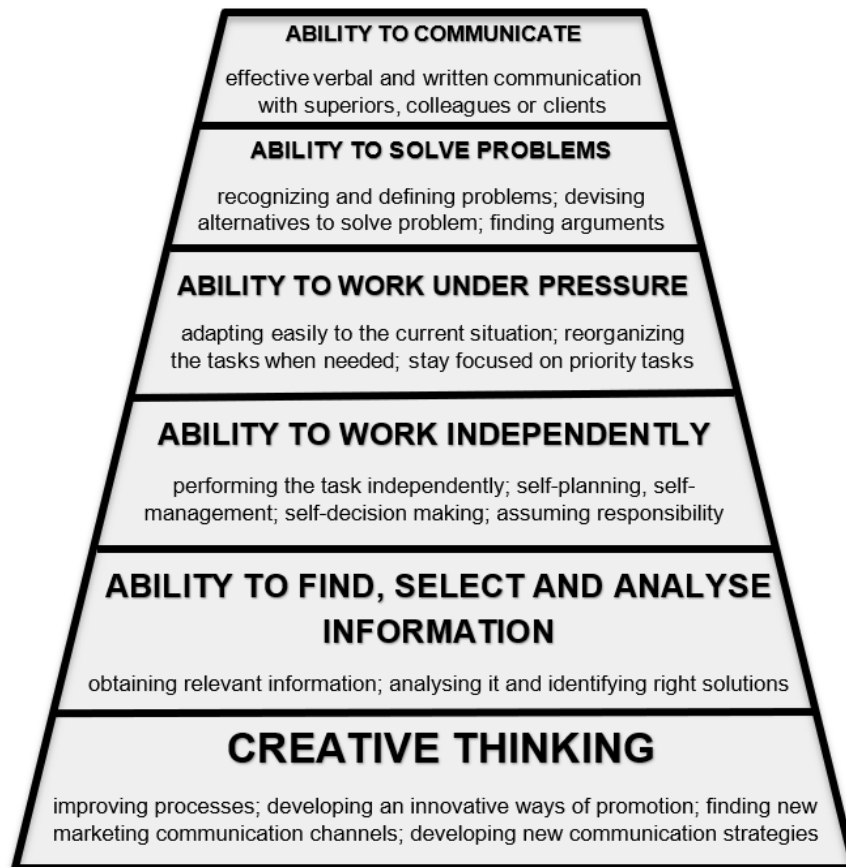


Figure 1. Proposed graduates' generic competency model for entry-level marketing communication jobs

Source: Application and own processing

Table 3. Characteristics of competent candidate's required competencies and behaviour for the marketing communication jobs according to respondents

Key competencies		Desired behaviour of competent graduate
1	creative thinking	<ul style="list-style-type: none"> • ability to evaluate a specific process and offer suggestions on how to improve it • ability to develop an innovative way to solve the task or achieve the project goal • ability to identify a unique way to promote the products, brand, events as well as develop the right strategy to do so in the future • ability to find and try new marketing (communication) channels to effectively communicate products, brands, events etc.
2	ability to find, select and analyze information	<ul style="list-style-type: none"> • ability to obtain necessary and relevant information purposefully and efficiently from various resources • ability to find a core message and distinguish between important and unimportant information • ability to analyze data and information to understand topics or problems, formulate possible solutions and identify the most effective one
3	ability to work independently	<ul style="list-style-type: none"> • independent performance of assigned tasks in the field of marketing communication • ability to independently find data and information and make decisions based on the resources obtained • being proactive as well as the ability to self-planning and self-management • ability to assume responsibility for the results of own projects
4	ability to work under pressure	<ul style="list-style-type: none"> • ability to adapt easily to the current situation and reorganize tasks or projects when needed • ability to produce high-quality results even when deadlines are changing • ability to stay focus on tasks that need to be done as a priority • ability to stay calm and focused on the project goals even in stressful situations
5	ability to solve problems	<ul style="list-style-type: none"> • ability to recognize and define problems • ability to devise different alternatives for solving the defined problem and evaluating them • ability to implement the most viable problem solution • ability to find arguments to support and defend specific decisions
6	ability to communicate	<ul style="list-style-type: none"> • effective verbal and written communication with superiors, colleagues or clients • ability to describe facts and proposals clearly, concisely, and intelligibly • ability to present facts and proposals to a smaller group of listeners • ability to make listeners interested, ability to argue

Source: Application and own processing

Thus, employers can make the recruitment process more transparent with competency-based HR management and, as a result, more easily select suitable and competent candidates for the correct positions. Another possible application of the proposed competency model in practice is developing the right competencies of future higher education graduates through updated marketing or business study programs according to the actual expectations of employers defined in the model. It can be understood as a strategic tool for re-evaluating and updating the content of various marketing and marketing communication-related study programs, especially regarding the systematic development of the most desirable key competencies group required by employers.

5. Conclusions

The key to establishing a positive reputation for small and medium-sized enterprises and their products and brands in the current era of sustainable development is effectively utilizing various marketing communication tools. However, this strategic objective cannot be accomplished without skilled and competent marketers. This paper aimed to identify the key competencies that should be included in a competency model for entry-level positions in marketing communication, which would meet the requirements and behavioral expectations of SMEs

operating in the Czech Republic. The developed generic model, based on data collected from 194 SMEs, consists of two components. It outlines an optimal combination of six key competencies. It defines the expected behavior for a competent candidate to excel in specific selection processes for various positions in the marketing communication field that require a higher education. The resulting competency model can bring more transparency to the selection process for both recruiters and job candidates by establishing standards for desirable key competencies in such marketing positions. Simultaneously, this tool can serve as an accelerator and a suitable starting point for the wider implementation of the modern competency-based approach in marketing and business degrees. The research limitations are caused mainly by two factors - the SME's size and the products that the company is offering. Although specific key competencies can be rated as very important by two different recruiters or managers, the behavior requirements of a smaller company operating in the current competitive environment may be significantly higher than that of more prominent companies with large marketing departments and an extensive customer base, or vice versa.

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DIFFERENCES IN SUSTAINABLE NUTRITION BEHAVIOUR OF DIFFERENT GENERATIONS OF CZECH CONSUMERS *

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Abstract. Sustainable behaviour in everyday life is a key aspect of sustainable development. Consumers can be the initiators of sustainability in their purchases, consumption behaviour and long-term investment decisions. This article focuses not only on the area of nutrition, which plays an essential role in increasing the impact of consumption behaviour on sustainable development. Nutrition and its sustainability are perceived differently by different generations. The article presents the results of a questionnaire survey of Czech consumers. The sample of 1000 respondents provides relevant answers to the research questions, namely, which generation buys more sustainable products and whether there is a significant difference between generations in the sustainability of nutrition. The results show that younger generations tend to purchase sustainable products to a greater extent. They are also more likely to be vegan or vegetarian than older generations, although still, the proportion of vegans and vegetarians in the Czech Republic is negligible. In contrast to this trend towards sustainability in nutrition among the younger generation is the reduction in meat consumption, which is most pronounced among those aged 55-64.

Keywords: consumer behavior; sustainable nutrition; generations; buying behavior; consumer

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1. Introduction

According to the World Commission on Environment and Development, sustainable development can be understood as the ability of the present generation to meet its own needs without compromising future generations in meeting their own consumption (World Commission on Environment and Development, 1987).

The idea of sustainable development was developed by John Elkington in his book 'Cannibals with forks: Triple Bottom Line of the 21st Century Business'. The essence of sustainable development encompasses three pillars (Triple Bottom Line): social, economic and environmental (Elkington, 1997; Androniceanu & Sabie, 2022).

The economic domain is associated with the production and sale of output. Here, in conjunction with the environmental pillar, one can mention the area of, e.g., circular economy and the associated amount of waste produced by each sector (Petrariu et al. 2022; Šimková et al., 2023; Bednářová et al. 2023) or bioeconomy, which is discussed in the article by Oláh et al. (2023).

In the case of consumers themselves, the environmental area can be supported, for example, by not wasting food or by sustainable energy consumption, which can provide many benefits for energy saving, renewable energy use and greenhouse gas reduction (Streimikiene et al., 2022; Oláh et al. 2022). On the other hand, it is also possible to use renewable energy sources for electricity generation, such as the wave energy of the sea (Kostikova et al., 2022; Androniceanu & Sabie, 2022).

The social pillar is supported, for example, by the idea of fair trade, which aims to improve the livelihoods of producers in developing countries and promote social change (Ribeiro-Duthie et al., 2021; Androniceanu et al., 2023a; Androniceanu et al., 2023b).

Related to sustainable development is corporate social responsibility (CSR) as a concept that is based on the idea of balancing the economic, social and environmental objectives of firms and that can improve various financial and market performances of the firm (Belas et al., 2022; Gavurova et al., 2022). It is also interesting to observe whether a relationship between CSR and corporate reputation exists. The latter is considered one of companies' most important assets and greatly influences business success. Research results by Berber et al. (2022) showed that CSR as a higher-order construct is positively related to corporate reputation and all dimensions of CSR (responsibility to employees, customers, local community, environment, suppliers).

Five factors significantly impact the creation of corporate reputation, namely innovation, ethical responsibility, authenticity of communication, environmental and philanthropic responsibility and economic responsibility of firms (Kelemen et al. 2022). Furthermore, that reputation positively influences consumers' perceptions and behavioral intentions (recommendation intention, reuse intention, and cross-purchase intention) and is essential to resolve uncertainty in consumers' decision-making process (Yi, 2023; Gavurova et al. 2023). Moreover, CSR and ethics are related to product innovation, brand equity and customer trust (Genga et al., 2022; Gavurova et al. 2018; Skare et al. 2023).

The previous information relates to an indication of what sustainability and sustainability in general are. But where do Czech consumers stand when purchasing sustainable products, and how do they relate to a critical human need, namely sustainable food, and are there differences between generations?

2. Theoretical background

Young people's approaches to sustainability can take different forms. For example, a study by Pink et al. (2020) with more than 480 students aged 18-26 from three universities in Kraków revealed that these respondents are socially and environmentally aware of the impacts of unsustainable consumption and production. Still, their actions do not correlate with this awareness because they avoid taking responsibility for their own actions as consumers. One reason for this may be the belief that consumers can only afford sustainable food in a better financial position, but at the same time, this does not correspond to the level of food waste. The problem may lie in a lack of ethical sensitivity and indifference to the impact of unsustainable farming when its effect does not directly affect the respondent. A 'wait and see' attitude to life may also be a significant problem. For example, in the case of so-called enforced sustainable behaviour, respondents have to adapt, which they eventually accept and are satisfied with.

For example, research on the population's consumption patterns was carried out with 1 053 Romanian consumers, without distinction between generations. Analysis of the questionnaire data revealed an overconsumption of animal products, starchy vegetables and bread and confectionery products. This dietary pattern with a high animal protein intake, correlated with a lack of diversification, is highly unsustainable and harms human health and the environment (Balan, 2022).

For example, beef production has a major impact on the environment. In the EU countries, this has been slightly downward over the last five years (2018-2022). However, more than 6 500 000 tonnes of beef carcass weight are still produced yearly (European Commission: Directorate-General for Agriculture and Rural Development, 2023a). In contrast, cereal production has both an increasing and a decreasing trend over the five years (2018-2022), with more than 267 000 thousand tonnes produced in 2022, which is more than 25 000 thousand tonnes higher than in 2021 (European Commission: Directorate-General for Agriculture and Rural Development, 2023b).

Research carried out by Di Novi and Marenzi (2022) analyzed the consumption behaviour of four generations, namely the Silent Generation (born 1926-1945), the Baby Boomer 1 Generation (1946-1955), the Baby Boomer 2 Generation (1956-1965), and Generation X (1966-1980), showed that increases in disposable income, changes in the role of women in society, and urbanization and globalization had a significant impact on consumption patterns for red and industrially processed meat among Italian consumers. Older generations have changed their diets more in favour of meat consumption than later generations, with more significant changes in the relatively affluent north of Italy compared to the south. In comparison, younger generations are likelier to adopt healthier and more environmentally sustainable eating habits.

Research by Arslan and Alataş (2023), conducted with Turkish university students aged 19-45, shows that most students believe it is important to eat sustainably. It was confirmed that as people's education and knowledge about sustainable nutrition increases, their healthy eating habits also increase. In addition, it was suggested that education on sustainable nutrition should be expanded.

This idea was also mentioned in the article by Leyva-Hernández et al. (2023), that sustainable food consumption is based on food education, the purpose of which is to develop healthy eating habits, which is achieved through an appropriate focus of education that encourages the consumption of local and seasonal food, the establishment of urban gardens and the promotion of creativity in the preparation of healthy dishes from local ingredients - shortening value chains, and the creation of distribution channels without intermediaries between consumers and producers, where producers and marketers play a crucial role.

Awareness and efforts to ensure sufficient knowledge on sustainable healthy diets are also based on research by AlBlooshi et al. (2022), which involved more than 1 000 students from Zayed University in the United Arab Emirates.

Not only food education within the education system but also so-called intergenerational transmissions are important in shaping (unsustainable) consumption across the life course, and these transmissions of behaviours and values offer opportunities for lifelong sustainable change and rethinking of food consumption in everyday life (Carrigan et al., 2023).

Sustainable healthy diets seek to support all dimensions of individual health and well-being and have a low environmental impact. It should be accessible, affordable, safe, transparent, etc (Androniceanu, 2021). Sustainable healthy diets aim to achieve optimal growth and development for all individuals and promote functioning and physical, mental and social well-being at all life stages for current and future generations. They should contribute to preventing all forms of malnutrition (i.e., undernutrition, micronutrient deficiencies), overweight, and obesity (FAO and WHO, 2019).

According to the Director-General of the World Health Organization, in the context of the United Nations Decade of Action on Nutrition (2016-2025), adult obesity, in particular, is set to increase globally, with more than 1.9 billion adults now overweight or obese. On the other hand, up to 222 million people in more than 50 countries are expected to face acute food insecurity, with malnutrition at critical levels (WHO, 2022).

Many studies have shown that a diet rich in plant-based foods and with fewer animal-based foods improves the health of individuals and the environment. Overall, the literature suggests that such a diet is a "win-win" because it benefits both people and the planet (Willett, 2019).

Sustainable diets, are based on trying to change consumer behavior so that their diets are more balanced and include plant-based foods. The vegan diet had the highest Sustainable Development Goals-Food (SDG-Food) index value, according to research by Hoehn et al. (2021). This index determines the level of alignment of any particular national, regional or local context in terms of the five different SDGs in relation to water-climate-food.

Another index that can measure healthy and sustainable diets is the SHED index (Sustainable-HEalthy-Diet Index), developed by Tepper et al. (2021). This index is a simple tool and reflects a sustainable diet's nutritional, environmental and sociocultural aspects.

The concept of a sustainable diet can also sometimes be perceived differently than reported in scientific studies. A study by Polleau and Biermann (2021) found that regional, seasonal foods and organic foods are seen as pillars of a sustainable diet and are considered particularly healthy and environmentally friendly. On the other hand, meatless diets are less associated with sustainable diets and are not perceived as particularly healthy or environmentally friendly.

And it was Radzyńska's (2021) research with 770 Polish respondents showed that local food was perceived by consumers as better than food produced by large-scale producers (so-called mass-produced, conventional food) and also as healthier, tastier and safer. In addition, respondents stressed that their production was environmentally friendly.

A survey of 252 Greek university students aged 18-23 also recorded a similar opinion. This research showed a focus on sustainable food consumption, not only on the purchase of regional foods but also a limitation on the consumption of seasonal fruits and vegetables (Kamenidou et al., 2019).

Authors Lourenco et al. (2022) sought to identify psychological barriers to adopting a sustainable diet. For example, their results showed that the main perceived barrier to adopting a plant-based diet was the enjoyment of eating meat, followed by a lack of information about plant-based diets.

Reducing meat consumption is believed to immediately contribute to combating the climate crisis. Regarding the beliefs of meat consumers to reduce their meat consumption, according to a study by Thurmer et al. (2022), it was found that these consumers reject the views on reducing meat consumption from a vegan than other meat consumers. On the other hand, however, their research highlighted the role of people's general willingness to engage in environmentally friendly behaviours.

One example of a sustainable diet is the Mediterranean diet (recognized as a healthy diet, a role model and a healthy lifestyle), whose main significance lies not in its specific foods and nutrients, but in the methods used to characterize and analyze it and the philosophy of sustainability at its core (Burlingame and Dernini, 2011).

In seafood consumption as a sustainable diet, research by Gibson et al. (2023) has indicated that Generation Z, whose members value sustainability in their purchasing decisions, may have unique views on sustainable seafood due to its sustainability values. The positive attitudes towards seafood among the surveyed sample of university students are intertwined with, for example, family vacations associated with fishing.

The Oslo-based non-profit organization EAT (2020), which focuses on the global food system, introduces the concept of Planetary Health Diet in its study. This diet mainly comprises healthy plant-based foods and can optimize human health while reducing environmental impacts.

Regarding food waste, for example, according to a survey conducted with 90 Turkish housewives aged 25-65, 24% of them reported that they waste food, while 53% reported that they do so only sometimes (Türk and Saleki, 2023).

Another interesting study on food waste reduction, which included the results of a questionnaire survey with 8,000 respondents from 8 countries, was by Iori et al. (2023). The results of this study indicated that among respondents, the most frequently reported use of food products after the expiration date, followed by awareness of the contents of their food supply. In terms of respondents' shopping behaviour, the use of shopping list, which is still quite widespread, was the least frequently adopted behaviour.

In the context of the fight against food waste, retailers started selling perishable food just before the use-by date at discounted prices. In this context, digital platforms were developed to connect local retail outlets and their consumers by sharing information about these discounts (Androniceanu & Georgescu, 2023). For this activity, it is important to ensure that both consumers and retail outlets remain active (Mullick et al., 2021).

Food waste is also opposed by the United Nations, which in its Sustainable Development Goals aims to halve food waste at the retail and consumer level by 2030 and reduce food loss in production and supply chains (United Nations, 2023).

In their paper, Torstensson et al. (2021) confirm the results of previously conducted studies on food consumption in Sweden by providing a different assessment of sustainable diets based on sales statistics of food retailers rather than self-reporting. Another important finding from this research is that animal products need to be reduced or replaced with plant-based alternatives to reduce the climate impact and increase the nutritional value of the diet.

Retail chains should understand that conveying information through marketing communication tools about sustainable products (quality, composition, production process, sufficient information, including reuse and

recovery of packaging), e.g. on packaging, labels, etc., could lead to an increase in the consumption of sustainable products and also improve consumer knowledge about the product, its nutritional value, use and recovery. It is also important to remember that retail chains are essentially the retailer of the products, and the information on the packaging of products on the store shelf is the direct responsibility of the manufacturer (Škiltė and Bormane, 2018).

The EU intends to revise the Regulation on providing food information to consumers in the context of the provision of information on sustainable products. This revision will consist of harmonized mandatory nutrition labelling on the front of the packaging for consumers to make informed food choices. It will also seek to develop nutrition profiles to limit the promotion (through nutrition and health claims) of foods high in fat, sugars or salt (European Commission, 2023).

On the other hand, this raises the question of how retailers perceive sustainable diets in general and what strategies and appeals they use to provide and promote the purchase of sustainable products. An example would be the study by Trewern et al. (2021), which suggested that UK retailers have a varied understanding of sustainable diets, which rarely include 'less and better' meat and dairy products. This could be exemplified by improving the sustainability of their meat and dairy supply chains, but they no longer implement interventions to reduce meat product purchases, for example.

Regarding the environmental focus of sustainable products, it is also interesting to consider, for example, efforts to reduce the sale of packaged liquid detergents. According to a study by Pak et al. (2022) concerning the decision by Wal-Mart (a US retail chain) to force its suppliers to switch to reduced production of packaged detergents, this decision had a market-wide impact and drove the production of non-concentrated liquid detergents out of the market.

In the case of sustainable (environmental) products, the attitude of retail consumers in choosing the mode of transport they use for their purchases is also important. The carbon footprint for the same products delivered through different distribution channels should not be identical, according to the research of Wang and Lin (2021).

3. Research objective and methodology

This article focuses primarily on the area of sustainable consumer nutrition but also sustainable purchasing behaviour in general. Sustainable nutrition is an important factor in reducing the impact of consumption behaviour on sustainable development. Nutrition and its sustainability are perceived differently by different generations.

The aim of this paper will be to identify differences between generations in their sustainable purchasing behaviour and in the purchase of sustainable food products themselves and consequently in their meat consumption.

To achieve the objective, the following research questions were set:

1. *Which generation buys more sustainable products?*
2. *Is there a significant difference between generations in food sustainability?*

This paper presents the results of a questionnaire survey of Czech consumers. The survey was conducted in February 2023, through an online survey via the Trendaro platform and in cooperation with the research agency BehavioLabs. A sample of 1,000 respondents provided relevant answers to the research questions. The sample's representativeness was ensured by quota sampling, which ensures that the distribution of relative frequencies of auxiliary statistical features in the sample corresponds to their distribution in the base population.

StatGraphics was used to process the data. Frequency tables and graphs were created not only to create an overview of sustainability in the diet of the Czech consumer but also for each generation, defined based on age

range. In this way, the article's authors try to show whether the emerging generation can significantly reduce the negative impacts of nutrition on sustainable development. The preference for sustainable products may be one aspect that will contribute significantly to climate protection. And their popularity with the younger generation may encourage their parents' consumer preferences. In interpreting the results, the results of the 2023 survey will be compared with the results of the authors' 2020 survey to identify the purchasing trend in the Czech market.

3. Results and discussion

Table 1 shows that Czech consumers do not intentionally seek out sustainable products to purchase. However, more than half of the respondents (586) said they sometimes buy these products. 34% do not consider this question at all when choosing products.

Table 1. Buying sustainable products

Do you buy sustainable products?	Absolute frequency 2023	Relative frequency 2023	Absolute frequency 2020	Relative frequency 2020
Yes, I search for them.	79	8%	109	11%
Sometimes.	586	59%	582	58%
I do not care about it.	335	34%	309	31%

Source: own processing

When comparing responses to the same question in 2020, there is also no increasing tendency to buy these products. Instead, the opposite is true, albeit to a negligible extent.

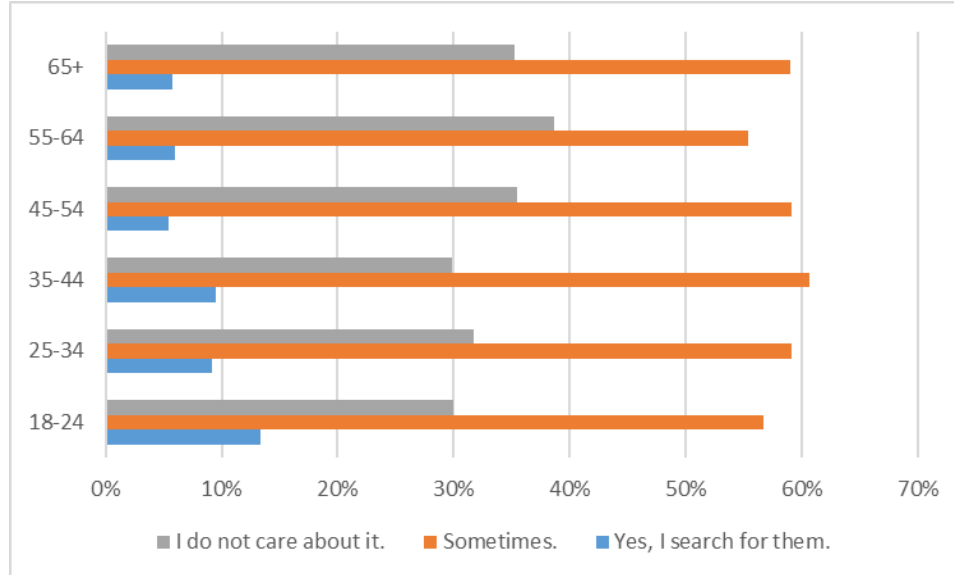


Figure 1. Buying sustainable products

Source: own processing

To assess the impact of age, age categories were established so that it is possible to build on life stages more than just the globally generalized characteristics of broadly defined generations.

Figure 1 shows that younger age groups win in the preference for sustainable products. Although purchasing sustainable products is more often associated with higher costs and the younger generation belongs to a lower

income group, the percentage of those who prefer sustainable products is above the 10% threshold. In contrast, those who are not interested in this aspect are under 30 %. The graph also shows a decreasing tendency to seek these products as age increases.

Based on these research results, the first research question, *"Which generation is more likely to buy sustainable products?"* can be answered by the younger generation between 18 and 24 years old. Similar results also emerged from research by Kamenidou et al. (2019) and Gibson et al. (2023). Sustainable products may occupy an important place in the consumption basket of Czech consumers; however, the next question focused on assessing the importance of the sustainability aspect of food purchasing.

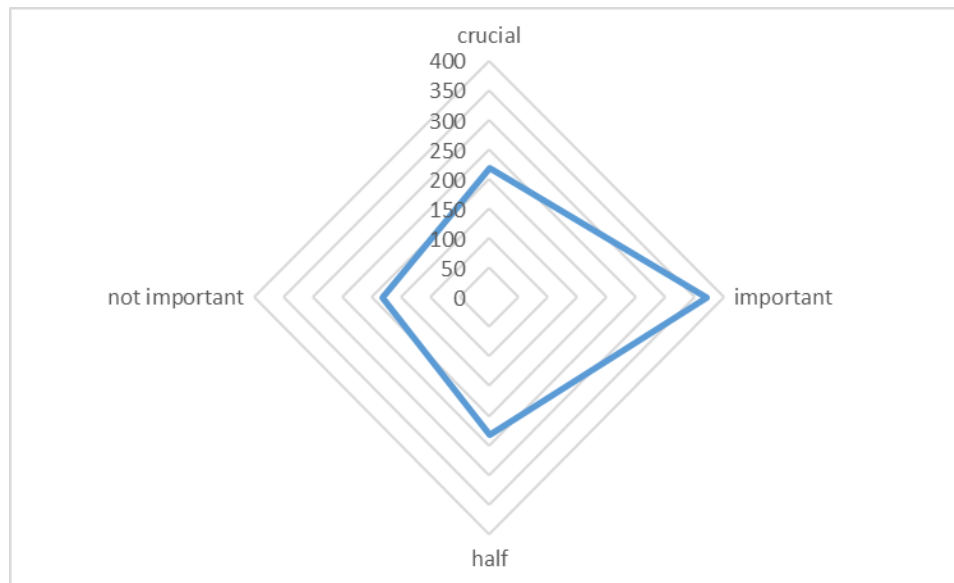


Figure 2. Importance of sustainable aspects in the food buying process

Source: own processing

Figure 2 shows that sustainability is an essential aspect of food shopping for Czechs of all ages. In fact, according to the survey results, 36% of Czech consumers consider sustainable products to be of high quality and health is a key (for 41% of respondents) or important (for 44% of respondents) factor when choosing what to eat. The highest percentages are found among the oldest age group 65+. For 59% of them, health is a key aspect, and for 31% an important one. The researchers also looked at habitual sustainable dietary behaviour from a dietary perspective, and the results from the research were important in answering the second research question, *"Is there a significant difference between generations in dietary sustainability?"*.

Table 2. Diet

What is your diet?	Absolute frequency	Relative frequency
vegan	33	3%
vegetarian	76	8%
I eat everything.	891	89%

Source: own processing

Table 2 clearly declares the prevailing trend to eat everything. When we look at the age categories (see Figure 3), the youngest age groups are again more interested in a sustainable diet.

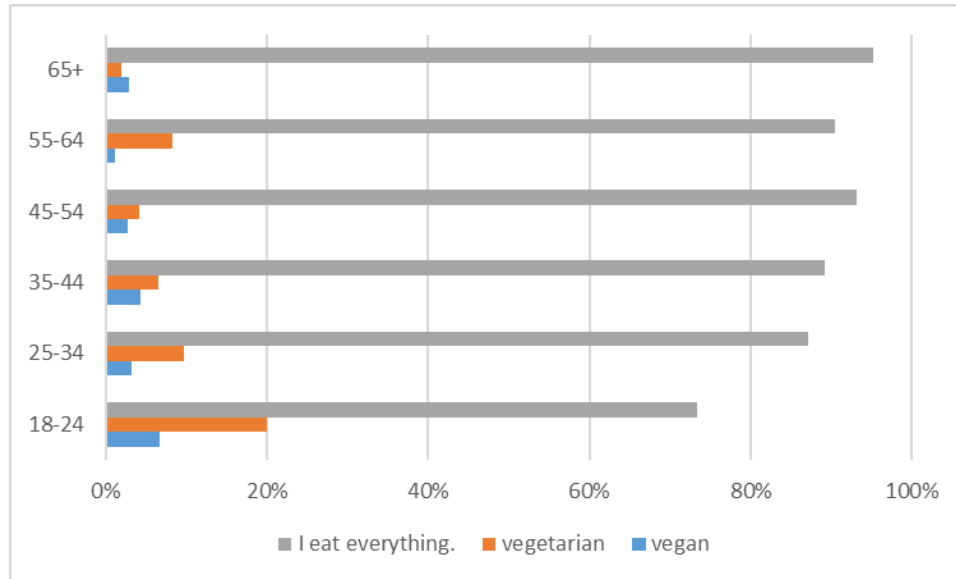


Figure 3. Diet
Source: own processing

The chart shows that the highest representation of vegetarians and vegans is among consumers aged 18-24. However, their numbers are still within the top 20 per cent. There are the fewest vegans in the 55-64 age group, and vegetarians in the 65+ category. The second research question can be answered based on these research results that, again, the younger generation is the one that does not include meat and meat products in their diet and, therefore, behaves sustainably in their eating habits. On the other hand, simply reducing meat consumption can also help to reduce carbon. Another question in the questionnaire survey was directed towards this issue, which concerned the willingness to limit meat consumption. The survey results showed that 67% of respondents eat meat as before and do not restrict their meat consumption. 19% try to restrict it but still eat it. This question was only answered by those who are neither vegan nor vegetarian - 89% of respondents.

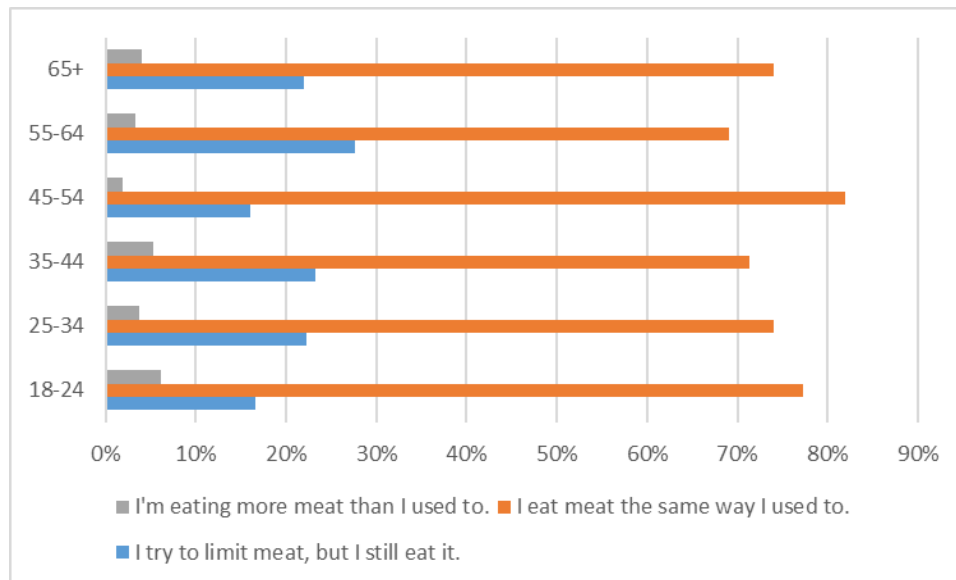


Figure 4. Eating meat
Source: own processing

Again, this factor was also compared in terms of age (see Figure 4). People aged 55-64 are the most likely to try to reduce their meat consumption (25%), while the same percentage of respondents aged 45-54 eat meat (over 80%). Only a negligible percentage of respondents in this age group eat more meat than before (3%).

This shows that meat restriction is more common among consumers aged 55-64. This confirms the difference between generations; although compared to the inclination towards veganism or vegetarianism, the trend is the opposite with regard to age. If we consider the claim that meat restriction leads to sustainability in diet, according to Di Novi and Marenzi (2022), Arslan and Alataş (2023), Willett (2019) and Hoehn et al. (2021), this generation would be perceived as more sustainable. However, a widespread reason is more likely to be health considerations. In contrast, the young follow nutritional trends, encouraging them to consume more meat.

Conclusions

The article focused on sustainable nutrition through the eyes of Czech consumers. First, the focus was on the purchase of sustainable products. In the Czech Republic, the interest in these products is relatively low. More than half of the 1000 respondents buy these products sometimes, but 34% of respondents are not interested in the issue of sustainability at all. With regard to age, there is a tendency that the younger the consumer, the more interested in sustainable products.

The sustainability of food was another topic monitored. The majority of respondents address the issue of sustainability in food. They associate it with the quality of food and, consequently, its positive impact on health, which is why the highest percentage of interest in sustainable food is among the oldest of the age groups surveyed, 65+. The results, therefore, show that sustainability in food is essential. However, the trend to eat everything still prevails in the Czech Republic. Overall, according to the study's results, there are only 3% vegans and 8% vegetarians. Again, younger age groups have shown a higher interest in these diets, especially vegetarianism.

Sustainability in nutrition is linked to the consumption of meat and its limitations. Nearly 90% of respondents answered that they eat everything, and the question on limiting meat in the diet was directed to them. Only 19% of respondents said they try to limit it but still eat it. The percentages of these responses did not vary much with age.

This suggests that sustainability as a concept is more important for younger generations. However, the benefits of sustainability in nutrition, such as quality and positive impact on health, is also an interesting decision factor for older generations more concerned about their health.

Communicating the sustainability aspect thus becomes interesting, especially towards younger generations. They are also more aware of the need for change and that they are the ones who can make a difference. It is possible to use this factor in the message towards this generation. Moreover, they are also the ones who can significantly influence the consumer behaviour of the middle-aged generations, who are often in the middle of the statistics.

Older generations draw on their experience and do not seek changes, except perhaps those promoting their health. And that is the message that should continue to be conveyed to them. Sustainable food is good quality and healthy; limiting meat consumption is good for their health and, incidentally, the planet. These are aspects that go hand in hand, but each generation perceives them differently.

The limitations of the above research can be seen in the fact that only one data collection method was used, namely a questionnaire survey. Therefore, it would be advisable to use other research methods of data collection,

such as focus groups or guided in-depth interviews not only with supporters of buying sustainable (food) products but also with their opponents in future research.

A common argument against sustainable behaviour is the economic factor. Sustainable products tend to be more expensive. Perhaps this is why there has been a slight decline in interest in sustainable products in recent years. The economic comfort of Czech society is lower. It would be interesting to investigate further whether income influences the willingness to buy sustainable products or otherwise contributes to sustainability in nutrition.

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CHANGES IN REAL INCOME OF HOUSEHOLDS IN THE CZECH REPUBLIC DUE TO THE RUSSIAN INVASION OF UKRAINE

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Abstract. The objective of the paper was to assess the impact of the invasion of Ukraine by the Russian Federation on real household income in the Czech Republic. The research methods used in the study include content analysis, seasonal modification of SARIMA, and discounting method, specifically NPV. Data were collected from publicly available sources of the Czech Statistical Office. Based on a content analysis of the macroeconomic indicators under study, inflation and gross monthly household income were selected to examine further development of real household income in the Czech Republic. Based on historical data, the SARIMA model made statistically relevant forecasts of the selected variables for the "pre-war" year 2022. Comparing real and forecast data, it was confirmed that the Russian invasion of Ukraine (from 24th February 2022 onwards) has shown how vulnerable the European financial system is to external shocks, which can be observed in significant inflationary changes. The ability of the SARIMA model to handle a larger range of data and accurately determined seasonality was demonstrated in forecasting the development of real household income. The identified economic consequences of deviations of the real and forecast figures in the "pre-war" period showed new realities in turbulent economic conditions. In order to further expand the research, combining the applied method with other analytical tools can be recommended. Moreover, it is advisable to include new relevant variables in the model. This would allow understanding better and forecasting the development of real household income in the context of current economic events.

Keywords: prediction; inflation; household income; invasion; Ukraine

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JEL Classifications: M21, E31, E61

1. Introduction

The financial crisis of 2008 brought into question the characteristics of previously observed standard economic theories (Boyer, 2018). Thus, the Great Recession caused an apparent contradiction between empirical findings and macroeconomic models based on rational expectations (Mauersberger et al., 2020). Traditional economic theory failed to explain, let alone predict, the imminent collapse of the financial system and its long-term effects on the global economy of European countries (Soltes & Gavurova, 2014, 2015; Battiston et al., 2016). The subsequent occurrence of the crisis triggered reactions conditioned by the specificities of each country worldwide (Santos et al., 2019). Terms such as tipping points, contagion and resilience have entered the financial and regulatory lexicon (Battiston et al., 2016).

Even nowadays, economists monitor and forecast economic sequences due to the impact of the 2007/2008 economic crisis. Determining the current and future state of the business economic cycle is a timely and extensive topic both in the past and the present (Vochozka et al., 2020; Gavurova et al. 2022).

Supporting the recovery from the global economic crisis brought temporary economic equilibrium, which was subsequently replaced by the crisis caused by the COVID-19 pandemic. The pandemic hit the world at a time when the effects of the global financial crisis and the subsequent Great Recession were still affecting the market economy (Moosa, 2022). The new nature of the economic and social crisis due to the spread of COVID-19 caused a spiral of shocks between supply and demand. It turned out that inflation comes when a stochastic shock hits the economy, which can be influenced by lowering the unemployment rate (Della Posta, 2022). The COVID-19 disease halted almost half the world, disrupting a quarter of financial market wealth. Global markets went into free fall, particularly in the later stages of the contagion (Ali, 2020). The complications that the COVID-19 crisis revealed are public deficits and a downturn in the business cycle (Ashta, 2021). The pandemic highlighted the growing gaps and inequalities, access and facilities in financial digitalisation (Vasile et al., 2022; Androniceanu, 2023; Androniceanu & Georgescu, 2023a).

The COVID-19 crisis proved to be a curse for financial markets, with unexpected levels of uncertainty and high volatility. Prediction hints that markets will increasingly panic as the disease moves from an epidemic to a pandemic. The global spread crossed geographical and continental boundaries (Ali, 2020).

Certain global signs of economic recovery and optimism during late 2021 were hampered by the impact of inflation and the Russian Federation's invasion of Ukraine. The global economy continues to deal with inflation, which is exacerbated by the energy crisis due to the emergency (Arner et al., 2022). The current state of inflation, combined with global factors, is unpredictable. Uncertainty about the crisis trajectory is real (Gavurova et al. 2017; Braunerhjelm, 2021).

It cannot be named or predicted, but the options are, for instance, to respond, identify and find ways to work with the crisis (Bloom, 2014). Observing hypothetical changes and fluctuations in the financial market is one of the options for adapting to macroeconomic changes and then reacting to these changes (Al-Zoubi et al., 2018; Gavurova et al. 2020). The long-term goal of realising the current economic situation formulates steps to achieve a sustainable post-war order (Gresova, et al., 2021; Androniceanu & Sabie, 2022).

The objective of this paper is to assess the impact of the invasion of Ukraine by the Russian Federation on real household income in the Czech Republic.

Since an emergency causes the crisis, there are likely to be turning points in the business cycle development that are identified by estimating macroeconomic data (Belas et al. 2019; Cavallari, 2022; Radchenko et al., 2023).

In order to meet the objective, it is necessary to first determine development of macroeconomic indicators, hence the first research question (RQ1) is as follows:

RQ1: What was the development of inflation and gross household income in the Czech Republic before the RF invasion?

National business is moving towards adapting to a transforming economy that is changing due to a diversity of threats. The consequences are fluctuations in macroeconomic indicators (Demchenko, 2018). As for the global economy, the war poses a threat, not only in the form of fluctuations, but it also brings a new challenge in the efforts of businesses and society to recover from the war (Lytvynova et al., 2022).

The formulation of the second research question (RQ2) and the third research question (RQ3) is aimed at determining the extent of the impact of the invasion on changes in the living conditions of households in the Czech Republic based on established indicators.

RQ2: What is the forecast for inflation and gross household income in the Czech Republic for 2022 based on historical data?

RQ3: What will be the deviation of the forecast and real inflation and gross household income in the year 2022?

During the invasion of Ukraine, there has been a deep decline in economic activity as well as the introduction of a number of changes to mitigate the shock in society and the economy (Irtysheva et al., 2022). The last, i.e. the fourth research question (RQ4), will focus on real household income, as this reflects the amount of goods and services households can afford (Yang et al., 2020).

RQ4: What will be the impact of identified economic consequences of the deviations on the development of real household income in the Czech Republic until 2025?

2. Theoretical background

According to Musil et al. (2019), changes in the interpretation of regional indicators affect price level development. Subsequently, these changes reflect the development of market microstructures and their economic equilibrium or vice versa. The financial downturn in 2008-2009 and the Greek crisis in 2011 showed that the economic systems of each country are interconnected and mutually influenced. Each crisis period is characterised by the specific nature of the economic crisis. However, one rarity remains constant: the sharp increase in prices in individual areas (Zubikova and Smolak, 2022).

During the global financial crisis of 2007-2008, banking systems were under stress (Haq, Tripe and Seth, 2022). According to Godechot et al. (2022), increased capital requirements and a cap on national spending led to a significant asymmetry in restructuring. As Shen et al. (2018) claimed, the global financial crisis of 2007-2009 revealed the need to measure and monitor the transmission of extreme market risk.

In 2019, the COVID-19 pandemic caused an economic slowdown in the Czech Republic and worldwide. At that time, the price dynamics on the market were characterised by an inflexible and insufficient supply of new properties, due to which it was mostly demand-driven. The property market was influenced by monetary and fiscal policies (Godechot et al., 2022). Cermakova et al. (2022) found that finance intentionally invested in all economic sectors to limit the negative effects of pandemic measures led to a sharp rise in property prices, particularly in wealthier areas with minimal unemployment rates.

Given the financial turmoil over the last 10 years, financial institutions have been the point of economic reaction. The problems that occurred in the financial system since the pandemic have not vanished but are now being exacerbated by the price level changes caused by the invasion of Ukraine by the Russian Federation (Arner et al., 2022). Ukraine and Russia are important players in the energy market, and this has been confirmed. According to Osicka and Cernoch (2022), the European energy transition is coming (Androniceanu & Georgescu, 2023b). The current existence of an unstable economy brings lessons from the past, which, from a financial viewpoint, has been experienced by every citizen not only in the Czech Republic, but also in Europe.

The disruption of international trade and its activities has affected EU countries. The ongoing war in Ukraine has had a devastating effect on human lives, infrastructure and global inflation. According to Aliu et al. (2022), the Russian invasion of Ukraine (from 24th February 2022) has shown that the European financial system is fragile to external shocks. Given the Eurozone's dependence on Ukrainian and Russian resources, the immediate food security problem became apparent.

In response to Russia's request in June 2022, gas payments were made in rubles, further complicating the current situation and strengthening the value of the ruble, which, in the view of Aliu et al. (2022) is not a hard currency. The empirical research study by Liang et al. (2022) showed that import and export trading are major factors affecting economic growth. James, Menzies and Chin (2022) followed concerns about the current stagflationary economic environment. Based on multivariate time series and observing external indicators, they identified the most anomalous historical periods most similar to current market dynamics. According to Vrbka et al. (2018), a powerful model for solving a number of economic classifications can be artificial neural networks which allow making of time series forecasts. Based on their content analysis of capital markets and by determining the magnitude and variability of the impact of the invasion by the Russian Federation, Serrano and Angosto-Fernandez (2022) applied a system of uncorrelated regressions to daily index returns that were affected by energy and economic factors.

According to Astrov et al. (2022), Western financial support seriously impacts the financial sector of every country engaged in it. As a result of the war, the whole of Europe was already affected by high inflation and sharp rises in the price level. Also, cost-burdened real incomes, real household incomes and a reduction in economic growth will not be left out.

Using sets of annual time series on the growth rate of macroeconomic indicators provides a picture of the development of economic indicators and the subsequent determining of their causal relationships, which is one of the objectives of this study. To assess differences in regional price levels, Kocourek et al. (2017) applied the method of estimating regional price levels in individual districts of the Czech Republic, based on which they arrived at a tool for a more accurate and realistic comparison of household living standards. The used data taken from the Czech Statistical Office, the Eurostat International Comparison Programme and the OECD showed differences in market prices that affected household needs at the regional level.

Geltner et al. (2022) examined the effect of NPV indicator on real purchasing power of a certain municipality. Their study was related to finding evidence of a positive correlation between two financial indicators that compared the market value of a company's assets with their replacement cost. Finally, the study examined whether NPV can be used to forecast real-world price increases and how NPV affects the purchasing decisions of investors and consumers.

Following on from the aforementioned study, the used beta-convergence framework was taken into account by Lichner et al. (2022) who then focused on observing differences in nominal and discretionary household incomes before the economic recession and during the crisis from January 2004 to December 2012. Their results supported the hypothesis that in assessing economic imbalance, income and consumption should be assessed together.

Arjunan (2022) came up with a fresh view where a new method for estimating NPV and IRR of an investment project was introduced. The method was different from the traditional discounted cash flow (DCF) approach that was replaced by the capital amortisation schedule (CAS) method. According to CAS, the interest rate at which the present value of the closing balance in CAS equals zero appeared equivalent to the internal rate of return.

Liang et al. (2022) applied a combination of linear and nonlinear models to forecast exchange rate fluctuations. The aim of obtaining the forecast was to enhance the ability of companies to avoid exchange rate risks. Using the ARIMA model, dynamic exchange rate fluctuations were analysed. The model's application allowed us to capture better the factors affecting exchange rates, including non-linear interactions between different variables. The analysis results showed that the mechanism of influencing economic growth is dependent on extraordinary situations, which can affect exchange rate fluctuations.

In terms of the comparative method, Shahriar et al. (2021) examined performance of hybrid models using Autoregressive Integrated Moving Average (ARIMA) and Artificial Neural Networks (ANN). According to the authors, the ARIMA method demonstrated the ability to work with a larger range of data and accurately determined seasonality, which corresponds to the research objective of this paper.

On formulating the forecast of dissolved gas concentration in transformer oil, Liu et al. (2022) also used the ARIMA model, or the seasonal modification of SARIMA, where the accuracy and stability of performance were demonstrated. Equally positive results in modelling river runoff forecast were achieved in the study by Zhang et al. (2022), where SARIMA allowed to use historical data and further analyse time series with seasonal variations.

In order to provide a comprehensive overview of the impact of emergency situations, it is important to take into account changes in household consumption behaviour, which, as claimed by Tran (2022), is considered a key measure of a country's economic growth or decline.

As regards this paper, the content analysis method will be used to collect and subsequently analyse data in relation to the above research questions. The development of inflation and gross household income will be shown based on identified variables' fluctuations over the specified period. The ARIMA model, or the seasonal modification of SARIMA, and the discounting method, specifically NPV, will be used to address the second research question. Descriptive statistics will be used to determine deviations of the forecast and real figures of the selected variables in the year 2022. The seasonal modification of SARIMA will also be applied to answer the fourth research question, which is to forecast real household income until 2025, as its use is relevant and demonstrable.

3. Research objective and methodology

Data on the development of the aforementioned variables for the period under review (2000-2022) are available on the website of the Czech Statistical Office, specifically in the database of time series of inflation and consumer prices and in the sections on social security, wages and labour costs (ČSÚ, 2022).

Another criterion that will be addressed is the development over time and the possible scenario of the development of the variables in 2022. In relation to the second research question (RQ2), particular time series in the form of quarterly frequency will be defined from 2000 to 2021. Data on the variables (inflation, gross monthly income increased by average income) will be taken from the public database of the Czech Statistical Office, specifically from the sections on social security, prices and inflation, wages and labour costs. Furthermore, in order to deepen the RQ2, the discount factor will be determined on the basis of historical data on price level adjusted for inflation for the period from December 2020 to December 2022. The elaboration of the third research question will follow on from the data obtained from the previous question. Finding the future development of real income will be finalised with the use of data on gross monthly income increased by average income. The data will

be drawn from the public database of the Czech Statistical Office, specifically from the sections on social security, wages and labour costs.

The time series analysis of the period under review serves to answer the first research question. The first step in creating a model of development of the variables will involve data collection related to this period. Using data published by the Czech Statistical Office, changes in the relevant data of a particular variable will be shown. The statistical software R will be used to make the collected data more transparent (Androniceanu, 2021). This step is preceded by data cleansing and also their quality control. Subsequently, the data will be implemented by means of graphical representations, which will be available in the Results section and enable the formulating of a conclusion based on the results obtained.

The SARIMA model will be applied to forecast inflation and average monthly income increased by average income. The seasonal modification of the SARIMA model, as proposed by Clarke and Clarke (2018), will be expressed using the following formula:

$$\phi_p(B)\Phi_p(B^s)(1-B)^d(1-B^s)^D Y_t = \theta_q(B)\Theta_q(B^s)\varepsilon_t.$$

The establishment of the model will be carried out in the statistical software R. Using data with quarterly frequency in the specified period, the forecast of the variables under study for the period of 2022 will be completed. Here, the purpose is to find out what the economic situation in 2022 might look like. Based on the observance of the previous period's trends and without the influence of the emergency situation, which was the Russian invasion of Ukraine, the second research question (RQ2) will be answered.

Moreover, in order to deepen the RQ2, an inflation-adjusted discounting of the price level for the years 2021 and 2022 will be performed. An inflation rate for each month of a particular year will be identified and then the numerical figure of this indicator will be removed from the nominal value of the price level. Also, the NPV method will be used to take into account the real value of money for 2021 and 2022, and the results will then be compared with each other. This method will be displayed with the use of a month-on-month inflation index considering the monthly price level always in relation to the previous month. Using the real discount factor in monetary terms of CZK 1 000, calculations will be made in the statistical software R in order to determine the impact of the aforementioned invasion on the inflation-adjusted price level development. The final step will be to compare the results of the real discount factor. The calculation formula will be as follows:

$$RPH = \frac{PH}{(1+i)^n}$$

where:

PH is the nominal value of the price level;

i is the inflation rate;

RPH is the inflation-adjusted price (i.e. the price level adjusted for inflation).

In the third stage, there will be a comparison of the forecast and real inflation and monthly income increased by average income for the year 2022. The comparison will be made in the statistical software R, into which the data related to the period under review will be installed.

In the final stage of solving the research problem, the SARIMA model will be applied. This will answer the fourth research question, i.e. forecasting future development of real household income in the Czech Republic until 2025.

Depending on the methods and data sources, research outputs will take the form of graphs and figures. The anticipated results should show how inflation developed over time. What could be the development of the selected variables in response to the invasion. What are the forecast deviations, real inflation, and gross household income in 2022. The real income development in the Czech Republic until 2025 should then be presented in the final part.

3. Results

Development of inflation and gross household income in the Czech Republic before the RF invasion.

During the period under review, the observed variables went through different stages, which is evidenced by the baseline result in the following graphs:

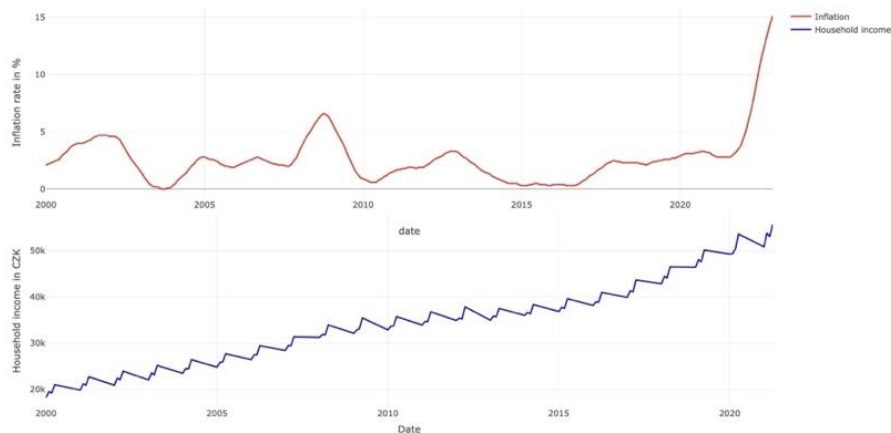


Figure 1. Development of inflation and gross monthly household income (ČSÚ, 2022)

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2022)

The above Figure 1 shows the development of inflation and gross household income from 2000 to 2022. When considering the first (top) curve related to inflation, it can be stated that the crises that hit the Czech economy have left their mark on the development of the given variable. Inflation was relatively high at the beginning of the year 2000, inflationary pressures gradually decreased, and from 2004 inflation stabilised at relatively low rates. Between 2004 and 2008, inflation in the Czech Republic was relatively stable and hovered mainly around 2-3%. In 2008, however, inflation increased significantly due to rising oil and food prices in world markets. This increase was temporary, and inflationary pressures eased in 2009. Then, inflation gradually increased from 2013 to 2017, reaching around 2%. The 2017 – 2021 period is noteworthy since the variable showed a largely stable trend. Subsequently, in 2021 and 2022, there was a significant increase in inflation due to the Covid-19 pandemic, disruption of foreign trade and, last but not least, the impact of the RF invasion of Ukraine.

The second (bottom) curve indicates a certain stability and consistency in the development of the other variable. Despite occasional fluctuations, it can return to its normal trends in a shorter time horizon.

Forecast of inflation and gross household income in the Czech Republic for the year 2022 based on historical data.

The inflation forecast is made using the SARIMA model in the statistical software R. The answer to the second research question can be found in the following graph, where the forecast development of the inflation variable for 2022 can be observed:

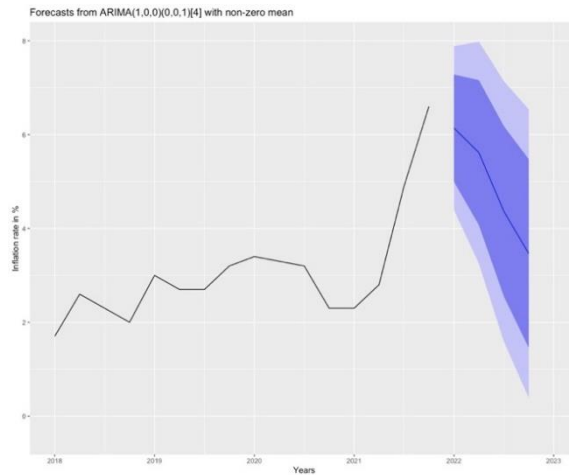


Figure 2. Forecast of inflation for the year 2022

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

The above graph in Figure 2 can be divided into two parts. The first part depicts the quarterly development of inflation from 2018 to 2021. Based on publicly available information, the following trends in the development of the variable can be established. In 2018, there was a fluctuating trend ranging from 1.70% to 2.60%. 2019 inflation started at 2.0% and gradually increased to 3.4%. In 2020, inflation was impacted by the COVID-19 pandemic due to reduced demand, reduced energy costs and other factors, and by the end of that year, the variable reached its minimum (2.30%). Then, there was an upward trend, significantly increasing to 6.6%.

The second part includes inflation forecasts for 2022. The projected trend in the first quarter of 2022 is expected to be 6.14%, whilst a decrease to 5.60% is expected in the second quarter of 2022. In the third quarter of 2022, inflation is expected to further fall to 4.40%. In the fourth quarter of 2022, it is expected to fall again (3.50%).

The specific forecasts of inflation development depend on the input data used to train the forecast model, and the resulting model's specification. For clarity, Table 1 with point forecasts is available in the list of appendices. In order to ensure the statistical significance of the forecasting, p-values of the inflation forecast for 2022 are provided in the following part.

z test of coefficients:

	Estimate	Std. Error	z value	Pr(> z)
ar1	0.912067	0.049391	18.4662	< 2.2e-16 ***
sma1	-0.477338	0.102407	-4.6612	3.144e-06 ***
intercept	2.663529	0.546074	4.8776	1.074e-06 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Figure 3. P-values of inflation

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

In order to meet the second research objective, differences are first identified in the real value of money between 2022 and the previous year. From the discounting output performed in the statistical software R, it is found that the sample amount lost CZK 61.78 in 2021 due to inflation. Moreover, in the period when Russia launched its invasion of Ukraine, the results show an almost two-fold change. The price level decline in the Czech Republic is

CZK 136.75 lower given the sample value of CZK 1 000. As opposed to the year 2021, the difference is CZK 75.025 in monetary terms.

The following part involves forecasting of the variable of gross monthly income increased by average income for the year 2022.

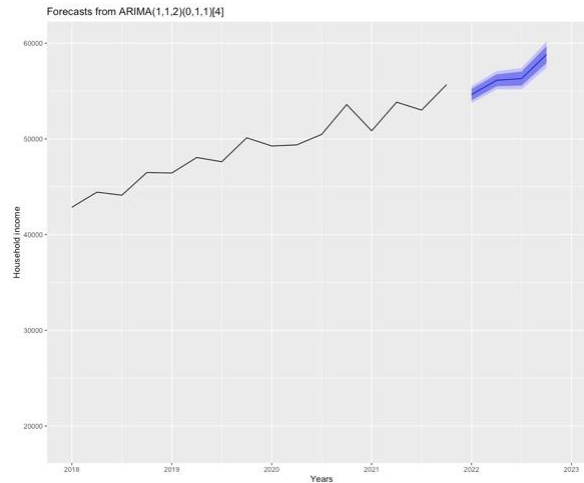


Figure 4. Forecast of monthly income for the year 2022

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

The above graph in Figure 4 of the quarterly development of monthly income from 2018 to 2021 can be divided into two parts. A gradual increase in the income was observed in 2018 and 2019. However, in 2020 and 2021, there was a decrease due to the COVID-19 pandemic. Then, it can be seen on the basis of the available information that the income gradually recovered and started to increase again towards the end of 2021.

The forecasts indicate a gradual increase in monthly income over the period under review. In the first quarter of 2022, the income is projected to reach 54 633. In the second quarter of that year, a slight increase in the income is expected, eventually amounting to 56 127. During the third quarter, further moderate growth is projected to reach 56 308, and the last quarter is characterised by an increase in income to 58 814.

For clarity, Table 2 with point forecasts is available in the list of appendices. Thus, given its input parameters, the resulting forecast of the variable of gross monthly income increased by average income is completed for the year 2022. However, in order to ensure the statistical significance of the forecasting, p-values are provided in the following part.

	Estimate	Std. Error	z value	Pr(> z)
ar1	0.858483	0.078053	10.9987	< 2.2e-16 ***
ma1	-1.494075	0.109896	-13.5953	< 2.2e-16 ***
ma2	0.828968	0.129165	6.4179	1.382e-10 ***
sma1	-0.925538	0.153999	-6.0100	1.855e-09 ***

Signif. codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.' 0.1 ' ' 1

Figure 5. P-values of monthly income

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2021)

Deviation of forecast and real inflation and gross household income in the year 2022.

Inflation rate in %		
Date	Real	Prediction
I-22	12,70	6,14
II-22	17,20	5,60
III-22	18,00	4,40
IV-22	15,80	3,50

Figure 6. Real and forecast inflation

Source: Own processing based on data from the Czech Statistical Office (2000–2021)

As regards the above data in Figure 6, several differences between the real and forecast inflation can be observed. In the first quarter, there is a statistically significant difference between the real rate (12.70%) and the forecast rate (6.14%). This difference suggests that the inflation rate exceeded expectations in the given period. In the second quarter, there is an even more pronounced difference between the real rate (17.20%) and the forecast rate (5.60%). This deviation indicates that the inflation rate was above expectations as well as being significantly higher. The third quarter is also characterised by a difference between the real (18.00%) and the forecast (4.40%) inflation. As in the previous case, the real inflation rate exceeded expectations. In the final quarter, the difference between the real (15.80%) and forecast (3.50%) rates is not as significant as in the previous quarters.

Household income in CZK		
Date	Real	Prediction
I-22	54228,00	54633,00
II-22	57392,00	56127,00
III-22	57913,00	56308,00
IV-22	61473,00	58814,00

Figure 7. Real and forecast monthly income

Source: Own processing based on data from the Czech Statistical Office (2000–2021)

The above comparison of the baseline data in Figure 7 shows several trends in the relationship between the real and forecast monthly income. In the first quarter, the real income (54 228) was slightly lower than the forecast income (54 633), with the difference between them being relatively small. This suggests that the income forecast was generally accurate, although the reality differed slightly from expectations. The second quarter saw an increase in the real income (57 392) compared to the forecast income (56 127). This difference indicates that the income was actually higher than originally expected. The third quarter again showed an increase in the real income (57 913) as opposed to the forecast income (56 308). This difference indicates that the income was again higher than expected. The fourth quarter again sees an increase in the real income (61 473) compared to the forecast income (58 814).

Development of real household income in the Czech Republic to the year 2025.

When considering the real household income as such, Figure 8 below illustrates forecasting of its future development in the Czech Republic until 2025. The forecasting is made with the use of a modified SARIMA model with quarterly data.

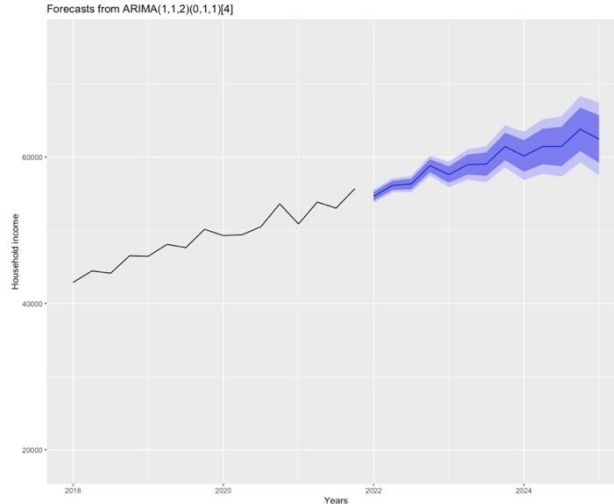


Figure 8. Forecast of real household income in the Czech Republic until 2025

Source: Own processing in statistical software R based on data from the Czech Statistical Office (2000–2022)

On the basis of the forecasting by the selected model, a slight increase in real household income in the Czech Republic is observed from 2022 onwards. The income rises during 2023, but falls towards the end of that year. A favourable development is expected during 2024, suggesting a gradual improvement in economic conditions. Then, the income is forecast to reach its peak in 2025, but is expected to decline again towards the end of the forecast period. The baseline forecast indicates that real household income has a trend of fluctuation and moderate variability.

Discussion

Based on the results achieved, all four research questions (RQ1, RQ2, RQ3, RQ4) can be answered.

RQ1: What was the development of inflation and gross household income in the Czech Republic before the RF invasion?

In the context of monitoring variables in the Czech Republic before the invasion by the Russian Federation, different development stages can be identified. Overall, it can be concluded that the development of inflation in the Czech Republic was characterised by considerable fluctuations, including periods of low and high inflation. The resulting instability reflects the impact on the internal factors of the Czech economy and the global economy.

The other variable under study, i.e., gross monthly household income, is characterised by a certain stability and consistency. Despite occasional fluctuations, the variable is able to return to its normal trends in the short term. This implies that household incomes maintained a particular degree of stability and were able to recover from occasional adverse fluctuations. This income stability is significant as it affects the living standards of the population and their consumption behaviour.

Determining the current and future state of the business cycle is a timely and extensive topic, as argued by Vochozka et al. (2020). Taking account of the development of both variables was a beneficial step towards a comprehensive grasp of the development of inflation and monthly household income.

RQ2: What is the forecast for inflation and gross household income in the Czech Republic for the year 2022 based on historical data?

Based on the historical data analysis, forecasts of inflation and gross household income in the Czech Republic for the year 2022 were made. The results of the selected SARIMA model were relatively accurate and, importantly, statistically relevant as well. The forecasts of the development of inflation and gross monthly income for 2022 outlined what the economic situation might look like if the trend of the previous periods was to be maintained. Applying the SARIMA model allowed to obtain relevant forecast results despite the dynamic and unexpected final figures. The results were comparable to the study by Shahriar et al. (2021), where the model's ability to handle a larger data range and determined seasonality was demonstrated.

In order to provide a comprehensive overview of the impact of emergency situations, the financial circumstances of households were taken into account. The assertion made by Osicka and Cernoch (2022) that the prevailing economic instability has been experienced by every citizen was confirmed in the results of the obtained real value of the price level. It turned out that during the period when the Russian Federation attacked Ukraine, there was a significant change in the price level compared to the previous period.

RQ3: What will be the deviation of the forecast and real inflation and gross household income in the year 2022?

In relation to answering the third research question, data from the previous research question were used. On the basis of the previous analysis, possible future inflation and gross household income were estimated for the "pre-war" year 2022. Comparing the real and forecast data confirmed that the Russian invasion of Ukraine (from 24 February 2022 onwards) has shown that the European financial system is vulnerable to external shocks, which can be easily observed in significant inflationary changes. The analysis of the real and forecast figures indicated that with regard to inflation, the real figures showed frequent deviations from those anticipated.

Considering the first quarter of gross monthly income, the real figures were lower than expected, whereas in other cases, they were higher.

RQ4: What will be the impact of identified economic consequences of the deviations on the development of real household income in the Czech Republic until the year 2025?

Using the selected SARIMA model, the development of real household income in the Czech Republic was found to be slightly fluctuating. The ability of the SARIMA model to handle a larger range of data and accurately determined seasonality, as claimed by Shahriar et al. (2021), was confirmed. The use of historical data, as in the study by Zhang et al. (2022), contributed to the careful analysis of the time series and the identification of potential fluctuations that may occur when modelling future estimates. Similar findings were also confirmed in the study by Liu et al. (2022), which focused on maintenance and safety. The SARIMA model proved to be a helpful tool for better forecasting of data with significant seasonality.

The identified economic consequences of the deviations resulted in the following development of real household income in the Czech Republic until 2025. The moderate growth of the income in 2022 suggests a certain stability. However, a decrease was expected towards the end of 2023, which could to some extent be due to changing economic conditions. The favourable development in 2024 indicated improving economic conditions, which could contribute to the real income growth. Towards the end of the forecast period in 2025, the income was expected to decrease again, which could signal volatility and uncertainty in the economy.

Conclusions

The objective of the research was to assess the extent to which the invasion of Ukraine by the Russian Federation has affected the real income of households in the Czech Republic. Regarding the information obtained, it can be concluded that the objective was met. The research fulfilled its objective and provided valuable insights into the relationship between the invasion of Ukraine by the Russian Federation and the aforementioned income in the Czech Republic.

Monitoring gross monthly household income in relation to inflation represents the development of key indicators of economic stability and living standards of the population in the Czech Republic. The analysis of the development of these variables in the period from 2000 to 2022 allows to identify long-term trends, cyclical fluctuations and possible deviations caused by economic events.

Modelling forecasts of inflation and gross household income for the pre-war year 2022 in the Czech Republic provides an opportunity to examine and analyse historical trends and new realities in turbulent economic conditions. The real inflation often deviated from the anticipated one, suggesting that it is a complex phenomenon. Accurate forecasting in a turbulent environment is challenging and difficult. In terms of gross monthly household income, it was important to regard household consumption behaviour. Although in this case the real income exceeded the forecast income, this situation could be seen as positive, but the significant and sharp rise in inflation must be taken into account. Given this inflationary growth, the slight increase in the monthly income cannot be considered positive.

The identified economic consequences of the deviations point to the importance of analysing external factors that may affect the development of real household income. Studying the variables of inflation and gross monthly household income brings a deeper understanding of the economic environment in the Czech Republic. These analyses provide valuable information for formulating policies related to social security and pension system.

When interpreting the above forecasts, it is important to bear in mind that the forecasting models were based on historical data and assume that the future will follow the same trends and patterns. Comparing the real figures with the forecast figures enabled us to assess not only the accuracy and reliability of the models used but also how crisis situations can affect the behaviour of economic indicators.

Due to the instability and rapidly changing nature of the issues under study, there are certain limitations and specified shortcomings within the presented framework. In order to further expand the research, combining the applied method with other analytical tools, such as neural networks is recommended. Moreover, it is advisable to include other relevant variables in the model. This would allow us to understand better and forecast the development of real household income in the context of current economic events.

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GENDER AND REGIONAL DISPARITIES IN INCOME LEVEL PERSPECTIVES IN UNITED STATES AGRICULTURE SECTOR*

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Abstract. Agriculture, as one of the most important sectors of the economy of many countries, has to deal with gender inequality, which is part of it, among other problems. For centuries, women have been excluded from this area, but nowadays, they have the opportunity to participate in agricultural activities to the same extent as men and achieve an adequate income. The success of women in US agriculture in the form of their income can be explained through the six indicators: age, family involvement, farm area, farming period, female operators, and partnership by applying the regression analysis. The coefficient of determination shows that the Heartland Region regression model has the highest statistical significance, explaining 51.03 % of the investigated data variability. The second position is kept very closely by the Upper Midwest Region with a value of 50.06 %; the next ones are the Delta Region with a value of 46.37 %, the Great Lakes Region with 44.44 %, and the Northwest Region with 43.24 %. All the regression models assigned to these regions are suitable for explaining. Surprisingly, there are cases where a mutual ratio of the regression coefficients of the same indicator for the two specific regions is twice as high or lower. It reveals there are deliberate regional disparities.

Keywords: agriculture; gender inequality; United States regions

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1. Introduction

The farms where women perform as the principal operators generate about 40 % less income than those led by men (Fremstad & Paul, 2020). A majority of the farms in the United States of America's agricultural sector are run as family businesses. Small family farms represent about 90 % of all farms, and thus, they operate on about 55 % of the whole farmland in the United States of America (Hoppe & MacDonald, 2013). The salary level for farmworkers is affected by productivity. It means that higher labor productivity advances the higher salary levels for workers. Between 1948 and 2017, their average salary level increased approximately 13 times (United States Department of Agriculture, 2022). The most noticeable characteristic of the principal farm operators is their age. The older operators are considered to be older than 65 years (United States Department of Agriculture, 2014). The principal operator is the person most responsible for all the farm operations.

This study aims to evaluate the income from an agricultural activity that affects the six explanatory variables – namely age, family involvement, the farming area, the farming period, the female operators, and the partnership. Specifically, the study focuses on investigating the regional approach that is important for the two main points. Firstly, it is crucial to obtain information about a potential area, and secondly, to reveal a possible relation among the explored regions. The analysis is carried out at the level of the regions of the United States of America, whose geographical division into the twelve regions is based on the National Agricultural Statistics Service of the United States Department of Agriculture. The sensitivity analysis is employed as the methodological approach, and the regression analysis is applied to demonstrate the analytical outcomes. Regression analysis, as the main analytical method, is believed to be the most appropriate tool to catch the coherence among the variables examined.

2. Theoretical background

Gender inequality in agriculture is addressed within a given state, as stated by Balezentis et al. (2021) in their study, where they examine gender inequality in agriculture across Lithuania. The analysis is aimed at young farmers and is based on the survey, which resulted in 473 questionnaires. T-test and chi-square tests were applied to observe whether the differences among the respondents' answers for checking the existence of gender inequality are significant. Their analysis shows that there are no significant differences across the gender, and the Lithuanian agricultural sector is equally advantageous for women and men farmers. However, many researchers evaluate gender inequality across regions, such as Pattnaik & Dutt (2020), who focus on analysing the main socioeconomic and cultural factors that influence women's participation in agriculture in two states, Gujarat and West Bengal, in India. The authors examine survey data of 800 households using the binary logit model. The regression analysis outcome demonstrates that women's participation in the farm sector differs over regions and depends on caste and economic factors. Loison (2019) analyses gender and regional disparities and livelihood diversification in the agricultural regions in rural Kenya. The author used panel data from 239 households between 2008 and 2013. Panel data models show that there are significant and positive relationship changes in household assets and livelihood diversification at a regional level. Broussard (2019) examines women's food security using the Gallup World Poll data for 146 countries, with a sample size of 132983 adults conducted in 2014. The analysis shows that the gender gap in food insecurity varies at the regional levels. Silva et al. (2018) focus on sustainable intensification at the farm, field, and regional levels. The authors use two International Rice Research Institute surveys to analyse constraints in Central Luzon, Philippines. Linear mixed models result indicate that changes in management practices over the past 50 years have positively affected labor productivity, but from the point of farm or regional level, no clear changes have been demonstrated in this study. Bianchi et al. (2021) focus on economic structures, material productivity, and socioeconomic determinants. The study uses panel data for 280 European regions collected from Eurostat. The authors use cluster analysis to classify European regions. The econometric analysis results show that socioeconomic factors on material productivity differ between regions.

Studies on gender inequality in agriculture monitor its manifestations based on various indicators (Imran et al. 2023). For many researchers, income is one of the most reliable indicators for determining the level of gender inequality in agriculture. Smith & Floro (2020) focus on the roles of food insecurity and gender in the migration decision process for the final sample of 135078 individuals across 94 low- and middle-income countries from 2014 to 2015 in the Gallup World Poll Survey. Their analysis using a series of binary-choice models shows that these relationships differ significantly by gender and level of gross national income. The study by Profumo et al. (2021) draws attention to women's empowerment in agriculture in association with food production and dietary diversity among children. The authors apply the multivariate regression models using the Abbreviated Women's Empowerment in Agriculture Index. They analysed 156 dual-adult rural households, demonstrating that the dietary diversity scores of empowered women and their children are higher than those between disempowered women and their children. Based on the analysis results, the authors confirm that there are small gender gaps in a decision on production depending on access to resources or control over income.

Akter et al. (2021) focus on analysing gender inequality in Southeast Asian agriculture. The study is based on 37 focus groups with 290 women farmers from Myanmar, Thailand, Indonesia, and the Philippines. Focus groups were created on recommendations by the Women's Empowerment in Agriculture Index. The authors confirm, first based on a qualitative data collection method and then by content analysis, that in the mentioned countries, women have equal access to resources and higher control of household income than men. At the end of the study, the authors declare that to bridge gender gaps in agriculture. It is important to distinguish among gender intervention frameworks, as they proved to be country-specific. Tambo & Mockshell (2018) examine the impacts of conservation agriculture technologies on household income in Sub-Saharan Africa. The study uses survey data from 9 countries. A cross-sectional sample of 3155 smallholder maize-producing households was analysed based on the regression and mean values of the variables. The impact of conservation agriculture techniques on household income was analysed using inverse-probability-weighted regression adjustment and propensity score matching. At the end of the study, the overlap among adopters and non-adopters of alternative conservation agriculture practices is shown by Kernel density distribution. Balancing tests applied before and after the Kernel matching score show that the introduction of conservation agriculture technologies significantly increases household income. Herrera et al. (2018) examine the income, productivity, and diversification of smallholders in Brazil. The study uses a database of about 4,7 million family farmers in the country and is conducted by the Ministry of Agrarian Development. The result of two linear regressions and Tobit regression is that smallholders as members of an agricultural cooperative or members of an agricultural association positively influence observed parameters.

Schmidt et al. (2021) analyse the United States female farmers at the county level obtained from the Census of Agriculture using fixed-effects panel regression. The analysis shows that women are more involved in farming in counties where income distribution is more equal, income levels are higher, and childcare availability is provided. Social responsibility is a critical perspective in this field aiming at sustainable development of the principles leading to diminishing the disparities in the small and medium businesses functioning (Gavurova et al., 2022). Zhang et al. (2021) investigate the determinants of market-oriented activities in agriculture and their impact on farm performance. Their study is based on data from a nationally representative survey consisting of 4560 rural Chinese farm households. The multinomial endogenous switching treatment regression results indicate that farm profits can be increased by land renting on cash cropping. Sainio et al. (2021) evaluate the farmer's views on the future of changing climate. They point to financial support, costs, and investments. The research sample consists of a total number of 6401 farmers in Finland. Kijima et al. (2020) analysed the agricultural efficiency in Uganda and Kenya. Panel data analysis shows that land rental is proving significant in both countries, and the land sales appear significant only in Uganda but not in Kenya. Špur et al. (2018) examine participants in small-scale farming in Slovenia. The research sample consists of 198 meadow owners from 2015-2016. The result of binominal logistic regression shows that factors like gender, income, age, or large meadow area significantly positively affect agri-environmental schemes. Richards et al. (2020) analyse private lands and reforestation. This study uses

survey data from 189 farmers in Brazil. Multinomial logit regression for valuation data is used. Results of mixed logit regression show that variables like income or area size are significant.

Another research subject in this field is landownership, as Yoking & Lambrecht (2020) examine the landownership and gender gap in agriculture using Ghana's Feed the Future Baseline Dataset. For the survey, the sample used 230 enumeration areas, and 4410 households were surveyed. The observed variables' association is evaluated using recursive bivariate probit models. All variables using clustered standard errors were denoted as significant in this investigation. Some studies examine urban agricultural types, such as a study where urban agriculture participants are ensured using survey data from 74 urban agriculture sites in parts of Europe and the United States in the study by Kirby et al. (2021). Quantitative analysis, factor analysis, multivariate analysis of variance, and multilevel multivariate analysis show that there are significant differences among participants in distinct urban agriculture types or agriculture near cities such as Wästfelt & Zhang (2018), whose research sample consists of 150 farming properties from Hisingen, Swedenland, and a combination of methods is applied to process data, or urbanisation and agricultural impact on the ecosystem, such as a study by Narducci et al. (2019), who examine the urbanisation and agricultural impact on ecosystem services in the western United States. The investigation is based on face-to-face surveys of 392 respondents.

On the other hand, some studies address the situation in rural areas, such as the study by Barbosa et al. (2020), which analyses the success of family farms from the rural women's viewpoint. This study uses the Q methodology to identify the factors that influence this success. The result obtained from 28 women as a research sample is that five viewpoints exist. Sen et al. (2021) examine three types of households from agriculture in rural Bangladesh using data from the Force Survey of 2000 to 2013. The result shows that in all observed groups, there was an increase over the 2000 to 2013 period.

3. Research objective and methodology

A total of seven variables are investigated in the analysis. The explained variable is represented by income. The remaining six variables perform as explanatory variables. These are the age – A, the family involvement – FI, the farm area – FA, the farming period – FP, the female operators – FO, and the partnership – P. The age indicator is expressed as an average value of age in years. Family involvement is set to characterise a type of explored business unit. The farm area measures land belonging to the particular observed farm expressed in acres. The figures are rounded to whole numbers. An average value of the length of the period of the farm operation is introduced as the farming period. The female operators show a sum of the female employees on the farm. Finally, the partnership also demonstrates the farming area but is meant for the whole enterprise. The data set covers the period from the year 2002 to the year 2017 in all the available censuses. The United States Department of Agriculture carries them out.

The applied geographical division is based on the National Agricultural Statistics Service of the United States Department of Agriculture. The following twelve regions are distinguished – the Delta Region – DR, the Eastern Mountain Region – EMR, the Great Lakes Region – GLR, the Heartland Region – HR, the Mountain Region – MR, the Northeastern Region – NER, the Northern Plains Region – NPR, the Northwest Region – NWR, the Pacific Region – PR, the Southern Region – SR, the Southern Plains Region – SPR, and the Upper Midwest Region – UMR. The Delta Region consists of Arkansas, Louisiana, and Mississippi. The Eastern Mountain Region serves Kentucky, North Carolina, Tennessee, Virginia, and West Virginia. The Great Lakes Region contains Indiana, Michigan, and Ohio. The Heartland Region covers a couple of Missouri and Illinois. The Mountain Region comprises Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming. The Northeastern Region includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. The Northern Plains Region encompasses Kansas, Nebraska, North Dakota, and South Dakota. The Northwest Region consists of Alaska, Idaho, Oregon, and Washington. The

Pacific Region includes California, Hawaii, and Nevada. The Southern Region comprises Alabama, Florida, Georgia, and South Carolina. The Southern Plains Region involves a couple of Oklahoma and Texas. Finally, the Upper Midwest Region covers Iowa, Minnesota, and Wisconsin. The terminology applied in the case of the Northwest Region comes from its original name, as mentioned by the National Agricultural Statistics Service of the United States Department of Agriculture. Hence, it is stated in this way. There is noted that the District of Columbia is omitted from the analysis because of its characteristics. Apart from this, Alaska, Delaware, Hawaii, and Rhode Island do not offer the data provision.

Under the focus of the research activities, the following research questions were identified:

- the research question 1: the gender perspective play a significant role in the field of the management of agricultural businesses;
- the research question 2: the regional perspective play a significant role in the field of the management of agricultural businesses;
- the research question 3: the socioeconomic sphere dimension significantly influences the performance of agricultural businesses.

The sensitivity analysis is employed as the methodological approach. The regression analysis demonstrates the analytical outcome. Each region and every state is scrutinised individually besides the analysis. The main analytical method is the regression analysis. The coefficient of determination with its adjusted version is applied to learn the regression model's impact. The F test is applied to obtain the overall significance of the linear regression model. The potential errors regarding autocorrelation are explored through the Durbin–Watson statistic and heterogeneity through the Breusch–Pagan test. Statistical significance is determined by a common five-percent threshold. There is to note that the tables visualising the regression models demonstrate the regression coefficients marked as RC and the assigned p-values marked as P.

4. Results

Firstly, the regional approach needs to be investigated. It is important from the two main points. On the one hand, the regional aspect is suitable for obtaining information about a potential area, where indicators representing the explanatory variables play a key role. On the other hand, this approach reveals a possible relation between the states inside the analysed regions. The coefficient of determination shows that the Heartland Region regression model has the highest statistical significance, explaining 51.03 % of the investigated data variability. The second position is kept very closely by the Upper Midwest Region, with a significance at a level of 50.06 %. The next three positions, from the third one to the fifth one, are held by the Delta Region at a level of 46.37 %, the Great Lakes Region at a level of 44.44 %, and the Northwest Region at a level of 43.24 %. All the regression models assigned to these regions are suitable to be considered as very explaining, and thus, they demonstrate their interpretation power. The following two positions are occupied by the Pacific Region, with an explanation level of 33.10 %, and by the Northern Plains Region, at a level of 29.57 %. These numbers perform as sufficient still. The further triplet, including the Eastern Mountain Region, the Southern Plains Region, and the Northeastern Region, explains the data variability ranging from a level of 20.48 % through a level of 19.42 % to a level of 16.54 %. Hence, these numbers can be understood as average. The Mountain Region and the Southern Region keep the lowest significance values, explaining an 11.02 % share and an 8.65 % share of the data variability. These two regions perform very weakly, although some points could be considered important regarding certain explanatory variables. This is mentioned below in the particular regression models discussion.

To fulfil the standard normative requirements of the coefficient of determination interpretation, the adjusted versions are calculated too. Though, their numbers are very similar, meaning their interpretation is the same. The highest difference reaches a 12.68 % decrease. It is visible for the second lowest significance value of the Mountain Region regression model. The second highest difference with a value of 11.51 % is kept by the absolutely lowest significant model of the Southern Region for a change. On the other hand, the lowest

differences are illustrated by the highest significant regression models. The lowest one, with a value of 0.97 %, is assigned to the second most significant regression model of the Upper Midwest Region, and the second lowest one, at a level of 1.09 %, to the best regression model of the Heartland Region. In other words, it is not needed to distinguish the standard version of the coefficient of determination from its adjusted version, as their difference is diminished by their own increase. The more significant the regression model, the lower the difference is, and vice versa. In the case of the lowest significant models, it is not needed to interpret such low numbers. Hence, their increasing difference is not interesting for this explanation.

Table 1. The Regional Regression Models

Region	Value	A	FI	FA	FP	FO	P
DR	RC	$-6,50 \cdot 10^3$	$-1,98 \cdot 10^{-1}$	$2,43 \cdot 10^{-1}$	$7,04 \cdot 10^3$	3,32	$7,00 \cdot 10^{-1}$
	P	$1,05 \cdot 10^{-9}$	$8,29 \cdot 10^{-5}$	$9,19 \cdot 10^{-2}$	$5,23 \cdot 10^{-9}$	$8,11 \cdot 10^{-1}$	$2,20 \cdot 10^{-51}$
EMR	RC	$-2,34 \cdot 10^3$	$-9,31 \cdot 10^{-2}$	$2,47 \cdot 10^{-1}$	$2,45 \cdot 10^3$	$-5,07 \cdot 10^1$	1,11
	P	$1,38 \cdot 10^{-3}$	$2,85 \cdot 10^{-2}$	$1,39 \cdot 10^{-1}$	$6,31 \cdot 10^{-3}$	$8,27 \cdot 10^{-8}$	0
GLR	RC	$-3,77 \cdot 10^3$	$8,01 \cdot 10^{-2}$	$3,13 \cdot 10^{-1}$	$3,42 \cdot 10^3$	$-5,20 \cdot 10^1$	$4,31 \cdot 10^{-1}$
	P	$1,76 \cdot 10^{-17}$	$1,45 \cdot 10^{-4}$	$1,75 \cdot 10^{-4}$	$8,13 \cdot 10^{-12}$	$5,61 \cdot 10^{-24}$	$1,11 \cdot 10^{-15}$
HR	RC	$-3,21 \cdot 10^3$	$5,84 \cdot 10^{-2}$	$2,60 \cdot 10^{-3}$	$4,96 \cdot 10^3$	$16,69 \cdot 10^1$	$5,39 \cdot 10^{-1}$
	P	$3,46 \cdot 10^{-6}$	$2,73 \cdot 10^{-4}$	$9,76 \cdot 10^{-1}$	$3,73 \cdot 10^{-14}$	$4,69 \cdot 10^{-20}$	$4,22 \cdot 10^{-26}$
MR	RC	$-7,43 \cdot 10^3$	$-1,01 \cdot 10^{-2}$	$5,45 \cdot 10^{-3}$	$4,64 \cdot 10^3$	$-1,11 \cdot 10^1$	$2,21 \cdot 10^{-2}$
	P	$4,61 \cdot 10^{-10}$	$2,67 \cdot 10^{-1}$	$7,25 \cdot 10^{-1}$	$9,47 \cdot 10^{-9}$	$5,50 \cdot 10^{-2}$	$2,09 \cdot 10^{-1}$
NER	RC	$-3,08 \cdot 10^3$	$-5,65 \cdot 10^{-2}$	$-4,15 \cdot 10^{-2}$	$2,42 \cdot 10^3$	$-1,18 \cdot 10^1$	$8,47 \cdot 10^{-1}$
	P	$3,37 \cdot 10^{-5}$	$1,52 \cdot 10^{-1}$	$7,51 \cdot 10^{-1}$	$2,08 \cdot 10^{-3}$	$6,51 \cdot 10^{-2}$	$4,24 \cdot 10^{-13}$
NPR	RC	$-6,95 \cdot 10^3$	$-4,33 \cdot 10^{-2}$	$-7,01 \cdot 10^{-2}$	$6,87 \cdot 10^3$	$-7,38 \cdot 10^1$	$3,09 \cdot 10^{-1}$
	P	$4,65 \cdot 10^{-25}$	$1,38 \cdot 10^{-6}$	$2,64 \cdot 10^{-2}$	$4,89 \cdot 10^{-17}$	$8,79 \cdot 10^{-11}$	$6,28 \cdot 10^{-26}$
NWR	RC	$-9,69 \cdot 10^3$	$-1,00 \cdot 10^{-1}$	$1,52 \cdot 10^{-2}$	$5,67 \cdot 10^3$	-7,59	$3,00 \cdot 10^{-1}$
	P	$1,21 \cdot 10^{-14}$	$1,46 \cdot 10^{-5}$	$7,02 \cdot 10^{-1}$	$1,31 \cdot 10^{-6}$	$5,93 \cdot 10^{-2}$	$2,81 \cdot 10^{-14}$
PR	RC	$-5,07 \cdot 10^3$	$4,19 \cdot 10^{-2}$	$3,62 \cdot 10^{-2}$	$1,09 \cdot 10^3$	$-1,01 \cdot 10^1$	$4,03 \cdot 10^{-1}$
	P	$1,64 \cdot 10^{-1}$	$5,27 \cdot 10^{-1}$	$7,27 \cdot 10^{-1}$	$6,57 \cdot 10^{-1}$	$3,57 \cdot 10^{-1}$	$1,43 \cdot 10^{-7}$
SPR	RC	$-7,25 \cdot 10^3$	$-6,13 \cdot 10^{-2}$	$5,48 \cdot 10^{-2}$	$1,04 \cdot 10^4$	-9,17	$1,65 \cdot 10^{-1}$
	P	$5,02 \cdot 10^{-13}$	$2,74 \cdot 10^{-5}$	$2,17 \cdot 10^{-1}$	$4,91 \cdot 10^{-27}$	$6,62 \cdot 10^{-2}$	$1,93 \cdot 10^{-11}$
SR	RC	$-1,54 \cdot 10^3$	$-1,68 \cdot 10^{-2}$	$-2,28 \cdot 10^{-1}$	$-1,39 \cdot 10^3$	$-1,77 \cdot 10^1$	$7,19 \cdot 10^{-1}$
	P	$1,00 \cdot 10^{-1}$	$7,08 \cdot 10^{-1}$	$2,13 \cdot 10^{-1}$	$9,77 \cdot 10^{-2}$	$7,01 \cdot 10^{-3}$	$3,31 \cdot 10^{-13}$
UMR	RC	$-7,22 \cdot 10^3$	$1,1 \cdot 10^{-2}$	$1,36 \cdot 10^{-1}$	$1,10 \cdot 10^4$	$-3,59 \cdot 10^1$	$6,05 \cdot 10^{-3}$
	P	$2,16 \cdot 10^{-28}$	$8,78 \cdot 10^{-6}$	$5,65 \cdot 10^{-2}$	$4,45 \cdot 10^{-59}$	$4,45 \cdot 10^{-11}$	$8,98 \cdot 10^{-1}$

Source: own elaboration by the authors.

The verification stage of the analysis also covers the overall significance of the constructed regression models through the F test. All the regression models fulfill this elementary statistical requirement with their p-values much lower than a statistical significance threshold of 5 %. All the created models are below a 0.01-per-cent threshold which is the lowest one applied usually.

The verification stage is further phase comprises the Durbin–Watson statistic and the Breusch–Pagan test. No regression model, except the Eastern Mountain Region regression model, is affected by heteroscedasticity as all the p-values are higher than a five-percent level of statistical significance. Moreover, many regression models are without a presence of serial correlation. The Durbin–Watson statistic confirms this. Nevertheless, the Eastern Mountain Region regression model, the Great Lakes Region regression model, and the Upper Midwest Region regression model do not fulfil this requirement as their p-value is lower than a five-percent level of statistical significance. The Mountain Region regression model also only slightly crawls a statistical significance threshold. It looks like only this regression model possesses some issues in this field.

Table 2. The Regression Regional Models Testing

Region	R ²	Adjusted R ²	F test	
			test statistic value	p-value
DR	$4.64 \cdot 10^{-1}$	$4.56 \cdot 10^{-1}$	$8.70 \cdot 10^1$	$1.88 \cdot 10^{-78}$
EMR	$2.05 \cdot 10^{-1}$	$1.98 \cdot 10^{-1}$	$4.82 \cdot 10^1$	$8.87 \cdot 10^{-53}$
GLR	$4.44 \cdot 10^{-1}$	$4.39 \cdot 10^{-1}$	$1.18 \cdot 10^2$	$2.91 \cdot 10^{-109}$
HR	$5.10 \cdot 10^{-1}$	$5.05 \cdot 10^{-1}$	$1.38 \cdot 10^2$	$8.40 \cdot 10^{-120}$
MR	$1.10 \cdot 10^{-1}$	$9.63 \cdot 10^{-2}$	$1.18 \cdot 10^1$	$1.57 \cdot 10^{-12}$
NER	$1.65 \cdot 10^{-1}$	$1.55 \cdot 10^{-1}$	$2.28 \cdot 10^1$	$1.38 \cdot 10^{-24}$
NPR	$2.96 \cdot 10^{-1}$	$2.89 \cdot 10^{-1}$	$6.97 \cdot 10^1$	$1.65 \cdot 10^{-72}$
NWR	$4.32 \cdot 10^{-1}$	$4.17 \cdot 10^{-1}$	$4.22 \cdot 10^1$	$3.90 \cdot 10^{-38}$
PR	$3.31 \cdot 10^{-1}$	$3.13 \cdot 10^{-1}$	$2.69 \cdot 10^1$	$5.32 \cdot 10^{-26}$
SPR	$1.94 \cdot 10^{-1}$	$1.88 \cdot 10^{-1}$	$4.39 \cdot 10^1$	$3.34 \cdot 10^{-48}$
SR	$8.65 \cdot 10^{-2}$	$7.65 \cdot 10^{-2}$	$1.30 \cdot 10^1$	$4.02 \cdot 10^{-14}$
UMR	$5.01 \cdot 10^{-1}$	$4.96 \cdot 10^{-1}$	$1.55 \cdot 10^2$	$3.14 \cdot 10^{-136}$

Source: own elaboration by the authors.

Age is the only explanatory variable that behaves negatively in all the investigated regions. The older the operator, the lower the income. It is very strange from an aspect of the wage evaluation in the industrial sectors and the entire business. On the other hand, the only positively influencing variable is the partnership for the whole scrutinised area. The farming period possesses the only negative case in the Southern Region. Otherwise, it positively influences the explained variable in all the remaining regions. A fascinating fact is that the farm area can also have a negative impact. This occurred in the Northeastern Region, the Northern Plains Region, and the Southern Region.

The highest negative impact of the age indicator is seen in the Northwest Region, peaking at a level of -9685.68. Oppositely, the lowest decline is reached at a level of -1536.9 in the Southern Region. Family involvement possesses the strongest power, with a multiplication of $8.0117 \cdot 10^{-2}$ in the Great Lakes Region and the lowest influence at a level of $-6.1282 \cdot 10^{-2}$ is seen in the Southern Plains Region. Only the three regions are influenced in a positive way by family involvement – besides the mentioned one, it is a triplet of the Heartland Region, the Pacific Region, and the Upper Midwest Region. There are three regions – the Northeastern Region, the Northern Plains Region, and the Southern Region – that behave strangely because the explained indicator is diminished through an increase in the farm area. It is absolutely unexpected outcome. Although all the remaining regions keep positive values. A value of $-2.2797 \cdot 10^{-1}$ for the Southern Region is the lowest one. Conversely, the income in the Delta Region is multiplied by $2.4324 \cdot 10^{-1}$ through its one-unit increment. The farming period as the explanatory variable behaves statistically significant for each region except for the Pacific Region. Its regression coefficients reach around several thousand. In the case of the Southern Region, each year of farming period length cuts income by 1.388.7 USD. The highest gain is reached in the Upper Midwest Region at a level of 11.028.59 USD, followed by the Upper Midwest Region at a level of 10.394.96 USD. The female operators indicator behaves considerably uniformly because only the income indicator of the sole region lies in a positive sphere. The income in the Delta Region is multiplied by 3.3250. On the other side, the absolutely extremely highest decline of income is demonstrated at a level of -7.38263 in the Southern Plains Region, which is more than ten times higher than the second one. The partnership indicator shows the strongest impact at a level of 1.1066 in the Eastern Mountain Region and the lowest influence with a value of $6.0531 \cdot 10^{-3}$ in the Upper Midwest Region.

Secondly, the interregional observation is scrutinised for a mutual view of regional relations. Surprisingly, there are many occasions where a mutual ratio of the regression coefficients of the same indicator for the two particular regions is more than two times higher or lower, meaning the influence of the same regression coefficient is many times stronger or weaker regarding the income as the desired explained indicator. There are the 233 occurrences

of such a situation. If a threshold is set to a value of 3, there are 165 such occurrences; hence, the numbers are being lowered till zero. The whole successions are visible in the following table with the thresholds set to the values 2, 3, 5, 10, 20, 50, and 100.

Table 3. Number of regression coefficients higher than a threshold

Indicator	Multiplication threshold							
	2	3	4	5	10	20	50	100
A	30	13	7	1	0	0	0	0
FI	32	23	17	11	2	0	0	0
FA	50	44	38	33	20	13	6	1
FP	38	21	16	8	1	0	0	0
FO	43	36	28	22	5	2	0	0
P	40	28	24	22	19	15	9	4

Source: own elaboration by the authors.

By and large, the contents of the previous table point out to the considerable heterogeneity of the explored data set. Therefore, further analytical steps are needed to investigate the data set's mutual relations. At least 30 occurrences for all the explored indicators are assigned with a multiplication factor higher than 2. This value is already relatively high to realise that each increment of the particular explored indicator influences more than a two times higher increase of the explained variable. The highest multiplication is seen at a level of 182.81 for the partnership from the Upper Midwest Region to the Eastern Mountain Region, meaning that a one-unit increment of this explanatory variable causes a 182.81-times higher increment of the income in the Eastern Mountain Region than in the Upper Midwest Region. The other three occurrences of such high multiplication are visible for the same indicator but for the Northeastern Region, the Southern Region, and the Delta Region in a descending way. Apparently, all these high values are caused by the very low regression coefficient in the Upper Midwest Region regression model. The remaining incidence happens for the farm area, whose a one-acre increment influences the income multiple times in the Great Lakes Region than in the Heartland Region.

6. Discussion

Men are more likely to be the primary landowners. Regarding participation in the decision-making process about income from agricultural activities, the gender gap is similar between primary and non-primary landowners (Yokying & Lambrecht, 2020). The gender dimension demonstrates that the female population is at the lower management levels, even though among the regular operators, the given explanatory variable is statistically significant in most of the regression models. The participation of women in agricultural activities is not very high also due to the cultural norms as in the Warri South local government area of the Delta State in the Federal Republic of Nigeria and thus, gender inequality in agricultural activity has a significant impact on the entire production process (Asamu et al., 2020). The study of the farmers' technical efficiency in the Federal Democratic Republic of Nepal shows that the specific region where the farm operates affects the improvement of performance and obtaining higher income from agricultural activities (Khanal et al., 2018). The regional aspect is a point that should be investigated further, too. Nevertheless, the relationship between productivity and the factors that influence it differs based on the economic structures of the individual European regions (Bianchi et al., 2021; Bilan et al. 2017). On the other hand, the quality factors demonstrate a significant entity in the production evaluation process (Belas et al., 2019; Stefko et al. 2017).

Though, the representation of young women in agriculture is still increasing. The analysis of the labour status of young female farmers confirms that on the farms that are led by young women, there is a higher probability of adopting various measures as climatic or environmental points to improve the state of agriculture of the different

types of farms – whether family or nonfamily (Unay-Gailhard & Bojnec, 2021). Only the three regions show statistically insignificant dimensions expressing family involvement, and only the two ones for the partnership variable. Altogether, this is a point about to dispute further. The family farms in the Swiss Confederation represent a challenge to gender equality. However, the organisation of the family farms provides opportunities to maintain this aspect. The study traces inequalities on the family farms that are related to status on the farm rather than gender identity. Based on the outcomes of the study, family farms are considered to be those where gender equality can be achieved (Contzen & Forney, 2016).

The farms with more than 72 hectares of maintained land are likelier to have a family successor (Arend-Kuenning et al., 2021). It is very difficult to confirm such a fact because the family involvement and the farming area are statistically significant only in the two regions – the Eastern Mountain Region and the Great Lakes Region – at the same time. There are also other attributes related to the farming area, such as the expenditures into the several areas of farming life; for instance, the analysis shows that farmers who manage larger farms are more willing to introduce new technologies into agricultural production and, thus, to invest more financial resources in education (Hu et al., 2022). Another aspect is pollution that can negatively affect the harvest, which can be considered a significant aspect (Simionescu et al., 2022).

7. Conclusions

Farming belongs to one of the most unequal professions in the United States today. Even though the number of women as principal operators is increasing, gender inequality in agriculture persists. Women tend to operate smaller farms, which concerns the farming area and the income from agricultural activities. The United States agriculture includes farms of various sizes and types. Most farms in the United States are small and makeup almost half of the farmland. Also, different types of farms produce specific commodities. Agriculture in the United States is represented by mainly family businesses.

The regression analysis is selected to examine the regional approach, which is considered to be important for two reasons. The first one reveals suitability for obtaining information on a potential territory, where the explored indicators representing the explanatory variables play a key role. Secondly, this approach discloses possible relations among the analysed regions. Applying the coefficient of determination, the five regions are found whose regression models with their estimated coefficients are considered statistically significant. Therefore, the regression models assigned to the Heartland Region, Upper Midwest Region, Delta Region, Great Lake Region, and Northwest Region are appropriate and highly explanatory. Thus, they demonstrate their interpretative power confirmed by the adjusted version of the coefficient of determination. The verification phase of the analysis consists of the overall significance of the constructed regression models through the F test. Interregional observation is also focused on getting a mutual view of regional relations. Surprisingly, many cases are found where a mutual ratio of the regression coefficients of the same indicator for the two specific regions is twice as high or lower. It reveals there are deliberate regional disparities. Moreover, a presence of considerable homogeneity in the explored data set can be mentioned. Therefore, further research is about to investigate the mutual relations inside the data set.

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PECULIARITIES OF SENSORY MARKETING

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Abstract. This article aims to provide a theoretical analysis of the primary sensory marketing types, tools and techniques. The methodological structure used in the study is based on theoretical descriptive, comparative, and analytical methods. The application of the qualitative approach is based on case analysis. The article examines the concept of sensory marketing and the types of technologies used. Qualitative research is original and innovative. It allows us to come to creative scientific insights, which can be instrumental in suggesting recommendations for improving the application of sensory marketing in practice. The results may have practical implications via benefits to the business and institutions provided by applying sensory marketing.

Keywords: sensory marketing; taste; touch; visual; scent; sound

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JEL Classifications: M30, M31, M37, O4, O5

1. Introduction

Sensory marketing has been around for many years now. The concept, also known as sensory branding, provides a form of marketing that appeals to consumers through all senses (Lindström, 2010). Although the idea has been studied in marketing for many years, its empirical research evaluating the impact on commercial results has only begun in the recent decade. Research has shown that sensory marketing supports the spontaneous reactions of customers (Li et al., 2023), their satisfaction and loyalty (Silaban et al., 2023), and predictable customer behaviour (Biswas et al., 2019). Additionally, sensory marketing increases brand equity (Shahid et al., 2022) and positive image overall (Hung et al., 2017). Many authors have started constructing their structural models (Hamacher, Buchkremer, 2022) evaluating the impact on marketing results.

However, empirical research in sensory marketing needs to pay more attention to the impact and primary purpose of using every type of concept. Moreover, the use of appropriate tools to achieve desirable goals has yet to be revealed. Therefore, the following objectives in the article are raised:

- to present an overview of sensory marketing definition, sensory marketing types and techniques;

- to apply the case study method in an example of various commercials related to sensory marketing;
- to create recommendations based on the result of the research for more specific use of different tools developing the concept of sensory marketing.

2. Review of literature on sensory marketing

2.1. Sensory marketing perception

Sensory marketing is based on emotional and behavioural actions ideal for selling products and services. It includes activities that create positive emotions and experiences for the consumer or user that associates sight, smell, taste, hearing, and touch with the brand. It uses one or more of the consumer's senses to entice and attract them to a product or service so that they become a customer. Sensory marketing aims to: 1. Attract potential customers; 2. Increase customer loyalty; 3. Provide a unique experience. Sensory marketing seeks to make the purchase of a product or service a pleasant process that is important to the consumer.

Lindström (2010) stated that a brand that uses multiple senses will be more successful than those that only focus on a few senses (one or two). This can be part of the advertising brand, such as a colour (for example, blue and white Tiche), a logo, a slogan, etc., or it may be a part of the product itself, e.g., product shape, fragrance (perfume) or taste of product (Vikki cheese). Kuczamer-Kłopotowska (2017) mentioned that sensory marketing is based on a holistic approach to the five senses and aims to provide specific stimuli to customers. Sight allows us to perceive colours, light, and its intensity, the design and graphic properties of various objects, packaging, decor, messages intended for us, and other essential motifs. We recognise audio brands or theme songs through hearing and receiving voice or musical messages and focus on sounds. The scent helps you perceive the smells associated with brands, their type, intensity, or fit with the product's character. Touch allows us to recognise shapes, textures, and changes in temperature, weight, and softness. Last but not least, taste it. In sensory marketing, this message should equate to the pleasure of using the product or service for the recipient. Sliburytė et al. (2017) stated that sensory marketing is a part of marketing that wants to be closer to the customer, appealing to the human unconscious being, which refers to the feelings, memory, perception, and emotions that are a personal part of everyone a person. Sensory marketing wants to be a marketing tool that influences the mood and behaviour of customers. Everyone reacts differently to atmospheric stimuli at the point of sale and then perceives it differently. Rodas-Areiza et al. (2018) mentioned that sensory marketing is a means of understanding the influence of the senses, connecting and integrating them to variables of a different nature to provide a comprehensive solution for the user relating to the brand and the products or services it offers. Torquati et al. (2018) argue that sensory experience is a stimulus to activate conscious and unconscious emotions in our brain, which respond to the stimulus positively or negatively. Liking is the sensory pleasure produced by a positive inspiration and has behavioural positive emotional responses to pleasant sensations. According to Torquati et al. (2018), marketers hope such a positive affective response will translate into a greater likelihood of food choice and purchase and a greater willingness to pay. Jiménez-Marín et al. (2019) mentioned that sensory marketing at the point of sale would be understood as such, which is for the five senses seeking their stimulation to create a pleasurable environment so that the customer increases the time of purchase. Simha (2019) analyses that sensory marketing connects the human brain to the five senses. It is in the human brain the person in whom the trademark is registered, and the image is created terms for mental concepts and imaginings. This image results from an individual's experience with a company or brand. Each person has a subjective experience that we call "Experience Logic". Koszembar-Wiklik (2019) argue that sensory marketing has a harmonious effect on the five senses but does not affect all of them. In practice, up to three dominant stimuli are selected to influence the client. According to Koszembar-Wiklik (2019), sight, hearing and smell are the senses involved. Touch is less common, and the least popular is the taste. On a large scale, sensory marketing is mainly used by large commercial chains, hotels, companies offering tourism services, or airlines. However, in the last few years, it has also been introduced for smaller businesses such as dental clinics, spa salons, hair studios, teahouses or pharmacies. Suresh (2019) stated that sensory marketing gains a customer's trust and focus by appealing to each of the five senses. It has become popular among industries and companies across the planet. According to Suresh

(2019), sensory marketing provides a complete experience. For this reason, it stands as a unique interactive way to attract the audience's attention. The sensory marketing process influences consumer behaviour, and this process focuses on how sensory marketing works to motivate and influence buyer behaviour. Correia et al. (2020) analysed that using sensory stimuli to create an environment that appeals to users' senses should not be understood as a particular form of manipulation but as a process of improving marketing activities to develop more significant value for the user. Joshi et al. (2020) argue that two decades ago, specialists decided to expand the sensing methods to explore the three untapped senses (smell, touch and taste) and apply them to the sector. A new field was born: sensory marketing. According to Joshi et al. (2020), sensory marketing comes with other concepts, such as experiential and emotional marketing. Research continues, and theories and models are still being experimented with sensory marketing, although scientists agree further research is needed. Only some companies, including fashion brands, have a well-defined sensing strategy or roughly experiment with it. Bhatia et al. (2021) mentioned that the field of sensory marketing is vast and very diverse, ranging from studies focused on and within the sense's integration, the use of sensory marketing in advertising, using one sense to influence other senses, and their interaction with its impact on consumer behaviour. Shilpa and Scholar (2021) analysed that sensory marketing is simply a winning process for customer trust and attention by appealing to each of the five senses. Not surprisingly, it became popular among various industries and companies worldwide. Marketing today is about the customer experience, and sensory marketing links this concept nicely. Sensory marketing provides a complete experience for users. Because of this, it stands out as a unique interactive way to engage your audience's attention. Hamacher and Buchkremer (2022) mentioned that specific sensory information about products and services can influence people's attitudes, purchase intentions, and consumption]. According to Hamacher and Buchkremer (2022), imagine the sound, smell and taste or feel of freshly brewed coffee when opening and closing the car door, the textile structure of the new dress. All these sensory stimuli provide valuable information about the product's value and can significantly impact the purchase decision process. Abdolmohamad et al. (2022) mentioned that the results of four experimental studies show that the sensory cues by which customers feel the amount of (mis)match between products and sensory stimuli products affect consumers' emotions, willingness to buy and experience. According to Abdolmohamad et al. (2022) by participating moderators such as images of colours, sounds, prices, and smells when dealing with multiple senses products (e.g., juice, coffee, burgers, soda) with different sensory cues, consumer emotions, willingness to buy and experience depends on affective preference and sensory congruence. Gracia et al. (2022) considered that sensory evaluation gives a judgment of the overall acceptability of a product because only consumers can determine whether a new product is acceptable. Some empirical papers have analysed consumers' Apple acceptance using consumers' sensory evaluations and studying their relationship with the consumers' willingness to pay. Pointke et al. (2022) argue that consumer research must assess sensory properties and perception during consumption to achieve sensory acceptability. There is limited data on which sensory aspects are essential to consumers, particularly in plant-based cheese alternatives and commonly used substitutes. Process optimisation and new technologies for the use and development of new plant proteins PBAP product development, but simultaneously, requires continuous sensory evaluation properties from the consumer's point of view. Natalia et al. (2023) mentioned the role of sensory experience in judgment and decision, interest marketing in the wave, expressed as sensory marketing. According to Natalia et al. (2023), some research has been done on the role of diffuse senses in consumer behaviour. Consumer buying behaviour includes user preferences, preferences, intentions and decisions related to user behaviour in the marketplace when purchasing a product or service. Sensory experience has an essential role in consumer buying behaviour. Sensory marketing is marketing that engages consumers' senses and influences their behaviour. Sensory marketing aims to send messages to the brain's right hemisphere, stimulate the consumer's senses, and ultimately create a connection between the consumer and the product and encourage them to buy.

2.2. Sensory marketing types and techniques

Five types of sensory marketing are distinguished in the scientific literature:

Visual marketing. It is the most used in the market in any of its sectors because it is the most efficient. The visual part is essential to attract potential customers and keep them loyal to brands with images designed according to their needs. Example: The store's visual content should clearly show what it offers. When using images to communicate with visitors, they must feel that the product they see meets their needs. Satria et al. (2022) mentioned that the role of the graphic designer performing creative Kumparan is shown the visual marketing team caters to Kumparan PLUS' premium content needs that strive to keep up with the times and the transformation of the new media industry with interactive communication method. Kumparan PLUS focuses on providing the highest quality content to match the information to the needs of different types of Indonesian people with attractive visual presentations, cover collections, cover stories, social media content and infographics. Karpenka et al. (2021) have identified individual image attributes that create video content on social networks. According to Karpenka et al. (2021), purpose, design, comprehensibility, and memorability have been identified as outcomes of many studies of image-based content from a technical perspective and benefits for consumers and brands. The image-based range encompasses the media goals of branded content created on social networks: task-oriented, engagement-oriented, and self-focused. Such plans select the general direction, the topics of the content, and whether the content is visual text. Task-oriented content is much more focused on sales than on the effectiveness or attractiveness of the content. Moreno-Armendáriz et al. (2023) mentioned that visual elements such as colour and shape could effectively communicate a product or service in advertising and promote and influence consumer perception of its quality. Similarly, the exterior of a person's Appearance plays a crucial role in non-verbal communication. It significantly impacts a person's social life interactions and insights into their emotional states. Maulidiyanti et al. (2022) stated that it was shown that audio-visual media was able to increase knowledge and attitudes towards growth. Audio-visual material is effective because the medium provides information that can be accessed through two senses: sight and hearing. According to Maulidiyanti et al. (2022), the results also show that social campaign products cannot be just an idea but must be supported by tangible products to be effective. Fu et al. (2023) analysed that the results show that visual style significantly influences consumer responses, with cause-oriented messages leading to higher brand attitudes and purchase intention than product-oriented messages. Meanwhile, the effect of visual style on both consumers' brand attitudes and purchase intentions is determined by perceived self-service motives. Adamus-Matuszyńska et al. (2021) argue that the purpose of this work is to evaluate the tourist offers of Polish territorial units in terms of the visual message - the logo and its content and to investigate whether they contain design components that reveal the harmonious development of the destination. The research method was a content analysis of advertising signs. According to Adamus-Matuszyńska et al. (2021), sustainable tourism development is focused on three pillars: nature, responsible tourism activities and sustainably protected historical remains. The authors conclude that logos with solid elements of nature and historical heritage do not mean the tourist offer is balanced. Lupu et al. (2021) mentioned that methodological or theoretical assumptions do not define visual studies as a field. It simply explains or uses what is visible, monitored, or visually regulated. According to Lupu et al. (2021), visual studies should expand the scope and theoretical orientations beyond the study of photographs. Visual research is a new field of qualitative approach.

Scent Marketing. The most important thing is to be creative and find that point that attracts the customer and stands out from the competition. For example, an olfactory marketing strategy should be to make the customer's first experience with the brand memorable by sending samples to potential customers in exchange for a click or email. Berčík et al. (2022) mentioned that pleasant smell is also part of the shopping atmosphere. How scent affects customer behaviour and purchasing decisions examines a relatively young field of science, one of the existing types of sensory marketing - aroma marketing, otherwise known as aromachology. Scent has a largely subconscious

influence; therefore, conducting its research using consumer neuroscience tools is appropriate. Berčík et al. (2022) examined the shopping atmosphere in Slovak grocery stores. They comprehensively conducted interdisciplinary studies on the cognitive and affective influence of selected aromatic compound user processes and evaluated their implementation efficiency in food retail companies. Gu (2022) stated that scent can effectively create a powerful brand personality and even remind users anytime and wherever possible. According to Gu (2022), Chanel once released a popular fragrance, Chanel No. 5. With it, the brand broke the mould of the world's women's perception and gave them a scent to give them courage and a spirit of adventure. At the same time, the fragrance directly transformed Chanel's elegant and confident brand personality. Urdea et al. (2021) mentioned that experiential marketing in e-commerce entirely focuses on the most satisfying customer experience. Therefore, traditional marketing methods will replace new techniques to create a sustainable business model. According to Urdea et al. (2021), with the growth and popularity of e-commerce, the question of how to create an attractive online shopping experience and how these actions can affect online business, especially in terms of competitive advantage, becomes very important. Each element of experiential marketing significantly impacts the consumer's decision-making process and offers many benefits when used in a digital environment.

Sound marketing (including audio and video). Associating audio with a product or service is nothing new. It's also no mistake that sound can be crucial in building a consumer-brand relationship. Hwang et al. (2022) mentioned that music events, concerts, and fan meetings that make up the music content will continue to grow as the number of network platforms connecting countries and regions increases even after the part-time era. Also, the music content metaverse can be combined with the platform's advanced technology, an 'immutable token (a unique and immutable unit of data stored on the blockchain)' which is expected to ensure protection and increase the value of the intellectual property, thereby diversifying platform and security. Li et al. (2023) stated that sensory marketing is a marketing method that includes the five senses of consumers (tactile, sight, taste, smell and hearing) and influences their perception, judgment and behaviour.

Taste marketing. Invitations to try or receive free samples are almost unmistakable. Once a customer's loyalty is established, when he needs a product related to his taste or something he has tried, he automatically associates it with that brand. Kokthi et al. (2022) stated that the main initial properties in the first phase were sensory properties that were related to taste and characterised by pairs of contrasts such as "heavy" and "light" or "dense" or 'sweet' and 'bitter'. Uncertainty arose in the use of grammatical structures such as "maybe", "probably", and "seemed". The first phase can theoretically be coded as how benefits and risks are perceived. In the brand phase, perceived benefits increased, and perceived risk decreased. Negative associations and words dropped appeared to express emotions, such as "enjoy". The complete information stage shows that brand reputation can help evaluate the product. In the complete awareness phase, uncertainty is significantly reduced. Sina et al. (2021) mentioned that food and beverage brands have changed young children's authentic taste perception in parallel taste tests, especially for those who watch more TV. A recent study found that eating while watching TV was associated with less bitter taste food and a greater preference for sweet-tasting food, suggesting that watching TV may decrease attention span sensory properties of food.

Touch marketing. This marketing can create very satisfying campaigns. Physically walking into a store and accessing a product or service encourages the use of touch. Tu and Yang (2019) mentioned that contact is the most widely distributed and present in the body, a complex sensory system with the most significant information. "Hand" is the most sensitive touch, and the feeling experienced when touching something with the hand becomes familiar to people, understanding how their way of thinking, life experience and knowledge accumulate. Psychologically, elements inherent in tactile sensory structures can also evoke a sense of life in users. These designs can enhance memories and deepen experiences. A literature review reveals that researchers have different approaches and definitions of "touch design". Jang et al. (2019) analyse that sensory marketing is an important marketing strategy because it allows consumers to differentiate a particular product or brand in various consumption decision-making situations. According to Jang et al. (2019), previous studies have also used sensory marketing in the food service

industry. Sensory marketing affects brand differentiation and brand loyalty. Jiménez-Marín et al. (2022) mentioned that, according to Lindstrom (2008), sensory marketing emerged as a tool to reach consumers' subconscious. In this regard, the researchers believe that although, over the years, marketers have studied consumers' senses more rigorously and systematically, there is still room for more consumer psychology and neuromarketing research that can reveal how the human brain acts, processes information and responds to marketing stimuli. Hamacher et al. (2022) stated that there are three sensory stimuli when used in a retail environment; one inspiration should have a lower level of arousal. If three strong sensory stimuli are used, the desire to purchase the product may decrease, resulting in a less positive evaluation. In digital sensory marketing, we can assume that sensory overload can lead to dissatisfaction with the website visited. Jiménez-Marín et al. (2022) argue that the integration of taste and touch occurred a little later in the 1990s because, among other things, touch-based (tactile or tactile) strategies are more challenging to implement. According to Jiménez-Marín et al. (2022), since the first studies conducted with feelings in 1909 and especially after the emergence of neuromarketing as a field, researchers often noticed connections between the senses and the perception of reality. Especially in the second half of the 20th century, the scientific community distinguished that more attention is paid to various mental processes (such as perception, sensations, mental associations, memory, and, above all, the interaction of the senses), and marketing departments soon began to take notice.

3. Sensory marketing cases study research methodology and analysis

3.1. Case study research methodology

A case study either allows you to move from general aspects to specific aspects of the study or will enable you to collect data that, in its way, helps to consider and create theoretical constructs. The goal of a case study is to provide an analysis of contextual processes that would reveal theoretical aspects of the phenomenon under study. Therefore, case studies can be applied as a part of complex research in connection with other research methods. When describing a unique case of a new phenomenon, case studies can be essential in generating hypotheses and constructing new theoretical models, highlighting testable theoretical aspects of the studied phenomenon.

3.2. Case study analysis

Visual marketing. Visual marketing is crucial as consumers are often attracted to products with eye-catching packaging, colours, and designs. To maximise the impact of visual sensory marketing, Frito-Lay's Cheetos uses attractive colours and graphics that reflect the brand identity and resonate with the target audience. Frito-Lay's Cheetos optimises package design to present its product most attractively. Example: Frito-Lay's Cheetos brand consistently uses bright orange packaging to grab consumers' attention and evoke the flavourful experience of eating Cheetos (Figure 1).



Figure 1. Lay's potato chip visual marketing
Source: Tasting Table, 2023

Scent Marketing. *Scent marketing* has been used for a very long time. Several thousand years ago, it was known about the influence of smell on human mood and behaviour. Various spices, oils, herbs, and perfumes attract buyers in markets and shops. If a pleasant atmosphere is created, the time the customer spends in the store increases, interest in the goods intensifies, and sales increase. Currently, various technologies make it possible to create the right atmosphere by choosing the emission's smell, intensity, and time.

Example: Inditex has achieved an excellent fragrance marketing strategy. The smell of Zara stores attracts shoppers and spends more time in them. In 2022, at the beginning of the year, the Zara brand presented a chocolate collection that echoed the new (and very chocolaty). In 2022, many gourmand-inspired collections emerged, fuelled by nostalgia and the comfort trend. The Zara brand presented its annual signature collection for winter and Christmas: salted caramel and gingerbread. Salted caramel: a delicious aroma with vanilla and nut butter notes, unexpectedly contrasting with a bold saltiness. Gingerbread: the smell of freshly baked cookies and gentle reminders of cinnamon and spices (Figure 2).



Figure 2. Zara home scent marketing

Source: Wicks, 2022

Sound marketing. Sounds are essential to marketing, whether it's music, songs, spoken word or noise. Sound marketing gets the attention of the target market through hearing. Audio marketing allows organisations to channel sight and sound into the senses. Brand marketing gives companies the ability to differentiate their marketing from others. Music and sounds can create a new brand, influence customer behaviour by generating memories, and provide customer information through a radio ad. An example of audio advertising in Lithuania is the TELE2 advertisement "And the rich save". All these commercials start with the same simple tune. A year later, most TV viewers could distinguish the melody and say what kind of advertisement it is and what the ad is aiming for (Figure 3).



Figure 3. Sound marketing example: TELE2 advertisement "And the rich save"

Source: Tele 2 Lietuva, 2013

Taste marketing. The goods that we usually buy in supermarkets, whether it is a favourite chocolate bar, toothpaste or snacks, always have a taste. Taste is an essential part of the food industry, so the products on the supermarket shelves have a taste. Taste is the most challenging thing to implement in marketing because of the varying degrees of individual taste. Supermarkets are one of the few sectors that use taste marketing to offer free tastings and samples. Ikea is an example of a retail brand that has developed a strong taste association for its brand in its in-store restaurants, with 30% of Ikea customers now visiting the store to eat. Restaurants extend the customer's visit to the store and increase the possibilities of purchasing food and other Ikea products (Figure 4).



Figure 4. Taste marketing: Ikea restaurant

Source: Strictly dumpling, 2020

Touch marketing. Touch is a marketing tactic that can be a great way to increase brand appeal. Some products require use before purchase. Examples of this are technologies such as telephones and cars. Cars usually require a hands-on test drive before a person chooses to buy. Being able to touch and interact with some products is essential in buying. Here are the techniques companies use to add touch to their sensory marketing campaigns. For brands like furniture retailers, letting customers sit down and feel the furniture before they buy is an integral part of marketing. Clothing retailers allow you to experience the look and feel of a garment. Apple was one of the first brands to provide store access to its technology. This approach permitted consumers to touch and interact with the technology before purchasing. Instead of focusing on sales, Apple's strategy has been to let people use the tools until they decide what works for them. Many stores today offer a similar try-before-you-buy experience (Figure 4).



Figure 5. Touch marketing: Apple example
Source: Patel, 2008

4. Discussion

The case study highlights the importance of the interaction of emotional and sensory factors, as the perception of sensory advertising depends on the impact of sensory advertising. For this reason, attention should be paid to the content of sensory advertising to the form of advertising. The study's results reveal that the understanding of sensory advertising is perceived more at the level of cognitive learning. The authors of this article emphasise the importance of sensory advertising to reach younger audiences. The authors agree that sensory advertising is considered one of the most effective forms of customer public relations.

Table 1. The case study: comparative analysis

Sensory marketing campaign\	Visual marketing	Scent marketing	Sound marketing	Taste marketing	Touch marketing
Year	2022	2022	2013	2020	2008
Target audience	Young people	Wider society	Wide society	Wide society	Young people
Goal of the campaign	To develop and support the promoted idea	To promote sales	To attract new customers	To attract new customers	To spread information
Specific features	Publicity	Publicity	Publicity	Publicity	Publicity
Sensory marketing level	Emotional engagement	Perception	Perception	Reality	Reality

Source: made by the authors

The comparative analysis of sensory marketing shows essential aspects:

1. Sensory marketing cases are more focused on the unique needs of specific segments of society rather than on general issues.
2. The primary purposes remain in sensory marketing campaigns: to encourage sales, to spread information, to form a customer need, and to develop the promoted idea.
3. The specific features of sensory marketing campaigns are *publicity* and *intense emotional response*.
4. *The level of sensory marketing depends on the marketing tools in use: visual marketing ensures emotional engagement, scent marketing and sound marketing stand for perception, while taste and touch marketing provide a sense of reality.*

Conclusions

Nowadays, brands are made to use touch, taste, smell, sound, and visual possibilities to establish a unique emotional connection with their customers. What was just a visual appeal is now transformed into new sensations and emotions, creating a memorable brand experience. In short, sensory marketing is understood to connect brands with consumers by appealing to all five senses. Thus, companies can connect with consumers' memories and emotions to make their products more meaningful. Marketing strategies can be applied to the five senses: sight, smell, slowness, taste, and hearing. The scientific literature analysis highlights the essence of sensory marketing, which can be described as a positive synergy between the senses, which increases the connection between sender and receiver. In other words, sensory marketing ensures that all historical links associated with the brand are adequately maintained. Finally, a sensory marketing strategy aims to provide emotional involvement and optimise correspondence between perception and reality.

The case study analysis revealed sensory marketing characteristics: a means of determining and interpreting consumer emotions, expression of new emotions, the possibility of creating consumer loyalty, and brand success. Case studies have confirmed that sensory marketing is expressed through the senses as applied to consumer behaviour; therefore, companies develop sensory strategies to differentiate their brand from competitors. As a result, the contemporary sensory marketing strategy is more based on emotional than psychological elements. It includes identifying the brand position in the three levels: emotional engagement, perception and reality. Such a platform provides wider opportunities for product development reflected in customer sensory benefits. Finally, multi-sensory touchpoints can link brands and customers, forming a long-lasting partnership.

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CIRCULAR ECONOMY AND RARE MATERIALS: A CHALLENGE FOR THE EUROPEAN COUNTRIES*

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Abstract. The paper provides a knowledge increase of the circular economy model in the context of rare materials in Europe. Rare materials play a crucial role in various industries but are often associated with limited availability and environmental concerns. The paper highlights the importance of circular economy strategies in Europe to enhance the sustainable management and utilization of rare materials. It emphasizes the need for comprehensive policies, collaborative initiatives, and technological innovations to foster the transition towards a circular economy for rare materials in Europe. With the circular economy approach, Europe could minimize the environmental impact, reduce dependence on imports, and promote the sustainable use of rare materials, ultimately contributing to a more resilient and sustainable future.

Keywords: circular economy; European countries; rare materials; sustainability

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JEL Classifications: I18, Q01, O32, M12, M38, C30

1. Introduction

The concept of a circular economy has gained significant attention in recent years as a means to foster sustainable economic growth and address the challenges of resource depletion and environmental degradation. At the heart of the circular economy is keeping products, materials, and resources in use for as long as possible, maximizing their value, and minimizing waste and environmental impacts. Within the circular economy context, rare materials hold a unique position. Rare materials, such as rare earth elements, lithium, and platinum group metals, are critical components in various industries, including electronics, renewable energy, and advanced technologies. They possess unique properties essential for producing high-performance and innovative products. However, the limited availability and the challenges associated with their extraction, processing, and disposal raise concerns about their sustainability and the need for more responsible management practices. The circular economy offers a framework to address these challenges and promote a more sustainable approach to rare materials. By implementing principles of the circular economy, such as designing for longevity and recyclability, promoting resource efficiency, and fostering product reuse and recycling, it becomes possible to reduce the demand for virgin rare materials and minimize the associated environmental impacts. The circular economy provides a holistic and systematic approach to maximize the value of rare materials throughout their lifecycle, from extraction to end-of-life recovery.

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Furthermore, the circular economy encourages the development of innovative technologies and processes that facilitate the recovery and recycling of rare materials from discarded products. By establishing efficient recycling systems, advanced separation techniques, and robust supply chains, it becomes possible to extract valuable rare materials from waste streams and reintroduce them into the production cycle, reducing the need for primary extraction. However, implementing the circular economy principles for rare materials takes time and effort. Technological limitations, economic feasibility, and geopolitical considerations can hinder achieving a fully circular and sustainable system. Collaboration between industries, governments, and research institutions becomes crucial to developing and deploying innovative solutions, promoting responsible sourcing practices, and addressing the complexities of rare materials within a circular economy framework. The paper aims to investigate if the circular economy provides a strategic pathway to address the sustainability challenges posed by rare materials. By integrating circular economy principles, such as resource efficiency, product reuse, and recycling, it becomes possible to maximize the value of rare materials, reduce environmental impacts, and foster a more sustainable and resilient economy. The circular economy offers a promising approach to ensure the long-term availability and responsible management of rare materials supporting sustainable development. The literature review section provides an overview and critical analysis of existing research and scholarly works relevant to the topic of the study. The methodology section describes the approach and procedures used to conduct the research study. The results section presents the findings obtained from the data analysis and interpretation. The discussion section provides an opportunity to interpret and explain the results obtained from the study. The conclusion section serves as a summary and final statement of the study's key findings and their broader implications.

2. Literature Review

The circular economy is an economic model (Murray et al., 2017) that aims to minimize waste (Song et al., 2015), keep products and materials in use for as long as possible (Mutz et al., 2001; Zecca et al., 2023) and regenerate natural systems (Morseletto, 2020; Piccinetti et al., 2023). It is possible to realize the concept of "closing the loop" (Hobson, 2016) by designing out waste and pollution (Hill, (2020), maximizing the value of products (Romero-Hernández et al., 2018), and ensuring that materials are reused, repaired, or recycled (Cole et al., 2019; Caratas et al., 2021). On the other hand, rare materials (Torreggiani et al., 2021) have limited availability in nature or are difficult to extract and process (Ang et al., 2020). They are often essential components in various industries, including electronics, renewable energy, and advanced technologies. Rare materials include rare earth elements, such as neodymium and lithium, used in producing magnets and batteries, respectively (Omodara et al., 2019). The circular economy can be crucial in managing rare materials more sustainably. By implementing circular economy principles, such as product design for longevity and recyclability, efficient resource management, and the use of renewable or recycled materials, we can reduce the demand for virgin rare materials. This can help alleviate the environmental impact of their extraction, processing, and disposal. Additionally, the circular economy promotes product reuse, remanufacturing, and recycling, which can help recover and retain rare materials from discarded products. By implementing efficient recycling systems and developing innovative technologies, we can extract rare materials from end-of-life products and reintroduce them into the production cycle. This reduces the need for primary extraction and decreases reliance on limited natural resources. However, it is important to note that the circular economy alone may not fully address the challenges associated with rare materials. Technological limitations, economic feasibility, and geopolitical considerations can still challenge achieving a fully circular and sustainable system for rare materials. Nonetheless, integrating circular economy principles can contribute to more responsible and efficient management of these valuable resources. Technological limitations can impact the management and utilization of rare materials in several ways: extraction and processing: rare materials often require specialized extraction and processing techniques due to their unique properties or occurrence in complex geological formations. Technological limitations in these areas can affect the efficiency and feasibility of extracting rare materials from ore bodies or other sources. Developing and improving extraction technologies is crucial to ensure a sustainable supply of rare materials (Balaram, 2019). Rare materials are often present in small quantities within complex products, making their recovery and recycling challenging. Technological limitations in separation, sorting, and recycling processes can hinder the efficient extraction of rare materials from end-of-life products. Developing advanced recycling technologies that can economically and effectively recover rare

materials from diverse waste streams is essential (Graedel, et al., 2016). This approach may restrict the availability of viable substitutes or alternative materials for rare materials. If no suitable alternatives exist, the demand for rare materials may grow despite their limited availability. Investing in research and development to discover or create alternative materials or technologies can help mitigate reliance on rare materials (Stratiotou Efstratiadis et al., 2022). Material efficiency and design actions can impact the rare materials required for specific applications. Advancements in materials science and engineering can enable the development of new materials or the optimization of existing materials, reducing the overall demand for rare materials in various industries. Addressing these actions means to realize economic feasibility. Economic feasibility (Jaroni et al., 2019) plays a significant role in managing rare materials. Several factors influence the economic feasibility of rare materials, including their availability, extraction costs, market demand, and geopolitical considerations. Rare materials are concentrated in small areas worldwide, and availability and scarcity may be strategic factors. The limited availability of rare materials can make their extraction and production more expensive. Some rare materials are found in small concentrations or are geographically concentrated in specific regions, which can increase the costs associated with exploration, mining, and processing. As the scarcity of a rare material increases, its price may also rise, affecting its economic feasibility (Hofmann et al., 2018). The economic feasibility is strictly linked to extraction cost; in fact, rare materials often require specialized extraction techniques, which can be costly. The complexity of extraction processes, the need for advanced equipment, and the environmental impact of extraction can all contribute to higher costs. Technological advancements and economies of scale can potentially reduce extraction costs over time. (Asadollahzadeh, et al., 2021). The literature review highlights the relationship between circular economy and rare materials and, at the same time, underlines a few critical processes that are necessary to be investigated.

Concentration of reserves. Rare materials are often geologically concentrated in a few countries or regions, leading to potential geopolitical implications. For example, China has historically been a dominant producer and supplier of rare earth elements, accounting for a significant portion of global production. The concentration of reserves in specific regions can create supply vulnerabilities and geopolitical dependencies for countries reliant on these materials.

Supply chain vulnerabilities. The global supply chains for rare materials can be complex and susceptible to geopolitical risks. Disruptions in supply due to political conflicts, trade disputes, or export restrictions can impact industries heavily reliant on these materials. This vulnerability has prompted countries and industries to diversify their supply sources and explore alternative material options to mitigate geopolitical risks.

Trade restrictions and tariffs. Geopolitical tensions can lead to the imposition of trade restrictions, tariffs, or export quotas on rare materials. These measures can disrupt supply chains and increase costs for industries dependent on these materials. Trade disputes and protectionist policies can further escalate geopolitical tensions and impact the availability and affordability of rare materials.

Geopolitical trajectories are emerging as strategic variables to create a relation between rare material and circular economy model implementation. Rare materials are critical for several strategic industries, such as defence, electronics, and renewable energy. Countries with significant rare material reserves or production capabilities can leverage their position to gain geopolitical advantages. The strategic importance of rare materials can influence international relations, alliances, and trade dynamics. Furthermore, geopolitical considerations have spurred efforts by countries and industries to explore alternative sources of rare materials. This includes investing in domestic exploration and production, engaging in international partnerships, and supporting research and development to discover new sources or develop alternative materials. Efforts to diversify supply sources aim to reduce geopolitical dependencies and enhance resource security. These trajectories are closely linked to the environmental and social impacts of extracting and producing rare materials. In some cases, geopolitical tensions may result in less stringent environmental regulations or inadequate labour standards in rare material-producing regions. Ensuring responsible sourcing practices and sustainable extraction methods becomes crucial to address these concerns. Managing geopolitical trajectories related to rare materials and circular economy implementation requires international cooperation, dialogue, and strategic planning. In the literature review, critical points emerged: geopolitical trajectories are strategic variables to create a relationship between rare material and circular economy model implementation. The methodology in the next paragraph intends to answer the following research question: In which industrial sectors does Europe execute collaborative actions that realize the circular economy and reduce the use of rare materials?

3. Methodology

A qualitative and quantitative methodology for studying the circular economy and rare materials involves using numerical data, statistical analysis, and mathematical models to quantify and measure various aspects of the topic. Here is an outline of a quantitative methodology for researching if Europe is implementing collaborative actions that realize the circular economy and reduce the use of rare materials. Understanding the current state of rare material management within the circular economy is necessary, assessing the industrial sectors implementing collaborative actions in Europe to reduce rare materials use. The relevant and available data sources for circular economy and rare material production, consumption, and recycling rates have been identified. These sources include Statistical databases Eurostat Circular Economy 2017 - 2023; Industry reports (World Bank 2017 - 2022; International Energy Agency 2017 - 2023); European government publications (EU 2017 - 2023); with particular attention to the regions/countries implementing actions linked to the circular economy model to reduce rare material use in the industrial sectors: Agro Food, Training, Education, ICT, Building, Energy, Mobility, Public and Military Aerospace, and Health. The data for the selected variables are linked to a specific period (2017 – 2022) and across 27 different European regions/countries. The data are comparable to developing descriptive analysis (qualitative) to understand the trends, patterns, and distribution of rare material flows. The data make it possible to build a matrix (quantitative) that highlights the industrial sectors with the greatest criticalities for the 27 European countries as regards reuse (Re) and remanufacturing (Rem) rates. The matrix displays the criticality levels for reuse (Re) and remanufacturing (Rem) rates in different industrial sectors across the 27 European countries. The criticality levels are determined based on relevant metrics, such as the percentage of products or materials reused or remanufactured within a sector and country. The matrix helps identify industries and countries where reuse and remanufacturing activities are thriving or lagging, highlighting areas where there might be room for improvement or critical challenges. A normalization (Singh & Singh, 2020) was performed for each data using the equation min-max method (formula 1):

$$1. I_{qc}^t = \frac{x_{qc}^t - \min_c(x_{qc}^{t_0})}{\max_c(x_{qc}^{t_0}) - \min_c(x_{qc}^{t_0})}$$

Starting from this assumption, differentiations can be calculated in the following

$$y(w,s) = \alpha(s) + \beta(s)(g(w) + \varepsilon(w,s))$$

w Country, $w = 1, 2, \dots, W$

s Sub Dimension of differentiation, $s = 1, 2, \dots, S$

y (w,s) observed score on indicator s for country w

g(w) Unobserved performance. g(w) is assumed to be a normally distributed random variable with mean 0 and standard deviation 1.

$\varepsilon(w,s)$ The phrase disruption is also known as the term mistake. It reports the perception and measurement error, as well as sample variance. Furthermore, it demonstrates the erroneous link between the specific notion indicated by indicators and the related broader component of efficacy. $\alpha(s)$ $\beta(s)$ Coefficients are helpful in mapping, together with the disturbance term $\varepsilon(w,s)$, unobserved governance into the observed data.

$\sigma^2(s)$ Variance of the disturbance terms of indicators common to all countries

Unobserved components also shape differentiation. The efficiency of these unseen components is judged by algebraically summing the scores acquired on each dimension y. (w;s). Following this hypothesis, it is possible to evaluate the unknown performance g(w); however, putting the error term and g(w) into brackets together is preferable. The model includes the following assumption: the random terms (disturbance terms) $\varepsilon(w,s)$ are not correlated with each other, i.e. perception errors are not correlated across dimensions and countries. To identify the model parameters, it is essential to consider that the mean of $\varepsilon(w,s)$ is zero for all w,s. The disturbance term has the same variance, $\sigma^2(w)$, among countries within a set indicator but may have a different variance among dimensions. Unobserved governance and observed indicators are linearly related, $\varepsilon(w,s)$ are statistically independent of g(w) for all w and s. Both g(w) and $\varepsilon(w,s)$ have a joint normal distribution. Starting with Min Max method, estimates of $\alpha(s)$, $\beta(s)$ and $\sigma^2(s)$ are achieved, and this model is founded on the next Likelihood function (formula 2):

$$2. L [w; \alpha, \beta, \sigma_{\varepsilon}^2(1), \dots, \sigma_{\varepsilon}^2(S)] \\ = \prod_{w=1}^W (2 \cdot \pi)^{-\frac{W}{2}} |\Omega|^{-\frac{1}{2}} \exp[y(w) - \alpha] \exp[y(w) - \alpha]' \Omega^{-1} [y(w) - \alpha]$$

S = score of dimension

W = number of countries

y(w) = the Sx1 vector of the y(w,s)'s for country w

y = the WSx1 vector of the y(w,s)'s for all countries α = Sx1 vector of the $\alpha(s)$'s

β = Sx1 vector of the $\beta(s)$'s

$\Omega = \beta \beta' + \text{diag} \{ \sigma_{\varepsilon}^2(s) \cdot \beta(s)^2 \}$

The formula 3 (weights p) expresses a relationship in which each indicator in the aggregation technique is inversely proportional to its error variance, i.e. the smaller the weight, the greater the variance of the error term.

$$3. p(s) = \frac{\sigma_{\varepsilon}(s)^{-2}}{1 + \sum_{s=1}^{S(w)} \sigma_{\varepsilon}(s)^{-2}}$$

Equation 3 assesses performance by taking a weighted average of the rescaled observed scores. These rescaled scores are derived by subtracting $\alpha(s)$ from each observed score y(w,s) and then dividing the result by $\beta(s)$. It is feasible to rewrite equation 1 in this manner while assuming a mathematical expectation. Because this is a calculation of expected values, we can assume that the expected value of the disturbance term, $\varepsilon(w,s)$, is 0. Equation 4 (mean) and 5 (standard deviation) assumptions indicate that the conditional distribution of unobserved governance g(w) is normal.

$$4. E[g(w)|y(w), \alpha, \beta] = \sum_{s=1}^{S(w)} p(s) \cdot \frac{y(w,s) - \alpha(s)}{\beta(s)}$$

$$5. sd[g(w)|y(w), \sigma_{\varepsilon}^2(1), \dots, \sigma_{\varepsilon}^2(S)] = [\sum_{s=1}^{S(w)} \sigma_{\varepsilon}^2(s)^{-2}]^{-1/2}$$

The variation of the (w,s) (equation 5) on each indicator increases as the number of specific indicators in which a single country appears decreases. Each indicator is rescaled so that more significant results are equivalent to better outcomes. A further rescaling is achieved by deleting the lowest possible score and dividing by the gap between the lowest and highest possible scores. The estimates of the $\alpha(s)$, $\beta(s)$ and $\sigma_{\varepsilon}^2(s)$, are achieved using Equation 2. The low level of $\sigma_{\varepsilon}^2(s)$ means that indicators will show similar results to the other indicators. The error variances will be more considerable if the indicators are uncorrelated. This score association underpins the concept of efficacy and is not directly related to perception errors. Because the results of equation 3 are inversely proportional to their imputed error variance, the indicators that reveal a high correlation will have a higher weight in the weight calculation than other indicators. Equation 4 can now be approximated for each country, yielding an estimate of the degree of performance g(w). Finally, equation 5 calculates the standard error of these estimations. Each country's efficacy assessments are rescaled by subtracting the mean across countries and dividing by the standard deviation across nations. The results are in the -2.5 to 2.5 range. The standard error (Equation 5) is calculated once more. The four indices, i.e., European Countries, Industrial Sector, availability risk, reuse and remanufacturing rare materials used, create a general performance highlighted with a matrix method. This method allows you to respond to the RQ, highlighted at the end of the paragraph relating to the literature review.

4. Results

Shared policies across all 27 European countries linked to the circular economy and rare materials for each industry sector, qualitative methodology, are reported in Table 1. The detailed projects are reported in Table 1. Table 1 does not show the sectors with no shared projects among the 27 European countries: Agro Food, Training, and Education.

Table 1. Shared projects policies across all 27 European countries linked to the circular economy and rare materials (*)

ICT	BUILDING	ENERGY SECTOR	MOBILITY	PUBLIC/MILITARY AEROSPACE	HEALTH
WEEE	EPBD	RET	EV	ESP	SP
RoHS	GBCS	EFM	CID	SAF	EPR
ErP	CDwM	CEWE	SPT	WRR	WRR
GPP	CPP	BESR	UMS	LCAEd	GHI
EUCEAP	BREEAM LEED	GM&SG	FES LCATI		

(*) *Source:* our elaboration on Eurostat Circular Economy, Industry Reports and European Government Publications (2017 – 2023).
Our elaboration

Shared policies across all 27 European countries linked to the circular economy and rare materials in the ICT sector highlight the following projects:

Waste Electrical and Electronic Equipment (WEEE) Directive: The WEEE Directive establishes requirements for collecting, recycling, and recovering electronic waste. European countries are implementing this directive, setting up systems to ensure the proper disposal and recycling of ICT equipment at the end of its life cycle. This directive promotes the circular economy by encouraging the recovery of valuable materials from electronic waste. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Restriction of Hazardous Substances (RoHS) Directive: The RoHS Directive restricts the use of hazardous substances in electrical and electronic equipment. It aims to reduce the environmental and health risks associated with these substances. By limiting the presence of harmful materials in ICT products, the directive promotes the use of safer and more recyclable materials. European countries involved: Austria, Denmark, Estonia, Finland, France, Germany and Italy.

Eco-design Requirements for Energy-Related Products (ErP): The Eco-design requirements for energy-related products aim to improve the environmental performance of energy-consuming products, including ICT devices. These requirements set energy efficiency standards and encourage using recyclable and repairable materials in the design and production of ICT equipment. European countries involved: Belgium, Denmark, Estonia, Finland, France, Germany and Italy.

Green Public Procurement (GPP): European countries have implemented GPP policies that include criteria for ICT equipment. These policies promote the purchase of environmentally friendly products, including ICT devices that meet specific sustainability requirements, such as energy efficiency, recyclability, and recycled materials. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Italy, Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.

European Union Circular Economy Action Plan (EUCEAP): The Circular Economy Action Plan of the European Union includes initiatives to promote sustainable and resource-efficient products, including ICT equipment. This plan encourages the extension of product lifetimes, the use of recycled materials, and the adoption of circular business models in the ICT sector. European countries involved: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, all 27 Countries.

Shared policies across all 27 European countries linked to the circular economy and rare materials in the Building sector highlight the following projects:

Energy Performance of Buildings Directive (EPBD): The EPBD sets requirements for the energy performance of buildings and aims to promote energy efficiency in the building sector. Many European countries have implemented this directive, including provisions for using sustainable and recycled materials in building construction and renovation. European countries involved: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain, Sweden,

Green Building Certification Systems (GBCS): Several European countries have adopted or developed green building certification systems that encourage sustainable and resource-efficient building practices. These systems often promote the use of environmentally friendly materials, including those with recycled content, and encourage circular principles in the construction and operation of buildings. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Spain, and Sweden.

Construction and Demolition Waste Management (CDwM): European countries have regulations and initiatives to manage construction and demolition waste. These policies promote recycling and resource recovery from construction and demolition sites, reducing the demand for new materials and encouraging using recycled materials in building projects. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.

Circular Public Procurement (CPP): Many European countries have introduced circular procurement policies requiring sustainable and resource-efficient construction practices. These policies promote using recycled materials, adopting circular business models, and considering the life cycle impacts of building materials in public procurement processes. European countries involved: Austria, Belgium, Croatia, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.

Sustainability Standards and Labels: European countries often adopt or recognize sustainability standards and labels for buildings, such as BREEAM (Building Research Establishment Environmental Assessment Method) and LEED (Leadership in Energy and Environmental Design). These standards consider the use of sustainable materials and promote resource efficiency in the construction and operation of buildings. European countries involved: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Shared policies across all 27 European countries linked to the circular economy and rare materials in the energy sector highlight the following projects:

Renewable Energy Targets (RET): Many European countries have set renewable energy targets to increase the share of renewable energy sources in their energy mix. These targets promote developing and deploying sustainable energy technologies, often prioritizing using materials with a lower environmental impact and reducing reliance on rare materials. European countries involved: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Netherlands, Poland, Portugal, Spain, Sweden,

Energy Efficiency Measures (EFM): European countries have implemented various energy efficiency measures and regulations to reduce energy consumption in the energy sector. These measures include energy efficiency standards for appliances, buildings, and industrial processes. By improving energy efficiency, countries can reduce the overall demand for energy and the need for resource-intensive energy generation. European countries involved: Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Portugal, Spain and Sweden.

Circular Economy in Waste-to-Energy (CEWE): Some European countries have implemented circular economy principles in the waste-to-energy sector. This involves promoting energy and valuable materials recovery from waste streams through technologies such as anaerobic digestion and incineration with energy recovery. These practices help reduce waste volumes, recover resources, and minimize environmental impacts. European countries involved: Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.

Battery and Energy Storage Regulations (BESR): European countries have established regulations and standards for the safe and environmentally sound management of batteries and energy storage systems. These regulations often aim to promote sustainable and recyclable materials in batteries, encourage responsible disposal, and support the development of circular business models for energy storage. European countries involved: Denmark, Estonia, Finland, France, Germany, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Grid Modernization and Smart Grids (GM&SG): European countries are investing in grid modernization and developing smart grids to enable a more efficient and flexible energy system. These initiatives often involve the integration of renewable energy sources, energy storage, and demand response mechanisms, which contribute to a more sustainable and resource-efficient energy sector. European countries involved: Austria, Netherlands, Portugal, Spain and Sweden,

Shared policies across all 27 European countries linked to the circular economy and rare materials in the mobility sector highlight the following projects:

Electric Vehicle (EV) Incentives: Many European countries have introduced incentives to promote the adoption of electric vehicles. These incentives include financial incentives, tax benefits, and subsidies for purchasing electric vehicles. By encouraging the transition to electric mobility, these policies aim to reduce the environmental impact of transportation and promote the use of materials with a lower ecological footprint. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Charging Infrastructure Development (CID): European countries invest in developing charging infrastructure for electric vehicles. This includes the installation of public charging stations and incentives for private charging infrastructure. By expanding the charging network, countries aim to support the widespread adoption of electric vehicles and facilitate the circularity of energy used in the mobility sector. France, Germany, Netherlands, Spain, Sweden.

Sustainable Public Transportation (SPT): Many European countries have implemented policies to promote sustainable public transportation systems. This includes using low-emission buses, trams, and trains and integrating renewable energy sources into public transportation networks. These policies reduce the reliance on fossil fuels and promote more sustainable and resource-efficient mobility. European countries involved: Austria, Belgium, Bulgaria, Croatia, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.

Urban Mobility Strategies (UMS): European countries are developing urban mobility strategies that prioritize sustainable and active modes of transportation, such as walking, cycling, and public transit. These strategies aim to reduce congestion, improve air quality, and promote shared mobility services, which can help optimize resource utilization. European countries involved: Austria, Denmark, Finland, France, Germany, Netherlands, Spain and Sweden.

Fuel Efficiency Standards (FES): European countries have adopted fuel efficiency standards for vehicles to reduce fuel consumption and greenhouse gas emissions. These standards encourage the development and adoption of fuel-efficient technologies, often requiring the use of materials with a lower environmental impact. European countries involved: Austria, France, Germany, Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.

Life Cycle Assessment in Transport Infrastructure (LCATI): Some European countries are integrating life cycle assessment (LCA) approaches into the planning and designing of transport infrastructure. LCA evaluates the environmental impacts of infrastructure projects throughout their life cycle, including material extraction, construction, use, and end-of-life. Countries can promote more sustainable and circular mobility solutions by considering the environmental impact of materials and infrastructure choices. European countries involved: Austria, Denmark, Finland, France, Germany, Italy, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Shared policies across all 27 European countries linked to the circular economy and rare materials in the public and private aerospace sector highlight the following projects:

European Space Policy (ESP): The European Space Policy provides a framework for cooperation among European countries in space activities, including the aerospace sector. The policy promotes sustainable and responsible space exploration, efficiently encouraging resource use and minimizing waste generation. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Italy, Netherlands, Poland, Portugal, Spain and Sweden.

Sustainable Aviation Fuels: Several European countries have established policies and initiatives to promote the use of sustainable aviation fuels (SAF). SAFs are derived from renewable feedstocks and help reduce greenhouse gas emissions from the aerospace sector. By supporting the development and adoption of SAFs, countries aim to promote circularity and reduce the sector's environmental impact. European countries involved: Austria, Belgium, Denmark, France, Germany, Netherlands, Portugal, Spain and Sweden,

Waste Reduction and Recycling (WRR): European countries have implemented waste reduction and recycling measures in the aerospace sector. These measures include collecting and properly disposing of aerospace waste, such as metal scraps, plastic components, and other materials. Recycling initiatives aim to recover valuable materials and minimize the environmental impact of aerospace activities. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Life Cycle Assessment and Eco-design (LCAEd): European countries promote the integration of life cycle assessment (LCA) and eco-design principles in the aerospace sector. LCA evaluates the environmental impacts of aerospace products and processes throughout their life cycle, from raw material extraction to end-of-life. Eco-design encourages using recyclable and sustainable materials and efficient manufacturing and maintenance processes. European countries involved: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Shared policies across all 27 European countries linked to the circular economy and rare materials in the health sector highlight the following projects:

Sustainable Procurement (SP): European countries promote sustainable procurement practices in the health sector, which consider the environmental and social impacts of products and services. This includes procuring medical devices, equipment, and pharmaceuticals produced with sustainable materials that follow circular economy principles. European countries involved: Austria, Denmark, Estonia, Finland, France, Germany, Italy, Luxembourg, Malta, Netherlands, Spain and Sweden.

Extended Producer Responsibility (EPR): Several European countries have implemented EPR schemes for medical waste, including pharmaceuticals and medical devices. These schemes hold producers responsible for properly managing and disposing of their products at the end of their life cycle, encouraging them to design products focusing on circularity and resource efficiency. European countries involved: Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain and Sweden.

Waste Management and Recycling (WRR): European countries have regulations and initiatives for adequately managing and recycling healthcare waste. These policies aim to reduce the environmental impact of healthcare

activities, including the appropriate handling and disposal of rare materials found in medical devices and equipment. European countries involved: Austria, Belgium, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain and Sweden.

Green Hospital Initiatives (GHI): Some European countries have established green hospital initiatives that promote sustainability and circularity in healthcare facilities. These initiatives focus on energy efficiency, waste reduction, and using environmentally friendly materials in constructing, renovating, and procuring medical equipment. European countries involved: Austria, Belgium, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain and Sweden.

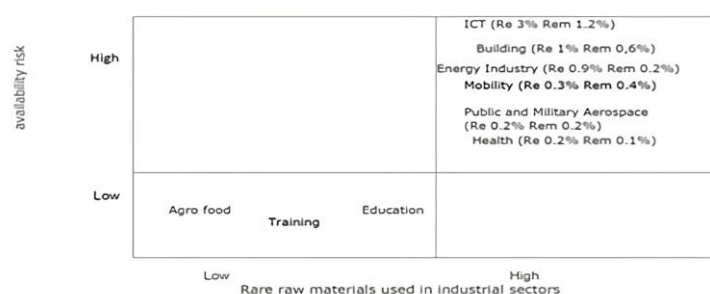


Figure 1. Elaboration on Eurostat Circular Economy, Industry Reports and European Government Publications (2017 – 2023)

Source: the authors

Applying the quantitative approach developed in the methodology paragraph, elaborating the matrix shown in Figure 1 is possible.

5. Discussion

The necessity for a systemic cultural transformation is highlighted by the essential transition from the linear economic-productive model to the circular economic-productive model (Meadows et al., 1972) has a big impact. The well-highlighted limits of the development of the linear model and the relative possible solutions date back to the 1970s, but it seemed useless to reflect and act at the time on the combination of development and sustainability today, 2023, that uselessness is the center of the economic and social life of every country in every part of the world. The shift, which has multiple paths, emphasizes two strategic pillars: geopolitical trajectories related to rare materials and circular economy implementation, developed in the paper. These two pillars entail shifting from a fossil-fuel-based and mechanical-technology-based socioeconomic structure to one based on mineral resources and digital technologies. The mineral-digital binomial, for example, is based on microchips and scarce raw materials such as silicon and palladium; microchips are in every product and, thus, in all productions. Magnets, particularly permanent magnets, enable wind power with their blades, but their applications include transportation and electronics. Cobalt and lithium are also crucial in creating batteries for the urban mobility industry and in mass-produced devices such as personal computers and smartphones. Rare materials in continuous extraction and use growth, as the IEA (2023) reported.

A shift that follows the existing cultural, systemic model of extracting, creating, using, and discarding is short-term, and it still needs to ensure the dual need for development and sustainability. Mineral-digital resources, which captivate a rising portion of the world's customers, present an economic and geographical problem: the quantity of these resources is limited and unequally distributed on the earth. Depletion of reserves in the medium term, geographical problem, physical availability and price of raw materials in the near term, economic difficulty. The impact of the Russian-Ukrainian war on the supply of energy resources, geopolitical and economic, is a recent example; the example of the past, in 2010 and not yet resolved is China, a global monopolist together with Africa, a geographical area in which China's economic control is solid, for the supply of rare raw materials. In this context, Europe's position is quite limited: it is a consumer but not a producer,

resulting in a high reliance. The European Union specifies a list of rare critical materials and strategic production components for all economic sectors with high supply risk. In the Union's economic history, the list is followed by rules that must reduce supply risks and build strategic collaborations. The goal is to diminish European reliance because the shift can only occur with access to scarce raw resources. It is important to remember that in our world's history, extracting has meant deforestation, polluting soil and water, reducing and/or losing biodiversity, or development without sustainability, negatively modifying the life of the environment and local communities. A reading of the initiatives carried out by local communities to defend their living spaces is exciting. A new cultural, systemic approach to recovering and reusing rare materials at the end of their life cycle can address the possible relationship between rare but commonly utilized raw elements in consumer items and dependence on them. The European Union calls on Member States to implement the circular economy (Marino et al., 2022; 2021), but the problem is also present in other geographical areas, such as Latin America and Africa (Marino et al., 2022a), emphasizing the importance of accelerating the transition through the recovery, reuse, and reuse of rare raw materials. The study reveals shared projects and not shared policies on the part of the Member States of Europe. The production of the products is not shared. In this logic, the absence of relevant projects, productions and developments in the food and training sector is also of interest. The European brand does not exist. It has not yet been created, and the implementation of the circular economy by reducing the waste of rare materials is essential to strengthening the geopolitical trajectories of Europe, which should be united not only in intentions but in economic decisions and technological productions regarding the implementation of the circular economy concerning rare raw materials. While shared policies in the circular economy and rare materials in 27 European countries demonstrate a collective commitment to sustainable practices, there are some limits and challenges to consider:

Diverse regulatory frameworks: European countries have their regulatory frameworks and national priorities, which can lead to variations in the implementation of shared policies. This can result in differences in interpretation, enforcement, and timing of policy adoption, making it challenging to achieve consistent and harmonized approaches across all countries.

Varied resource availability: European countries have different access levels to rare materials and resources. Some countries may have more significant reserves or access to certain rare materials, while others may face scarcity. This variability can affect the implementation and effectiveness of shared policies related to rare materials, as countries may have different levels of reliance on these materials in their respective industries;

Economic considerations: Transitioning to a circular economy and addressing rare materials can involve significant costs and investments. European countries differ in economic resources, technological capabilities, and industrial structures. Implementing shared policies in the circular economy may require financial support, technical expertise, and infrastructure development, which could pose challenges for some countries with limited resources;

Stakeholder engagement and coordination: Achieving a circular economy and addressing rare materials requires collaboration and engagement among various stakeholders, including governments, industries, research institutions, and civil society. Coordinating efforts and ensuring effective participation from all relevant stakeholders across 27 European countries can be complex and time-consuming;

Monitoring and reporting: Monitoring and evaluating the progress of shared policies in the circular economy and rare materials across 27 European countries can be challenging. Harmonizing data collection methods, setting common indicators, and ensuring accurate reporting from all countries can be difficult, which may affect the ability to assess the impact and effectiveness of these policies;

Transboundary challenges: Some circular economy and rare materials issues may have transboundary implications, such as waste movement or sourcing materials from outside the European Union. Addressing these challenges requires cooperation and coordination among countries, as well as aligning policies with global frameworks and initiatives:

Despite these limitations, the shared policies in the circular economy and rare materials among European countries provide a foundation for collaboration, knowledge-sharing, and coordinated action. They help foster a common understanding of the importance of sustainability and resource efficiency and provide opportunities for countries to learn from each other's experiences and progress in addressing these challenges. Collaborative efforts can focus on diversifying supply sources, promoting responsible sourcing and production practices, fostering recycling and circular economy approaches, and encouraging research and development for alternative

materials. Countries can work towards a more stable and sustainable rare material supply chain by addressing geopolitical challenges.

Conclusion

The circular economy approach offers a promising solution to the challenges associated with rare European materials. By Improving resource efficiency, recycling, and waste reduction, the circular economy can contribute to the sustainable management and utilization of these critical resources. Europe's focus on implementing comprehensive policies, fostering collaboration, and driving technological innovation is crucial for successfully transitioning to a circular economy for rare materials. In particular, intervening in this regard to diverse regulatory frameworks, the varied resource availability, stakeholder engagement and coordination, monitoring and reporting of shared policies, and transboundary challenges are actions that improve the shared geopolitical trajectory. Europe can mitigate environmental impacts, reduce dependence on imports, and ensure the long-term availability of rare materials. Embracing the principles of the circular economy for rare materials aligns with sustainability goals. It presents economic opportunities and a pathway towards Europe's more resilient and resource-efficient future.

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**Publisher**<http://jssidoi.org/esc/home>**NFT-ENRICHED SMART CONTRACTS FOR SMART CIRCULAR ECONOMY MODELS****Vera Gerasimova ¹, Gunnar Prause ², Thomas Hoffmann ³**^{1,2,3} Tallinn University of Technology, Ehitajate tee 5, 19086, Tallinn, Estonia² University of Applied Sciences Wismar: Technology, Business and Design, Philipp-Müller-Str. 14, 23966 Wismar, GermanyE-mails:¹ vera.gerasimova@taltech.ee; ² gunnar.prause@hs-wismar.de; ³ thomas.hoffmann@taltech.ee

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Abstract. A smart contract is an electronic transaction protocol intended to digitally facilitate, verify, or enforce the execution of the terms of underlying legal agreements. Thus, by following the traditional perception, smart contracts target reducing transaction costs, including arbitration and enforcement costs, by realizing trackable and irreversible transactions using blockchain technology for distributed databases. However, the potential of smart contracts goes far beyond cost reductions by facilitating the entrepreneurial collaboration of cross-organizational business processes. Industry 4.0 aims to create smart supply chains. Smart contracts and Non-Fungible Token (NFT) solutions can realize new smart business models in the circular economy. The recent case study from the automobile industry demonstrates how using NFT technology in the form of a digital certificate can become an integral part of smart product lifecycle management in the frame of a circular economy integrating innovative business models with smart service design concepts. By doing so, the use of NFT paves the way for dynamic and adaptable supply chains, evolving needs of stakeholders towards a sustainable and circular economy. The authors participated in research projects related to smart supply chains and circular economy. Thus, the paper discusses the question of how and to what extent smart contracting, blockchain technology, NFT solutions, and Service Design can facilitate the implementation of smart business models in the context of the circular economy. The research is based on expert interviews, surveys, and case studies from EU projects focusing on the Baltic Sea Region.

Keywords: smart contracts; Non-Fungible Token (NFT); smart supply chains; service design; business models; circular economy

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Additional disciplines: law; information and communication; ecology and environment; transport engineering; environmental engineering; informatics

1. Introduction

The classical pathway of mass production has been known as a linear model where products that reach the final stage of their lifecycle are trashed so that the remaining resources are wasted, creating an imbalance between resource supply and goods demand (Murray et al., 2017). With the current trend in production and consumption rate, sustaining development and providing future generations with resources will not be possible. Overcoming the contradiction between the need for economic growth and the necessity for accomplishing environmental sustainability is thus one of the most compelling issues of our time (Hobson & Lynch, 2016; Marques et al., 2018; Zecca et al., 2023).

Catering the need for an alternative model of sustainable development with closed material loops, the Circular Economy (CE) emerged within the debates. The concept gained increasing attention on national - e.g. in the Netherlands (Dutch Ministry of Environment, 2016) as well as regional (European Commission, 2018) policy targets and is covered increasingly in business sector reports (e.g. Ellen Macarthur Foundation, 2013a, 2013b). The number of academic studies on the CE is increasing, and different authors have reviewed its various definitions and approaches.

While there is no comprehensive definition of the CE concept yet, the main objective of CE is to maintain the value of materials by keeping them in circulation and, consequently, reduce our reliance on material extraction (Kirchherr et al., 2017). According to Hislop & Hill, "the circular economy represents a development strategy that maximizes resource efficiency and minimizes waste production, within the context of sustainable economic and social development" (Hislop & Hill, 2011, p. 2).

However, after decades of discussion and research around CE, the linear model is still deeply entrenched. There are political, economic, technological, and legal obstacles to the transition to a circular economy (Hart et al., 2019). There is a strong need for political support to promote the circular economy concept (Araujo Galvão et al., 2018). The absence of incentives to adopt CE still exists, and new incentives are required to increase the speed of transition to CE.

Approaches to overcome these deficits have their sources in political incentive systems and new production paradigms labelled smart supply chain management in the context of Industry 4.0 (Prause, 2014, 2015; Ahmadov et al., 2022). The main aims of those approaches are laid on the fusion of the virtual and the physical world based on smart internet technologies and networked production processes coming along with energy and resource efficiency, increased productivity, shortening of innovation and time-to-market cycles together with a horizontal and vertical integration through value networks and an end-to-end digital integration of engineering across the entire value chain. Thus, the internet-linked production facilities and networked manufacturing systems open up a machine-to-machine-communication and interaction, called M2M, which allows to name, identify and trace single products during their whole creation process and later on during their lifetime, which generates new perspectives for the entire supply chain including product design and development, operations management and logistics.

Of particular interest for the circular economy is the possibility to identify and trace products during their lifecycle (Eshghie et al., 2022), which opens the opportunity to attach special conditions, services and rights to events during different phases of their lifetime. Recent research stresses the potential of blockchain technologies together with smart contracts to facilitate event-triggered and automatized transactions within supply chains (Philipp et al., 2019). Such blockchain and smart contract platforms allow supply chain parties to encode business rules based on negotiated legal agreements, i.e., a smart contract can be considered as an electronic transaction protocol to enforce digitally the negotiation and execution of the terms of an underlying legal contract designed to fulfil conditions like payments, legal obligations, and enforcement without third parties.

In the circular economy context, such a smart contract realizes the digital execution of legal agreements and linked transactions related to special events on the product lifecycle. Non-Fungible Token (NFT) represent digital assets that can be integrated into blockchains and can be used to realize links to specific data sets and to identify and attribute special features to a product. Besides this, NFT can be used to parametrize smart contracts to realize special services related to the product or to implement and specify smart business models.

The paper highlights the potential of using blockchain technologies together with smart contracts to facilitate event-triggered and automated transactions within supply chains, allowing supply chain parties to encode business rules based on negotiated legal agreements. In the circular economy context, smart contracts can realize the digital execution of legal agreements and linked transactions linked to special events in the product lifecycle. NFTs represent digital assets that can be integrated into blockchains and used to connect specific data sets and identify and attribute special features to a product. NFTs can also be used to parametrize smart contracts to realize special services related to the product or to implement and specify smart business models.

The research presented in this paper is based on literature expert interviews, surveys conducted within the context of European Union (EU) projects focusing on the Baltic Sea Region, and a case study. The author aimed to explore how and to what extent smart contracting, in cooperation with blockchain technology and NFT solutions, can facilitate the implementation of smart business models in the circular economy context.

2. Circular Economy

The Circular Economy (CE) concept addresses resource depletion and environmental degradation caused by the linear economic model. The concept of the CE can be traced back to the early 1970s when the Club of Rome, a global think tank, published a report titled "The Limits to Growth" (Meadows et al., 1972). The report highlighted the issue of resource depletion and predicted that the world's resources would be exhausted within the next century if the linear economic model continued to be used. The report called for a new economic model focusing on sustainability and resource efficiency. In the 1980s and 1990s, the idea of CE gained momentum, with several researchers and organizations advocating for a new economic model that focused on waste reduction and resource efficiency. In 1994, Walter R. Stahel, a Swiss architect and economist, coined the term "cradle to cradle" to describe the idea of a closed-loop system that allows for the continuous reuse of resources and materials (Stahel, 2010).

In the 2000s, the CE concept gained traction in business, with several companies adopting CE principles in their operations. In 2012, the Ellen MacArthur Foundation, a UK-based charity, was founded to promote the CE concept globally (Ellen MacArthur Foundation, 2012). The foundation's report, "Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition," provided a comprehensive overview of the concept and its potential benefits.

In 2015, the CE concept gained global recognition when it was included in the United Nations' Sustainable Development Goals (SDGs). Goal 12 of the SDGs calls for sustainable consumption and production patterns, with a specific target to "implement the 10-year framework of programs on sustainable consumption and production, all countries taking action, with developed countries taking the lead" (United Nations, 2015).

Today, the CE concept is widely recognized as a critical strategy for achieving sustainability and reducing resource depletion and waste. The concept has gained widespread adoption in business, with several companies adopting circular economy principles. The CE concept has also obtained significant support from governments and international organizations, with several countries and organizations developing circular economy strategies and policies.

The CE concept has evolved from a relatively new idea in the 1970s to a mainstream concept in the 21st century. The concept has been supported by businesses, governments, and international organizations and is now recognized as a critical strategy for achieving sustainability and reducing resource depletion and waste. CE has become an increasingly popular topic of discussion in recent years due to its potential to address some of the most pressing sustainability challenges facing society. CE aims to reduce waste and promote sustainable consumption and production by maximizing the value of resources through a closed-loop system. CE is also an economic model that aims to reduce waste and promote sustainable consumption and production. It is based on the concept of closed-loop systems, where resources are kept in use for as long as possible through reuse, repair, and recycling (Ellen MacArthur Foundation, 2013a, 2013b). CE is seen as a way to decouple economic growth from resource consumption and environmental degradation by promoting more efficient use of resources and reducing waste.

The principles of CE are based on the idea of designing waste and pollution, keeping products and materials in use, and regenerating natural systems (Ellen MacArthur Foundation, 2019). These principles are reflected in various practices, such as product design for circularity, closed-loop supply chains, and collaborative consumption models. One of the key principles of CE is product design for circularity, which involves designing products to minimize waste and maximize their lifespan. This can include designing products that are easy to repair, upgrade, or recycle (Bocken et al., 2016). Another essential principle is closed-loop supply chains, which

involve creating a closed system where materials and products are kept in use for as long as possible (Tukker et al., 2015). This can involve practices such as remanufacturing, refurbishing, and recycling.

There are many examples of CE in practice across various industries and sectors. One example is the textile industry, where circular models are being developed to reduce waste and increase resource efficiency (Ghisellini et al., 2016). This can involve using recycled fibres, designing products for disassembly, and implementing closed-loop supply chains. Another example of CE in practice is the sharing economy, which involves collaborative consumption models promoting the sharing of resources and products (Bardhi & Eckhardt, 2012). This can include practices such as ride-sharing, co-working spaces, and tool libraries.

CE offers a promising approach to promoting sustainable consumption and production by maximizing the value of resources through a closed-loop system. Its principles are reflected in various practices, such as product design for circularity, closed-loop supply chains, and collaborative consumption models. There are many examples of CE in practice across multiple industries and sectors, and policymakers, businesses, and consumers increasingly recognize its potential for promoting sustainable development.

CE is closely related to sustainability, as it provides a framework for economic growth that aligns with sustainable development principles. Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987). The circular economy is seen as a critical approach for achieving sustainability as it seeks to reduce the depletion of natural resources, minimize waste, and lower greenhouse gas emissions (Ellen MacArthur Foundation, 2015).

The circular economy model emphasizes the importance of designing products and services with the end in mind. It involves a shift away from the traditional linear take-make-dispose model to one where resources are kept in use for as long as possible through strategies such as recycling, reuse, and remanufacturing (Kirchherr et al., 2017). By keeping materials in circulation, the circular economy reduces the need for virgin resource extraction, which can have negative environmental and social impacts. The circular economy offers numerous benefits for achieving sustainability. One key benefit is the reduction in resource depletion. By keeping resources in circulation, the circular economy minimizes the need for virgin resource extraction, which can lead to habitat destruction, air and water pollution, and other negative environmental impacts (Kirchherr et al., 2017). Another benefit of the CE is the waste reduction. The circular economy minimizes waste generation by designing products and services for longevity and end-of-life considerations. It encourages the use of resources more efficiently and effectively. This can also reduce the need for landfill space and associated costs (Stahel, 2016). The CE can also create new economic opportunities. For example, the recycling and remanufacturing industries can provide new jobs and revenue streams while reducing the reliance on the traditional linear economic model (Ellen MacArthur Foundation, 2015).

CE promotes the efficient use of resources, reduces the environmental impact of economic activities, and helps to preserve natural ecosystems. These benefits make CE an essential concept for achieving sustainable development and addressing modern challenges while promoting innovation and economic growth.

3. Smart Contracts for Smart Supply Chains

Supply chain management (SCM) coordinates and optimizes cross-company business processes based on downstream flows of goods and services and upstream flows of information and finance (Jacobs & Chase, 2020). Coordinating supply chain flows represents a challenging task, and recent research results advocate a significant potential in blockchain technologies for facilitating supply chain management (Gligor et al., 2021).

This enthusiasm towards blockchains stems from the underlying technological concept that uses time-stamped ledgers of transactions without a central authority. In other words, transactions are not recorded centrally, and each party maintains a local copy of the ledger consisting of a linked list of encrypted blocks comprising a set of transactions that are hashed and grouped in blocks and thus broadcasted and recorded by each participant in the blockchain network (Sternberg et al., 2021). When a new block is proposed, the participants in the network agree upon a single valid copy of this block according to a consensus mechanism. Once a block is collectively

accepted, it is practically impossible to change it or remove it i.e. a blockchain can be considered a replicated append-only transactional data store, which can replace a centralized register of transactions maintained by a trusted authority (Philipp et al., 2019). With blockchain technology, the necessary visibility and transparency can be generated in SCM – which is especially beneficial for SCRM.

A closer look at the term blockchain indicates that often two meanings are mixed, namely a distributed database and a data structure consisting of a linked list of blocks of transactions, where each block is cryptographically chained to the previous one by including their hash value and a cryptographic signature, in such a way that it is impossible to alter an earlier block without re-creating the entire chain since that block. Blockchain platforms additionally offer the possibility of executing scripts on top of a blockchain, called smart contracts, allowing parties to encode business rules like negotiated legal agreements. Thus, a smart contract can be considered an electronic transaction protocol to digitally enforce the negotiation and execution of the terms of an underlying legal contract designed to fulfil conditions like payments, legal obligations, and enforcement without third parties. Such a smart contract realizes the digital execution of legal agreements and linked transactions between distributed units within a network or supply chain with reduced transaction costs, being trackable and irreversible (Prause, 2019).

One of the newest developments in the context of smart contracts is non-fungible token (NFT) representing digital data stored in a blockchain. Such an NFT can be distributed to a specific and exclusive individual owner, i.e. it represents a proof of ownership of a blockchain record and can be transferred, i.e. traded. The essential characteristics of NFTs are that they contain links to digital files, are uniquely identifiable, and are easy to create. In particular business sectors, especially in the cultural and creative industry (CCI), NFTs enjoy high economic importance because the linked digital files represent the market value of an NFT. It must be pointed out that NFTs represent a public certificate of authenticity or proof of ownership defined by the blockchain. Still, they do not grant a copyright in the represented object itself – which also means that the author (or licensed user) may create a generally unlimited number of further NFTs representing the same object. Neither do NFTs grant any other legal rights over their associated digital file (Wang et al., 2021) - they are, in other words, a mere "digital label" (e.g., with the function of a price tag) to any object selected to be represented by it.

In a CE context, NFTs can be used as uniquely identifiable tokens that refer to a digital file that stores rights and conditions for certain tripper points in the product lifecycle. Underlying smart contracts can use these NFTs for executing scripts with parameters stored in the digital files, i.e., in such a way, smart contracts can be parametrized through NFTs with actual parameters along the lifecycle of a product.

Overall, there are many benefits associated with blockchain implementation in supply chain management. The study of Ayan et al. (2022) confirms that blockchain technology can enhance supply chain transparency, traceability, and accountability, leading to increased efficiency, reduced waste, and improved environmental and social sustainability. The authors also provide case studies from the food, fashion, and energy industries to illustrate the potential of blockchain in promoting sustainability. Dounas et al. (2021) also state that using NFTs in construction and architecture allows the expansion of Digital Twins applications using blockchain technologies, where components are connected with particular aspects of the building performance and their maintenance is potentially automated through smart contracts. (Dounas et al., 2021).

4. Previous research on NFT-enriched Smart Contracts for Circular Economy models

In recent years, a growing share of literature has addressed the applications of blockchain technologies and smart contracts in various sectors. These studies have highlighted the potential of these technologies for improving operational efficiency, transparency, and trust among supply chain participants (Kshetri, 2018; Tapscott & Tapscott, 2016). There is also an emerging body of literature exploring the potential of NFTs, which represent unique digital assets that can be integrated into blockchain platforms (Non-Fungible Tokens, 2021). These studies have suggested that NFTs can provide new ways of managing and verifying ownership, tracking product life cycles, and creating digital twins of physical assets (Adhami et al., 2018; Khaqqi et al., 2018). Consequently, NFT-enriched smart contracts have also gained significant attention in recent years for their

potential use in circular economy models to safeguard a maximal use of products to save resources or to enhance the possibilities of reuse and recycling.

Navarro et al. (2022) investigated the design, implementation, evaluation, and operation of a verifiable registry for digital product passports of ICT products using blockchain technology. Their experimental results confirm that digital product passports can serve as viable instruments for promoting transparency and environmental accountability in the ICT sector and as an example for other product sectors to meet the world's climate change goals, which are too important to overlook.

Another research by Alves et al. (2022) examined current approaches to traceability in the textile and clothing value chain and explored the technologies necessary for promoting a circular economy in this industry. The specific focus was put on blockchain technology for registering activities on traceable items throughout the value chain and the Internet of Things (IoT) technology for identifying the digital twins of these traceable items. The authors concluded that more efficient and sustainable management of the textile and clothing value chain can be achieved by leveraging these technologies.

A study by Dos Santos et al. (2021) proposes a method for efficient and unrestricted publicity of third-party certification of plant agricultural products using smart contracts and blockchain tokens, providing economic incentives to actors in the supply chain. The study finds that this method can improve food safety and reduce counterfeiting and greenwashing. Implementing tokenization can enhance transparency, promote sustainable consumer behavior, and lead to a more trustworthy supply chain.

Research by Wu et al. (2023) aimed to find a better way to keep track of construction waste material when it's traded across borders. The researchers proposed a blockchain-based solution to create a digital passport for each piece of waste material. The framework involves digitizing into NFT-enabled passports, preventing duplicate issuances, enhancing transparency, improving trading efficiency, and securing transaction records. A prototype of the framework was developed and found to be feasible with satisfactory performance, serving as a reference for future blockchain NFT-enabled passport applications in the circular economy.

5. Service Design for Circular Economy

Service Design (SD) is a process that involves creating user-centered services that meet the needs and expectations of users while also considering the broader context in which the service operates. This approach places the user at the center of the design process and emphasizes the importance of understanding user needs, behaviors, and preferences. SD has been used in various fields, including healthcare, education, and retail, to create services that meet users' needs while also achieving business goals. The concept of SD emerged in the early 1990s as a response to the increasing complexity of service provision in the post-industrial economy. Since then, the field has rapidly developed, with practitioners and academics exploring and refining the principles and methods of SD.

SD can be employed to create sustainable business models by addressing the social and environmental aspects of the business. The social aspect of sustainability involves creating services that meet the needs of all stakeholders, including customers, employees, and the wider community. The environmental aspect of sustainability involves reducing the environmental impact of the business by adopting sustainable practices. According to Bitner et al. (2008), SD can help to create sustainable business models by focusing on three key areas: service delivery, service environment, and service communication. Service delivery involves designing services that meet the needs and expectations of customers while also being efficient and effective. Service environment involves creating a physical and virtual environment that supports the service and enhances the customer experience. Service communication involves creating clear and effective communication channels that enable customers to access the service and provide feedback.

A sustainable business model is a business model that generates economic, social, and environmental value. According to Stubbs and Cocklin (2008), sustainable business models involve four key components: economic viability, social responsibility, environmental responsibility, and innovation. Economic viability involves

creating a profitable business model that generates value for stakeholders. Social responsibility involves creating a business model that considers the social impact of the business on all stakeholders. Environmental responsibility involves creating a business model that minimizes the environmental impact of the business. Innovation involves creating a business model adaptable and responsive to changing market conditions. SD can facilitate the development of sustainable business models by incorporating the four components of sustainable business models into the design process. According to Sangiorgi (2011), SD can facilitate the creation of sustainable business models by adopting a systemic approach that considers the interdependencies between economic, social, and environmental factors. SD can also facilitate the adoption of sustainable practices by involving stakeholders in the design process and creating services that meet the needs and expectations of all stakeholders.

SD can also be beneficial for the creation of smart services discussed in this paper and have the potential to revolutionize the way supply chains operate. Designing and implementing such systems is complex and requires a user-centered approach. Designing services that use Smart contracts technology also requires a deep understanding of the technology and the specific industry in which the service will be applied.

SD employs a range of tools to create and improve the product or service. Two common tools used in SD, such as co-creation, are journey mapping and service blueprint, which can be largely applied to contribute to CE. Journey mapping is a visual tool that maps out a customer's steps when interacting with a service, from initial awareness to post-service follow-up. This tool helps designers and stakeholders identify pain points and opportunities for improvement throughout the customer journey (Stickdorn et al., 2018). Service blueprinting is another tool that visually maps out the service process but from the internal perspective of the service provider. This tool helps identify the different people, processes, and technologies involved in delivering the service and areas for improvement (Bitner et al., 2008). Both journey mapping and service blueprinting are effective co-creation tools for SD, as they involve collaboration between designers, stakeholders, and customers to ensure that services are designed with the customer experience in mind. By using these tools, service designers can create more effective and efficient services that meet the needs of all parties' needs.

SD can create services that utilize Smart Contracts in several ways. One way is by identifying the key stakeholders and their needs and designing the service to meet them using smart contracts. This can include designing the user interface for interacting with the smart contract, as well as the process for creating and executing the contract. Another way SD can be used is by identifying potential pain points or inefficiencies in existing processes and using smart contracts to streamline and automate those processes. This can include using smart contracts to automate payment and settlement processes and enforce compliance with regulatory requirements. SD can also be used to design the governance and decision-making processes for smart contract-based services. This includes designing the process for amending or updating the smart contract and determining the appropriate level of decentralization for the service. As such, organizations need to consider the integration of SD in the development of smart contract-based services. In conclusion, SD can be a valuable tool in creating smart services and dealing with emerging challenges related to CE.

6. Methodology

This paper employs a mixed-methods research design that includes expert interviews, desktop research, a literature review, and a case study approach. Using multiple methods allows for a comprehensive and multi-dimensional analysis of the research topic, providing a more robust understanding of the phenomenon under investigation. The expert interviews provide insights from professionals with extensive experience and knowledge in the field. At the same time, the desktop research and literature review offer a broad and systematic review of existing literature and data sources. The case study approach enables in-depth analysis of a particular phenomenon or context, providing a detailed and contextualized understanding of the research topic. Together, these methods provide a rigorous and comprehensive approach to research and analysis.

This paper aims to investigate how smart contracting, in cooperation with blockchain technology and NFT solutions, can facilitate the implementation of smart business models in the circular economy context.

The research is based on expert interviews, surveys, and a case study conducted in the context of EU projects focusing on the Baltic Sea Region.

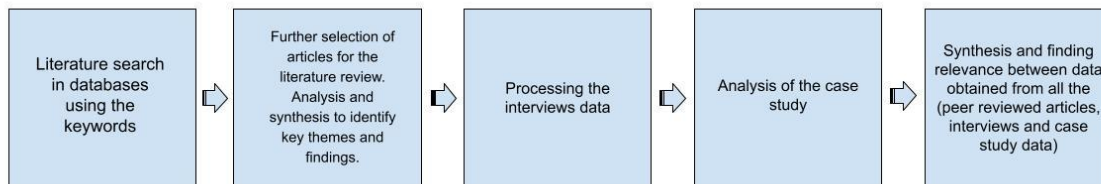


Figure 1. Methodological procedure of the study

Source: authors' own elaboration

This literature review was conducted using desktop research, which involved a comprehensive search of relevant academic articles and literature from reputable sources. The search used Scopus, Google Scholar, and Web of Science databases. Keywords used in the search included "NFTs," "smart contracts," "circular economy," "blockchain," "supply chain," and "sustainability." The inclusion criteria for articles in this literature review were relevance to the topic, recency, and peer-reviewed status. Articles published between 1999 and 2022 were included to ensure that the most recent and up-to-date research was included. The search initially yielded many results, which were then screened based on their abstract and title to identify relevant articles. After screening the initial results, 20 academic articles were selected for the literature review, representing the most relevant scientific papers related to our study. These articles were then analyzed and synthesized to identify key themes and findings related to the benefits of using NFT-enriched smart contracts in circular economy models.

Overall, desktop research provides a comprehensive and efficient method for conducting literature reviews. It allows researchers to access a vast array of relevant literature from different sources and enables the efficient screening and selection of articles that meet the inclusion criteria. Furthermore, using various databases ensures the inclusion of diverse perspectives and insights, enhancing the validity and reliability of the review's findings. In addition, expert interviews were conducted to understand the potential of smart contracts and NFT solutions in implementing circular economy practices. The interviews were conducted with professionals from various fields, including blockchain technology experts, supply chain managers, and circular economy practitioners. The interviews were conducted using a semi-structured approach, and the questions focused on exploring the role of smart contracts and NFT solutions in circular economy practices.

Surveys were conducted to gather quantitative data on using smart contracts and NFT solutions in circular economy practices. The survey questions were designed to understand the level of awareness, adoption, and perceived benefits of using smart contracts and NFT solutions in circular economy practices. The surveys were distributed among professionals from various fields, including blockchain technology experts, supply chain managers, and circular economy practitioners.

The expert interviews, surveys, and case study data were analyzed using a qualitative and quantitative approach. We review a case study focusing on Alfa Romeo's Tonale hybrid SUV to explore the potential of smart contracts and NFTs in facilitating smart circular economy business models. The qualitative analysis was conducted to identify themes and patterns in the data, while the quantitative analysis was conducted to obtain numerical data on the use of smart contracts and NFT solutions in circular economy practices. The findings from the analysis were used to answer the research question and provide insights into the potential of smart contracting in the context of the circular economy.

The authors aimed to explore how and to what extent smart contracting, in cooperation with blockchain technology and NFT solutions, can facilitate the implementation of smart business models in the context of circular economy. Expert interviews allowed the author to gather insights and opinions from individuals who possess in-depth knowledge and experience in the fields of circular economy, smart contracting, and blockchain

technology. These experts were selected based on their expertise and experience in the industry, and their opinions were used to shape the research questions and the study. The research comprises 12 interviews that were conducted between September 2022 and March 2023 in Estonia and Germany in a structured format in the frame of national and EU projects on circular economy, allowing the author to gather specific information about the challenges and opportunities associated with implementing smart business models in the context of circular economy.

The survey component of the research aimed to gather data from a larger sample of individuals with varying levels of expertise and experience in the field. The survey was designed to collect information on the use of smart contracts and NFT solutions in the context of a circular economy and identify any barriers to implementation and potential areas for improvement. Finally, a case study was conducted to provide real-world example of implementing smart business models in the circular economy context. This case study was selected based on its relevance to the research questions. It provides insights into the industry's practical applications of smart contracting and NFT solutions.

Overall, the combination of expert interviews, surveys, and the case study provided a comprehensive picture of the challenges and opportunities associated with implementing smart business models in the circular economy context. The gained empirical measures represent a classical multi-method approach combining quantitative and qualitative data from different sources that were analyzed and interpreted using a methodological triangulation approach in the sense of Altrichter et al. (2008) to acquire a more detailed and better-balanced picture of the research situation. Finally, the empirical results of the research are discussed in the context of the current literature.

7. Two Case Studies: The Alfa Romeo's Tonale and the EV-Purchasing Model

Alfa Romeo's Tonale hybrid SUV represents a groundbreaking application of blockchain technology and NFTs in the automotive industry. This case study provides insight into how smart contracts and NFTs can revolutionize the automotive industry, transforming customer experiences and influencing business models in the circular economy context.

The Alfa Romeo's Tonale, set to launch in 2023, stands out in the automotive market by incorporating blockchain technology. Each Tonale comes with a complimentary NFT a digital certificate linked to the vehicle (Alfa Romeo, 2023). This digital certificate will continuously update with essential vehicle data, ensuring a consistent and reliable record of the vehicle's history. Hence, the NFT records and updates information about maintenance and milestones, such as reaching 100,000 miles. It provides a well-documented vehicle history, offering added value to the owner if the vehicle is ever sold. This utilization of NFTs offers an innovative solution to a longstanding issue in the used car market – information asymmetry and difficulty verifying a vehicle's history.

Moreover, smart contracts' realized integration with NFTs could automate various vehicle-related transactions. For instance, smart contracts could be set to trigger maintenance services when the vehicle reaches certain milestones. This innovative approach illustrates how blockchain technology, when integrated with smart contracts and NFTs, can significantly enhance automotive companies' customer experience and service efficiency. Thus, integrating smart contracts, NFTs, and service design in Tonale's model can potentially revolutionize the automotive industry's business model. For instance, a "product-as-a-service" model could be explored, wherein customers pay for access to the vehicle rather than its ownership. Such a model could encourage manufacturers to design more durable, repairable, and recyclable vehicles since they would be responsible for their end-of-life management.

The Tonale case demonstrates that a well-implemented service design can ensure a consistent supply of used materials to recycling plants. The digital certificate, in this case, adds value to owners who keep their vehicles well-maintained and reach certain usage milestones, motivating them to contribute to circular economy aims, i.e. this system also facilitates the resale process, as the digital certificate provides potential buyers with an entire, reliable history of the vehicle. The service design process requires collaboration among various

stakeholders, including manufacturers, dealers, service providers, and customers. This can ensure a seamless transition of the product through its lifecycle and enhance the transparency of the product lifecycle, particularly for complex products such as cars. In conclusion, the Alfa Romeo Tonale case demonstrates how the innovative combination of blockchain technology, smart contracts, NFTs, and service design can substantially enable the automotive industry to contribute to the circular economy. This case study provides valuable insights that could guide future research and policy-making initiatives to promote adopting these technologies in various industries.

A second case highlights the role NFT's can play in business model development. In recent times, new business models have emerged that leverage the use of electric vehicles (EVs) to enhance sustainability. The discussed case represents an anonymized company, well-known to the authors and based in Estonia. It purchases brand-new electric cars directly from manufacturers at discounted prices, rents them to individuals, and replaces them when they reach 10,000 km. It presents an interesting case for examination. While this model may seem unsustainable at first glance due to the rapid turnover of vehicles, some aspects could be considered eco-friendly. The cars are electric, reducing carbon emissions during usage (Hawkins et al., 2013). Moreover, the low mileage at which the cars are sold in the regular market suggests that the vehicles will still have a long life ahead of them, potentially replacing older, less efficient vehicles.

A closer view to the benefits of the EV Turnover Model reveals the implicit sustainability aspects to this model:

1. Lowered Carbon Footprint: By maintaining a fleet of new electric vehicles and ensuring their rapid turnover, these companies ensure that the cars on the road are equipped with the latest energy-efficient technologies. Such practices can lead to reduced greenhouse gas emissions over the vehicle's operational life (Sprei & Ginnebaugh, 2018).
2. Second-Life Utility: Selling a car after just 10,000 km ensures that it remains in near-pristine condition, which could substitute and effectively retire an older, potentially more polluting vehicle on the road. This means these vehicles will likely serve two owners throughout their lifespan, optimizing their utility (International Energy Agency, 2019).
3. Economic Incentives for Sustainability: The model also offers a unique economic proposition by allowing consumers to regularly experience new vehicles without long-term commitment, thereby potentially increasing the adoption rate of EVs (Sierzchula et al., 2014).
4. Promotion of Electric Vehicles: By making the latest electric vehicles accessible and affordable to the general public through leasing, this model indirectly promotes the transition from conventional fuel-based vehicles to electric ones. This transition is crucial for reducing the overall carbon footprint of the transportation sector (International Energy Agency, 2019).

By comparing the EV model with the Alfa Romeo Tonale hybrid SUV, it becomes evident that the latter offers more comprehensive sustainability features. For example, Tonale's NFT system keeps a digital record of the vehicle's history, promoting responsible ownership and potentially extending the vehicle's lifespan (Alfa Romeo, 2023). This contrasts with the business model described above, which focuses on quick turnover rather than long-term utilization and accumulating a well-documented history (McKinsey & Company, 2017).

8. Results and Discussion

Both models aim to capitalize on the transition to cleaner and more sustainable forms of transportation; Tonale's approach offers broader implications for a circular economy. By incorporating blockchain technology and NFTs, Alfa Romeo supports sustainability and enhances customer experience and operational efficiency (Geissdoerfer et al., 2017). In juxtaposition, the Alfa Romeo Tonale hybrid SUV offers a different layer of sustainability and innovation. Beyond its hybrid functionality, its integration of NFTs to provide a digital log of the vehicle's history promotes extended vehicle life cycles and responsible ownership, leading to new features in the classical business models in the car sector (Alfa Romeo, 2023):

1. Digital Accountability: The NFT system, by offering an indisputable, continuous record of the car's milestones and maintenance, fosters an environment of accountability. This might discourage rapid turnover and encourage longer ownership, which has sustainability implications (Ajanovic & Haas, 2016).

2. **Market Valuation:** Such well-documented histories can elevate the vehicle's second-hand market value. Prospective buyers would be more inclined to purchase a vehicle with a transparent record, ensuring these vehicles remain in circulation for longer (Delucchi & Lipman, 2001).
3. **Circular Economy Aspects:** Tonale's approach, encompassing the fusion of technology like blockchain and NFTs, underscores the broader goals of a circular economy. Through lifecycle traceability and fostering responsible ownership, the potential waste and rapid turnover could be curtailed (Geissdoerfer et al., 2017).

Conclusively, while both models advocate for eco-friendliness and sustainability, they do so from different angles. The EV turnover model emphasizes rapid renewal, whereas the Tonale hybrid SUV leans towards comprehensive lifecycle management.

Navigating the sustainable landscape presented by Alfa Romeo's Tonale hybrid SUV and contrasting it with alternative EV business models, one can appreciate the multifaceted approaches toward achieving sustainability in the automotive domain (Geissdoerfer et al., 2017). Both models signify the industry's shift towards greener practices; however, their differences illuminate the vast spectrum of sustainable opportunities and challenges. As smart contracts and NFTs steadily permeate this industry and business models evolve to prioritize sustainability, the journey towards a cleaner, more efficient automotive future gains momentum (Tapscott & Tapscott, 2016; Kshetri, 2017). This discourse serves as a testament to the industry's commitment to sustainability and the innovations that arise from it.

Summing up the review of the two distinct cases - the Alfa Romeo's Tonale Hybrid SUV's integration of NFT technology and the sustainable business model of purchasing, renting, and reselling electric cars - several recommendations emerge for stakeholders in the automotive industry:

1. **Digital Integration and Traceability:** The integration of NFTs by Alfa Romeo showcases the potential of digital traceability in enhancing the car ownership experience. Manufacturers should explore the possibility of integrating similar technologies, not just as a value proposition for consumers but also as a measure to ensure proper maintenance longevity and even to reduce fraudulent practices in used-car markets (Tapscott & Tapscott, 2016).
2. **Sustainable Business Models:** Purchasing electric vehicles, renting them out until a set mileage, and then selling them is an innovative approach that speaks to a broader strategy. It reduces the environmental impact by promoting electric vehicle usage and ensures cars have a longer life cycle with multiple users. Other companies can adopt similar models, emphasizing economic benefits and environmental sustainability (Eisenhardt & Graebner, 2007).
3. **Incentives for Electric Vehicles (EVs):** Given the environmental advantages of EVs, governments and policymakers should provide further incentives to consumers and businesses that promote their usage. This could include tax breaks, grants for R&D in sustainable transport, or even subsidies for consumers.
4. **Collaborative Initiatives:** As seen in the two cases, innovation often results from a synergy of different sectors - tech and automotive, in the case of Alfa Romeo, and the rental and resale market in the electric car business model. Collaborative efforts between industries can lead to groundbreaking business models and sustainable solutions (Chesbrough, 2003).
5. **Consumer Education:** The success of both models largely depends on consumer acceptance. It's essential to invest in consumer education initiatives about the benefits of such models, both in terms of personal benefits (like the NFT's ability to record car data) and broader societal advantages (such as the environmental benefits of EVs).
6. **Adaptable Supply Chains:** In an era of rapid technological advancements, automotive companies should ensure adaptable supply chains. This adaptability allows for the quick integration of innovations, whether they are in the realm of digital tech like NFTs or in sustainable business practices.
7. **Research and Development:** Continued investment in R&D is essential. Both cases underscore the significance of innovation in driving the industry forward. Auto companies should allocate resources to refine existing models and pioneer new, disruptive solutions that cater to an evolving market and a planet needing sustainable solutions.

Consequently, while the two cases present unique strategies and outcomes, they collectively highlight the automotive industry's vast potential for innovation, sustainability, and consumer-centric solutions. Adopting these recommendations can benefit individual stakeholders and pave the way for a more sustainable and efficient automotive ecosystem. Hence, the potential of using smart contracts together with NFTs to facilitate the implementation of smart circular economy business models, using the case of Alfa Romeo's Tonale hybrid SUV as a reference. The research is based on expert interviews, surveys, and a case study conducted in the context of EU projects focusing on the Baltic Sea Region.

The authors emphasize the need for an alternative model of sustainable development with closed material loops in terms of the CE, which maintains the value of materials and reduces reliance on material extraction. The linear model is still deeply entrenched due to political, economic, technological, and legal obstacles, and the transition to a circular economy requires political support and incentives. Hence, smart supply chain management and Industry 4.0 approaches aim to fuse the virtual and physical worlds based on smart internet technologies and networked production processes. These approaches open up machine-to-machine communication and interaction, allowing for the identification and tracking of products during their lifecycle, which generates new perspectives for the entire supply chain, including product design and development, operations management, and logistics.

The results of this study suggest that smart contracting, blockchain technology, and NFT solutions can facilitate the implementation of smart business models in the context of the circular economy. The study found that smart contracts enable automated, secure, and transparent execution of agreements and transactions, which can reduce the transaction costs associated with traditional contracts. Smart contracts can also ensure that the terms of agreements are executed as intended, without the need for intermediaries.

The study also found that NFTs can be used to create digital representations of physical assets, which can be used to verify their authenticity and ownership. NFTs can also be used to encode special features and conditions related to the product, such as its environmental impact, recycling potential, and end-of-life options. This allows for the creating of smart business models that incentivize sustainable practices and promote circular economy principles. Furthermore, the study found that the combination of smart contracts and NFTs can enable the creation of new business models, such as "product-as-a-service", where customers pay for access to the product rather than ownership. This can encourage manufacturers to design more durable, repairable, and recyclable products, as they would be responsible for the end-of-life management of the product.

The study also highlights that SD can be crucial in ensuring a consistent supply of used materials to recycling plants. By using SD principles, a system can be created that encourages suppliers to provide a steady flow of used products that meet the quality and quantity requirements of the recycling plants. One approach to achieving this is designing a supply chain that considers the needs and motivations of all stakeholders involved. Prause (2015) states that a sustainable business model should motivate the product owner to contribute to circular economy aims, which can be achieved through different incentive types, including refund systems and tax incentives.

The case of the Tonale hybrid SUV by Alfa Romeo comes with a complimentary NFT, essentially a digital certificate, which continuously updates with information about the vehicle, tracking maintenance and milestones (Alfa Romeo, 2023). This innovative approach embodies the seamless blend of physical and digital realities, creating a robust ecosystem of information around the product and thereby enriching its value and lifecycle management.

This case study demonstrates the potential for smart supply chain management and Industry 4.0 approaches, allowing for identifying and tracking products during their lifecycle, thereby opening up new perspectives for the entire supply chain, including product design and development, operations management, and logistics. Thus, smart contracts, coupled with blockchain technologies, allow for event-triggered and automated transactions within supply chains. This revolutionary method enables supply chain parties to encode business rules based on

negotiated legal agreements. In the context of a circular economy, smart contracts realize the digital execution of legal agreements and linked transactions corresponding to special events in the product lifecycle.

Tonale's NFTs represent digital assets integrated into blockchains, used to link specific data sets and identify and attribute special features to the product. NFTs can be used to parameterize smart contracts to realize special services related to the product or to implement and specify smart business models. Hence, the Alfa Romeo Tonale case study shows that the combination of smart contracts and NFTs can enable the creation of new business models, such as product-as-a-service, where customers pay for access to the product rather than ownership. This encourages manufacturers to design more durable, repairable, and recyclable products, as they would be responsible for the end-of-life management of the product.

The Tonale case also shows how service design can be crucial in enhancing the overall user experience. By tracking and documenting the vehicle's history, users can have a clear picture of the vehicle's status, facilitating maintenance and improving resale value. A system can be created that encourages owners to maintain their vehicles well and reach usage milestones, motivating more sustainable behavior.

To design an effective incentive system, service design techniques such as journey mapping and co-creation can be utilized. By considering the needs and motivations of all stakeholders involved, a sustainable business model can be established that motivates vehicle owners to contribute to circular economy aims. In conclusion, the Tonale case provides an effective model for incorporating blockchain technologies, smart contracts, and NFTs into the automotive industry, presenting new business models and approaches to contribute towards a circular economy. It demonstrates how NFTs can bridge the physical and digital worlds, facilitating new ways of managing and interacting with products.

Finally, the study identifies challenges associated with adopting smart contracts and NFTs in the circular economy context, such as the need for standardization of smart contract templates, the development of interoperable NFT standards, and the legal recognition of smart contracts and digital assets. Furthermore, it suggests the need for education and awareness-raising among stakeholders regarding these technologies' potential benefits and challenges.

9. Conclusions

Smart contracts, blockchain technologies, and NFTs are reshaping the contours of supply chain management and the broader scope of the circular economy. These technologies offer potential far beyond cost reduction, facilitating cross-organizational business processes, promoting transparency and traceability, and paving the way for innovative business models. This paper explores the utility of these digital tools in the context of circular economy, using the case of Alfa Romeo's Tonale hybrid SUV as a case study. The Tonale case demonstrates how an NFT, essentially a digital certificate, can become an integral part of the product lifecycle, constantly updating with information about the vehicle, including maintenance and milestones. This offers valuable insights for the vehicle owners and potential future buyers, thus contributing to a more efficient and transparent used car market. Hence, it showcases how innovative technological applications can promote product durability, repairability, and recyclability, all cornerstones of the circular economy. It also exhibits how these digital tools can catalyze new business models like product-as-a-service, shifting the focus from product ownership to product utility.

In summary, implementing smart contracts and NFTs facilitates the creation of robust, well-documented product lifecycles, empowering consumers, producers, and suppliers alike. They pave the way for dynamic and adaptable supply chains that cater to the evolving needs of stakeholders, thereby contributing towards a sustainable and circular economy.

Nonetheless, the study also acknowledges the challenges in integrating smart contracts and NFTs into the broader economic landscape, including issues surrounding legal recognition, the need for standardization, and the development of interoperable standards. There is also an evident need for increased education and

awareness among stakeholders regarding these emerging technologies, their potential benefits, and associated challenges.

Ultimately, this research advocates for the continued exploration and integration of such digital tools in various industries, contributing towards the transition to smart supply chains and circular economies. The findings and discussions from this paper can be utilized to develop future policies and initiatives aimed at promoting smart contracting and NFT solutions across industries.

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ON THE MOTIVES OF BELIEF IN CONSPIRACY THEORIES*

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Abstract. Conspiracy theories represent one of the phenomena of today's modern information society. They have occurred in human society in every historical period. They are nothing new, but in the 21st century, they have experienced an unprecedented boom, which is undoubtedly related to the rapid development in the field of communication and information technology, the expansion of the Internet, the massive use of social networks and the quick exchange, spread and sharing all kinds of information. For many years, conspiracy theories stood outside the mainstream interest of academics and scientific institutions. Only in the last few years has the situation changed, and initiatives have attempted to build a theoretical framework and conceptualize this construct. For this reason, we decided to contribute to current research in the field of conspiracy theories through this work and, using the relevant qualitative theoretical scientific research methods, to participate in clarifying this increasingly frequent phenomenon in modern human society.

Keywords: conspiracy theories; motives; information; modern information society

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1. Introduction

Conspiracy theories have become a very widespread phenomenon in recent years. They have become one of the phenomena of today's modern society. Undoubtedly, the rapid development in communication and information technologies, systems and tools, the expansion of the Internet and the massive use of various social networks contributed significantly to this. Conspiracy theories are characterized by the fact that they deal with irrational beliefs about the illegal and threatening plans of secret societies, groups or influential people and their plots

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against ordinary people. They can be highly improbable (e.g., the claim that aliens, who have taken on human form, live among us or that the Earth is a flat plate) but also relatively plausible (e.g., that specific secret organizations regularly violate privacy laws and spy on people).

Belief in conspiracy theories has occurred in every historical period (Groh, 1987; Uscinski & Parent, 2014). Although in the past the importance of anticipating real conspiracies and creating conspiracy theories was often important for human survival due to their frequent occurrence, which could lead to his death (Van Prooijen & Van Vugt, 2018), an enormous number of current conspiracy theories are in terms of their content irrelevant and illogical. American polls show that up to 55% of people believe in at least one conspiracy theory - currently, the most common one is that a group of Wall Street bankers orchestrated the financial crisis intending to dominate the world economy (Oliver & Wood, 2014). The situation is no different in Slovakia, Poland, Hungary, or the Czech Republic, where, for example, 30 to 36% of people believe in the conspiracy theory that Jews are trying to dominate the world (Krekó, 2015).

Fundamental to the research of conspiracy thinking are those findings that point to relatively stable individual differences in the tendency to believe in conspiracy theories - a person who believes in one conspiracy theory is more likely to believe in other, seemingly unrelated conspiracy theories (Goertzel, 1994; Swami et al., 2011). This tendency to believe in conspiracy theories means that despite the diversity and wide variety of conspiracy theories, there are common psychological processes behind them. Recent research works with belief in conspiracy theories as a conspiracy mindset, a mentality with specific elements typical of this thinking.

The importance of understanding and investigating this phenomenon stems not only from their irrational nature but mainly from research that has pointed to the negative connection between belief in conspiracy theories and the well-being of individuals and society as a whole. Although doctors agree that vaccines do not cause autism, many people believe otherwise and deny themselves and their children essential vaccinations, putting themselves and their health at risk (Jolley & Douglas, 2014a). Belief in conspiracy theories has also been associated with a reduced willingness to vote or engage in environmental behaviour due to the belief that global warming is a hoax (Jolley & Douglas, 2014b). Belief in conspiracy theories also harms interpersonal relationships (Harambam & Aupers, 2015), is associated with the advocacy of violent protest actions (Chayinska & Minescu, 2018), with extremism and contributes to the process of radicalization and violent tendencies of extremist groups (Bartlett & Miller, 2010).

Although, in the last few years, the scope of knowledge about conspiratorial thinking and the number of actively working researchers have increased, so far, only a few initiatives have appeared that have tried to build a theoretical framework and conceptualize this construct (Douglas, Sutton, & Cichocka, 2017; Van Prooijen & Douglas, 2018, Van Prooijen & Van Vugt, 2018). This fact indicates that the research and development of conspiracy theory is still in its infancy. For this reason, we have decided to contribute to the current research in the field of conspiracy theories as part of our scientific research activity and, using relevant methods of qualitative theoretical scientific research to clarify this increasingly frequent phenomenon in the modern information society.

2. Theoretical view of the development of the investigation of conspiracy theories and their definition

One of the first researchers who established and popularized the term conspiracy theory was Karl R. Popper (1949). According to him, the conspiratorial view of the world is very typical for society and developed from traditional religious ideas that gods are behind inexplicable events, which nowadays have been replaced by secret influential associations, groups, and powerful organizations. Initial descriptions of this construct occurred mainly in historical and political essays. In one of these essays, Hofstadter (1964) called conspiracy belief a paranoid style. Although he did not use the term in a medical sense, it spurred future research that found a link between belief in conspiracy theories and paranoia (Darwin, Neave, & Holmes, 2011; Grzesiak-Feldman & Ejsmont, 2008;

Imhoff & Lamberty, 2018). It was in the late 1980s that publications began to appear that included theoretical definitions and analyses of historical evidence for this phenomenon (Graumann & Moscovici, 1987). The term conspiracy theory was any alternative hypothesis, opinion, or story used to explain the circumstances of an unclear phenomenon or event, the background of which was a certain conspiracy.

Definitions of conspiracy theories gradually became unified, and nowadays this concept is briefly defined as *"a set of unfounded beliefs that lead a person to believe that the main cause of a certain event is a conspiracy of several actors working together, with a clear goal, often illegally and in secret"* (Swami & Furnham, 2014, p. 220). A broader definition describes conspiracy theories as *"unproven and remarkable conspiracy claims that: a) deny more likely consideration; b) presuppose, in terms of their content, extraordinary malice and competence on the part of the conspirators; and c) are, in the sense of epistemic reasoning, based on evidence that is considered by legitimate epistemic authorities to be of poor quality and resistant to questioning or correction"* (Brotherton, 2013, p. 12-13).

According to Van Prooijen (2018), every belief in conspiracy theories and conspiracy thinking contains 5 main signs, with the help of which we can distinguish this construct from other similar constructs, such as belief in the paranormal, paranoid thinking or superstition.

The first sign is finding patterns (pattern perception) in the surrounding environment and non-random connections between events, objects, and people. The conspiracy theory assumes that the incident did not happen by chance, by coincidence, but something more is hidden behind it.

The second sign is based on the assumption that the incident was sophisticated, detailed and deliberately planned by intelligent actors. This sign is marked as an "agency detection", whereby these intelligent actors form coalitions.

The third sign is that if a person believes that only one actor is behind the event, this statement cannot be called a conspiracy theory because it does not contain its main component – the conspiracy of several people.

The fourth sign is hostility because the intentions of these actors are always selfish and malicious.

The last sign that defines conspiracy theories is the concealment of these intentions from the public (continued secrecy); covert operations remain uncertain, unproven, and unsupported by solid evidence.

3. Belief in specific conspiracy theories and conspiracy thinking

Goertzel (1994) was responsible for the initial research on belief in conspiracy theories and asked the question of to what extent belief in conspiracy theories is a general trait. According to him, the best predictor (presupposition) of belief in a particular conspiracy theory is that a person believes in another. Based on the significant correlations between individual conspiracy theories, he offered support to science for further research into belief in conspiracy theories as a general ideological dimension. Currently, there are two ways to deal with belief in conspiracy theories:

- a) belief in specific conspiracy theories,
- b) general propensity to believe in conspiracies (Abalakina-Paap, 1999).

Specific conspiracy theories contain statements directed against a specific group of people and prompted by context (e.g. social, historical, cultural). Even though there are many specific conspiracy theories, and they are very different in content, the same processes stand in their background, captured precisely in the general tendency to believe in conspiracy theories. It is, therefore, possible to say that it is this general tendency (regardless of the content of conspiracy theories) that leads people to believe in specific conspiracy theories, the content of which is

contextually conditioned (Swami, Chamorro-Premuzic, & Furnham, 2010; Krekó, 2015). A public opinion poll, for example, can deal with belief in specific conspiracy theories without reflecting on the general tendencies that lead to beliefs about their truth.

The current area of interest is primarily the general tendency to believe in conspiracy theories. Currently, we can come across various terms that indicate this general tendency, e.g., "conspiracy mentality" (Moscovici, 1987), "generic conspiracist belief" (Brotherton, French, & Pickering 2013), "conspiracist ideation" and "endorsement to the conspiracy" (Swami et al., 2011). The term conspiratorial thinking is used in this work.

4. Motives of belief in conspiracy thinking

Labelling a person as a conspirator has acquired a pejorative connotation based on the historical and contemporary association of belief in conspiracies with paranoia (Hofstadter, 1964; Imhoff & Lamberty, 2018). However, it is not the role of science to deal with whether conspiracy theories are true. However, specific conspiracy theories have proven real (e.g., Watergate). The critical question is what factors and variables lead a person to doubt the facts presented and believe in conspiracy theories. As part of our qualitative theoretical research on conspiracy thinking, we will, therefore, focus on a relevant synthesis of theoretical findings using appropriate research methods, emphasizing epistemic, existential, and social motives for belief in conspiracy theories.

4.1 Epistemic motives

Among the epistemic motives that lead a person to conspiratorial thinking, we can mainly include the fulfilment of curiosity and the reduction of uncertainty, especially in those situations in which a person does not have all the relevant information available and also in those situations in which random events seem to be challenging to understand (Douglas et al., 2017). On the one hand, it can be a desire to search for information with the aim of reducing uncertainty, on the other hand, this recognition is, within the framework of conspiratorial thinking, accompanied by cognitive deficits (Kossowska, 2007). This idea was supported by the results of research studies showing that the need for cognitive closure, defined by Kruglanski (1990) as the desire to find an answer to avoid uncertainty and confusion, is positively related to conspiratorial thinking (Marchlewska et al., 2017; Swami, Voracek, Stieger, Tran, & Furnham, 2014; Umam, Muluk, & Milla, 2018).

The need for cognitive closure can act as a defence mechanism for someone who feels that the information available to understand a certain phenomenon is limited and, therefore, resort to simplistic and flawed explanations (Umam et al., 2018). Paradoxically, on the one hand, conspiracy theories provide explanations that serve as a refuge in the face of uncertainty and confusion, but on the other hand, they can increase discomfort and insecurity when people become aware of the danger posed by conspirators (Douglas et al., 2017).

Conspiracy theories are well insulated from epistemic access to new information and resistant to questioning or correction. At the same time, they are based on low-quality and weak evidence that contains gaps and unclear details (Brotherton, 2013). A large body of studies has, therefore, focused on heuristics in conspiratorial thinking. Barkun (2003) summarizes the basic attributes of conspiracy theories in three points: a) nothing happens by chance, b) nothing is as it seems, and c) everything is connected. Conspiracy theorists commit a fundamental error and more often make conclusions that relate to influential groups, even when adequate situational explanations are available (Clarke, 2002). Brotherton and French (2015) supported this theory with research in which respondents who interpreted vague and contrived events as intentional and planned were more likely to resort to conspiracy thinking than respondents who interpreted these events as random.

In another study, the same authors found that participants with conspiracy thinking tended to commit conjunction fallacies, which are described by Tversky and Kahneman (2008) as a specific error in reasoning where people overestimate the probability of co-occurring events (e.g., “Olivia is a saleswoman in the shop.” is a more likely statement than “Olivia is a shop assistant and also active in the anti-globalization movement.”) (Brotherton & French, 2014; Dagnall, Denovan, Drinkwater, Parker, & Clough, 2017).

A similar heuristic was found in another study that discovered a relationship between conspiratorial thinking and causal interpretations of spurious correlations. Participants agreed with statements that contained spurious correlations (e.g. "Increased morbidity in people is associated with more hospital visits.") and claimed to be able to interpret them. Respondents with conspiracy thinking were also more likely to prefer an explanation of a certain event as being causally connected to a similar recent event. At the same time, they liked events or stories presented as interconnected more than when presented as isolated and random. These results indicate a certain tendency of people with conspiracy thinking to give causal interpretations to events that are not related in any way because it can help them understand the world and explain certain circumstances (van der Wall, Sutton, Lange, & Braga, 2018).

Another possible explanation for why conspiracy thinkers tend to infer unlikely causal connections between phenomena is that they prefer to explain large effects in terms of significant causes; for example, it may seem that the sudden death of Princess Diana could not have been just an accident after all (Van Prooijen, 2018).

A slightly different group of studies focused on the idea that people with conspiratorial thinking tend to overestimate their knowledge and ability to understand complex phenomena. During the experiment, participants with a conspiracy mentality succumbed to the illusion that they could explain phenomena that they do not understand at all ("illusory of explanatory depth") (Vitriol & Marsh, 2018) and the heuristic called the "hindsight problem" or also called "I-knew-it" effect.

In another study, participants with a higher conspiracy mentality after the election results were more likely to claim that they knew the election outcome all along (Lamberty, Hellman, & Oeberst, 2018). Conspiracy thinking has been shown to have a close positive relationship with intuitive thinking and a negative relationship with analytical and rational thought (Ståhl & Van Prooijen, 2018; Swami et al., 2014; Van der Wal et al., 2018; Van Prooijen, 2017). Moderate to strong correlations were also found between conspiracy thinking and belief in paranormal phenomena, paranoid thoughts, and certain schizotypal personality traits. The most robust relationships were found to be with unusual perceptual experiences, paranoid thoughts, superstition, ideas of reference (the belief that random and irrelevant events are directly related to the person), and magical thinking. These aspects of the schizotypal personality reflect disorganized thought processes and a rejection of analytical thinking (Barron, Morgan, Towell, Altemeyer, & Swami, 2014; Darwin, Neave, & Holmes, 2011), which has also been shown in other research with people with conspiratorial thinking to have reduced trust in influential (mainstream) sources and, conversely, increased faith in lay non-expert (alternative) sources (Imhoff, Lamberty, & Klein, 2018).

4.2 Existential motives

Whether a person finds refuge in conspiratorial thinking, existential motives also play a significant role, including the need for security and perceived control over one's surroundings (Ušiak & Trubenová, 2020). The propensity to believe in conspiracy theories may also be associated with increased self-esteem, an inappropriate perception of oneself as the centre of attention of others and the associated feeling of being the target of a deliberate attack by others. This idea was supported by research that found a positive association between conspiratorial thinking and individual narcissism (Cichocka, Marchlewska, & Golec de Zavala, 2016). At the same time, the perception of oneself in the centre of interest of others is also associated with a higher degree of paranoid thoughts, which

further feed conspiratorial thinking. Several studies have found that people who score higher on the paranoia scale are significantly more likely to endorse conspiracy claims (Darwin et al., 2011; Grzesiak-Feldman & Ejsmont, 2008; Imhoff & Lamberty, 2018). One of the characteristics of paranoia is a self-referential perception of the behaviour of others (Fenigstein & Vanable, 1992).

Because these constructs may seem very similar, knowing the differences that set them apart is excellent and appropriate. Both constructs assume particular intentions of others, which a person applies to himself. Conspiracy thinking is more specific; it assumes the intentions of powerful groups' secret societies, while paranoia assumes a particular purpose from each person. The fundamental difference is that while in the case of paranoia, the target is the person himself, in the case of conspiratorial thinking the target is the society to which the person belongs (Imhoff & Lamberty, 2018).

The results of other studies also contribute to the idea of an overvalued perception of oneself, which can be a defence strategy against feelings of inferiority. It turned out that participants with higher conspiracy thinking also had a more increased need for uniqueness, which expresses their need to differentiate themselves from others and show their uniqueness. Conspiracy-thinking participants much more often thought that they were the owners of unique information, which, unlike them, most people do not own (Lantian, Muller, Nurra, & Douglas, 2017).

In another study, the results also pointed to a highly functional aspect of endorsing mainly lesser-known and less popular conspiracy theories related to the fulfilment of the need for uniqueness (Imhoff & Lamberty, 2017). The connection between conspiratorial thinking and overestimated self-perception can also be linked to the above-described epistemic motives, mainly to overestimation of one's own knowledge and predictive thinking (Vitriol & Marsh, 2018). Support can also be found in the proven relationship between the need for uniqueness and narcissism (Emmons, 1984; Lantian et al., 2017).

In this case, the second component of existential motives is the fulfilment of the need for security and safety (Beňuška & Nečas, 2021; Kavan, 2021). The feeling that the impact of social change threatens the basic values of society can strengthen conspiracy thinking and the endorsement of conspiracy theories. The perception of a threat to personal safety as a result of social changes can affect the perception of the legitimacy of the relevant social systems, the questioning of society, the importance of membership in this society and the extent to which a person attributes to them based on the values emanating from society. A heightened sense of this threat has been associated with conspiratorial thinking (Federico, Williams, & Vitriol, 2018).

Conspiracy thinking among respondents also increased when they perceived a threat to the legitimacy of the social system. Conspiracy-thinking participants perceived society as fairer, more legitimate, and safer, attributing society's problems more to malicious individuals than systemic causes (Jolley, Douglas, & Sutton, 2017). Within the system-justification theory, which Jolley et al. (2017) offer to interpret the results, conspiracy thinking is a response to perceived threats. System-justification theory explains that people are motivated to maintain a positive image of the existing social, economic, and political establishment, thereby symbolically satisfying their social, epistemic, and existential needs. Threatening this justice, integrity and legitimacy of the social system also threatens these needs and force people to defend themselves or rationalize the status quo even at the expense of their interests.

The extent to which people can exercise and control their social environment is linked to their desire to make sense of that environment. This sense-making is a central component of conspiratorial thinking (Douglas et al., 2017). In several research studies, participants who felt a threat of control over their environment had a stronger tendency towards conspiratorial thinking (Kay, Gaucher, Napier, Callan, & Laurin, 2008; Sullivan, Landau, & Rothschild, 2010; Van Prooijen & Acker, 2015; Whitson & Galinsky, 2008). An insufficient feeling of control

also increases the perception of illusory patterns in the environment, which, according to Van Prooijen (2018), is one of the five signs of conspiratorial thinking.

When a person feels a threat of control over his environment, perceiving powerful enemies can serve as psychological compensation. Enemies, in this case, play the role of a psychological focus responsible for adverse events and threats to life and well-being that cannot be controlled. People with conspiratorial thinking tend to deny the influence of random forces on any adverse event and to immediately shift the blame to "powerful enemies", while the fact that these enemies have been exposed brings them a sense of security (Sullivan, Landau, & Rothschild, 2010).

A similar and equally important driver of conspiratorial thinking is perceiving and finding meaningful patterns in stimuli that random processes have generated. This perception is also associated with the belief that random and irrelevant events are directly related to the person who perceives them, which leads to a certain degree of egocentricity (Van Prooijen, Douglas, & de Inocencio, 2017).

Van Prooijen and Van Vugt (2018) conceptualized two possible theories why people resort to conspiracy thinking and why it is so influential:

- a) conspiracy theories are an evolutionary by-product of a set of cognitive mechanisms (pattern perception, detection, and revelation of enemies) that have evolved for various reasons,
- b) conspiracy theories are part of a developed adaptive psychological mechanism to detect and reveal dangerous coalitions.

The first hypothesis assumes that conspiracy theories occur as a by-product of cognitive mechanisms: the perception of patterns, threats, and detection of actors and coalitions. These can sometimes be perceived as erroneous or overestimated, and conspiracy theories result from distortions of these mechanisms. The second hypothesis posits that conspiratorial thinking has an adaptive basis, designed to address and deal with realistic threats of coalitional violence that were present in the past among our ancestors. Conspiracy thinking could thus be functional in the environment of our ancestors, who were often threatened by deadly conspiracies. However, when these threats have disappeared in the current era, it has already lost its adaptive value.

4.3 Social motives

Motivating elements that can contribute to conspiratorial thinking include the individual's desire to maintain a positive self-image and the image of the group to which the person is a part and with which he identifies. Attributing adverse outcomes to others can contribute to maintaining an image of oneself and one's group as competent and moral or, failing that, as being sabotaged by powerful and unscrupulous others (Douglas et al., 2017).

Conspiracy thinking can also serve as a strategy to satisfy specific group needs, e.g., participants who identified with the protesting group movement defended the group's conflictual behaviour through the belief that members of the government were conspiring against the group (Chayinska, & Minescu, 2018). This ingroup effect (adherence to the group to which the individual belongs) is also supported by the results of other research studies, which show significantly greater susceptibility to conspiracy thinking in minority ethnic groups (Crocker, Luhtanen, Broadnax, & Blaine, 1999; Van Prooijen, Staman, & Krouwel, 2018) even if these conspiracy theories are irrelevant due to their position in society (Van Prooijen et al., 2018).

Another significant predictor contributing to the explanation of this construct is collective narcissism, which reflects the belief in the importance of the member group ("ingroup"), inter alia, conditioned by the recognition of

others (Cichocka, Marchlewska & Golec de Zavala, 2016; Golec de Zavala, & Federico, 2018). Narcissistic identification with a group of which the individual is a member is positively related to the endorsement of conspiracy theories that are directed against groups to which the individual does not belong ("out-group") (Cichocka, Golec de Zavala, Marchlewska, & Olechowski, 2015).

According to Winiewski, Soral and Bilewicz (2015), conspiracy thinking is based on the scapegoat theory. Social psychology often mentions this theory in the context of hostility and hatred towards groups and minorities. They become a scapegoat worthy of punishment for negative consequences caused by entirely different causes. Its reformulation within the framework of conspiracy thinking proposes that the group scapegoat does not have to be only a vulnerable and powerless minority but also a group that people believe is powerful and dangerous. Frustration, which flows from deprivation or an unfavourable life situation, often plays the primary role. This frustration motivates a person to attribute causes to influential groups, which he puts in the role of a scapegoat.

People with a conspiratorial mindset tend to personalize groups, seeing them as a collective enemy with hostile intentions towards their group. Conspiracy theories are causal: they attribute to the group they are targeting a collective goal (desire for power and dominance), collective behaviour and a high degree of egoism in terms of support and solidarity within the group, alongside a disregard for the well-being of those outside the group.

Conclusions

Based on our research findings, we can theoretically consider conspiracy thinking as a specific unconscious strategy that helps a person to fulfil epistemic, existential, and social needs. Within epistemic motives, conspiracy thinking offers a simple scheme to understand the causes of obscure events. Conspiracy thinking is associated with intuitive and distorted thinking, susceptibility to various heuristics, and overestimating one's abilities and knowledge. The last aspect is a manifestation of self-evaluation, essential in fulfilling existential motives. Research has shown that conspiracy thinking is associated with an increased need for uniqueness, individual narcissism, and an egocentric view of oneself. In addition to maintaining a positive self-image, a person also needs to maintain a positive image of the group he is a part of.

Conspiracy thinking is also associated with prejudice against groups that are perceived as powerful or threatening. In social motives, conspiratorial thinking is also related to collective narcissism, whereby out-groups become the target of prejudices and scapegoats, which cause difficult life situations or inexplicable events. One of the most recent attempts to explain conspiracy thinking is the evolutionary theory by Van Prooijen and Van Vugt (2018), who hypothesize that this phenomenon is a by-product of cognitive mechanisms that were developed for our ancestors' security, namely the detection and revelation of enemies, and finding connections and patterns in the surrounding environment. Nowadays, however, conspiracy thinking is already maladaptive.

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**Publisher**<http://jssidoi.org/esc/home>**PECULIARITIES OF VIDEO STREAMING INDUSTRY DEVELOPMENT*****Alexandra Ioanid ^{1*}, Denisa Iliescu ²**^{1,2} *National University of Science and Technology POLITEHNICA Bucharest, Bucharest, Romania*¹ *Academy of Romanian Scientists, Bucharest, Romania**E-mail:*^{1*} alexandra.ioanid@upb.ro (Corresponding author); ² denisamiliescu@gmail.com*Received 18 August 2023; accepted 19 October 2023; published 30 December 2023*

Abstract. The term “streaming” defines modern technologies for distributing the contents of files and audio or video in a continuous stream via a wired or wireless internet connection. The word “streaming” also means a “continuous flow” and represents a newly developed multimedia technology content carried out between the transmitting source and the receiving device. This article delves into the multifaceted dimensions of the streaming services industry, emphasizing the pivotal role played by innovation, technology, and performance. Through a comprehensive exploration, we highlight the transformative impact of real-time content. With projections indicating continued exponential growth, the industry's trajectory is analyzed within the context of the multidimensional triadic model. Case studies on industry leaders underscore the criticality of research and development investments in driving profitability. As the industry evolves, companies prioritizing user experience and technological innovation prepare for sustained success in this dynamic landscape. This article is a compass for industry stakeholders, providing insights into the intricate interplay of innovation, technology, and performance within the streaming services sector.

Keywords: innovation; technology; performance; streaming technology; multidimensional triadic model

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1. Introduction

Streaming technology began to develop in the 2000s, simultaneously with the development of computing capacity and computer performance stimulated by the expansion of the Internet. Since 2005, video streaming technology has gained global scale with the emergence of YouTube, Google Video and Dailymotion. The first two subsequently merged and provided widespread access to streaming entertainment content via the Internet (Wilbert, M., 2019). Thus, following technological developments, entertainment applications transmitting real-time content have attracted increased interest and functionalities (Zotos et al., 2011).

The streaming services industry refers to transmitting media or entertainment content to electronically interconnected devices, such as screens, televisions, personal computers, smartphones, and tablets, wherein content is simultaneously rendered throughout its transmission. Online streaming removes the necessity for

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prior content downloading and retention, with supported formats encompassing auditory and visual media, podcasts and webcasts, musical vignettes, cinematic productions, and serialized television programming (Frade et al., 2021; Austerberry, 2013). As the tendency for this mode of amusement increases, streaming services have emerged as a paramount facet of internet consumption (Lambrinos & Demetriou, 2010; Bampis & Bovik, 2018; Laterman et al., 2017; Nguyen et al., 2023).

Online streaming diverges from conventional video or audio content dissemination modalities, characterized by its dynamic transmission approach (Farhand & Tsechpenakis, 2023). Leveraging streaming technologies, antecedently readied audio files, video files, podcasts, webcasts, and music videos are methodically segmented into data packets and consecutively disseminated, enabling immediate access and viewing. Besides the waiting time being non-existent, the files can be played in real-time, another advantage being saving memory. Thus, the media files will not consume memory and will not take up additional space, being deleted automatically immediately after finishing watching or listening to them. This present study focuses on studying the multidimensional model of innovation, technology, and performance in the streaming services industry, a revolutionary and disruptive industry for the traditional model of transmission and consumption of entertainment content.

2. Review of literature. Innovative technology for entertainment

Multimedia streaming encompasses the real-time conveyance and distribution of entertainment content across a network to the recipient. Consumers of entertainment materials experience an uninterrupted and synchronized reception of media elements, coincident with their ongoing transmission and devoid of temporal lags (Maia et al., 2015). In streaming technology, a multimedia file is divided into tiny divisions, as appears in Fig. 1. Each division consists of a fraction of the original file and can be streamed individually. As a result, end-users are empowered to engage with the entertainment content contemporaneously with the reception of the data stream, thereby negating the necessity for data storage capacities. Moreover, the rendering of the content playback occurs instantaneously, transforming the streaming experience into a real-time phenomenon (Lam & Rossiter, 2008; Darwich et al., 2021).

Facilitating the adoption of the pioneering streaming technology necessitates the acquisition of a subscription-based affiliation with an online streaming service provider, alongside possessing a technologically proficient apparatus capable of accommodating said innovation. The seamless integration of these elements mandates steadfast, high-velocity Internet connectivity. Diverse devices of varying capabilities and specifications align with an array of personalized requisites, including but not limited to high-resolution 4K playback mechanisms, hands-free contrivances, specialized gaming peripherals, devices furnished with or bereft of remote-control interfaces, as well as economically viable options (Lambrinos & Demetriou, 2010; Bampis & Bovik, 2018; Nguyen et al., 2023).

Additional technological paradigms and inventive breakthroughs, including but not confined to artificial intelligence (Mariani et al., 2023), machine learning (Suárez-Cetrulo et al., 2023; Shahraki et al., 2022; Jeon et al., 2020), and blockchain technology (Yuan et al., 2022; Tapscott & Tapscott, 2018), are poised to usher in transformative effects upon the landscape of the online streaming media sector. These technological underpinnings are intended to yield novel enhancements in the realm of streamed video content, augmenting the already pioneering domain of the streaming industry itself, which constitutes an innovation of technological merit (Lambrinos & Demetriou, 2010; Bampis & Bovik, 2018; Nguyen et al., 2023). The expectations are that all of these will create new opportunities for growth and development in the coming period and represent disruptive factors in how entertainment content is transmitted and consumed. The spread of this mode of entertainment transmission will accelerate and attract new users constantly in the future.

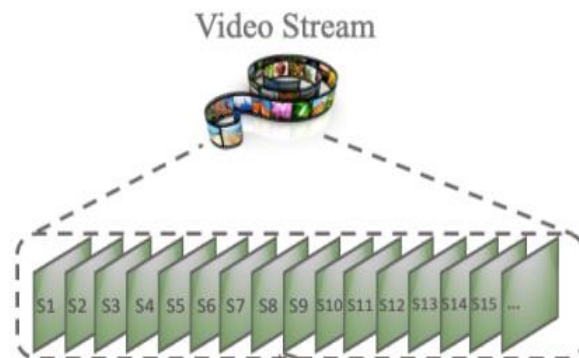


Figure 1. Video streaming structure
Source: Darwich et al. (2021)

Enhanced streamlining capabilities

Enumerated within the ambit of streaming technology's favorable attributes lies the augmentation of transmission capacity, accomplished at a notably diminished expenditure in juxtaposition to conventional modalities. This technological facet also engenders superior visual and auditory fidelity, optimizing the frequency spectrum allocation and ameliorating the financial outlays of modernizing transmission equipment (European Commission, 2006). Moreover, this technological milieu empowers users with the capacity to compile lists of viewing preferences (Hagen, 2015; Aguiar et al., 2021), thereby affording the prerogative to stipulate intermissions and revisit content at will (Ji et al., 2023).

According to Darwich (2020) there are three types of streaming: video-on-demand streaming, live streaming and live video streaming on demand, as shown in Figure 2. Within the realm of on-demand video streaming, the corpus of video content assumes the form of pre-existing video files ensconced within a repository designated for video streaming. Following user requisites, this content pool is gathered forward and seamlessly disseminated, generating a continuous playback upon their devices. This variant is facilitated by the Internet conduits, orchestrated by esteemed transmitters such as Netflix, Amazon Prime Video, and Disney+.

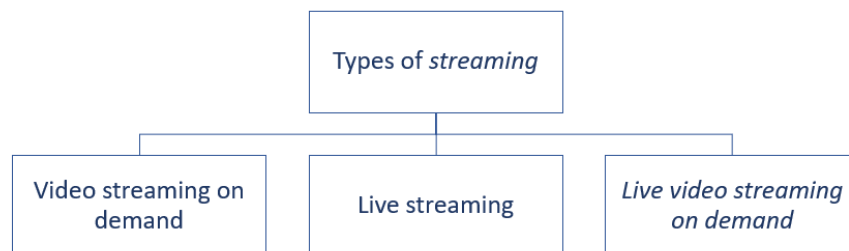


Figure 2. Types of streaming
Source: Darwich et al. (2020)

Within live streaming, the content undergoes instantaneous conveyance to recipients concomitantly with its recording through the video camera's lens. Consequently, the transmission unfolds in temporal synchronicity, devoid of antecedent archival and storage procedures. The domain of on-demand live video streaming represents an amalgamation of video-on-demand and live-streaming paradigms. In this modality, the live event is contemporaneously recorded during its unfolding and live-streamed, subsequently availing itself for subsequent on-demand viewing. This affords the advantage of accommodating users not concurrently tethered to the Internet during the live transmission, enabling deferred access at their discretion.

In the last three years, the online streaming market has grown significantly (da Silva & Lima, 2022, Wu & Chiu, 2023). In 2020, the number of users exceeded the threshold of 1 billion (Watson, 2021). According to a report

by Research & Markets (2019), the market growth projection is 18.3% annually until 2026, reaching a value of approximately \$150 billion. The exponential growth witnessed in the online streaming market signifies a shift in consumer behavior. It heralds a new era of entertainment consumption, with far-reaching implications for content creators, technology companies and consumers alike.

The literature review has provided a comprehensive overview of the streaming services industry, emphasizing the pivotal role of innovation, technology, and performance in driving its rapid evolution. While existing studies have delved into various aspects of this dynamic sector, there still needs to be a notable gap in exploring the interplay between R&D investments, technological innovation, and subsequent profitability within industry leaders. This study seeks to address this gap by conducting a detailed analysis of the relationship between R&D investments and profit margins, shedding light on the critical role of continuous innovation in ensuring sustained profitability. Furthermore, examining organizational culture and capital infusion as catalysts for research and development activities will offer valuable insights into the mechanisms that drive innovation in the streaming services industry. By filling this gap in the literature, this study aims to contribute to a deeper understanding of the factors shaping the success of companies within this rapidly evolving landscape.

3. Research Approach

This study employs a mixed-method approach, combining quantitative analysis with qualitative case studies. The quantitative component involves an in-depth examination of financial data from industry leaders Netflix and Amazon over five years, focusing on R&D investments, profit margins, and other key performance indicators. The qualitative aspect involves detailed case studies to provide context and deeper insights into these companies' innovation strategies and organizational cultures.

This research aims to investigate the intricate interplay between innovation, technology, and performance in the video streaming services industry. Specifically, the study seeks to understand how R&D investments contribute to technological innovation and subsequently influence the profitability of industry leaders. Additionally, it aims to explore the role of organizational culture and capital infusion in driving research and development activities.

This paper explores the video streaming services industry, striving to study the complex interrelationship among innovation, technology, and performance. Three primary research questions guide the article. Firstly, how do investments in research and development influence business performance and profitability in leading companies in the streaming industry? How do organizational culture and capital infusion impact innovation-driven technologies in this dynamic sector? The third question is, how does the multidimensional triadic model of innovation, technology, and performance provide insights into companies' competitive standing and evolutionary trajectory in the video streaming services industry? Through an extensive study of industry leaders, this research emphasizes the pivotal role of innovation, technology, and performance in shaping the success and evolution of the video streaming services sector.

4. The multidimensional triadic model innovation – technology – performance

The domain of video streaming services stands as a paradigm-shifting and perturbing force within the conventional ideas of content transmission and consumption in the entertainment sphere. This sector, so far underrepresented in scholarly inquiry due to its recent creation and rapid evolution, has substantial developmental prospects, offering significant opportunities for scientific and research purposes.

Triadic models, elucidated as theoretical frameworks comprising three interdependent constituents, manifest a complexity exceeding the mere tripartite configuration. These models, of triad essence, must embody a systemic and integrative disposition. They are designed to be an integral component of an overarching system, accentuating the intrinsic significance of each element while accentuating the interconnections that bind them.

This integrated framework is an invaluable analytical tool for theoreticians and assumes a pivotal role as a decision-making prop for managers, entrepreneurs, and legislators. Under its integral synergistic nature, the

model fosters a higher order of possibilities and augmented value, positioning itself as an indispensable asset in the horizon of research and practical application (Scarlat, 2017).

Scarlat and Iliescu (2021) articulated that a "triad" embodies a multifaceted and intricate construct, permeating diverse realms of scientific inquiry and shared knowledge. This concept finds its expression in a myriad of contexts, some of which include: the triadic color scheme, the tricolor flag, the political triumvirate, the triadic literary form that appears in medieval literature from the area of Wales and Ireland or the triads in chemistry that record the oldest system of classifying elements by atomic weight (Döbereiner's Law of Triads, 1817). Such instances underscore the pervasive and interdisciplinary nature of the "triad" concept, spanning diverse disciplines and historical epochs, epitomizing the potent interplay between symbolism, structure, and classification (Scarlat & Iliescu, 2021).

Additional instances of triads permeate the academic discourse, exemplified by the "triple helix" model elucidated by Etzkowitz (2003; 2008). This dynamic configuration, conceived in 1993, encompasses the synergistic interplay of three distinct domains: academia, industry, and government, forging a nexus of innovation and progress. Similarly, Ohmae (1985) introduces a triad in global economic geography, delineating the geographic regions of North America, Western Europe, and East Asia as pivotal epicentres. The triadic construct extends its reach to encompass continental divisions, as seen in the amalgamation of North America, Central America, and South America, or the Benelux coalition uniting Belgium, the Netherlands, and Luxembourg.

Drawing inspiration from triadic manifestations that resonate with economics, project management, entrepreneurship, and marketing, the present research converges on the triad of Technology, Innovation, and Performance. This triadic interplay assumes a pragmatic organizational vantage, underscoring a nuanced analysis of its latent potential. The study embraces an all-encompassing methodology, exemplified in synthetic, systematic, and synergistic facets (commonly referred to as the three S's), a conceptual framework expounded by Scarlat in 2017.

The impending study, rooted in the realm of business and organizational dynamics, aspires to unravel the particularities of the Technology – Innovation – Performance triad. This endeavor embodies a holistic perspective, echoing the very essence of synergistic interconnections (Scarlat, 2017).

Based on the triad innovation, technology, and performance (Scarlat & Iliescu, 2021; Scarlat, 2021), the present work proposes the multidimensional triad innovation, technology, and performance, a complex, multidimensional model, which puts at its center the triad innovation – technology – performance, each of its elements being in turn formed by a triad as depicted in Fig. 3. Thus, the technology component is made up of the triad hardware – software – knowledge, the innovation component is made up of the triad capital – organizational culture – patents, and the performance element is made up of the triad number of users – turnover – profitability.

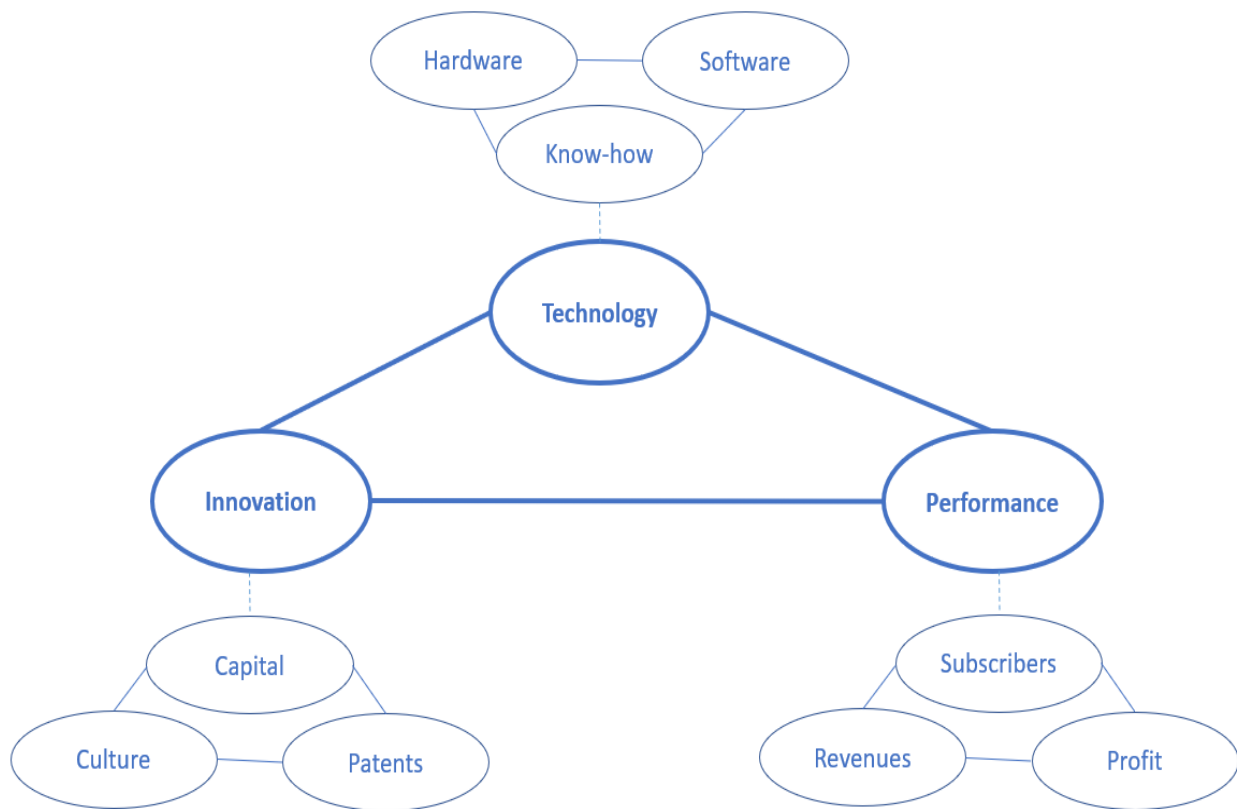


Figure 3. The multidimensional triadic model innovation – technology – performance

3.1. The Technology triad: hardware – software – know-how

Enterprises in the online domain cultivate and oversee many technologies spanning infrastructure and informational systems. This pursuit mandates a requisite degree of training and expertise, facilitating a technology triad's genesis. Within this triad, the constituents encompass hardware components, software systems, and a reservoir of technical understanding.

The term "hardware" encompasses the totality of apparatus and tangible components that comprise the streaming system. This contains specialized devices meticulously tailored for the express purpose of online audio or video streaming. The realm of hardware devices remains a dynamic landscape characterized by perpetual advancement, with innovative technological breakthroughs and functionalities surfacing regularly (Chernova, 2018; Messaoud et al., 2022).

"Software" comprehensively denotes the collective assemblage of computer programs and applications instrumental in the governance and management of the streaming system. These software applications are installed and run on computational machinery and tangible systems following predefined algorithms. The paramount objective of these information systems is converting original content into the desired format, a process facilitated by programming languages that manifest keen interest from academic and professional environments alike (Andrade et al., 2023; Gorawski et al., 2023).

In tandem, the experience of online streamed video entertainment is enabled through entertainment streaming applications. These software platforms, functioning as intermediaries, empower subscribers to access and enjoy entertainment content via Internet-connected devices, regardless of geographical location (Oyedeke & Simpson, 2018).

"Technical know-how" embodies a constellation of practical, instrumental, and technical competencies, serving as a conduit for translating scientific knowledge and concepts into actionable endeavors, thereby fostering the innovation and development of novel technologies or addressing specific needs. This repository of expertise constitutes an organization's foundational intangible asset, augmenting its research and development (R&D) capabilities (Cleveland et al., 2015) and creating the prospects to generate future financial gains (Bechlioulis et al., 2023; Manea et al., 2021). These competencies form a deep interconnection with technological advancements, manifesting as both catalysts for their inception and consequences of adaptation to research outcomes and developments within the field (Parayil, 1991; Lipsey, 2001).

Furthermore, this consolidation of skills emerges as a statement of entrepreneurial orientation (Fellnhöfer & 2022), encapsulating the capacity to navigate and leverage the evolving landscape of technology and innovation.

3.2 The Innovation triad: capital – organizational culture – patents

The arena encompassing online and video entertainment is a fiercely competitive and perpetually evolving domain, marked by frequent consumer preferences and predilections oscillations. Innovation, delineated with a dual dimension (Svahn & Henfridsson, 2012), is deeply rooted in the necessities of economic entities while maintaining a vigilant focus on the intricate interplay of market commercialization dynamics and envisioning its future trajectory (Manea et al., 2021). This innovation framework coalesces into a triadic configuration characterized by the blend of capital infusion, organizational culture, and patent acquisitions.

Foremost among the constituents of technological innovation is the capital, a fundamental element that, coupled with an organizational culture markedly dedicated to research and development pursuits, confers a favorable environment conducive to the inception of financially rewarding innovations. The academic environment inquiries within this domain underscore the incontrovertible nexus between capital infusion and the trajectory of innovation performance. The injection of capital wields a profound influence on the outlines of innovative undertakings, and notably, it holds the potential to advance the temporal span leading to product commercialization (Bechlioulis et al., 2023; Prado & Bauer, 2022; Bai & Tang, 2022).

Furthermore, the merits of innovation are amplified when enterprises underscore the paramount significance of human capital and the cultivation of a technology-oriented setting (Ramírez-Solis et al., 2022).

Within global economies, corporate performance and innovation have emerged as paramount imperatives for enterprises, with their bedrock firmly grounded in the tower of organizational culture. At the crux of organizational success and innovation resides a fusion of established habits and behavioral norms, coalescing to constitute the framework of a company's culture. The embracement and propagation of change among personnel positively and favourably impact organizational innovation, thereby implicitly influencing overall corporate performance (Naveed et al., 2022; Byun, 2022). Furthermore, a cultivated culture stimulates an encouraging climate for the emergence of ecologically conscious technological innovations, thus furnishing a conduit for sustainable progress (Ullah et al., 2022).

3.3. The Performance triad: subscribers – revenue – profit

Concerning the performance triad, it encompasses an interconnection of three pivotal constituents: firstly, the consolidation of streaming service users, commonly referred to as subscribers; secondly, the financial inflows arising from online streaming entertainment; and finally, the underpinning profitability yielded by this multifaceted endeavor.

Streaming service users, defined as subscribers, denote individuals who remunerate a subscription fee to procure access to online-streamed entertainment content. As such, the customer base is an output of innovation, a performance measurement tool, and a source of income in the streaming services industry. Companies constantly seek to increase their customer base by focusing on the quality of experiences and satisfaction (Vendrell-Herrero et al., 2023 & Mullin, 2022).

The revenue within the streaming industry encompasses the cumulative earnings derived from diverse sources, containing subscription payments (Lozic, 2020), proceeds from advertising sales (Lawrence, 2022), and individualized viewing transactions. So, companies in the industry of entertainment streaming services offer a wide variety of entertainment programs, including movies, series, documentaries, sports broadcasts or games, for which they charge different types of subscriptions (Reiff, 2022; Jang et al., 2021; Wu & Chiu, 2023).

Profitability characterizes a favorable outcome achieved by a company oriented toward realizing financial gains over a fiscal year. This achievement emanates from the skilful allocation and utilization of its available resources, spanning material assets, financial capital, and human capital. This strategic utilization is orchestrated in a manner conducive to facilitating optimal conditions for all stakeholders involved. This skillful resource management strives to ensure enhanced future performance, establishing a discernible interrelation between a company's performance and overall welfare (Carp & Mirea, 2017).

4. The influence of innovation and technology over performance

The focus on research and development activity and the inclination towards the new factor and overcoming existing barriers and the status quo are key elements that indicate a company's interest in innovation, technology and sustainable development. Both investors and customers, society or other stakeholders, look with increased interest at companies that invest in research and development, these companies holding the premises of increased potential in achieving long-term success, improved profitability and a positive return.

The R&D investments represent a benchmark in the online entertainment streaming industry for technology and innovation. This study launches the hypothesis H0 that R&D investments influence business performance through increased profitability. The subjects of the study are the streaming industry leaders Netflix and Amazon, and the analysis will be based on a period of five financial years.

4.1. The relationship between R&D investments and profit margin at Netflix

As can be seen in Table 1, investment in research and development doubled during the mentioned period, starting from 1.2 billion USD allocated to this activity and increasing the amount constantly, reaching investments of 2.7 billion USD after five years. The profit margin percentage remained positive during the same period, rising from 10% to 21%.

Table 1. R&D investments and profit margin at Netflix

Netflix	2022	2021	2020	2019	2018
R&D investments (billion \$)	2.7	2.3	1.8	1.5	1.2
Profit margin (%)	18	21	18	13	10

To demonstrate the hypothesis and to verify the relationship between the R&D investments and the profit margin at Netflix, the correlation formula will be used as below:

$$\frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (1)$$

where r = correlation coefficient

n = number of observations

x = R&D investment values at Netflix

y = profit margin at Netflix

Following the calculation using formula (1), $r = 0.82$ is obtained, a value that indicates a strong positive linear correlation and a confirmation of the H0 hypothesis: investments in research and development contribute significantly to high profitability. In the analyzed period, constant investments in research and development have helped Netflix enjoy positive financial results and increased profitability (Fig. 4).

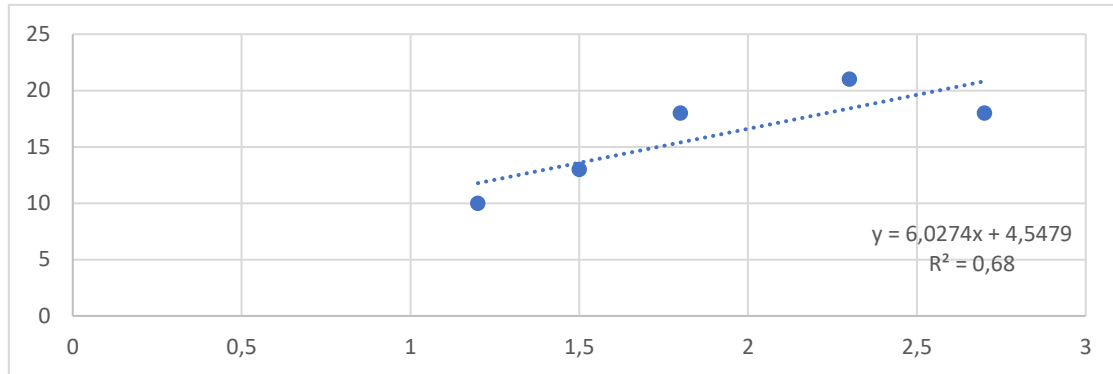


Figure 4. The correlation between investments and rentability at Netflix

4.2. The relationship between R&D investments and profit margin at Amazon

As can be seen in Table 2, investments in research and development have been a point of interest for the Amazon Company, starting from 29 billion USD allocated to this activity in 2018 and increasing the amount constantly, reaching investments of \$73 billion after five years. The operating profit margin percentage remained positive during the same period, with 4% and 8% variations.

Table 2. R&D investments and profit margin at Amazon

Amazon	2022	2021	2020	2019	2018
R&D investments (billion \$)	73	56	43	36	29
Profit margin	8	7	6	4	4

To demonstrate the hypothesis and to verify the relationship between the R&D investments and the profit margin at Amazon, the correlation formula will be used below.

$$\frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (2)$$

where r = correlation coefficient

n = number of observations

x = R&D investment values at Amazon

y = profit margin at Amazon

Following the calculation using formula (2), $r = 0.95$ is obtained, a value that indicates a strong positive linear correlation and a confirmation of the H0 hypothesis: investments in research and development contribute significantly to high profitability. In the analyzed period, Amazon invested heavily in research and development, obtaining multiple patents, which resulted in additional revenue and increased profitability (Fig. 5).

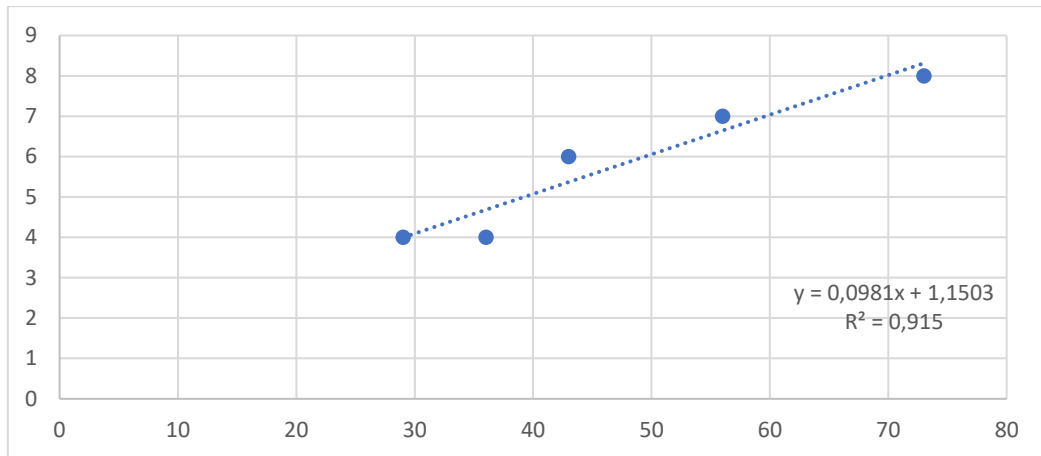


Figure 5. The correlation between investments and rentability at Amazon

Analyzing the pivotal role of research and development (R&D) investments in the online streaming industry provides valuable insights into the influence of innovation and technology on business performance. This study, centered on industry leaders Netflix and Amazon, establishes a compelling correlation between R&D investments and profitability. Notably, both companies steadfastly committed to R&D, with significant financial allocations. This commitment yielded results, as evidenced by positive shifts in their profit margins. The robust positive correlation coefficients ($r = 0.82$ for Netflix and $r = 0.95$ for Amazon) affirm the hypothesis (H0) that R&D investments substantially contribute to strengthening profitability. These findings serve as a resounding endorsement of the strategic significance of R&D investments in sculpting and reinforcing a company's performance landscape, propelling them towards enduring financial triumph in the intensely competitive online entertainment domain.

The demonstrated correlation between R&D investments and profitability suggests a broader trend: that innovation-driven strategies are not only relevant but essential in a rapidly evolving digital era. As companies seek to capture and retain audiences in an increasingly competitive market, the ability to pioneer and adapt cutting-edge technologies becomes a defining factor for success.

5. Discussion

The present study delved into the intricate nexus of the innovation, technology, and performance triad in analyzing the video streaming services industry. Through a comprehensive exploration of these dimensions, we have illuminated crucial insights into the dynamics propelling this dynamic sector forward.

Our investigation underscores the pivotal role of innovation as a catalyst for technological advancements and subsequent performance enhancement. The triadic innovation, technology, and performance model emerges as a robust framework, shedding light on the multifaceted interactions and interdependencies that characterize this industry. Our findings echo the sentiments of scholars such as Carp and Mirea (2017), emphasizing the correlation between companies' performance and their adeptness in developing and deploying innovation-driven technologies.

Moreover, the central role of organizational culture must be considered. A culture steeped in innovation spurs the development of decision-making models and provides a conducive environment for integrating engineering and business. This resonates with the emerging trends identified in the study, where companies proficient at adapting to changes, embracing change, and fostering innovation demonstrate heightened levels of success.

Furthermore, the significance of capital infusion in stimulating innovation is evident. As we've discussed, capital is a crucial enabler in driving research and development activities, thereby shaping the landscape for

technological breakthroughs. This aligns with Bechlioulis et al.'s (2023) assertion that capital is pivotal in expediting time-to-market and underpinning innovation-based profitability.

The analysis presented herein highlights the intricate interplay between innovation, technology, and video streaming services industry performance. As the industry continues its accentuated rise, these insights can serve as guiding examples for companies aspiring to navigate the landscape of technological innovation while optimizing their performance for sustained success.

Conclusions

The triadic innovation model, encompassing innovation, technology, and performance, emerges as a robust foundation for analyzing companies at the vanguard of the video streaming services industry. This dynamic sector has seized a dominant position within the entertainment market, undergoing rapid expansion recently. The interconnection of innovation, technology, and performance is a suitable approach to scrutinize these industry players, given their role in the sector's evolutionary trajectory and competitive standing (Martínez-Sánchez et al., 2021 & Kim et al., 2021). Those companies have transformed traditional industries (Bloomberg, 2022 & Yu et al., 2022) and have prospects of actual growth rates (Auletta, 2014), considering the untapped market potential. Companies that demonstrate adaptability to shifts in the actual dynamic landscape or proactively instigate transformations, fostering an internal culture that facilitates innovation and top-performing technologies, are susceptible to attain elevated levels of accomplishment and exceptional performance.

In conclusion, streaming technology has revolutionized how we consume entertainment content. This dynamic industry, characterized by its real-time access and diverse modalities, has seen exponential growth, with projections indicating continued expansion. The multidimensional triadic model of innovation, technology, and performance provides a comprehensive framework for understanding the driving forces behind this industry's success.

Furthermore, our exploration of R&D investments at industry leaders like Netflix and Amazon underscores the critical role of continuous innovation in ensuring sustained profitability. Organizational culture and capital infusion emerge as critical catalysts, fostering an environment conducive to research and development activities. As we look ahead, it is evident that the streaming services industry will continue to shape the future of entertainment consumption. Companies prioritizing innovation, investing in technology, and fostering a culture of adaptability are poised for continued growth and success in this ever-evolving landscape. With the potential for untapped market opportunities, the streaming industry stands as a beacon of innovation and technological advancement, reshaping traditional modes of content consumption.

The scientific novelty of this study lies in its comprehensive examination of the innovation-technology-performance triad within the context of the video streaming services industry. By applying rigorous analytical methods to the streaming industry dataset, this research advances our understanding of how these interrelated elements shape the competitive landscape of the digital entertainment sector. Integrating case studies, statistical analysis, and theoretical frameworks offers a nuanced perspective that transcends conventional examinations of business performance. This approach provides actionable insights for industry practitioners and contributes to the academic discourse surrounding the pivotal role of innovation and technology in contemporary business models. As such, this study stands at the forefront of research endeavors to unravel the complexities of the digital streaming revolution, offering practical value for industry decision-makers and conferring new perspectives on the dynamics of innovation and technology in today's highly competitive market.

In this rapidly evolving landscape, industry players must remain at the forefront of technological innovation. This entails substantial investments in research and development and cultivating a corporate culture that embraces change and creativity. As the demand for high-quality, on-demand content continues to increase, companies prioritizing user experience and staying attuned to modern technologies will be best positioned to capitalize on this expanding market. The multidimensional triadic model is a guiding compass, illuminating the intricate interplay between innovation, technology, and performance.

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ROLE OF IDEOLOGY IN SOCIAL AND POLITICAL DEVELOPMENT (EXTREMISM AND PACIFISM)*

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Abstract. Throughout human history, there has never been a single line of organisation of society. The implementation of different ideas has always been carried out as a project developed because of the real needs of people. Numerous projects have become established and continued to the present day. However, a lot of them degenerated and changed the image of the world in such a way that they became the cause of conflicts. There has also been fragmentation in the implementation of human desire for peace but also desires for rebellion and rejection of inherited cultural or political patterns. We chose pacifism and extremism to compare two forms of the image of the world throughout history. Pacifism is one of the few movements or ideologies which tolerates any national, religious, cultural, or identity-building diversity, and as such, automatically becomes the opposite of extremism, which in its essence either negates or completely denies diversity or plurality. The primary aim of this article is to analyse the mottos of pacifism, to emphasise the universality of its principles as one of the possible defence mechanisms against the spread of aggressive, polarised, and militant tendencies which jeopardise individual societies, and to point out the potential of mutual influence between the constructs so diverse as pacifism and extremism.

Keywords: history of changes; social development; pacifism, extremism; global environment

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1. Introduction

The concept of cooperation in the field of building, shaping, and preserving a lasting peace throughout the globe presupposes the need to maintain cooperation in the most important areas of progress (Wadjdi et al., 2023; Bamigboye, 2023). The areas which have been in the long run considered as principal are cooperation in politics, economy, security, protection of the biosphere, or cooperation in the unification of the anthropological aspects of life (such as identity, culture, and ethics). All of these assume a planned research, exchange of knowledge and improvement of education. Emphasis is placed (especially in the long-term perspective) on societal elements, as their essence is the universal ability to serve humankind.

The process of approaching communities contributes to strengthening the ideas which should shape the ability of humanity to survive, as well as strengthen the universality of diplomatic, legal, political and ethical norms. Nevertheless, it is still being determined whether these standards can become permanent, or they change as a result of unexpected events related to changes in the natural or social environment. If they cause changes in international politics, they often also become the reason for various types of global threats (Deneen, 2022). Deneen calls these factors "a disease". They involve, above all, mainly environmental imbalance causing severe consequences for humanity, growing inequality in the distribution of the planet's wealth, the decline of traditional public and state institutions, the loss of trust in the authority of all kinds and its replacement by authoritarianism, as well as other symptoms that contribute to the fragmentation of society (ibid., p. 9-10).

Throughout human history, there have been numerous theories, ideologies, cultural and moral concepts whose investigation has, from the past to this day, been the subject of the formulation of many scientific disciplines (Innset, 2023). For comparison in the presented study, which seeks answers to the problems that have arisen, we have chosen two streams with opposite and contradictory concepts. They are pacifism and extremism. Despite standing at opposite poles of starting points and conclusions, they share some common features. On the one hand, both these ideologies or theories are fusions of several scientific disciplines, diverse opinions and different methodologies. On the other hand, they both have a clearly defined goal - to improve the status of life and society, albeit by various means. In the case of extremism, it is about "improvement" according to the ideas of the extremists themselves, in the sense of claiming the unconditional and exclusive validity of opinions on the functioning of society and the state, using a variety of means - from the legitimate to the violent ones.

Pacifism was formed in ancient times. It has always been related to the preservation of security by the "rule" of peace (*pace*). Its basic idea was to protect all the possible means which would serve this aim, and society would be able to implement them. Such ideas can already be identified in the Pre-Socratic philosophers, in the work of Aristotle, later in St. Augustine, in modern times, especially in the transcendental philosophy of I. Kant, in Catholic philosophy, but also other religions.

The philosophy of Marxism at the turn of the 19th and 20th centuries perceived pacifism as a "struggle for peace". However, this oxymoron, partially distorting the essence of pacifism, was not accepted as a cliché. On the contrary, it became a part of numerous paradigms of modern philosophy, not only Marxism, which most often perceived the necessity of change for the better as a "struggle" (of classes, economic-, cultural-, anti-racist, etc.), i.e., as changes in society that can only be brought about by a revolution, often accompanied by violent rhetoric and violent activities. (Dinuš, 2011). The Marxist theory is still alive and triggers strategies of development, which are criticised (Prado, 2023).

As each revolution removes an existing form of power and establishes another, it is in these breakthrough periods that violence and even extremism find their way into the pacifist agenda from ancient times to the present.

Multiple historical events prove that the application of pacifist ideology can, in specific situations, result in resistance, violence and even extremism.

Hence, if every revolution overthrows the existing form of power and establishes a new one, even if to preserve peace and order, it inevitably also involves phenomena referred to as syndromes of evil. The clinical manifestations of this syndrome are cynicism, pessimism, misanthropy and even the humiliation of a person, while manifestations of extremism are also not excluded. The events that are supposed to bring about change (e.g., conflict, local war, national violence) are succeeded by the so-called "construction stage". Nevertheless, this is often followed by the realisation that individual leaders or groups cannot improve the world and establish lasting peace (Bregman, 2020, p. 29-31).

Democracy is an open and pluralistic system, and as such, it allows citizens, groups and nations to cultivate and present ideas which, under certain circumstances, can become radicalised and a security threat.

It can be seen in almost all European countries, where radical and extremist political parties have recently come to the fore, but also extremist activist groups and individuals. They have a destructive impact on the democratic political system and cause increased social instability. Therefore, preserving peace and security is an essential part of modern established democracies. In a global sense, this demonstrates the "necessity" to wage a war against extremism and terrorism carried out by democratic states (in Afghanistan, Iraq, in the states of the former Yugoslavia, but also in the current conflict between Russia and Ukraine, with adverse consequences for the whole of Europe and the wider area) (Zaplatinskij, 2015). At first glance, pacifism perceived in this way - as a certain inciter to resistance - is losing its transformative power. Fortunately, this is not the case. It is only one of the narrow attitudes to this ideology, however significantly harmful.

However, pacifism created numerous documents and declarations of global importance that prevented national and international violence. Its systems of value are still up-to-date, informative, and feasible even in today's world. Therefore, we will focus on both opposing ideologies/theories in the following parts of this study.

The primary goal of this paper is to analyse the ideas of pacifism, which are essential for the present because, as one of the few movements/ideologies, it tolerates any diversity, be it in the national, religious, cultural, or identity-forming sphere. In the context of the above-stated goal, we also want to point out the possibilities of mutual influence between pacifism and extremism and determine the degree of the existing confrontation of pacifist ideas with the ideas of extremism. If societies are built on the principles of modern democracy, why do these extremist movements also appear in these environments? Why are they not part of only those regimes that have yet to resolve structural problems with power, government, and authority? Suppose humanity is to formulate a universal political or civic program of such a type as to act as a barrier against aggressive, militant and society-threatening tendencies appearing even in contemporary established democracies. In that case, the ideas of pacifism and their implementation will be beneficial.

We also adapted adequate methods to the goal set above. In our work, we mainly use analysis/synthesis and comparison. Only analysis can lead us to identify problems, while it is true that we mainly use historical and structural analysis. Comparison has been a proven method since ancient times, and it provides research with unlimited opportunities to determine a specific area and subject of study within the set goal.

In our article, we mainly focused on the following ethical connotations: 1. what particular good does the application of the ideas of pacifism in the politics of the contemporary world bring to society? 2. what specific measures could society accept if radical solutions to unresolved problems are adopted? (currently, they are, for example, the consequences of the ongoing conflict on the European continent). Current domestic and international

politics are threatened by radicalism and especially by extremism related to citizens' dissatisfaction in many world countries. Therefore, it is essential that humanity can transpose the positive aspects of both ideologies. For democratic systems, extremism (if given sufficient attention) is an early warning against a possible threat of authoritarianism. This interpretation has been known to philosophers for two millennia, and current political leaders must try to understand if the present world system should move towards peace and prosperity.

The historical development of human society provides numerous examples of how two opposing ideologies transformed into a less aggressive mutual relationship than at the time of their birth. This is to be credited to the consistent development of science and the acceptance of its results into reality. At the same time, it leads to intermingling the consequences of pacifism and extremism, as elaborated in the text below.

2. Pacifism as a movement – peace and war from the viewpoint of pacifism

The term pacifism (from the Latin *pacificus*: the one who grants/brings peace) is refined and unambiguous from the point of view of the terminological practice of political sciences. Pacifism has no connotations; it is comprehensible and used in *pacifist* and *pacification* forms.

Records show that *pacifism* started to be used as a term in political sciences at the beginning of the 20th century when there were several movements with a robust anti-war character. These movements were on European and American continents since the beginning of Modern Times, i.e., the 16th – 17th centuries. Nevertheless, they were aimed against violence as a social, seen by pacifism as a moral insufficiency of man. The character of these movements was pragmatic because they implemented a new element into the systems of values built previously by religion – condemnation of particular evil (combat, elimination of ethnic groups which hindered violent colonisation, as it was happening in the United States of America but also Russia and the Balkans), using culture. They published books denouncing these negative phenomena, and precisely, this type of literature gained success with readers, comparable with the present-day cult of bestsellers. (Brock, 1972) The situation also helped this cultural and civic support in Europe during this period. After several wars and revolutions, which made the period between the 17th and 19th centuries one of numerous conflicts and violence, especially from the point of conflicts between conservative and liberal understanding of human freedom, state independence and their right to self-determination, they were the first pacifist organisations. The need to prevent violence was also cultivated. The methods of violence were being distinguished as well. Law had already defined the term organised violence, ergo war, which was related to a conflict between groups defined by states, nations and ethnic groups.

Another level of violence referred to the conflict between the groups which defined classes, religions, cultural and social differences, where the violence did not inevitably have the character of "organised" war but was a kind of rebellion or revolt and voiced an extreme effort to change the nature of society. This type of conflict played an essential role in the fact that society started distinguishing between violent responses from, e.g. the government or an authority, and the non-violent reaction based on an ancient Christian tradition.

In the second half of the 19th century a sophisticated system of pacifism built on the traditions mentioned above was formed, the ideals of Enlightenment, and the developing sciences such as social science and international law. They both dealt with reasons for a change in the structure of society and tried to find potential for rectification. Establishing scientific facts was also helped by activists from the lines of erudite citizens. One of them was for example B. von Suttner, the first woman to be awarded the Nobel Peace Prize. (Baxer, 1988)

However, as mentioned in the beginning, the idea of peace as the highest value in society was much older; hence, our analysis has to go back deeper into the past.

We can find records of the Panchsheel Treaty Movement in ancient India, the philosophy of Stoics in Ancient Greece and Rome, but especially in Christianity, which in the dawn of the first century provided strong motivation for various nations because of its central idea of "all people being brothers and sisters". Christianity significantly differed from similar Jewish cultural traditions in the first century, predominantly militant.

Central Europe found a distinguished pacifist authority in the person of J. A. Comenius (1592-1670), whose teachings influenced many Christian emancipation movements, unfortunately, towards a rather militant direction. However, it also affected the views of many philosophers of the Enlightenment period, especially G. W. Leibnitz (1646-1716) and, even more significantly, the Swiss lawyer and diplomat E. de Vattel. These two were the first theorists of political thinking at the beginning of Modern Times who promoted the idea of peaceful solutions to conflicts in both national and international space (Lasicová & Ušiak, 2012). The frequented terms nowadays, such as mediation, negotiation and reconciliation appeared previously in the theoretical works of these personalities.

Additional new elements were imported into the pacifist ideas by early liberals T. Hobbes and J. Locke, because their works were dominated by the themes of the natural right of people to create federative and supranational units which would implement peaceful solutions rather than wars of conquest (ibid., 2012).

There was an idealist idea, a natural result of their philosophy. Suppose people are free to make their own decisions, acting and thinking. In that case, they will not oppose the power represented by the state: Power will be accepted provided its enforcement is following the requirements and needs of citizens. *"Legitimation is guaranteed by the so-called narrative stories, such as the idea of free citizenship, of political and often even social equality, the realisation of the representation principle (...), and it can also be implemented on two levels: the level of universal legitimacy (the whole political system, or the worldwide system), and the level of local legitimacy. The stress is here on some danger of disintegration of popular identity (deliberation), which means that the division of power may split the will of sovereign people because some part of people will legitimise different powers."* (Koper, 2003, p. 26) Reflecting on the philosophical approach to the exploration of power in modern political systems and also in other social phenomena, author J. Koper points out what is also the central theme of our analysis, i.e. that even the legitimate power does not always have necessary instruments to be able to prevent demonstrations of totalitarianism, extremism and radicalism. Ideas of pacifism can still be considered alive because they can exist and be implemented along with diverse forms of power.

However, the best interpretation of pacifism can be seen in connection with the anti-war declarations and agenda that spread in the early 1800s. Peace is the idea upon which pacifism builds any other values and claims. Pacifists of the 18th and 19th centuries wanted permanent or "eternal peace". The principle of this idea is known primarily from the works of I. Kant. (Kant, 1980) Kant built his concept of eternal peace on surprisingly modern principles. Society was supposed to provide for "education to peace" and support economic integration, for which wars have always been unsuitable and adverse. States are equal in the international milieu, and the government (not monarchy) must provide for civil control over the military, including anti-government movements. In case war is inevitable – pacifism analysed various wars - it should only serve as the means for achieving stability and peace. In the work of L. Beaton "The Struggle for Peace", the author says that already the pacifism of 19th century divided wars into psychological, ideological, economic and non-typical, which would nowadays correspond with the term "hybrid war". In the work of L. Beaton "The Struggle for Peace", the author says that already the pacifism of 19th century divided wars into psychological, ideological, economic and non-typical, which would nowadays correspond with the term "hybrid war".

An essential position in the theory of pacifism also has the concept of a just war, which is *sapientes pacis causa bellum garant*, or war which is waged as a decision to achieve peace. The idea of a just war has also been part of history, accompanying humankind from Aristotle to the foundation of the United Nations, which is in part implemented in the UN Charter. At the present, however, the term of a just war has been devalued considerably. It

is still a relevant idea that we are striving for, but its implementation could be improved mainly by effective law enforcement. The reasons are problems mentioned in the introduction above – economic and political crises, new security threats, and the human factor, presently connected with uncontrollable migration. Experts agree that any war is, in a particular manner, unjust because it is the people and civic infrastructure who suffer most in it (Nečas & Ušiak, 2010). No human victims, holocaust, genocide or violence can be excused by the so-called "just demands" of one part of the nation against another one (an ethnic group, religious group, etc.). All modern wars (i.e. the ones in the previous three decades) started as an escalation of unfulfilled national, territorial, civic, political, economic, religious and cultural rights of a particular population group. They were first initiated as radical deeds, extremist actions, to which the state authority, represented by the governing community, responded by use of power.

At present, the difference between a civil (intrastate) and an aggressive war (between two or more countries) is disappearing because, in case of a threat to the international community, the states which are affected by the threat (territorially, ideologically or economically) are obliged to intervene (as an example can be used the war in Ukraine). It is impossible to determine the extent to which these interventions have been intentionally misconstrued. This creates the opportunity to look for reasons for violence, which are also at the origin of extremism. There is also a semantic problem. Extremism is interpreted as a movement, as an ideology, and also as a program. These three levels require different specifications to determine the reasons for the birth of an extremist movement or ideology, the implementation circumstances, and the programs' elimination.

The problem is that a pacifist is a person who refuses to accept social phenomena such as extremism. Hence, they also reject terrorism, militarism, racism, nationalism and fascism. In the 20th century, this refusal was also adopted by socialism, as many countries of the so-called third world landed themselves in the socialist regime mainly due to wars. The ideology of socialism is unacceptable from the pacifists' point of view because they cannot accept the central slogan of the ideology, "fight for peace", as a permanent constituent of social development. During the socialist era, which most Soviet-bloc countries had gone through, this hostility had a fundamentally humane and emotional dimension. The involved countries had in their legislation ordained compulsory military service based on the Military Service Act (Odpovídá linka Československé armády, 1992). Denial of compulsory military service was considered criminal and subject to prosecution. Exceptions were only made for individuals (men) who had health problems. Equally, pacifists had a moral problem with killing someone – if they were part of any active combat worldwide.

This dilemma is also one of the historical traumas of humans. On the one hand, from the times of Ancient Greece to kill was a crime, but killing an enemy was a heroic act. It was accepted in all wars. There was a shift in the 1970s when the course of war and violence because of race, ethnicity or religion became a lucrative topic for any media, especially television. It turned out that many former soldiers could not cope with the post-traumatic shock due to being killed in a war. Man is not disposed to kill unknown people who symbolise "the other side". A modern war does not change anything it refers to; on the contrary, it has even sharpened the population's feeling of guilt. It is actually extremism and terrorism which are mentioned in connotation with these feelings. Not only individuals but society as a whole has lost the sense of limits in the performance of oppression because it has been manipulated by the media, which facilitates the production of violence as a permanent social phenomenon. Society, formed by aggressive social networks through internet "culture", cannot provide adequate upbringing for the younger generation, who also have lost the limits in demanding their requirements and use inadequate means, similar to the ones that extremist groups operate with (Lorenz, 2003).

According to pacifists, the worst characteristic of contemporary society is the loss of control over the manifestations of violence by the present-day state. It has no means to prevent the spread of extremism and the racist propaganda responsible for terrorism (Rogers, 2018).

Pacifists also continue to debate the question as to which form of coexistence for an individual and society is better, whether individualism or holism. Individualism emphasises the human as a free being. There are doubts about the usefulness of individualism because humans are a part of a specific society, social stratum, or more minor or significant group. All these communities, to a certain extent, determine human actions and, at the same time, prospects. They are often in divergence with his/her philosophy.

The holistic concept is a form of cohabitation which indicates the dependence of individuals on society, nevertheless, by adapting the environment to their own image. (This concept originates in Marxism, especially the work of K. Marx *Theses on Feuerbach*, further developed in sociology by T. Parsons and a well-known theorist R. Cox.) However, there is a concept which interconnects both forms of cohabitation. It is a philosophical concept of personalism, promoting the idea that the correlations between the relations of an individual and society are reciprocal and equivalent. As all concepts of pacifism present the world and the outcome of the activity of harmonic forces in society, the individual human has a harmonic status in relation to society. This concept was revitalised in philosophy, ethics, and political sciences in the second half of the 20th century. It is behind the ideas of cooperation, solidarity, multiculturalism and all pan-movements with a humanistic orientation, which alone can gradually eliminate the negative phenomena, such as racism, religious intolerance, neofascism and terrorism. In this part of this discourse, we are dealing with the question of to what extent we can think of pacifism as an ideology.

Every ideology must have some meaningful orientation and must be capable of innovation. The idea of pacifism is extremely important, especially at this point in time. It is active in the virtual agenda against war and conflicts. However, we assume that its everlasting contribution to politics and morals needs to be sufficiently appreciated. We can ask why this relationship has become a kind of cliché in some limiting situations. Why does it only come into the limelight during pre-election campaigns, in medialised cases about scandals, corruption and anomie? It is probably because the political systems are very different from the moral ones. In a political system, morality is a complement to the agenda used for the manipulation of citizens. Morality is a permanent component of most philosophical concepts. In this sense, most ideas connected with pacifism are axiological – peace and stability are the cornerstone upon which security stands, as well as freedom and understanding between nations. The presence of morality is permanent, even though sometimes latent. Politics as a system does not need to be part of morality, it only manifests in it as practice and has a temporary, cyclical objective. Morality does not need propaganda; it needs impulses that man can only provide.

On the contrary, propaganda is essential for politics; all parts of the political agenda need well-proven and focused communication designed to achieve the desirable results. While the axiology of politics is relative, the axiological dimension of morals is permanent. From this point of view, pacifism can be considered a doctrine that, in the future, should have the potential to act as an efficient counterweight against subversive forces and movements in society. If for nothing else, then the reason that extremist, racist and terroristic methods used by some groups in society to reach their goals (beyond most governments' control) can hardly be used as an argument against the benefits of peace, stability and balance in society.

3. Pacifism as an ideology and a program preferring peace and non-violence

The opinions on pacifism as an ideology vary. They are mainly based on generalising the experience of societies that have undergone different developments. In permanently militant and conflicting societies, which we know from the history of European and Asian (or other) continents, pacifism represents an idea which has been helping communities to survive if they have been tossed into long-term conflicts of high and low intensity, caused by racial, ethnic, religious and cultural reasons. Pacifism meant the community's right to resistance without confrontation, to express divergence without incidents, for an alternative solution to the unbearable situation to prevent additional escalation and securitisation of the conflict.

From this point of view, pacifism may appear as a homogenous doctrine, which acts on the scale of brutal violence and its elimination, or at least de-escalation using "peaceful resistance". (Jaroszewski, 1971) Social reality, however, is different. As we have shown above, pacifism is based on peace. European (or Euro-Atlantic) space has connotations of different values, elaborated with time in several scientific disciplines. *Peace* is older than the terminological clarification of nation, state, and international space. Despite that, the significance of peace has always been connected to ending some conflict between human communities, whether the conflict was of external origin or due to some internal mayhem. Peace meant the end of violence, fighting, and destruction, but peace as such had been typologically varied since antiquity. In Ancient Rome, peace as the termination of war was terminologically labelled by the term *pax*, which is etymologically related to the term *pact*. So, it is a contractual construct between the fighting entities which decided to ratify the termination of warfare by an agreement, treaty or any other type of accord on mutual relations. This concept is the basis for a later defined and broader definition of peace, but it is enriched by the questions, such as:

- What kind of peace do we want to establish?
- Who do we want to make peace with?
- Can peace be made forever as an "eternal peace", or is it only possible when it is only established for a limited time?
- What type of violence will be removed by establishing peace?
- Is peace only related to eliminating physical violence and economic disintegration or mental torment of people?

All these questions have been part of paxology (science about peace) since late Middle Ages, but they were reflected also in antiquity, e.g., by Aristotle. However, until the 17th century, they were not part of the normative structure. They first appeared as a draft of a legal concept in the works of Hugo Grotius, a significant figure of international law at the dawn of Modern Times (Coker, 2002).

Several scientific disciplines have been searching for answers to the questions above. According to many theoreticians, pacifism is developing in this permanent effort to answer the questions, not just as a part of the eventual peaceful cohabitation of people but in particular as a political program. Pacifism considers the contractual character of war and peace. Its basic premise is that it is formed as an auxiliary ideological implement of various peace strategies or as an auxiliary ideological implement of a non-conflicting resistance against violent structures of society. This type of pacifism is a political program oriented against direct institutional violence that the state (or any other participant) inflicts through war. The 20th century, particularly its second half, promoted pacifist movements as significant instruments of the public's resistance against war and elevated them to operational programs.

The most famous examples are various pacifistic movements protesting against wars in Korea and Indochina (the 1950s-1960s) and against the Vietnam War (1960s-1970s), which took place as mass movements in Western Europe and the USA. They had a significant cultural and social effect; however, they implicitly affected the political development of Western Europe and the US Howard (Howard, 2000). At the same time, they became a mental program, especially for the younger generation.

A broader connotation of the word peace is also a significant category of values in many other ancient cultures. The Greek expressions *Eirene*, Hebrew *shalom* and Arabic *salaam* express something we call today a Just Peace. It involves exclusion not only of the above-cited institutional violence but also structural violence, which today develops due to cruel treatment within economic exploitation, political oppression and repressions of various types intended to degrade the human as an autonomous being and devastate their identity. The cited manifestations of mainly structural violence are considered to be triggers of extremist movements.

The development of all ancient civilisations was accompanied by manifestations of structural violence, particularly when it was gradually institutionalised. It has always occurred by violent maintenance of specific social forces, i.e. political power. This structural violence survives even to the present day. It is the fundamental reason for armament, revitalisation of military blocs and growing use of cybernetic means of information as an instrument of securitisation. We cited the expressions Eirene, shalom and salaam as civilisational concepts based on Just Peace. These concepts from different cultural environments have the following common features:

1. War cannot be aggressive. (This feature is expressed in the UN Charter as a rule of international law.)
2. War must be the ultimate means of dealing with the situation when any other means fails.
3. War must be finished by a Just Peace so that its termination is not an opportunity or reason for subsequent conflicts.

These requirements are just variations of other more elaborated and sophisticated ones. They are the consequence of the development (of the endeavour) to prevent war as an instrument of dealing with international disputes and preventing the escalation of structural violence. Despite positive efforts which have always existed in these concepts, a Just War is nowadays basically only an ideal towards which humanity may be heading. Still, it is not a predictable solution shortly.

That is why reaching for the ideal of a conflict-free society has become the new agenda of pacifism. It has a strong social character, focused on the elimination of the internal violence of a state, such as:

- Transforming the unjust structures of society related to global militarisation.
- Asserting human rights as the basic requirement of humane security.
- Solving ecological problems, which are accelerators of numerous wars and conflicts.
- Solving ecumenical integration of all people of goodwill, regardless of their race and religion.
- Solving the increasingly considerable social inequality as a result of wars and conflicts.

The new agenda of pacifism also has a robust institutional representation in the third sector, the non-governmental organisations. Nevertheless, the popularity and efficiency of these organisations are now dichotomous – the development of information technologies and the phenomenon of social networks allow controversial propaganda and agitation to groups and individuals, which abuse the idea of pacifism for the promotion of negative attitudes. Opposition against violence, armament, military pacts and military and defensive organisations is not usually in accord with pacifistic ideas; on the contrary, it verges to another extreme, into militant propaganda, into a proclamation of extremist–neofascist, antisemitic and racist attitudes. We assume that political and social sciences are only at the beginning of investigating the listed phenomena.

The concept and meaning of the word peace have at least one additional important dimension. It is in the Far East, East Asia and South Asia concepts, which include an essential term related to our context, the Hindu concept of *satja* and *ahinsa*. *Satja* means inner peace, peace with oneself, peace in one's soul, balance and stability of character, which can do no violence against anything in society. If a man, a social group or a nation do not feel *satja*, outer peace cannot be secured – in our Euro-Atlantic understanding – as peace among nations and countries. *Satja* is the precondition of a collective identity aimed at the equality of people. After this condition is fulfilled (to feel peace with self), a human has the right to require freedoms to which they are entitled. Otherwise, they lose this right. The expression *ahinsa* means harmless, safe for others, and the world of nature. *Ahinsá* expresses the obligation to protect nature, plants and animals, and the protection of our world. Only then will I be granted the right to exploit space and products offered by nature (Sapolski, 2006).

This concept of peace is remarkable because it involves the ecological dimension, which is lacking in Western ideas. Moreover, it is remarkable, thanks to the deconstruction of the terms of law and duty as perceived by our Euro-Atlantic thinking. The sequence is changing – If I fulfil my duties towards myself, other people, nature and

the world, I will be granted the rights I possess; otherwise, I am not eligible for them. The concept is not isolated in the given geographic space. Ahinsa is the fundamental line of Gandhi's non-violent resistance against structural violence. *Contradictio in adjecto* – non-violent fight – *Satjagraha* of Gandhi is an alternative to pacifism, exceeding the relatively narrow space as it is seen primarily by Europe and the USA. Chaotic reminiscences of the young generation in the West towards the opening of Hinduism, Buddhism, Taoism and Confucianism became a matter of fashion and social prestige. However, analysing this indoctrination of mainly young people shows even more severe and profound reasons. We believe one is the absence of accepting pacifism's system of values in contrast with the sterility of consuming society with the continuous threat of various conflicts.

4. Extremism – from a movement to an ideology

Suppose we perceive violence as an accepted part of extremism. In that case, the task is to achieve changes in the public and political order of states/societies; it is only possible to allocate time to certain manifestations in a specific period. Violence has been a permanent part of human society. Still, there is an opposing argument regarding this definition – violence can be eliminated if there are instruments to suppress it and prevent it from originating. Violence is a social phenomenon, constantly forming itself as a result of changes in a particular human community and usually having more than just one cause. It is a hybrid phenomenon created as a complex of causes; however, social and cultural reasons for its escalation are indeed present both as social factors and as catalysts with other factors. This social phenomenon also includes, on the one hand, the glorification of elements still existing in social contacts – such as patriotism and nationalism.

On the other hand, if wrong appraisal exists, e.g., by intentional propaganda, these positive elements can transform into a form of violence. In the first instance, it is usually verbal or structural violence, which develops into the institutional form. It is crucial if these forms of violence become part of the internal policy of the intra-political agenda of a country or the agenda of a regular political party. If so, they create the substrate for an ideology and non-democratic components within the democratic society (Rorty, 2007).

J. J. Rousseau wrote in his work *The Social Contract* that people are not inborn enemies. Violence in human society appears because of property and resources. It means that this humane dimension of man must be cultivated on and on. When raised and educated towards humanity, structures are built in the human mind that determines the behaviour in adulthood. When grown and educated towards defending one's egoistic interests, the socialisation of the young generation will also take this direction.

Violence in open form is, in most human communities, considered inhumane. It is displaced by a system of facultative and obligatory rules which are in accord with the cultural identity of a particular society in time and space. If violence is resistant to instruments intended to reduce it, it has transformed into ideology and political games, which are manifestations of extremism. Extremism is thus interpreted as an act of justice, a solution to existing social threats, and a political opposition aimed at participating in the political system of a particular state. If there is violence – specifically extremism – even in verbal form, it triggers a rationalisation of this phenomenon. There are ongoing attempts to explain why this policy is essential. Apologists of extremism point out the unsolved economic, social, medical, national, ethnic and other problems and offer solutions to how they should be dealt with. Extremism is presented as an opinion of a part of society feeling strongly that their requirements are unfulfilled and the goals are false (Danics, 2015).

According to the above-cited author, if violence is rationalised in a particular time and space, it is done by making one particular historical or present event into a fetish. This is happening in such a manner that this event starts to appear as a threat to society unless a particular political subsystem intervenes. This is the road to success in the case of many European political parties with extremist elements in their agendas, either nationalist, chauvinist or any other type. In this respect, it is important to think about the importance of participatory democracy as the type

of democracy which gives the citizen, the individual, a chance to believe that *"... participation is useful and worth sharing because the citizens feel that they are not manipulated by power. (...) they may participate in participation and feel it is rewarding, but they tend to participate actively and consider the decisions taken as obligatory. On the other hand, when there is systematic marginalisation of the position and influence of individuals and their unsatisfactory representation, they tend to believe that their ideas and needs will be only rarely assessed as seriously and taken as equally important as the preferences of the others."* (Kováčik, 2009, p. 150) This example points out that even the humanistic type of democracy – the participation democracy (Sekerák, 2017) – is not immune against the feelings of injustice as the cause of extremist movements and the subsequent ideological “management” of the problem.

In the history of European countries, many events first originated from social and cultural impulses as positive movements and later escalated into serious conflicts. Religious wars document them at the beginning of Modern Times, class conflicts during the bourgeois revolutions, and national conflicts, especially in the 19th century when national states were formed either due to the disintegration of empires or, on the contrary, by the unification of small states.

The most atrocious conflict involving an extremist ideology was the period of Fascism/Nazism. For sociologists, but also other social sciences, this remains a period of great importance for the research, where the following questions should be reflected again:

1. Why did Europe allow the holocaust?
2. Why are genocide and the function of concentration camps questioned nowadays?
3. Is historical memory fading? Or is indifference towards the past part of the new European identity?

From the point of view of sociology, people are not divided between the good and the bad. People become bad when communication breaks down or falls victim to stereotypes aimed at propaganda as an instrument used by the media, particularly social networks. The possible fault is also a remaining historical cliché, which was formed in the mid-1800s during bourgeois (national) revolutions. In this regard, we must question whether these clichés are still valid. A nation is a united, sovereign unit with the right to self-determination. If it gets this opportunity, the eccentric forces of ethnic groups and nationalities (differing in culture and religion) will cease to act, and the nation will function with a single national interest. This customary opinion is contradicted by the situation in the Balkans from the 1990s until 2017. A nation can only develop in the geographic region where it was formed. This does not apply to enclaves (The conflict between Armenia and Azerbaijan for the sake of Nagorno-Karabakh can be used as an example. However, this thesis is also refuted in the Slovak Vojvodina in Serbia) (Šimoňák, 2008).

The need for an acceptable reinterpretation of these historical clichés is a real challenge for political and social sciences. This is one of the possibilities to comprehend the reasons for the formation of extremism in the past and now, and at the same time, to define extremism properly, which would help to deter the risks of extremism in the decisive sphere of administration.

In modern society, defining the limits of what is tolerable and what is a real threat to society is essential. The difference in setting boundaries in specific countries shows the persistence of democratic ideas. However, there are generally only two ways to prevent the dangerous growth and spread of the threats connected to violence (extremism):

1. When their existence is in a state which is endangered (e.g., authoritarianism) but has the capability of creating the adequate means to remove them, or,
2. If they result from communication failure in international relations, it is imperative to revitalise this communication, using influential ideology with prominent positive characteristics.

The first method is related to the particular state's constitution, and to the civilian control over its observance. In 1787, when the Constitutional Convention, headed by the future president George Washington, met in Philadelphia, Pennsylvania, the proceedings included several necessary structural measures which the Founding Fathers approved as a protection against the eventual formation of a powerful central government. It was civilian control (Constitution of the USA, Art. II. par. 2) which granted the president a double role – to be the Commander in Chief of the military, but granted him at the same time the position and the right to be in charge of civilian control over military policy. The constitution assured that the legislature could also be responsible for the right of a militia to intervene, if necessary, to protect lawfulness in the Union (Krejčí, 2009). This control method is inherent in the constitutions of all modern democratic states. Its weak point, however, is actually in the problematic assessment of the limit between radicalism and extremism, primarily if the supporters of radicalism (operating within the limits set by the constitution and laws) group in political parties, operating regularly by the authority of the results of democratic elections. This situation is not just an issue of one state; it has trans-European vitality and recurs with various intensities periodically. According to G. Friedman, this internal political tension will have a relatively permanent than periodical character and rather global than regional dimension. The second half of the 21st century will become when the opposition will try to accomplish a technologically controlled overturn. The United States of America will become an enemy of traditionalists worldwide, as they will produce many of the most controversial technologies, and the model of their inner social confusion will become the norm (Friedman, 2009).

The second approach to dealing with the growing radicalism and extremism is more complex. It relates to the solid philosophical context evident in Europe from antiquity through the Middle Ages, Renaissance, Modern Times up to the present. We are referring to the idea and thereon built ideology of pacifism, which, despite its modern present forms (e.g. Non-Aligned Movement as well as other peace concepts), formulates and rationalises the much earlier ideas which, despite modifications and deformations, have been widespread throughout the history when the specific European values were being formed.

Similarly, the defence against the growing radicalism and extremism in democracy manifests itself in two ways: on the one hand, the practical idea of the power of the citizen (through the constitution and laws) is postulated so that society is not dominated by hostile and uncontrollable forces (Ivančík & Nečas, 2023). Similarly, defence against the growing radicalism and extremism takes shape towards two initiations: on the one hand, it is the practical idea of the power of citizens (through constitutions and law) being postulated to prevent harmful and uncontrollable forces from taking control over society. On the other hand, the humane message is being proposed to answer the elementary question of whether it is pacifism or a conflicting militantism that corresponds to human nature in society, even though wars have always been part of human civilisation.

Throughout the development of European thinking and culture, upon which democracy is built, both methods of defence against radicalism and extremism have been tested, and the idea of pacifism seems to be of permanent importance. It is the foundation on which international law is built, not only the European Union (EU) system of laws but also the constitutions of democratic countries “*which must avoid being threatened with power, and also using power*” (Charter of the United Nations). Nevertheless, just recently, in close vicinity of the EU, these laws have been repeatedly violated in the conflict between Ukraine and Russia.

5. Summary

Both Pacifism and Extremism are ideologies, movements, or programs (depending on the point of view) which have been part of evolution in the development of society. They occurred with varying intensity. With some level of simplification, the importance of pacifism has been growing with the increasing intensity and cruelty of modern wars. At the turn of the 19th and 20th centuries, they are referring to the legacy of A. Nobel is an agenda of great social significance still relevant because its extent and depth keep growing.

Extremism is partly a consequence of modern liberal ideas because it does not deny people the right to protest against politics (government, political party) if they disagree. However, it is crucial that the state power can guard the intensity of the protest and has the means to eliminate the escalation of demonstrations into uncontrollable violence.

It is important to emphasise that pacifism is a significant concept, mainly because the history of European thought lacks sufficiently elaborate reasons and results of structural violence, inner peace, the responsibility of an individual (and also organisations) for protection, and of the creative role of non-violence in human history. The concept of pacifism is open, which makes it very similar to the ideas of freedom and justice. No country, nation or culture can proclaim their concept or doctrine as the best. All those mentioned above and many other related humane concepts are a product of the thoughts and activities of human society. It is the heritage of the past and a project for the future, which can also be used as a device against structural violence, which nowadays employs most of all extremism.

T. Zálešák quotes an interesting modern metaphor, already pointed out by Confucius (Zálešák, 2022), that what was on the edges of the political spectrum in the past is now being pushed into its centre, making yesterday's extreme part of the mainstream in the domestic and international politics. The history of the development of human society proves that all accepted rules, requirements, canons and laws are based on basic human needs - preservation of life, protection of family and property, but also on freedom and independence, whether it is moral, political, religious, cultural and economic freedom. A person evaluates themselves according to the constructs in which they were born, grew up and applied themselves as a member of society. However, all these self-evaluations depend on how society deals with political power, morality, the level of privacy protection, and the possibilities of freedom.

Well-known are the libertarian theses that a selfish action of an individual may not necessarily be harmful to society. On the contrary, it can cause a sense of order and compliance with rules, provided others do not follow these rules, especially people and institutions that should help solve social problems. That is why we will use Confucius's quote, which does not correspond precisely to the original but makes sense: "When words lose their meaning, the people lose their freedom." (ibid., p.56) Nevertheless, it can also be reversed if the words (expressions, laws) are not created concerning the demands of freedom and ethics; the word *people* as the foundation of society will lose its meaning. People will find themselves in shackles and start looking for a solution. Mostly extreme if there is no other way. In the sense of ancient philosophy, extremes (even if antiquity did not know this term) are the opposite of virtue or prowess, i.e., the ability of a person not to succumb to "evil forces" but to face them as a balanced individual, not by violence but by moral action.

The question remains whether the two extreme positions that we defined at the beginning of the text - pacifism and extremism - have the ability of a mutual solution through ethics and concrete morality. We assume this should be the goal of the modern politics of democratic states.

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RISK FACTORS' PREDICTION MODEL FOR THE INVESTMENT EVALUATION*

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Abstract. The article deals with the issue of increasing the competitiveness of enterprises and their long-term sustainability based on the efficiency of investment processes. Implementing new approaches to the company's decision-making processes will allow companies to overcome the pitfalls of the market environment created by the post-COVID period and the current energy crisis that has affected the world markets after the conflict between Ukraine and Russia. The article aims to verify the application of the methodology for increasing the competitiveness of enterprises based on the use of a model creating a fusion of traditional and sophisticated tools. The analyses carried out are based on the investment decisions of a real company operating in the Slovak Republic's territory in the production and supply of security products. Mathematical modelling and Monte Carlo simulation are based on the company's accounting and operational financial outputs (profit and loss statement, balance sheet). The methodology is based on mathematical modelling through static traditional financial approaches and their verification through sensitivity analysis, regression analysis and Monte Carlo simulation based on distributional distributions of risk factors. The output is the assessment of risk factors and their significance for the criterion value Net Present Value (NPV).

Keywords: Competitiveness; Sustainability; Monte Carlo Simulation; Sensitivity Analysis; Regression Analysis

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JEL Classifications: C15, G32, L26

1. Introduction

The current situation in the market environment is influenced by the post-COVID impacts and the energy crisis, which is caused by the war conflict. The global energy crisis affected mainly small and medium-sized businesses. Most of these enterprises are solving financial problems that significantly affect the competitiveness and subsequent sustainability of enterprises in the future. The current constructivist approach, which is applied in the management of enterprises in Slovakia, is based on rational approaches, which employ analytical thinking and maximize the benefits of the enterprise. The current enterprises must respond to the solution of the created

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imbalance in the market by changing the approach to a systemic-evolutionary one, the aim of which is to ensure the viability and competitiveness of the enterprise. This approach should become a pillar of the company's decision-making process.

Achieving business viability is aimed at identifying business risk factors early and applying new approaches (Fabianova, 2019; Gavurova, 2022). The authors' definitions of companies' viability and competitiveness differ. In some studies, competitiveness is defined as the ability to protect and improve the company's market position and adapt its market strategy to changes in the market environment (Rodrigues-Diaz, 2018). Some studies describe competitiveness as the continuous competition of companies in domestic and foreign markets (Pike, 2014; Istudor et al., 2022). The business environment is determined by turbulence, which is a consequence of the increased uncertainty of the market environment and the transformation of current business models based on traditional approaches to management (Day and Schoemaker, 2019; Schoemaker and Day, 2021). The current crisis in the market environment has forced businesses to operate more agilely to develop the necessary knowledge and skills and acquire the skills required in financial and investment decision-making. Day and Schoemaker (2019) and other authors (Fabianova, 2019; Ključnikov, 2022; Oulehlova, 2021; Derradji, 2020) emphasize three dynamic capabilities for managing uncertainty and risk: perceiving change earlier than competitors, taking advantage of opportunities more effectively and transforming the business as needed.

2. Review of literature

The investment activity of a company, especially investments in production, is a necessary condition for the competitiveness of every manufacturing company. Organizational structure, resource availability, and risk management attitudes vary depending on the size of firms (Marom et al., 2019). Many studies examine the relationship between competitiveness, innovativeness, and financial risk management (Jin & Lee, 2020; Zhang, 2021; Wille, 2017). For example, Nohong et al. (2019) also analyze some SMEs in Indonesia and show that financial risk management is also affected by the competitiveness of these enterprises. The positive relationship between financial risk management and company competitiveness was also verified by the studies of Karadağ (2018), Yang et al. (2018), Gates et al. (2012) and others. Decision-making on investments is a strategic decision and, therefore, should be supported by a thorough analysis of production possibilities and an analysis of the economic efficiency of the investment, including risk situations. Several research works are devoted to the issue of investment decision-making from different perspectives (Nguyen, 2021). A research paper by Freiberg & Scholz (2015) approaches a comprehensive analysis of the benefits resulting from investment in manufacturing and examines all relevant impacts related to the investment. Within the investment decision-making framework in production enterprises, mentioning the financial point of view is essential, which is usually considered first in practice. Business financing leads to the creation of new tools for financing and securing the needs of the business (Tobisova, 2022; Ključnikov, 2022; Li, 2017). Correct investment decision-making, which is supposed to ensure the viability of the enterprise for many years, must be based on an effective decision and after consideration of all related economic aspects and with the acceptance and determination of an acceptable level of risk (Hwee, 2001; Ristanovic, 2021). In practice, the efficiency and riskiness of investments are often analyzed and evaluated by mathematical and economic methods, e.g. methods based on neural networks (Zhao, 2022; Herianingrum, et al., 2019), methods based on failure mode and effect analysis (FMEA), or based on interval-valued intuitionistic fuzzy analytical hierarchical process (AHP) (Ristanovic, 2022; Ilbahar, 2022). For effective economic and financial risk assessments, applying programs based on Monte Carlo simulations seems appropriate (Huo, 2021). Khalfi & Ourbih-Tari (2019), He (2020) and Zheng (2019) are among the authors who use investment risk analysis using Monte Carlo simulations. They proposed a decision model for evaluating investment risk using the @RISK software. Abba et al. (2022) investigated the investment risks of renewable energy using dynamic risk assessment methods and quantitative methods such as Monte Carlo simulation. The investment model of nuclear power used the theory of real options combined with the Monte Carlo method (Zhu, 2012). As this research above analyzes the effects of competitiveness on financial risk management and efficient investment decisions of

enterprises, it differs from other studies. It becomes a valuable contribution to the academic literature. Anyway, investment decisions processes and used tools still require further investigation.

An examination of the financial problems of companies from different approaches and a broad perspective of the application of new sophisticated methods in financial and investment decision-making fill this gap in research.

The research topic of the article is related to the objective and transparent assessment of the company's investment decisions based on criterion parameters relating to practical experience or expert estimates of practitioners. The research problem is the quantitative and qualitative evaluation of the methodology that solves the issue of competitiveness and sustainability of small and medium-sized enterprises in Slovakia (Wille, 2017). The research question is focused on the assessment and verifiability of the methodology for the introduction of new approaches to the evaluation of investment activities of companies based on sophisticated and modern software tools based on the support of decision-making processes through the fusion of traditional and new methods in the field of financial and investment planning. On this basis, the article works with two hypotheses:

Hypothesis 1 (H1). Companies that use a methodology that introduces new software solutions in financial and investment decision-making within the framework of increasing competitiveness and sustainability in the market will obtain a better result based on the competitiveness assessment methodology than companies that only rely on traditional deterministic approaches for financial and investment decision-making.

Hypothesis 2 (H2). Suppose the developed procedure of the complex methodical model of increasing enterprises' competitiveness and sustainability is applicable to assessing the competitiveness and sustainability of enterprises within Slovakia. This sequence of steps is also appropriate within the European integration processes for assessing enterprises in countries with a similar market system.

In the following sections of the article, a comprehensive overview of the relevant literature focused on competitiveness and its increase through mathematical modeling of financial indicators, sensitivity analysis, regression analysis and Monte Carlo simulation with a focus on assessing the company's investment activities. The following section discusses the methodological procedure and methods of analyzing the company's financial data. In the next sections, the research results and discussion are interpreted. At the end of the article, the results of the analyses are evaluated, and future research development trends are presented. The article presents a tool for expanding traditional approaches to measuring competitiveness based on multivariate and stochastic aspects of competitiveness in financial decision-making.

2. Materials and Methods

The issue of the competitiveness of businesses is currently very topical. Many companies in the territory of the Slovak Republic are presently looking for ways to increase their competitiveness. The basis of the article is to present a methodology that can increase the competitiveness of companies in the territory of the Slovak Republic. The article represents a partial output research project, which aims to create and verify a methodology for ensuring the competitiveness and sustainability of companies. The basic approach of the methodology was presented in previous research (Tobisova et al., 2022), which was aimed at solving the issue of investment decisions to implement new software tools into decision-making processes. The essence of the methodology is using the Monte Carlo method implemented in the MS Excel environment and the additional Crystal Ball software tool.

For the practical application of the methodology, a company that operates in the territory of the Slovak Republic as a manufacturer and supplier of security products was chosen. The company plans to modernize its technological equipment for the production process by purchasing a new line for sheet metal ringing. The purchase price of the line is estimated at €47,422.08. The line will be used for the production of five products.

The methodology consists of three basic steps, which can be described as follows:

- 1) Development of a mathematical apparatus that uses the calculation of static economic variables based on classic methods in the MS Excel environment.
- 2) Identification of risk factors that appear as assumptions with defined distributions in the Monte Carlo simulation process.
- 3) Sensitivity analysis aimed to get a basic idea of the impact of individual risk factors on the criterion value - Net Present Value, and thus also a kind of control, whether the impact makes sense and whether there is an error in the model.
- 4) The task of Correlation and regression analysis is to analyze mutual relations between variables. Using correlation analysis, we assess the quality (strength, tightness) of the selected regression function between variables. Its task is, therefore, to evaluate the tightness of the statistical dependence between the investigated variables.
- 5) Monte Carlo simulation, which enables assessment of the criterion quantity also on the basis of stochastic quantities and on the basis of taking time into account. The software tool Crystal Ball, an add-on in the MS Excel environment, was used to implement the simulation.

The first step of the methodology is the development of a mathematical apparatus aimed at calculating the Net Present Value (NPV). The relationships shown in Table 1 were used to prepare the mathematical apparatus.

Table 1. Basic relations of the mathematical apparatus.

Parameter	Formula	Explanatory notes
Operating cost	$\text{Operating cost} = \sum (\text{DC} + \text{IC} + \text{D} + \text{OC})$	DC—Direct cost IC—Indirect cost D—Depreciations OC—Other costs
Revenues	$R = \sum_{i=0}^n (P + S)$	R—Revenue P—Price S—Sale (quantity of sales)
Operating Cash-flow	$\text{Operating CF} = \text{Net Income} \pm \text{Changes in Assets \& Liabilities} + \text{Non Cash Expenses}$	
Discount rate	$I_{fn} = I_p \times (1 + i)^n$	I_p —current value of investment required for future value to be reached I_f —future value reached at certain value of update i —interest rate (update) n —number of periods
Net Present Value	$NPV = \sum_{i=1}^n \frac{CF_i}{(1 + r)^i}$	CF_i - net cash flow in i -year of project existence i - selected year of project operation n - last year of assumed project lifetime r - selected discount rate in %/100






The mathematical model is primarily based on traditional approaches without considering the influence of time. Individual economic quantities are static and do not consider the time factor of inflation and expected economic





increases in particular sectors. The result of the mathematical model is the calculation of the value of the NPV indicator, which also becomes a simulated quantity in the next steps of the methodology.

The method of calculating the Net Present Value parameter is one of the most appropriate and widely used financial criteria. It includes the entire lifetime of the project, as well as the possibility of investing in another equally risky project. The calculation considers the time value of money and depends only on anticipated cash flows and the opportunity cost of capital. The advantage of this method is that it can describe arbitrary cash flows and also the fact that the result is the absolute value of the benefit of the investment in today's prices. The resulting value indicates how much money the realization of the investment will bring to the company. If the NPV value is positive, the project is feasible. Conversely, if the NPV value is negative, the project is unacceptable. When comparing several investment alternatives, the higher NPV is preferred.

After developing the mathematical model, it is necessary to identify the risk variables in the model, which in the next step represent the basic assumptions of the Monte Carlo simulation. To identify risk variables, it is possible to use the risk mapping method, or it is possible to base it on expert estimates. For the purposes of the article, risk assumptions were established, which are listed in Table 2.

Table 2. Basic relations of the mathematical apparatus.

Assumption	Distribution function
VAT	 Uniform
Expected increase in production	 BetaPERT
Expected price growth	 BetaPERT
Expected increase in wages	 BetaPERT
Expected increase in materials	 BetaPERT

Expected increase in energies	 BetaPERT
Production of product 1 – 5	 BetaPERT
Selling price of product 1 – 5	 BetaPERT
Tax base	 Uniform

As shown in Table 2, individual risk assumptions were assigned distribution functions, within which the simulation ranges were defined as minimum and maximum values.

3. Results

Sensitivity Analysis

The principle of this analysis is that the resulting values of the criterion value are calculated based on the selection of values from predefined intervals of possible values of risk factors. The Crystal Ball software tool was used to perform this analysis. The output is a tornado graph, which displays individual risk factors in descending order according to the degree of their influence on the criterion value. The quantiles of 10% and 90% were chosen for the sensitivity analysis in the simulation environment. Even in this case, the influence of only one risk factor is always considered without considering the simultaneous effect of other risk factors. The result of the sensitivity analysis in the form of a Tornado graph is shown in Fig. 1.

Fig. 1 shows that the main risk factors are the selling prices of products 3 and 4. Subsequently, the selling price of product 2 and the expected increase in prices. The figures show that the 10% quantile of the risk factor in the form of the selling price of product 3 has a value of €17.77, and the selling price of product 4 has a value of €42.78. The 90% quantile reaches the value of 15.23 for the selling price of product 3 and 38.22 for the selling price of 4. In these two factors, the range of values of the criterion value, that is, of the NPV values, is between 10% and 90% of the quantile of the considered sales price of product 3. The stated values can be interpreted so that if the selling price of product 3 is only 10%, the NPV value will be €491,198. It can also interpret the other values from the mentioned Tornado graph similarly.

As part of the sensitivity analysis, the Crystal Ball software tool also offers a Spider Chart based on the same principle as the Tornado graph. The only difference is that the resulting values of the criterion value are monitored

not only in the interval values of the risk factors but also between them. Spider Chart of the analyzed company is presented in Fig. 2.

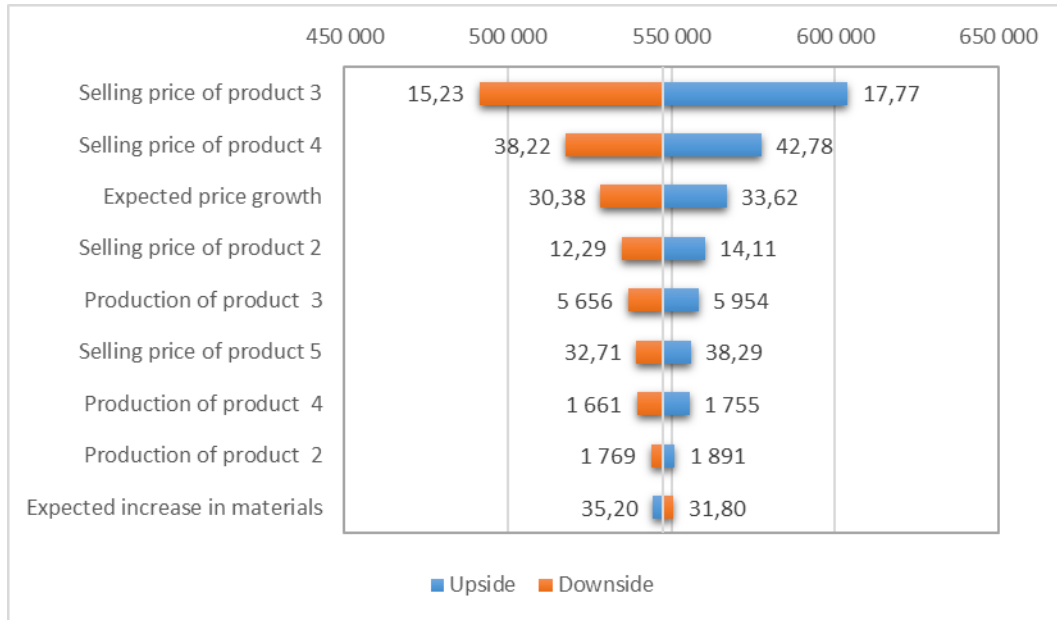


Fig. 1. Result of the sensitivity analysis in the form of a tornado graph. Source: own research.

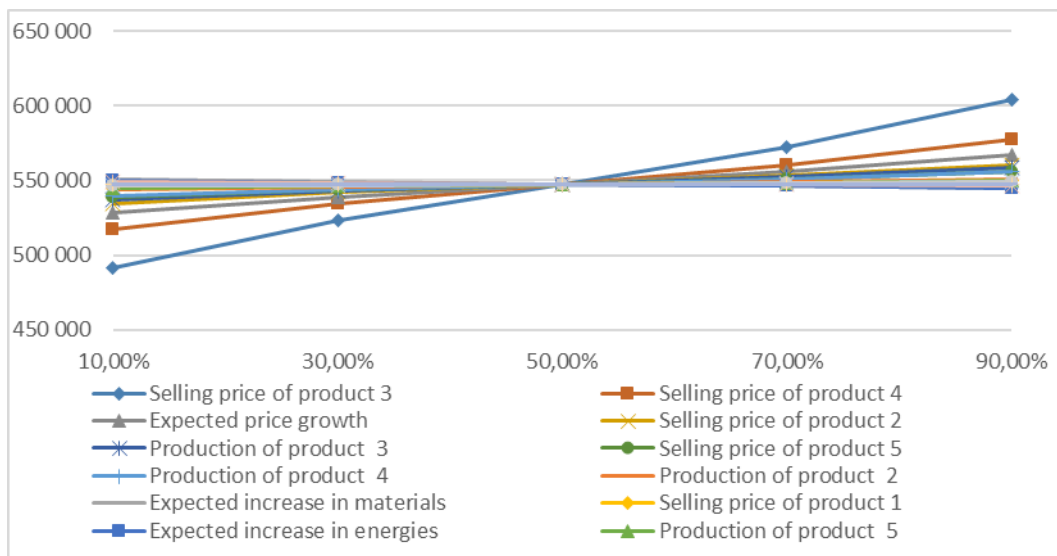


Fig. 2 Spider Chart of the analyzed company. Source: own research.

Spider Charts are used to show the degree of influence of risk factors, while the height of the degree of influence is directly proportional to the slope of the lines. The advantage of Spider Charts compared to Tornado graph is the possibility of capturing possible non-linear effects of the risk factor in the observed quantile interface. The Spider Chart also showed the same results demonstrated by the Tornado graph. In this case, the selling price of product 3 and product 4 is considered to be the main risk factors that influence the criterion value.

Correlation and Regression Analysis

Correlation dependence involves finding relationships between quantities. Causation remains behind in this case. Correlation and regression analysis tasks coincide only in connection with confirming a relationship between the values of two quantities. Regression analysis always has two variables, one of which is dependent.

For the needs of the article, a correlation and regression analysis were performed based on testing occasional relationships between quantities. In this case, the values of the variable were determined, and it was determined whether these variables affect the change of the dependent variable. Crystal Ball software was used to process the analysis, the output of which is Scatter graphs shown in Fig. 3. The factors entering the correlation and regression analysis were risk factors.

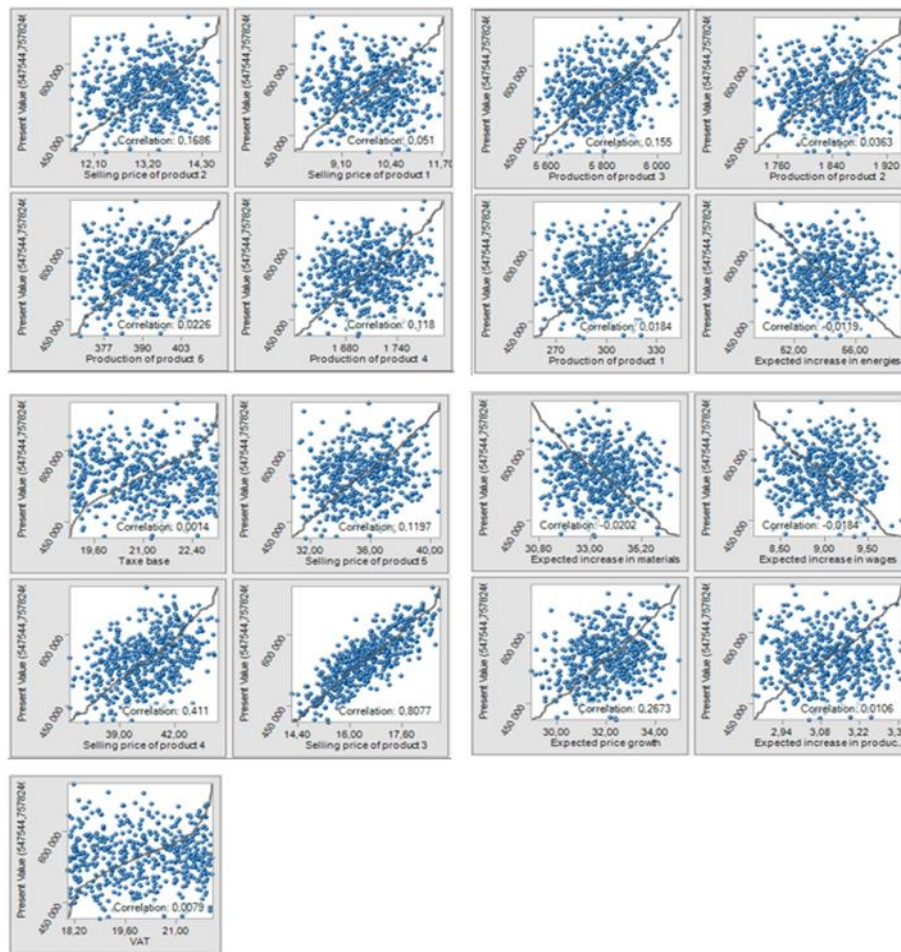


Fig. 3. Scatter graphs of correlation and regression analysis. Source: own research.

Monte Carlo simulation

If the behavioral results of the model show positive values and appear "acceptable", a Monte Carlo simulation can be performed. The Crystal Ball software tool is used for the simulation. As part of the simulation setup, defining the number of simulation steps is necessary. The number of simulation steps within the company we analyzed was 10,000. The given number indicates how many values were generated for each risk factor and the same number of values obtained for each criterion value. The Monte Carlo simulation outputs a series of frequency histograms of the criterion quantity and its automatic recalculation. Histograms enable a graphical representation of the value of the criterion value and its frequency within the framework of the numerical/probability distribution from the point of view of risk analysis. The graphic representation of the histogram of the quantity of NPV is in Fig. 4.

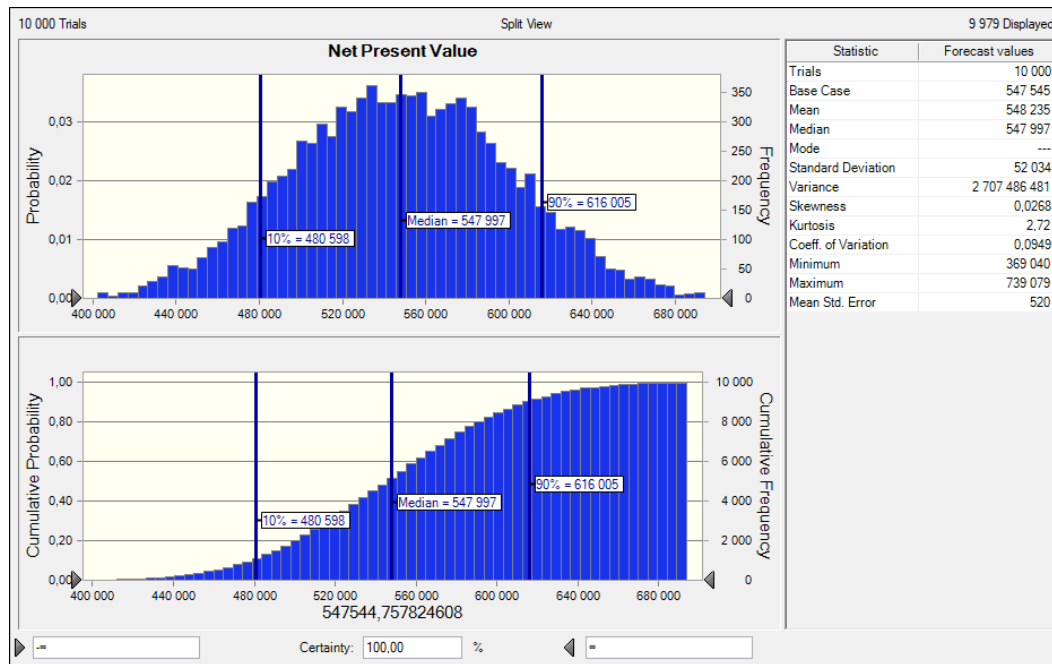


Fig. 4. Scatter graphs of correlation and regression analysis. Source: own research.

The probability histogram shows a symmetric distribution according to the mean and probability. At the same time, it is possible to identify that the company, when buying a new production line, with 100% probability, will achieve positive values of the monitored variable, i.e. Net Present Value. The mean value in the form of the median in the Monte Carlo simulation is €547,997.

The Crystal Ball software environment also enables sensitivity analysis through Monte Carlo simulation. This sensitivity analysis is comparable to the outputs obtained through classical sensitivity analyses (such as the sensitivity analysis above), but it is built on entirely different approaches. The basic approach is the distribution of individual risk factors from the point of view of their contribution to the aggregate variance of the distribution of the criterion quantity. For the analyzed company, the sensitivity analysis is calculated using the Monte Carlo simulation tool shown in Fig. 5.

This presentation of risk factors and their impact on the criterion value is clear and easy to read. When taking a closer look at the processing of this analysis, however, it is evident that this is only a derived calculation, the accuracy of which could be better. Sensitivity analysis through Monte Carlo simulation is based on rank

correlation. This correlation is based on the generation of individual risk factor values. The result is subsequently summarized criterion values. This contributes to the dispersion, which is based on the square of the rank correlation values and their subsequent normalization to 100%. The resulting values are sorted in the next step, while the degree of rank correlation between the risk factors and the criterion value is calculated. This method makes it possible to identify the influence of individual risk factors on the criterion value based on correlation. In contrast, the effect of all other variables is taken into account.

Implementing simulations and new approaches to increasing enterprises' competitiveness and subsequent sustainability is a challenging process primarily due to the fundamental differences between the deterministic and stochastic methods. The success of new modern approaches to companies' decision-making processes results mainly from a change in thinking and the ability to overcome negative attitudes towards change. In current enterprises in the territory of the Slovak Republic, the use of approaches used for a long time in all areas of the company, whether decision-making, economic or operational, still prevails. However, the development of the current market environment forces companies to reach for new approaches that would allow them to gain an advantage in tough competitive battles in individual markets. Using modern software tools can save companies time and facilitate decision-making when making investment decisions, which is a prerequisite for the sustainability of companies in the future.

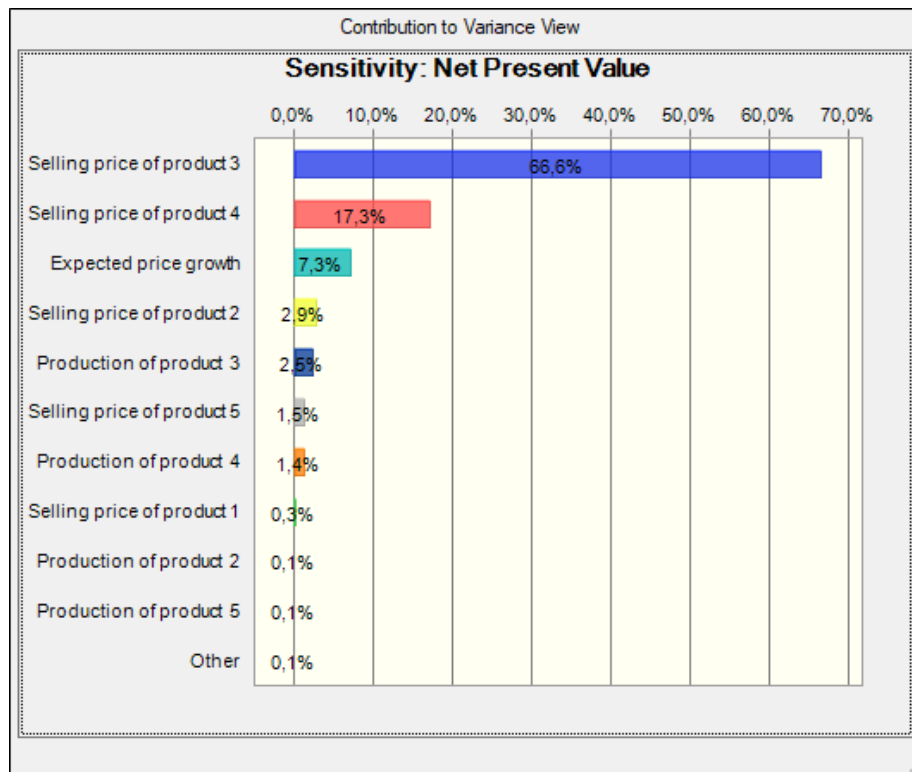


Fig. 5. Sensitivity Analysis of NPV – Monte Carlo Simulation. Source: own research.

Sensitivity analysis in the Monte Carlo simulation environment has its limits. The limiting factor is primarily the impact of risk factors, which are analyzed separately in the calculations without implementing dependencies between individual risk factors. This approach can lead to the exclusion of one of the factors based on the assessment of its insignificant influence on the criterion value, taking into account the influence of other risk

factors. Despite this fact, sensitivity analysis in the software environment of the Monte Carlo method has several advantages. The first advantage is the possibility of the first graphic control between individual factors and the criterion value. The second advantage is evaluating the significance of the analyzed risk factors from the point of view of their relationship to the criterion value. As part of the relevance evaluation, a list of those risk factors that are no longer significant for further analysis is created. The third advantage of sensitivity analysis is the possibility of identifying non-linear relationships between risk factors and the criterion variable. The considerable sensitivity of the model causes significant changes in the resulting values of the criterion quantity, even with minor changes in the importance of the risk factors. Low sensitivity, on the other hand, means that even the most extensive changes in the values of the risk factors may not cause significant changes in the criterion value.

From the sensitivity analysis for the analyzed company, it follows that the most risky factors that significantly impact the change of the criterion value are the selling prices of products 3 and 4. The above-processed sensitivity analyses, i.e. classical sensitivity analysis and sensitivity analysis in Monte Carlo simulation, showed a significant influence of the same factors on the criterion value, confirming the methodology's correctness aimed at increasing enterprises' competitiveness. The fundamental pillar of the methodology is the Monte Carlo method, which requires a complex analysis based on a stochastic approach and consideration of the time factor when assessing investments.

From the simulation results, the most exciting value is the difference between the mean value and the median based on the skewness of the distribution. The distribution is skewed in favor of the company to the right because the skewness shows a positive value. From the 10,000 generated values, it can be found that the median value for NPV is €548,235, which is €690 higher than the starting value for the most likely scenario (Base Case). The realization of the investment will reach the lowest value of €369,040 and the highest value of €739,079. The probability distribution of NPV is relatively symmetrical; a slight positive skewness (Skewness) of 0.0268 informs about the deviation of the probability distribution to the right, i.e. towards higher profit values. The skewness of the distribution (Kurtosis) of size 2.72 means that the resulting probability distribution shows the so-called fat tails versus a normal distribution (with a kurtosis of 0), i.e. the probabilities of extreme events are higher than the normal distribution predicts. From the abovementioned characteristics, we can conclude that the research confirmed a significant dependence between competitiveness and financial risk management.

4. Discussion, limitations and implications

As mentioned in the literature review, many authors are devoted to the issue of simulations in financial management. The broad applicability of simulations creates space for individual researchers to devote themselves to various specific areas of the researched topic in their studies. As it has been proven, many authors focus their research on monitoring the interrelationships between competitiveness, innovativeness and financial risk management in companies in different parts of the world (Jin & Lee, 2020; Zhang, 2021; Nohong, 2019; Karadağ, 2018; Yang, 2018; Gates, 2012) and various sectors of the economy (Kucera, 2021; Mazanec, 2021). However, these authors do not use modern software tools and apply selected economic methods to solve the problem. Opposite the application of modern tools and techniques in financial planning is dealt with by other authors (Ristanovic, 2022; Ilbahar, 2022; Zhu, 2012; Zhao, 2022; Hussain, 2019), who focus their research on the Monte Carlo method and its applicability in various sectors of the economy. However, they apply the Monte Carlo method to production processes, logistics, engineering, etc.

In Slovakia, there needs to be a guide for small and medium-sized companies to solve financial planning and simulation of investment decisions, which would allow these companies to integrate modern software tools into decision-making processes.

We also concluded that the system of risk management and financial planning represents a multidimensional concept and a complex process that creates a prerequisite for creating a basic system procedure for evaluating, controlling and determining an acceptable level of business risk. This procedure represents a unique and original tool for supporting managerial decision-making processes in various companies. The uniqueness of this fuzzy rooting methodology, presented in the previous sections, is demonstrated using the Monte Carlo method on a numerical example. Many authors (Ejegwa & Onyeke, 2021; Aruldoss et al., 2013; Burton et al., 2020) currently use such methodologies to demonstrate decision-making processes in different parts of societies.

The practical benefit of the presented procedures, methods, methodologies, and algorithm is their functionality and usability. Functionality is defined by the very existence of the methodology and subsequently by its practical verification in Slovak companies. However, the condition remains the clear interpretation of the results, for which the assumption of their correlation with other companies in the business environment applies.

Although the Monte Carlo method is used in companies operating in countries with a solid economic background and in large foreign corporations, this method is rarely used in Slovakia. The proposed methodology in the presented form provides businesses in Slovakia with guidance for introducing effective tools into investment decisions by enabling companies to see the behavior of the investment and its input variables (funding sources, credit terms, etc.) in a set time horizon. Such a focus of research is also necessary from the point of view of practical application to increase the effectiveness and efficiency of models and methodologies in the conditions of the Slovak Republic. We consider the mentioned connections and causal relationships to be significant in the direction of practical application; therefore, we recommend that they be addressed in future research as well.

Conclusions

The research goal was quantitative and qualitative verification of the methodology focused on the issue of increasing the competitiveness and sustainability of small and medium-sized enterprises in Slovakia. The proposed methodology is an effective tool that introduces new approaches to the evaluation of investment activities of companies based on modern tools, which it implements into companies' decision-making processes. The methodology was and is being verified as a part of the research project on real small and medium-sized enterprises that conduct their business activities in Slovakia and plan to improve their competitiveness and sustainability in the future. The methodology is based on a sequence of steps based on the following areas: (i) mathematical modeling with deterministic quantities, (ii) sensitivity analysis focused on the detection of critical factors that significantly affect the NPV criterion value, (iii) regression analysis for detecting interdependencies between methodology values and (iv) simulation through the Monte Carlo method, the calculations of which were carried out by the Crystal Ball software tool in the MS Excel environment. The proposed software tool was also chosen due to its relatively straightforward operation and easy availability. The fusion of traditional and modern tools, integrated and interconnected within the methodology, gives businesses a sophisticated tool for managing today's turbulent environment. A combination of deterministic and stochastic modeling makes it possible to perform analyses and simulations that consider the time factor in financial and investment planning. The graphic outputs of individual analyses provide a simple, easy-to-read tool for assessing demanding numerical and statistical data, which is the methodology's output. The advantage of the Monte Carlo simulation is also an overview of statistical analyses, which enables a more effective assessment of the outputs of the methodology.

Within the sensitivity and regression analysis framework, it is possible to identify risk factors that significantly affect the simulated quantity. The simulated value of the methodology can be profit, cash-flow, NPV, or any other financial indicator. To fulfill the research task of the article, the NPV value was chosen as a criterion value, which integrates the time factor through simulation, which allows companies a simple and practical insight into the

future development of financial indicators. The issue of increasing competitiveness and ensuring the sustainability of businesses is currently very topical, primarily due to the turbulent market situation due to the global economic and energy crisis. In this environment, it is pretty challenging to implement investment decisions without detailed planning. Among experts in the academic and scientific field, there is a rather significant discussion about mitigating risks in the business environment.

As demonstrated during the research, the methodology in its individual steps is feasible, and the interconnection of individual analyzes represents a multi-criteria tool for assessing companies' investment decisions. Despite the advantages of computer simulations, it is also necessary to point out possible shortcomings and threats arising from using these tools. Sufficient skills and knowledge in controlling the software environment and following procedures may not represent quality outputs. For the simulations to work effectively, it is necessary to know and correctly identify the distribution functions in the initial steps of the simulation, to master the basic mathematical relationships in financial modeling that define the correlations and dependencies between individual factors, and above all, to properly identify the criterion value entering the simulation as the resulting value. The source of information in individual steps is thus the results of expert estimates and detailed analysis of financial data of companies. The methodology as a tool for increasing the competitiveness and sustainability of enterprises is a simple tool for solving financial and investment decisions. Still, its use in practice is much broader than the article states. Developments in the business environment and computer technology field create prerequisites for expanding the use of software tools for simulation in risk management.

The article demonstrated that companies that integrate modern approaches into their decision-making processes can increase their competitiveness and thus ensure sustainability in the market environment. Simulations and modeling considering the time factor give these companies an advantage in the form of knowledge of future developments or the possible behavior of financial indicators in the future already in real-time. The sequence of steps in the methodology can be applied to various companies in Slovakia. Due to the relatively clear and simple display of deterministic mathematical correlations and calculations, the methodology can be easily modified to different market environments in other countries, creating a prerequisite for its wide use in practice.

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STUDY OF THE IMPLEMENTATION POSSIBILITY OF SUSTAINABLE DEVELOPMENT GOALS*

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Abstract. After assessing the relevance of sustainable development goals (hereafter SDGs) and their implementation in the context of scientific literature, this article examines the experience of research participants' involvement in the performance of SDGs. It discusses the possibilities of managing sustainable development processes. 198 respondents participated in the research. Analytical descriptive, quantitative and statistical research methods were applied. Quantitative data analysis was performed by calculating analysis of variance (ANOVA) and percentage distribution (frequency). Using the Student's - t criterion, a comparative analysis of the evaluation of the experience of involvement in the implementation of SDGs was performed in two groups of subjects of different ages. It was identified that the respondents engage in the implementation of SDGs in both the environmental and social fields by their behaviour: they combine various means of transport during trips and participate in ecological management campaigns, help poor and vulnerable people, allocate funds for charity, support and look for ways to reduce inequality (social, gender, religion, age, etc.). However, the observed lowest estimates indicate less expressed efforts of the research participants in contributing to the implementation of SDGs by sorting waste/garbage, saving paper and electricity, and respecting the rights and needs of every person. After conducting a comparative analysis in terms of age, it was found that the expressiveness of the experience of involvement in the implementation of SDGs is different in the two groups of subjects. The results of the statistical analysis showed that the younger research participants, belonging to the age group under 35 years old, evaluated their efforts in contributing to the implementation of SDGs in both social and environmental fields with significantly higher estimates than the elder respondents belonging to the age group over 36. When evaluating the possibilities of achieving SDGs, the results of the research confirmed the importance of public education on the topics of sustainable development, as well as the importance of raising personal awareness in the family and educational institutions and encouraging young people to be more actively involved in the implementation of SDGs. Television, media and social networks are also named ways to ensure sustainable development processes. The results of the research will have a lasting value in the scientific discussion about SDGs and the possibilities of their implementation, as well as practical significance in predicting possible ways of managing sustainable development processes and creating social and environmental well-being, forming public awareness and responsibility, changing mindsets, and attitudes.

Keywords: sustainable development goals; sustainable development principles

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1. Introduction

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Sustainable development includes environmental protection capacity, policy formulation and implementation and monitoring, science, technology, and research; development of national data and statistics; cleaner production; and trade-related capabilities. The globalisation process, economic competitiveness, technological changes, innovation support, environmental protection, and natural problems should focus more on quality than quantity. It is the knowledge-based economy and sustainable development that attract a lot of attention from scientists and politicians. Both processes are focused on improving quality, which increases competitiveness, so it is appropriate to highlight the most critical aspects of the mentioned processes. In recent years, organisational cohesion has become one of the most popular and ambitious concepts in modern management. Environments and organisations are tightly connected; the long-term success of organisations depends on how harmoniously they are integrated into the environment and feel the social mood of the interested parties. Scientists from various countries have studied the issues of sustainable development. Elder et al. (2016) mentioned that sustainable development includes environmental protection capabilities, formulation and implementation of policy and monitoring, science, technology, and research, while Dacko et al. (2021) analyse sustainable development in international agreements, treaties, and conventions dealing with and relating to the broadly defined natural environment protection with optimal use of energy resources. Crespo et al. (2017) stated that teaching and learning sustainable development must be implemented to achieve SDGs. Hedlund-de Witt (2014) mentioned that it is necessary to consider different worldviews when discussing sustainability and offer broad tentative suggestions. According to the Government of the Republic of Lithuania (2003), sustainable development is understood as a compromise between environmental, economic, and social goals of society, enabling the achievement of universal well-being for present and future generations without going beyond permissible environmental impact limits; while Čižauskaitė-Butkaliuk (2014) stated sustainable development should be more focused on quality than quantity.

The research problem is made concrete by raising *problematic questions*: what is the experience of the research participants in contributing to the implementation of SDGs? What are the possibilities of managing sustainable development processes by developing the field of public education on sustainable development topics and involving institutions responsible for the implementation of sustainable development goals?

Aim of the research: after studying the experience of research participants' involvement in implementing SDGs, predict the possibilities of implementing these goals.

Research objectives:

1. After analysing the scientific literature on the subject under consideration, find out the current assumptions, possibilities and conditions for implementing SDGs that today's researchers are studying.
2. To find out the respondents' experience and the efforts made in implementing SDGs.
3. Based on the assessment of the research participants, suggest solutions for the implementation of SDGs.

2. Sustainable development: theoretical aspects

Sustainable development is becoming one of the most popular ideas of social development. Sustainable development helps society, companies, and individuals to change their behaviour concerning the environment. It covers three leading indicators: economic, ecological, and social. More and more attention is being paid not only to the financial performance results but to the formation of a harmonious and responsible society, improving the quality of life. Social, economic, and environmental rules of sustainable development motivate people to stick with the message. Only an effective, continuously developed, supported, and encouraged culture of knowledge sharing can meet the needs of society in the current period, preserving opportunities for future generations to meet their own needs and preserving a sustainable environment for future generations. Sustainable development is based on three main elements - environmental protection, economic and social well-being. Čiegis (2004) stated that the term sustainability began to be used in various contexts and became especially popular after the International Union for Conservation of Nature (IUCN) published the World Conservation Strategy in 1980, which had a clear, practical goal: to encourage a more focused approach to the management of living resources and to provide political guidelines. How could this be implemented? It was a completely new approach that tried to combine the conservation and utilisation of nature with environmental

and development goals. Luque González et al. (2021) stated that sustainability can be defined within two typologies - weak and - strong sustainability. The first assumes that natural capital and economic capital are perfectly interchangeable substitutes over a period, while the second is a sound economic principle that is impossible to replace by natural resources in a complex biological system. The principles of sustainable development were formulated in 1992 at the global top-level conference in Rio de Janeiro. More than 170 heads of state signed the Rio Declaration, and “Agenda 21” was announced at this conference. Based on these and the documents adopted later at the World Heads of State and Government Meeting held in Johannesburg, countries prepared National Strategies for Sustainable Development. The document sets 17 sustainable development goals (SDGs) and 169 smaller tasks (targets), which cover many policy areas and are intended to be implemented by 2030.

The essence of the definition of sustainable development is to emphasise the long-term economic development of countries/states to rationally harmonise the economic, social, and environmental interests of society. All these factors must not only be combined and complement each other but the attention to quality must be given.

Liu (2009) stated that sustainable development includes economic growth and reducing its impact on the environment. It also assumes that Earth can provide enough resources for humanity to meet present and future needs.

Sustainable development principles. Navickienė et al. (2021) mentioned that sustainable development is a development that meets the needs of the present without reducing the ability of future generations to meet their own needs, and this is the central long-term ideology of social development that emphasises the interdependence between the three harmonious development pillars (dimensions) - economic development, social development, and environmental protection. According to Navickienė et al. (2021), this concept began to be widely used only in the 20th century because until then, humanity did not appreciate the changed situation due to the strengthening of civilisation and economic activities and because there are no areas left untouched by humans on the planet. Still, in the last century, humanity realised. There was a need to balance the development of the global society due to the rapid population growth and the increase in their consumption.

Sustainable development must be carried out in a balanced and simultaneous manner in three dimensions: social, economic, and environmental. Staniškis et al. (2012) and Vasiljevienė et al. (2008) state a strong relationship between these dimensions - decisions in one of the dimensions will always affect the other dimensions. Sustainable development is a development that ensures better development and quality of life for both current and future generations. In other words, economic development will be harmonious and sustainable only if it positively affects the social environment and those around it.

Žičkienė et al. (2019) identified the most critical features of sustainable development: 1) preservation of economically beneficial capital reserves, increase of production productivity and limitation of adverse external effects; 2) meeting the needs of the current generation, reducing inequality and uncertainty, ensuring the stability of social systems and cultural diversity; 3) decoupling economic growth from environmental deterioration, responsible management of natural capital and restoration of capital of critical natural resources, changing the current methods of assessing social progress; 4) determination of principle global, macro- and lower regional levels, cooperation of international, national and local level institutions, promotion of public activeness.

Possibilities of implementing sustainable development goals. Examining the situation of the implementation of SDGs on a global scale, it is evident that this process only sometimes goes smoothly due to subjective or objective reasons. Crespo et al. (2017) mentioned that their article aims to report a carried out higher education Master’s study in Thermal Engineering at the University of Vigo based on teaching and promoting sustainable development. According to Crespo et al. (2017), it mainly consists of individual cases solved by the students in which the different criteria of sustainable development should be addressed. According to the authors, the results were evaluated by a sustainable rubric developed based on the 17 SDGs recently announced by the United Nations. Finally, a discussion of the outcomes is given, related to sustainable development in higher education.

Grainger-Brown et al. (2019) analysed that the SDGs framework is a template for a sustainable future, with goals that include poverty reduction, better health and education, climate change, and preserving forests, oceans, and cities. Real consensus on the SDGs is difficult to achieve due to the almost universal applicability of the targets. Still, overall, the SDGs agenda is perceived as a valuable gathering tool to rally the world's nations around a central vision for a better future. Mobilising societal change and directing investments and strategies to pressing global issues is critical.

Ionescu et al. (2021) assessed the implementation of SDGs in Bulgaria, as well as the existing development potential, considering the current knowledge gap related to this critical topic. Eurostat data was processed using dynamic indices and time series analysis based on the ARIMA methodology to identify development trends and progress dynamics of key indicators related to the SDGs. Ionescu et al. (2021) calculate that in 2030, the projected 36.28% of targets will be met, but it also reveals the great potential to accelerate the transition to a low-carbon economy and a more sustainable and inclusive society.

Firoiu et al. (2021) mentioned that a sustainable society is based on sustainable education; in Romania, access to education is unlimited. Youth and adults are encouraged to improve their skills and competencies. This society is ready for a sustainable future. However, regarding specific indicators, Romania occupies a lower position than the European average, which is relevant for the OECD program for international student assessment. School abandonment, poor infrastructure, and deprivation of investment in sustainable education have resulted in a significant undervaluation of education in Romania. From a lifelong learning perspective, Romania has yet to foster a tradition that promotes lifelong learning. The lowest percentage from the national budget for education in Romania in 2016 was 3.7%, compared to the European average of 4.7%.

Mestdagh et al. (2023) studied the following areas of implementation of SDGs: (1) evaluation of the state of SDGs implementation by organisations, (2) review of SDGs implementation activities (3) evaluation of the direct impact of COVID-19 on the organisation's sustainable goal implementation, 4) evaluation of the direct impact of COVID-19 on the organisation's implementation of individual sustainable development goals. Thus, participants were asked both directly and indirectly about the relationship between the variables of COVID-19 and SDGs implementation.

According to Płonka et al. (2022), the study showed that very often, the idea of sustainable development is simplified to care about environmental protection. Such reasoning ignores or marginalises the other aspects that have formed the triad of sustainable development from the beginning, i.e., economic dimension and social context. Moreover, as indicated in the literature on this topic, only a holistic approach to these three vectors provides a sufficient basis for defining the changes taking place in terms of sustainable development. In the presented study, shortcomings were observed both in emphasising the concept of sustainable development, in explaining its essence in the program's content, and the fairness of learning. The benefits of solid sustainable development education are not limited to specific knowledge and a good foundation. They are manifested in social attitudes that are desirable not only from an environmental point of view but also from an economic and social point of view. Spending on social education for sustainable development feeds into the macroeconomic account by saving modern production technologies and reducing waste generation, which is important in every aspect of sustainable development.

Bardal et al. (2021) stated that the results of the conducted research showed that the successful implementation of SDGs in local and regional planning requires that both municipalities and counties have the capacity and resources necessary to work with SDGs implementation. To prioritise work on the performance of the SDGs, respondents mentioned the importance of administration leaders, expressing that this is an essential and prioritised task. Municipal cooperation was also mentioned as a possible strategy to overcome the capacity barrier. However, as one respondent commented, work on sustainable development goals must be integrated into existing activities and not become something separate from the service delivery activities for which municipalities and county councils are responsible.

Sonntag et al. (2022) state that the research has shown that sustainable development is perceived as a source of new entrepreneurial opportunities, helping solve social and environmental problems. This is beneficial for companies, as they can contribute to the implementation of "green solutions" and, at the same time, respond to the needs of customers who are increasingly paying attention to the benefits of these solutions. This is

important because the vast majority of those interviewed believed that there is a lack of financial resources that mainly hinders the implementation of SDGs in companies.

Fallah Shayan et al. (2022) analysed that SDGs help corporations achieve their corporate social responsibility goals because they are more comprehensive on a global scale. The SDGs are holistic and interrelated, meaning one purpose can help others. The results of the SDGs last longer; therefore, they save companies time and money.

Yeh et al. (2022) remark that the social goals of sustainable development are directly related to people's daily lives, such as health, water, energy, consumption, and production, and have attracted more researchers' attention. On the other hand, the frequencies of all SDGs studied in these review papers were within a narrow range. More research on the SDGs has focused on specific SDGs rather than the SDGs as an indivisible and integrated framework as defined in the UN Resolution. Systematic thinking is critical to research related to sustainable development and the SDGs.

Mestdagh et al. (2023), Płonka et al. (2022), Bardal et al. (2021), Sonntag et al. (2022) Fallah Shayan et al. (2022) et al. research distinguishes essential things - that it is a holistic approach, that these three areas are interrelated and mutually influencing. This is also confirmed by Plonka et al. investigation. From the point of view of scientists, public education on sustainable development is one of the essential factors contributing to the implementation of the SDGs.

It is clear that in today's context, the implementation of sustainable development goals acquires particular importance for achieving quality of life and creating well-being for future generations. When it comes to SDGs, it should be kept in mind that it is holistic, covering three areas, i.e., environmental, social, and economic, which are interconnected. Therefore, it can be defined as an indivisible, integrated system when the implementation of goals in the economic field is related to the environmental and social areas. The possibility of reaching SDG goals depends on the behaviour and lifestyles of companies and people. Behavioural attitudes still need to be investigated.

3. The research methodology

Research organisation and a sample of subjects. When organising the research, the following systematic logic was followed: 1) analysis, evaluation, and summarising of the scientific and methodical literature related to the topic and the results of the conducted scientific research related to the topic under consideration. This helped to clarify the objectives of sustainable development and aspects of their implementation and to create a research instrument. 2) conducting diagnostic research, which allowed to study the experience of the research participants and the efforts made in contributing to the SDGs and to predict possible ways and means of implementing the SDGs. The questionnaire distribution method was an online survey. 3) formulation of conclusions based on the analysis of scientific literature and research data, predicting the possibilities of achieving the SDGs.

Research methods. Analytical descriptive. The analysis of scientific literature and documents on SDGs in the social, economic and environmental fields was carried out, and research related to the topic under consideration was discussed, which examined SDGs and the possibilities of their implementation. *Quantitative method.* In analysing the experience of research participants in getting involved in the implementation of SDGs and predicting the possibilities of implementing them, a quantitative research method (questionnaire survey) was used. The statements of the questionnaire were compiled based on theoretical insights criteria identified in the scientific literature, which were used to examine the experience of the research participants in getting involved in the implementation of SDGs and, based on the respondents' point of view, revealed the possibilities for the implementation of SDGs. The validity of the questionnaire was determined by calculating Cronbach's alpha values in each group of questionnaire statements separately. The results of the statistical data analysis show that the overall degree of internal consistency of the questionnaire statements (number of variables = 33) is high enough (Cronbach's alpha = 0.86) and varies from 0.851 to 0.88. The internal consistency of the variables was also checked in each group of the questionnaire separately. The questionnaire identified constructs: 1) the expression of research participants' involvement and efforts in contributing to SDGs; 2) the possibilities of implementing SDGs. After checking the expression of the group

of statements in the questionnaire about the involvement and the efforts made in contributing to SDGs, which consists of 20 statements, Cronbach's alpha = 0.9084 was calculated and varied from 0.9005 to 0.91. When defining the question group of the possibilities of implementing SDGs, the results of statistical data analysis show that the degree of internal consistency of the statements of this question (number of variables = 13) is sufficiently high (Cronbach's alpha = 0.817) and varies from 0.804 to 0.822. Based on the fact that internal consistency should be between 0 and 1, and the value of Cronbach's alpha coefficient reaching 0.60 is considered suitable for research (Pakalniškienė, 2012), the Cronbach's alpha calculated during this research shows that both questions - Involvement and efforts made in contributing to implementation of SDGs and SDGs implementation possibilities- groups of statements should be considered as matched. To check whether several constructs consist of the statements of the question group of involvement and the efforts made in contributing to the implementation of SDGs, principal components factor analysis was performed using Varimax rotation. The results show that the data is suitable for factor analysis: KMO=0.793 (possible not lower than KMO=0.6), and Bartlett's specificity test $p < 0.001$. The results of the factor analysis show that the statements of the question form two factors: a) social and b) environmental, and their weights range from 0.683 to 0.812. After performing a factor analysis of the main statement components of the possibilities of implementing SDGs by applying Varimax rotation, the results show that the data is suitable for factor analysis: KMO=0.731 (possible not less than KMO=0.6), and Bartlett's specificity test $p < 0.001$. The results of the factor analysis show that the statements of the question form two factors; on that basis, the following constructs are distinguished: a) education and public education on the topics of sustainable development; b) involvement of institutions responsible for the implementation of SDGs. Factor weights in this group of statements range from 0.708 to 0.742. *Statistical.* Statistical analysis methods were used to process the data collected during the research. When determining differences in several independent populations, the Student's t-test was applied (to compare the averages of two independent samples), and quantitative data analysis was performed by calculating variance analysis (ANOVA) and percentage distribution (frequency). When the significance level was less than 0.05, the difference in characteristics was considered statistically significant. Statistical data analysis was performed using SPSS (Statistic Package for Social Sciences) software version 17 data package and MS Excel 2016 computer program.

The sample of subjects. Lithuanian residents ($n=198$) participated in the research, more than two-thirds of which were women ($n=132$ (66.7%)) and only 65 (32.8%) were men, and one respondent did not specify his/her gender. Analysing the distribution of subjects by age, it can be seen that more than half of those who took part in the research belong to the age group of 36 years and older ($n=115$ (58.1%)), while a smaller proportion of respondents belonged to the age group under 35 ($n=83$ (41.9 per cent)). The research sample is convenient. The research was conducted using an electronic system, which probably led to a more passive involvement of Lithuanian residents. Therefore, this study is small-scale, and the results may only partially reflect part of the population, so this fact can be termed a research limitation. However, the results of this type of research can only be reliable by transforming them beyond the study group. However, in the perspective of further research, to achieve greater representativeness, to formulate essentially statistically significant conclusions concerning the phenomenon under consideration, and also so that the general whole can be judged based on the obtained results, it would be appropriate to delve deeper into the subject under consideration by expanding the sample of subjects.

The research procedure. Respondents for this research were selected using convenience sampling. A distribution method using an electronic system - an online survey - was used. The survey was conducted following the principle of quality control, i.e., an internal check of the survey was carried out (completeness of filling out the questionnaire, consistency and duration of the survey). Incompletely or carelessly completed questionnaires (e.g., the same numbers are marked in all graphs of the questionnaire, etc.) were excluded from further data analysis. For further data analysis, 198 questionnaires were used, which can be considered suitable for statistical analysis. The duration of the research was two weeks. During the investigation, the ethical principle of voluntariness and free decision to participate was observed. The study was conducted anonymously; the results were processed and presented in aggregate, and data confidentiality was ensured.

4. Analysis of research results

Sustainable development process management initiatives will only achieve the desired result with consumer awareness and responsibility for their actions, following the principles of sustainable development. Analysing how the research (see Figure 1) participants evaluate their efforts in contributing to the implementation of the SDGs, the highest averages of the estimates in the general sample showed that respondents monitor and track their behaviour concerning the SDGs from an environmental perspective: they cooperate with others and seek ways to solve climate change issues (M=3.06), combine various means of transport during trips (M=2.67) and participate in environmental management actions (M=2.67). Also, during the research, it became clear that those who participated evaluated their efforts in contributing to implementing SDGs in the social field with sufficiently high estimates. According to respondents, they help poor and vulnerable people (M=2.68), allocate funds for charity support (M=2.69), and are also active in finding ways to reduce inequality (social, gender, religious, age, etc.) (M=2.7). Meanwhile, the statistical analysis of the data showed that the research participants evaluated their efforts in contributing to the implementation of SDGs in such areas as sorting waste/garbage (M=1.83), saving paper (M=1.83) and electricity (M=1.85)).

On the other hand, respecting the rights and needs of every person, regardless of their social status, was evaluated as the weakest behaviour contributing to the implementation of SDGs (M=1.67). Recent results show the need to look for ways and means to ensure the management of sustainable development processes and to shape consumers' attitudes and responsibility for their impact on the world's climate and its change, encourage changing their consumption habits, sort waste, save paper, and also strengthen commitment to electricity stewardship. In addition, when examining respondents' self-assessment of their behaviour from a social aspect, using various methods and measures, it is necessary to emphasise the importance of respecting the rights and needs of every person, regardless of their social status.

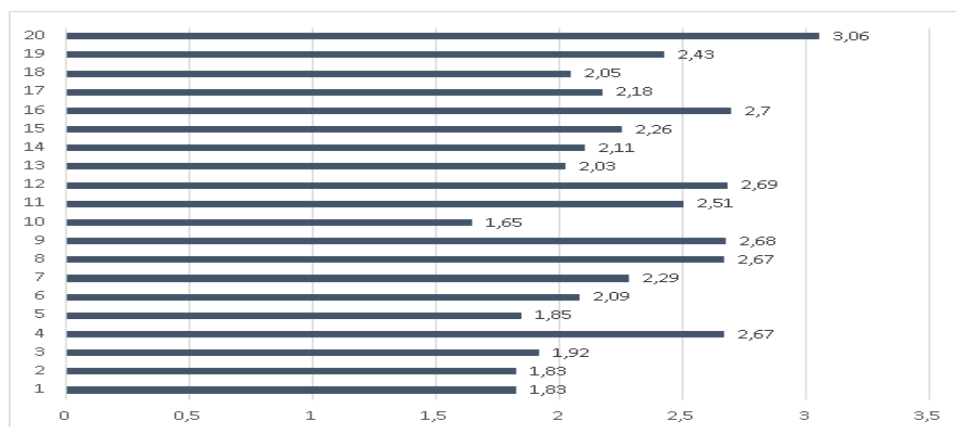


Figure 1. Behavior of research participants in relation to SDGs (n=198; mean values (M), max=5)

- | | |
|---|---|
| 1. I sort waste/garbage | 11. I feel responsible for people suffering from hunger and malnutrition and look for ways to solve the problems related to poverty |
| 2. I save paper (e.g., use it for drafts, print on both sides, email documents, etc.) | 12. I allocate funds for charity, sponsorship, support |
| 3. I feel responsible for the negative impact of the release and discharge of harmful substances on air pollution | 13. I am trying to change my consumption habits (not wasting food, etc.) to contribute to the fight against hunger and malnutrition |
| 4. During my travels, I combine various means of transport (public transport, scooter, etc.) | 14. I am trying to use all the educational opportunities available to me to learn |
| 5. I save electricity and feel responsible for its consumption | 15. I notice inequality (social, gender, ethnicity/race, religion, age, etc.) in my environment and can assess its effects |
| 6. I save water in my daily activities | 16. I am looking for ways to reduce inequality (social, gender, ethnicity/race, religion, age, etc.) |
| 7. By my behaviour, I try to contribute to water storage and improve its quality | 17. I can manage and use natural resources moderately |
| 8. I participate in environmental management actions (e.g. DAROM and other ecological management campaigns) | 18. I understand my impact on the world's climate and its change, both locally and globally |
| 9. I help poor and vulnerable people | 19. I encourage others to protect the climate and contribute with their behaviour to the reduction of climate change |
| 10. I respect the rights and needs of every person regardless of their social status | 20. I collaborate with others to find ways to solve climate change questions |

After performing calculations in different age groups, it became clear that statistically significant differences are observed even in seventeen out of twenty answer categories (see Table 1). After calculating the t-test, it became clear that the younger research participants, belonging to the age group up to 35 years old, evaluated their efforts in contributing to the implementation of SDGs in both social and environmental areas with statistically significant ($p < 0.05$) higher averages than older respondents, belonging to the age group above 36 years and older. According to the assessment of the research participants of younger age (up to 35 years of age), the latter's efforts in contributing to the implementation of SDGs by sorting waste/garbage ($M=2.29$) and saving paper ($M=2.33$) were evaluated with higher average estimates than those of elder age (from 36 years and older) of the study participants ($(M=1.5)$ and $(M=1.58)$ respectively). In addition, according to the research data, it can be seen that younger respondents have a more robust expression of responsibility for the negative impact of the release and emission of harmful substances on air pollution ($M=2.25$) and understanding of their impact on the global climate and its change both locally and globally ($M=2.24$), while significantly ($p<0.05$) lower mean estimates were found in the group of older (over 36 years and older) research participants (respectively: $(M=1.68)$ and $(M=1.9)$). Also after calculating the t-test, significant differences in means were determined (see Table 1) showing that saving electricity ($M=2.25$) and water ($M=2.57$) and responsibility for their consumption, active involvement in organised environmental management actions ($M=3.43$), as well as helping poor and vulnerable people ($M=3.18$), feeling responsible for people suffering from hunger and malnutrition and making efforts to find ways to solve problems related to poverty ($M=2.84$), allocating funds charity and support ($M=3.18$) and respect for the rights and needs of every person, regardless of their social status ($M=1.8$) are more strongly expressed in younger respondents' answers than in the older study participants' answers, which group,

when evaluating their efforts contributing to the achievement of the SDGs, lower mean scores were determined (respectively: (M=1.56), (M=1.74), (M=2.11), (M=2.32), (M=2.26), (M=2.33) and (M=1.54)). In addition, the statistical data analysis showed that the research participants belonging to the age group under 35 years rated their efforts in changing their consumption habits to contribute to the fight against hunger and malnutrition (M=2.35) and also in finding ways to reduce inequality (social, gender, religion, age, etc.) (M=2.98), encouraging others to protect the climate and contribute with their behaviour to reducing climate change (M=2.76), managing and using natural resources moderately (M=2.51) and more actively cooperating with others in finding ways to solve climate change issues (M=3.48) than elder respondents, whose group's statistically significantly lower estimates in these aspects show the latter's weaker expressed efforts. They more strongly expressed passivity in contributing to the implementation of SDGs (respectively: (M=1.79), (M=2.5), (M=2.2), (M=1.94) and (M=2.75)).

Table 1. Evaluation of one's efforts in contributing to the implementation of SDGs in different age groups (under 35 years (n=83), over 36 years and older (n=115); mean values (M), standard deviations (SD), max=5 when $p < 0.05$)

	Age group under 35 years old		Age group over 36 years old		t	p
	M	SD	M	SD		
I sort waste/garbage	2.29	1.19	1.5	0.77	5.315	0.001
I save paper (e.g. use it for drafts, print on both sides, email documents, etc.)	2.33	1.06	1.58	0.77	5.426	0.001
I feel responsible for the negative impact of the release and discharge of harmful substances on air pollution	2.25	1.2	1.68	0.87	3.715	0.001
During my travels, I combine various means of transport (public transport, scooter, etc.)	2.57	1.35	2.75	1.23	-0.986	0.325
I save electricity and feel responsible for its consumption	2.25	1.06	1.56	0.79	5.074	0.001
I save water in my daily activities	2.57	1.14	1.74	0.9	5.494	0.001
By my behaviour, I try to contribute to water storage and improve its quality	2.77	1.13	1.94	0.9	5.554	0.001
I participate in environmental management actions (e.g., DAROM and other ecological management campaigns)	3.43	1.46	2.11	1.21	6.74	0.001
I help poor and vulnerable people	3.18	1.31	2.32	0.95	5.09	0.001
I respect the rights and needs of every person regardless of their social status	1.8	0.96	1.54	0.7	2.063	0.041
I feel responsible for people suffering from hunger and malnutrition and look for ways to solve the problems related to poverty	2.84	1.23	2.26	0.99	3.55	0.001
I allocate funds for charity, sponsorship, support	3.18	1.41	2.33	1.14	4.539	0.001
I am trying to change my consumption habits (not wasting food, etc.) to contribute to the fight against hunger and malnutrition	2.35	1.12	1.79	0.79	3.895	0.001
I am trying to use all the educational opportunities available to me to learn	2.16	0.93	2.07	0.89	0.668	0.505

I notice inequality (social, gender, ethnicity/race, religion, age, etc.) in my environment and can assess its effects	2.29	1.15	2.23	0.88	0.36	0.719
I am looking for ways to reduce inequality (social, gender, ethnicity/race, religion, age, etc.)	2.98	1.27	2.5	0.98	2.886	0.004
I can manage and use natural resources moderately	2.51	0.99	1.94	0.69	4.478	0.001
I understand my impact on the world's climate and its change, both locally and globally	2.24	1.05	1.9	0.88	2.374	0.019
I encourage others to protect the climate and contribute with their behaviour to the reduction of climate change	2.76	1.2	2.2	0.98	3.491	0.001
I collaborate with others to find ways to solve climate change questions	3.48	1.19	2.75	1.11	4.456	0.001

The existing problems in the environmental and social fields are of increasing concern and show the need, in the implementation of the paradigm of sustainable development, to promote global awareness associated with the choice of each person in their behaviour, contributing to the improvement of the quality of life, protection of the environment, reduction of poverty, ensuring the guarantees of justice and solving other problems. The latter statement is also confirmed by the results of this research, which revealed that despite the efforts made by the research participants in contributing to the realisation of SDGs through their behaviour, after analysing the data, it should be recognised that in most cases, the efforts made in contributing to the implementation of SDGs are insufficient. This is especially evident after performing calculations in groups of research participants of different age groups. After conducting a comparative analysis, the results showed that older (over 36 years and older) study participants evaluated their efforts in contributing to implementing SDGs in the environmental and social fields with lower average estimates than younger respondents. The recent results reveal the fact that it is necessary to raise people's awareness from a young age and to examine the topics of sustainable development in educational institutions and the development and implementation of social responsibility in organisations by defining goals and providing specific measures for the performance of SDGs, fostering employees' more profound understanding of the meaning of sustainable development, becomes relevant through self-education, encouraging participation in training and creating traditions in the organisation, which can be one of the prerequisites to constructively orient and transform the attitudes and value orientations of users (especially older persons), contribute to a change in mindset and perception by encouraging them to follow the principles of sustainable development, by becoming more actively involved in sustainable development processes and to follow the directions of sustainable development in your personal life. Thus, the results show the need to look for more effective ways to encourage consumers to be more actively involved in their behaviour in contributing to the implementation of SDGs. Therefore, in creating social and environmental well-being, an essential aspect of ensuring sustainable development processes is the search for tools and methods that affect the change in the mindset, attitude and attitudes of consumers, decision-making, awareness and responsibility formation, as well as active involvement and participation in the processes of implementing SDGs.

The harmonious implementation of development goals contributes to the fostering of ecology, ensuring the quality of life, and promoting economic growth. Therefore, when disseminating information about the performance of SDGs, it is necessary to look for the most effective ways and means to attract the attention of consumers and, at the same time, attract their more extensive audience. In promoting the principles of sustainable development in your personal life, it is crucial to provide information about SDGs and their implementation. Depending on the choice of the right strategy, the success of the chosen measures will depend on whether attention is drawn to the information and whether the desire to make a decision based on the principles of sustainable development is aroused. To make the provided information more attractive, more dynamic, and reach a larger audience, stimulate interest, convince and encourage to follow the principles of sustainable development, various means and methods can be applied. Thus, public education on sustainable development topics can be one of the ways of managing sustainable development processes.

What would encourage people to follow the principles of sustainable development? The data analysis revealed (see Figure 2) that in the opinion of more than two-thirds of the research participants if the topics of sustainable development were more discussed or shown on television (64.1%) and from a young age in families, people's awareness would be raised by encouraging responsible consumption and production (71.7%), this would encourage people to follow the principles of sustainable development. The research also revealed that, in the opinion of more than half of the research participants, if more were written about sustainable development topics in the media or social networks (58.1%), educational institutions would examine sustainable development topics more often (56.1%). Youth would be more actively involved in the implementation of the goals of sustainable development (59.6%), which, according to the respondents, would involve more people in the processes of sustainable development and encourage them to follow the principles of sustainable development. Thus, education and upbringing from an early age, both in the family and in educational institutions, as well as access to relevant information on sustainable development topics in social networks and its dissemination in the media and the involvement of young people to participate more actively in decision-making that affects their current life and future, can be one of the essential factors that encourage people to follow the principles of sustainable development and to participate more actively in the processes of sustainable development. On the other hand, according to the assessment of the research participants, events or charity events on sustainable development topics are more often organised (45.5%), innovations that are implemented, and modern technologies that are applied in production (44.9%), and greater attention from the authorities and politicians which is also paid to promoting sustainable development (40.9 %) and increased funding for the implementation of these goals (43.4%) were named as the most critical factors encouraging to follow the principles of sustainable development. Meanwhile, only a tiny part of the research participants admit that the seminars and trainings that are organised on the topics of sustainable development (27.8%) and meetings with authoritative specialists in their field, who would speak on the issues of SDGs (27.3%), as well as the information provided on sustainable development in publications or literature (21.2%) would encourage people to follow the principles of sustainable development; these factors are assessed as less effective in contributing to promoting the implementation of SDGs.

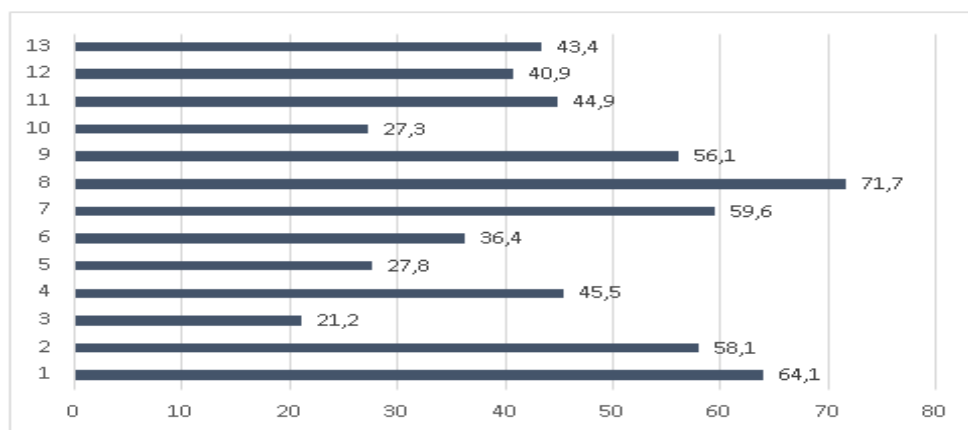


Figure 2. Measures to encourage people to follow the principles of sustainable development (n=198, per cent)

Remark:

- | | |
|--|---|
| <p>1. If the topics of sustainable development were more discussed/shown on television.</p> <p>2. If more were written about the topics of sustainable development in the media and social networks.</p> <p>3. If there were more information on the topics of sustainable development in publications and literature</p> <p>4. If more events, charity events (e.g. supporting people with disabilities, people with low incomes, etc.), initiatives (e.g. "DAROM", etc.) were organised on the topics of sustainable development</p> <p>5. If more trainings and seminars were organised on the topics of sustainable development.</p> <p>6. If more discussions and debates were organised on sustainable development (e.g., on television, radio, etc.).</p> | <p>7. If the youth were more actively involved in implementing SDGs.</p> <p>8. If people's awareness was raised in families from a young age (responsible consumption, creation of production and services without polluting the environment, etc.).</p> <p>9. If in the educational institution (school, higher education institution), the topics of sustainable development were discussed.</p> <p>10. If more meetings were organised with authoritative specialists in their field, they would speak on the topics of sustainable development and the implementation of its goals.</p> <p>11. If innovations were implemented, modern technologies were applied (e.g. in production).</p> <p>12. If there was an increase in the attention of the authorities and politicians in promoting sustainable development.</p> <p>13. If more funding were allocated to the implementation of the SDGs.</p> |
|--|---|

It can be said that the promotion of following the principles of sustainable development is most associated with the education of society, attitude formation both in the family and in educational institutions, as well as attitude formation using various communication methods and means (e.g., showing on television, media or social networks). Also, encouraging young people to become more actively involved in the implementation of SDGs and providing more funding, the development of production modernisation directions and introducing innovations were identified by research participants as the main factors that encourage people to become more actively involved in sustainable development processes and follow the principles of sustainable development by taking responsibility for their actions and decisions.

A comparative analysis of the data showed that the approach to assessing the factors that encourage people to follow the principles of sustainable development and are most likely to contribute to active involvement in sustainable development processes is not statistically significantly related to the age of the respondents (see Table 2). However, based on the results of the analysis of variance, it became clear that the mass media and social networks, which would provide information on the topics of sustainable development, were evaluated by a more significant part of the younger survey participants belonging to the age group up to 35 years (69.9%) as a factor that could encourage people to follow the principles of sustainable development more than this factor was evaluated by the elder (36 years and older) study participants (49.6 per cent); applying analysis of variance (ANOVA), this variable is statistically significantly related to the age of the subjects ($F=8.436$, $p=0.004$). Meanwhile, the analysis of variance (ANOVA) revealed that the evaluation of the factors that encourage people to follow the principles of sustainable development is not significantly related to the age of the respondents (see Table 2), which suggests that all the factors that can contribute to encouraging people to follow the principles of sustainable development principles, importance was rated at a similar level regardless of age.

Table 2. Assessment of factors that encourage people to follow the principles of sustainable development (in the age group under 35 (n=83), in the age group over 36 and older (n=115); per cent; results of variance analysis of estimates and age, when $p < 0.05$)

	Age group under 35 years old	Age group over 36 years old	F	p
If the topics of sustainable development were more discussed/shown on television.	63.9	64.3	0.005	0.944
If more were written about the topics of sustainable development in the media and social networks.	69.9	49.6	8.436	0.004
If there were more information on the topics of sustainable development in publications and literature.	27.7	16.5	3.641	0.058
If more events, charity events (e.g., supporting people with disabilities, people with low incomes, etc.), initiatives (e.g. "DAROM", etc.) were organised on the topics of sustainable development	51.8	40.9	2.33	0.129
If more trainings and seminars were organised on the topics of sustainable development.	33.7	23.5	2.535	0.113
If more discussions and debates were organised on the topics of sustainable development (e.g., on television, radio, etc.).	38.6	34.8	0.294	0.588
If the youth were more actively involved in the implementation of SDGs	57.8	60.9	0.183	0.669
If people's awareness was raised in families from a young age (responsible consumption, creation of production and services without polluting the environment, etc.).	65.1	76.5	3.14	0.078
If in the educational institution (school, higher education institution) the sustainable development topics were discussed.	56.6	55.7	0.018	0.892
If more meetings were organised with authoritative specialists in their field, who would speak on the topics of sustainable development and the implementation of its goals.	27.7	27.0	0.014	0.907
If innovations were implemented, modern technologies were applied (e.g., in production).	41.0	47.8	0.912	0.341
If there was an increase in the attention of the authorities and politicians in promoting sustainable development.	38.6	42.6	0.325	0.569
If more funding were allocated to the implementation of the SDGs	44.6	42.6	0.075	0.784

After summarising the results, to promote the implementation of SDGs, it is crucial to choose appropriate measures and methods, taking into account the individual characteristics of users based on values, creating innovations, and initiating dialogue with interested parties. On the other hand, using as many different means as possible fosters a deeper understanding of the meaning of sustainable development among consumers through self-education, participation in training, and using the possibilities of television and social networks. In addition, promoting the active involvement of young people in the processes of implementing SDGs and promoting awareness and a sense of responsibility for their behaviour, as well as cooperation with experienced specialists and encouraging them to use the potential of collaboration, involving experts in sustainable development, the formation and implementation of development policy both at the levels of educational institutions and organisations, and examining and making proposals when making decisions on sustainable development issues at the policy level (changing laws, creating new rules) can be a prerequisite for the formation of a sustainable development identity. On the other hand, as a prerequisite for constructively orienting and transforming users' attitudes and value orientations, contributing to a change in mindset and perception by promoting the principles of sustainable development, communication tools can be applied.

Conclusions

1. Moving towards sustainable development goals is the central aim of the development of modern society. Still, their implementation faces many obstacles that arise from the inability of the market to solve the arising problems. Therefore, businesses must solve these issues together with the state.

2. The results of the research revealed the experience of respondents' involvement and efforts in contributing to the implementation of SDGs:

2.1. The highest estimated averages show that research participants combine various means of transport during their trips and participate in environmental management campaigns, help poor and vulnerable people, allocate funds to charity, support and look for ways to decrease inequality (social, gender, religion, age, etc.).

2.2. The lowest averages of the estimates indicate weaker efforts to contribute to the implementation of SDGs by sorting waste/garbage, saving paper and electricity, and respecting the rights and needs of every person, regardless of their social status.

2.3. The comparative analysis of the data showed that the younger research participants, belonging to the age group under 35 years, evaluated their efforts in contributing to the implementation of SDGs in both the social and environmental fields with significantly higher estimates than the elder respondents belonging to the age group over 36 years. In that group, the considerably lower estimates indicate the latter's passivity and less expressed efforts to contribute to the implementation of SDGs through their behaviour.

3. According to the research participants, when creating social and environmental well-being, an essential aspect of ensuring sustainable development is enhancing personal awareness in the family and educational institution, as well as encouraging young people to become more actively involved in implementing SDGs. Also, television, mass media and social networks can be essential tools that can influence the change in the mindset and attitudes of users, decision-making, awareness and responsibility formation, contributing to the implementation of SDGs. Meanwhile, seminars, trainings and meetings are organised on the topics of sustainable development with authoritative specialists in their field, who would speak on the issues of sustainable development and the implementation of their goals, as well as the information provided on the topics of sustainable development in publications or literature are evaluated as less effective ways of contributing to the promotion of the implementation of SDGs.

The findings may facilitate devising better-tackled policies.

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COMMERCIALIZATION OF UKRAINIAN & SLOVAK SCIENTIFIC RESEARCH: FACETS AND IMPLEMENTATION ALGORITHM*

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Abstract. The article emphasizes the need to develop entrepreneurship in the academic environment to commercialize the scientific research results as one of the possible directions. The problems that prevent Ukrainian and Slovak scientists from commercializing their scientific developments are highlighted, classified, and described in detail, and recommendations are proposed for solving these problems. The commercialization of scientific research is based on transforming scientific developments into profitable commercial products or services that can be successfully introduced to the market. The study examines various aspects of commercialization, including evaluating the commercial potential of scientific research, developing business models, finding investors and partners, intellectual property, marketing innovations, and sales. The elements of innovative ecosystems of different countries and Ukraine are described. Various algorithms for commercializing scientific research are suggested and scrutinized, including specific steps scientists must perform to introduce their developments to the market successfully. The difference in commercialization processes in Ukraine and economically developed countries is demonstrated. A business commercialization algorithm is proposed, which assumes that the first step is to analyse the demand for innovation. It has been proven that projects developed under the market's needs today and in the future are more effective for commercial use. Hence, this approach provides better opportunities for attracting investments, creating strategic alliances with the industrial sector, and increasing effective commercial projects. Recommendations suggested by the authors can help Ukrainian and Slovak scientists commercialize their scientific works more effectively, which will positively impact economic development.

Keywords: commercialization of knowledge; technology transfer; entrepreneurial university; commercialization algorithm

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1. Introduction

During the last ten years, the academic environment has significantly changed due to the need to integrate entrepreneurial practices into traditional scientific processes. Entrepreneurship development in science and universities is recognized as an essential factor in stimulating innovation and economic development (Theodoraki et al., 2022; AUTM, 2023). Entrepreneurship in science, which includes the commercialization of scientific research, the creation of innovative companies and cooperation with businesses, is becoming a vital element of the university's innovation ecosystem (Gontareva et al., 2022; Volosheniuk, 2020).

Studying entrepreneurship development in the academic environment becomes an integral part of universities' innovative policy and development strategy to increase their innovative potential, ensure economic growth, and form a competitive scientific environment.

Commercialization of scientific research contributes to transforming scientific ideas into innovative products and services, stimulating the country's economic development. This allows scientific achievements to go beyond laboratories and be introduced into the real sector of goods and services manufacturing, contributing to the creation of new jobs and increasing the competitiveness of the national economy.

Commercialization of knowledge can provide additional sources of funding for scientific research. In the conditions of a limited budget and science funding in Ukraine, the possibility of attracting investments from the private sector is vital for supporting and developing scientific research.

Stimulation of commercialization processes can contribute to attracting young talents to science, giving them prospects for realizing their ideas and abilities. Young scientists are often looking for opportunities to apply their knowledge in practice, and commercialization in universities can be an effective tool to achieve this (Cabagnols et al., 2022).

Developing mechanisms for commercializing scientific research will help integrate Ukrainian science and scientists into the global scientific and innovative space. This, in turn, will promote the exchange of knowledge, technologies and experience, increasing the quality and efficiency of scientific research. Also, commercialization has a significant social impact, contributing to solving current social problems, improving the population's quality of life, and stimulating social progress. Developing a clear concept and algorithm for commercializing scientific research in Ukraine is essential to creating an effective innovation system that stimulates economic and social development.

2. Theoretical background

The world science generates many inventions that permeate all areas of human activity, including health, engineering, digital technologies, the agricultural sector, and energy. However, only a few of these inventions reach commercial use; many remain in academic laboratories at the patent or testing stage. Commercializing scientific discoveries is a complex process requiring significant investment, time, and specialized knowledge. Although patent registries contain millions of invention descriptions (Figure 1), only a tiny fraction of them transfer into successful commercial products or processes, highlighting the importance of developing strategies to overcome the many challenges on the way to market. The World Intellectual Property Organization (WIPO) provides detailed statistics on patent activity and commercialization, which provides an overview of global trends.

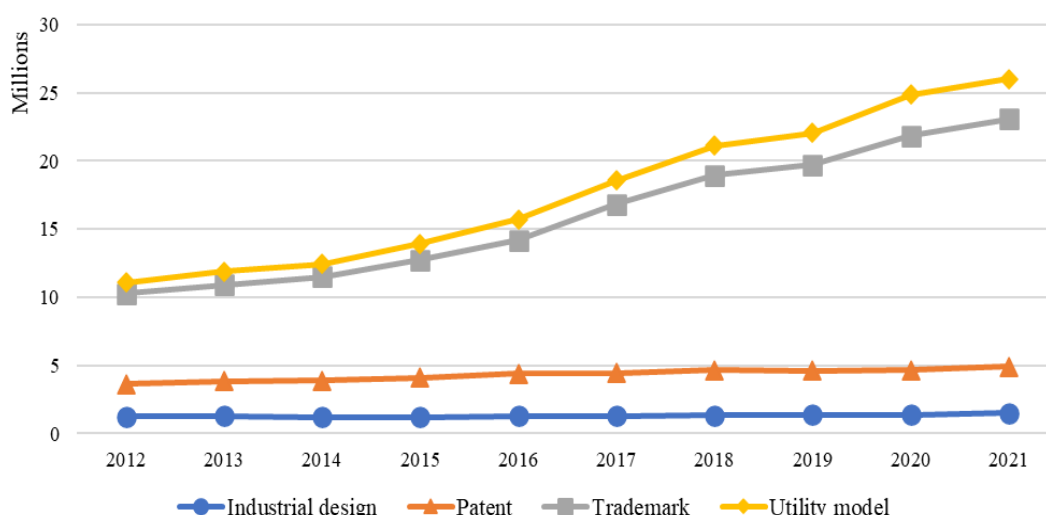


Figure 1. The total number of applications in the world, according to the Data Center of the World Intellectual Property Organization
Source: WIPO IP Statistics Data Center

Ukraine is undergoing an institutional reform of the intellectual property sphere and implementation of the relevant legislation. Since November 8, 2022, the State Organization "Ukrainian National Office of Intellectual Property and Innovations" (UNOIP) has performed the functions of the national intellectual property authority, which was formed after the restructuring of the Ukrainian Institute of Intellectual Property, responsible for issuing patents for inventions, utility models, industrial designs, signs for goods and services, copyright and related rights. There are still many unresolved issues in this area, the main one of which is an overly bureaucratic system of intellectual property rights registration, and its protection could be more efficient both in the legal and practical spheres.

Olena Orliuk, the UNOIP head, noted in the Annual Report (2022) that the renewed national intellectual property authority inherited both traditional functions regarding expertise and registration of IP rights, as well as new ones - participation in measures to improve standards of legal protection, development of alternative methods of dispute resolution, raising the level of business culture in this area, promoting creative industries and building the innovative ecosystem of Ukraine.

In 2022, 28,971 applications for objects of industrial property were submitted to UNOIP, of which more than 2,760 applications were for inventions, 2,378 – for utility models, 819 – for industrial designs, and 23,014 – for trademarks. Figure 2 represents the dynamics of submitted applications. The war in the country explains the decrease in their number in 2022. And even under these conditions, this reduction is not irretrievable.

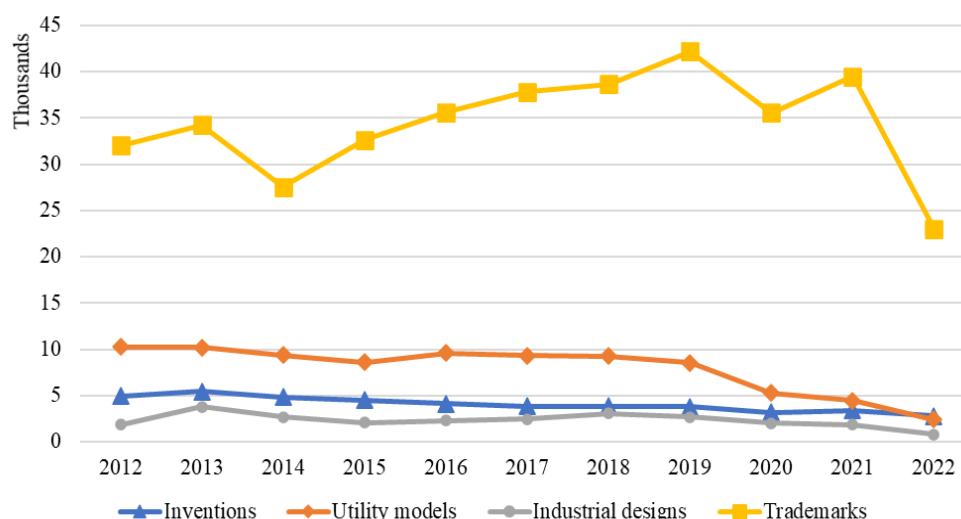


Figure 2. The total number of applications in Ukraine based on the data of the State Organization "Ukrainian National Office of Intellectual Property and Innovations" (UNOIP)

Source: The reports of the State Organization "Ukrainian National Office of Intellectual Property and Innovations"
<https://ukrpatent.org/uk/articles/UKRNOIVI-statistics>

According to the UNOIP statistics for 2022, 1,566 inventions, 2,074 utility model patents, 656 industrial samples and 16,028 trademarks were inscribed into the State Register of Patents for Inventions (Figure 3).

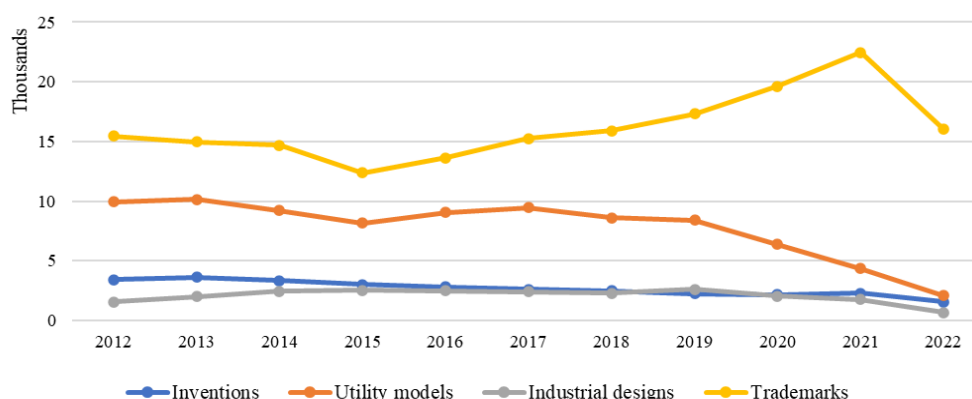


Figure 3. Number of registered intellectual property objects in Ukraine based on the data of the State Organization "Ukrainian National Office of Intellectual Property and Innovations" (UNOIP)

Source: The reports of the State Organization "Ukrainian National Office of Intellectual Property and Innovations"
<https://ukrpatent.org/uk/articles/UKRNOIVI-statistics>

The process of technological transfer is crucial to the commercialization of knowledge. It includes the transfer of technologies and knowledge from scientific institutions to the real sector of the economy. Rothaermel and Thursby (2005) examined how universities can improve their capacity for technology transfer and knowledge commercialization. Yermachenko et al. (2015) suggested how governmental bodies can exchange information between relevant state authorities and the commercial sector by installing an integrated e-reporting system comprising the statistical data of travel companies. Sidak et al. (2023) insisted on the responsibility of legal authorities in the provision of regulated development in strategic sectors, pointing to the financial sector's vulnerability if not included in the innovative development process. Tvaronavičienė and Burinskas (2022) analyze the effect of foreign direct investments on the innovative sectors. Klus (2022) added the geopolitical aspect to the technological transfer process. Tvaronavičienė et al. (2021) and Filip et al. (2023) inspected the social influences caused by the comprehensive technology implementation. Technology transfer includes many mechanisms and activities, such as collaborative research, contract research, consulting services,

technology licensing, postgraduate education, training for enterprise personnel, exchange of research personnel, and other forms of information transfer (Hsu et al., 2015).

Scientific publications on the commercialization of knowledge focus on the study and description of the mechanisms of cooperation agreements between participants in the transfer process. In their review of the knowledge commercialization literature, Haessler et al. (2023) concluded that a high level of technology variability and a large number of different participants (scientists, management of a scientific institution, manufacturer, service companies, etc.) influence the process of commercialization of technologies. The authors performed a systematic literature review covering 154 articles published in 43 journals over 28 years. They formulated conclusions describing various factors influencing the use of new technologies and identifying fundamentally different mechanisms for creating technological innovations (Labunska et al., 2019).

Knowledge commercialization is a vital element of innovation, which involves transforming ideas, research and knowledge into commercial products or services. This process requires effective interaction between science, industry, and government. Universities generate new knowledge through scientific research and development. Etzkowitz and Leydesdorff (2000) developed a "three-helix" model that describes the interaction between universities, businesses, and government to promote innovation and economic development. Kalantaridis et al. (2017) showed that the participants of this process have common knowledge bases, norms, and cognitive frameworks. Most Ukrainian authors focus on legal issues and problems of intellectual property protection, omitting economic priorities in the case of commercialization (Chugrii, 2017; Pashchenko & Khomenko, 2023).

The government can play an essential role in the commercialization of knowledge by providing funding for research, stimulating cooperation between universities and industry, and establishing a favourable regulatory environment (Brantnell & Baraldi, 2022). Mowery et al. (2005) examined how government can facilitate innovation and the commercialization of knowledge. The regional context also affects the growth of university spin-offs, but with different intensities in different countries (Prencipe et al., 2020).

The development of innovation ecosystems is essential to support the commercialization of knowledge. Moore (1993). described an innovation ecosystem as a network of organizations interacting with each other to promote innovation and new product development. Woodfield et al. (2023) proved that the ecosystem is crucial for commercializing knowledge in traditional low- and medium-tech industries (for example, specific sectors of textile production, agriculture, the metalworking industry, etc.). They have proposed models for commercializing knowledge and various ways of obtaining value in these areas.

Scientists carry out scientific research in universities. At the same time, understanding the attitude of scientists toward entrepreneurship in the university is critical but needs to be studied (Agapito et al., 2022). An analysis of the academic environment in four European countries found that academics in the natural sciences see their faculties as more entrepreneurially oriented than the social sciences (Kalar & Antoncic, 2015). New temporal structures could be used to understand the possibilities of university technology commercialization practices (Kalantaridis & Küttim, 2023).

This study is particularly relevant given the strategic importance of entrepreneurship in universities for sustainable development in a highly competitive global academic environment. Investigating successful world practices and commercialization models of scientific research results allows us to determine the optimal strategies and tools for stimulating and developing entrepreneurship in the Ukraine and Slovak Republic universities (Ponomarenko et al., 2021).

3. Aim and methodology

The study aims to determine strategic steps and recommendations for the effective commercialization of scientific developments by Ukrainian and Slovak scientists. To achieve this, the research uses a multifaceted methodological approach, which includes: literature review (critical analysis and synthesis of existing publications on technology transfer and knowledge commercialization to create a fundamental understanding

of the current background), comparative analysis (consideration of different interpretations of the concept of commercialization followed by classification based on precise characteristics to identify best practices and potential gaps), classification analysis (systematization of the facets of commercialization according to criteria, including the type of knowledge, participants and implementation mechanisms), network analysis (study of participants in a network of knowledge transfer and cooperation between organizations to understand the dynamics and relationships that facilitate or hinder commercialization, cross-cultural research (study of commercialization practices in different countries to gain information on global successes and challenges and adapt the results to the Ukrainian and Slovak environment).

4. Results and discussion

Knowledge commercialization is a multifaceted process that transforms scientific discoveries, technologies, and innovations into commercially viable products or services. Different scientists and researchers define this concept, depending on the context and perspective of the study. Below are some examples of definitions of knowledge commercialization from different authors.

Etzkowitz and Leydesdorff (1995) developed the “Triple Helix” theory, which states that the commercialization of knowledge is an interaction between universities, industry, and government to create innovation and economic development. Nelson (1993) defines commercialization as the process by which knowledge and technology generated in scientific research are transformed into new products, processes or services that can be used in the market. Nagel et al. (1991) define commercialization as a process that involves integrating three main components, innovation, entrepreneurship, and capital, to transform knowledge and technology into goods and services that generate economic benefits. Wright (1983) states that the commercialization of knowledge involves the creation, evaluation, protection, and transfer of intellectual property for its further use for commercial purposes. The conducted research made it possible to propose the following classification of the concept of commercialization of knowledge according to the following characteristics: scope, area of application, type of knowledge, process participants, and implementation strategy (Table 1).

Table 1. Classification of the concept of commercialization of knowledge

Classification sign	Type	Content
Scope	Broad definition	Covers the entire process from knowledge creation to its commercialization
	Narrow definition	Focuses on a specific step in the process, such as turning discoveries into products.
Area of application	Academic environment	Commercialization in universities and scientific institutions.
	Industry	Implementation of innovations and technologies into the production (manufacturing) process.
Type of knowledge	Technical/technological knowledge	Commercialization of innovative technical developments, materials, technologies.
	Non-technical knowledge	Commercialization of social, economic, managerial innovations.
Process participants	University commercialization	The crucial importance of universities in the process of commercialization
	Corporate commercialization	The main role of the private sector in the process of commercialization
Implementation strategy	Direct commercialization	Selling innovative products or services to end users.
	Indirect commercialization	Technology licensing, transfer of intellectual property rights to other companies.

Source: developed by the authors

The understanding of knowledge commercialization varies among academia, depending on their research context and perspective, but its primary purpose remains to create economic benefit. This point presumes that effective commercialization requires coordinated interaction between different sectors of society and fields of knowledge, as well as a strategically thought-out approach to intellectual property management, built taking into account the best global practices and the study of best practices.

The approach to commercialization of research in different countries of the world varies, depending on cultural, economic, political and scientific factors. For example, the US has a well-developed

commercialization system through technology parks, incubators, and enabling legislation (such as the Bale-Dole Act) that allows universities to own and license intellectual property created with federal funding. The European Union focuses on improving the conditions for commercialization through various financial instruments and programs, such as Horizon Europe, which support innovative projects and cooperation between member countries (Filipová et al., 2019; Piccinetti et al., 2022). China considers the commercialization of research as part of its national development strategy and invests significant resources in supporting innovation and technology transfer. India focuses on strengthening the link between industry and research institutes, introducing startup incentives, and simplifying commercialization procedures. Studying the experiences of different countries and developing effective commercialization models are critically beneficial for creating conditions that would allow scientists to maximize their scientific potential and ensure social and economic benefits from investments in science.

In Ukraine and the Slovak Republic, the approach to the commercialization of scientific research is traditionally based on research institutes and universities, which are the country's leading centres of scientific research. However, the commercialization process in Ukraine can be characterized as transitional and being at the formation stage. In Ukraine, overcoming several barriers, such as insufficient funding of science, bureaucratic obstacles, weak interaction between science and business, and an underdeveloped culture of commercialization in academic circles, is necessary. Overcoming these challenges can significantly strengthen the country's commercialization process of scientific developments. Table 2 shows the main problems scientists face in the commercialization of their research, classified into 4 main groups: organizational resource, legal and social.

Table 2. The main problems of Ukrainian and Slovak scientists in commercialization and recommendations for their overcoming

Group of problems	Problem	Description	Recommendations
Organizational problems	Lack of infrastructure	Lack of specialized incubators, technology parks and other locations to support commercialization	Promote the creation and development of infrastructure facilities and cooperate with existing incubators and technology parks.
	Bureaucratic barriers	High level of bureaucracy and difficulties in navigating the legislative regulations.	Optimize bureaucratic processes to ensure access to legal information and consultations.
	Lack of business connections	The need to improve cooperation between scientific institutions and the business sector.	Establishing ties with the business sector through participation in exhibitions, conferences, and other events.
Resource problems	Insufficient funding	Limited resources for the growth and improvement of scientific developments.	Look for alternative funding sources, such as grants, venture capital investments, and crowdfunding.
	Limited access to investments	Difficulties in attracting investments, especially in the early stages of project development.	Develop pitching skills, improve business planning, and demonstrate the commercialization potential of developments.
Legal problems	Patent tasks	The complexity and duration of the process of obtaining patents.	Creation of a joint structure by several universities with the involvement of legal consultants to speed up and simplify the process of obtaining patents.
	Insufficient protection of intellectual property	The need to strengthen the system of protection of innovators' rights.	Thorough documentation of all development stages, ensuring legal protection of innovations.
Social problems	Cultural factors	The need to create a more entrepreneurial and innovative culture.	Involvement in public discussions on the topic of innovations, conducting educational programs and master classes for the development of entrepreneurial culture.
	Disadvantages in education and training	Lack of specialized programs and courses that prepare scientists for the commercialization of their developments.	Development and implementation of courses and training dedicated to commercialization and business strategies.
	Limited market opportunities	Limitation of the market for some types of innovative products, which complicates their commercialization	Research of international markets, adaptation of products to the needs of different markets, and establishment of partnership relations abroad.

Source: developed by the authors

This table provides an overview of the main problems that Ukrainian and Slovak scientists face when commercializing their developments and offers specific recommendations for solving these problems.

Figure 4 shows the current scientific research process in Ukrainian and Slovak universities.

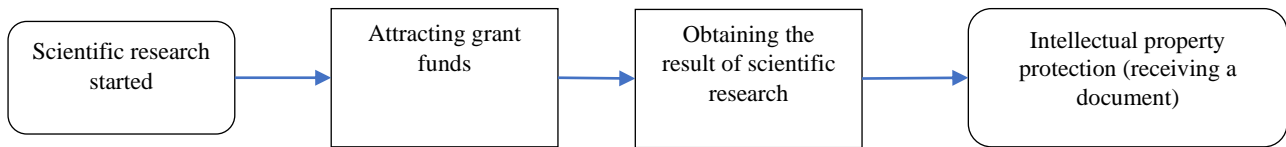


Figure 4. Modern practice of scientific research in universities of Ukraine and the Slovak Republic,

Source: developed by the authors

Unfortunately, the result of technology transfer at universities is only obtaining a patent for the outcome of scientific research. In turn, the classic commercialization algorithm is complex and multifaceted, requiring a deep understanding of various aspects and the implementation of a number of actions. Let's consider its components in more detail.

1. Assessment of commercial potential:

- determination of commercial potential – understanding whether the research solves a real problem on the market and whether there is a demand for this solution;
- market analysis - research of potential markets (clients, consumers) for a product or technology and identification of key stakeholders;
- patent search - checking existing patents and determining the possibility of patenting a specific research result.

2. Prototyping and validation:

- prototype development - the creation of a working prototype (or MVP) of a product or technology for demonstration to potential investors or partners;
- testing and validation - testing to confirm the functionality and effectiveness of the solution.

3. Protection of intellectual property:

- patenting – obtaining a patent for innovations to protect intellectual property;
- copyright and trademarks – registration of copyright and trademark, if necessary.

4. Business model development:

- business plan - development of a detailed business plan or Canvas business model, which includes a commercialization strategy, financial forecast and marketing plan;
- revenue model – defining how the product or technology will generate revenue (for example, through sales, licensing, or partnership agreements).

5. Search for funding and partners:

- investments – attraction of investments through venture financing, grants or angel investors;
- partnerships - establishment of partnership relations with industrial companies or other research institutions.

6. Production and sales:

- production - development of a production plan for scaling a product or technology;
- marketing and sales – development and implementation of marketing and sales strategies for each target audience;
- monitoring and optimization– regular assessment and optimization of the commercialization process to increase efficiency and profitability.

7. Scaling:

- expansion into new markets - identification and expansion of presence in new markets;
- constant research and development to improve the product or technology.

These steps may vary depending on the specific situation and research area, but they generally offer a systematic approach to commercializing scientific research. It is important to remember that success in this field requires technical knowledge and an understanding of market processes, strategic planning, and project management skills.

Considering all these aspects and implementing coordinated actions in each can significantly increase the chances of successful commercialization of scientific research.

There is a significant gap between academic research in universities and business innovation demands in Ukraine and the Slovak Republic. Scientists often need to pay more attention to assessing the commercial viability of projects, which is critical for further effective commercialization. Unlike basic research, applied research should be accompanied by an evaluation of its commercial potential.

Analysing the commercial potential of scientific research is a crucial step in commercialization, providing a critical role in this process. It combines a series of actions that contribute to assessing innovation opportunities in the market and identifying possible risks and benefits.

Carrying out such an analysis is often beyond the expertise of scientists, as most of them may need to gain the necessary knowledge in the commercial sector. Therefore, entrusting this task to experts who may also be employees of university technology transfer centres specializing in this area is better. The critical stages of assessment and expert specialization are presented in Table 3, which is a guide to defining competencies at each stage. This table provides a structured view of evaluating the commercial potential of scientific research, describing each stage, the relevant steps to be taken, and the experts who can be called in for qualified assistance.

Table 3. Contents and recommendations for involving experts in the evaluation of the commercial potential of scientific research

№	Stage	Description	Actions	Experts
1	Market analysis	Research of the market, customers, competitors and trends	Determination of the target segment, analysis of customer needs, analysis of competition, study of market trends	Market analysts
2	Technical assessment	Assessment of the technical readiness of a product or technology	Determination of technical readiness level (TRL), SWOT analysis	Technical experts
3	Financial analysis	Calculation of the cost of development, potential income and profit	Cost analysis, estimation of potential income, determination of product price	Financial analysts
4	Risk assessment	Identification of potential risks and strategies for their minimization	Determination of technical, market, financial and legal risks, development of prevention strategies	Risk management consultants
5	Creating a business model	Development of a profit generation model	Choice of business model (sale, licensing, partnership)	Business consultants
6	Patent analysis	Checking for the presence of existing patents, the possibility of patenting	Searching for patents, determining the possibility of patenting	Intellectual property lawyers

Source: developed by the authors

Ukrainian and Slovak scientists can benefit from the experience of other countries and involve professionals in the field of business, marketing, public administration and legal support to ensure the success of their projects. There are many successful examples and best practices in the field of commercialization of scientific research in the world:

1) university technology parks and incubators - Stanford Research Park, USA - one of the world's oldest and most successful university technology parks. It provides infrastructure and resources for startups and large companies based on innovation and technology. It promotes technology transfer and commercialization of scientific research;

2) licensing and cooperation with business - MIT Technology Licensing Office, USA - MIT has one of the most active licensing departments in the world, which promotes the commercialization of technologies developed by the university through licensing and the creation of spin-off companies;

3) early-stage financing funds - Y Combinator, USA - one of the most famous startup accelerators in the world, which offers financing, mentoring and access to a wide network of investors and partners for the development of startups at the early stages;

4) research consortia - Fraunhofer Society, Germany, one of the largest applied research organizations in Europe, which unites several research institutes for cooperation with industry and commercialization of scientific developments.

5) innovation support programs - Horizon Europe, the European Union, is the world's most extensive research and innovation funding program that supports the entire innovation value chain from basic research to bringing products to market.

These practices and organizations have already proven their effectiveness in commercializing scientific research, and their experience can be helpful to Ukrainian and Slovak scientists and innovators. Providing access to resources, networks, and market knowledge are critical elements for successful commercialization.

Visually, the classical algorithm for commercializing scientific research in universities, considering the entrepreneurial component (highlighted in *italics*), can be presented as follows (Figure 5). It should be noted that each stage enables pivoting or refusing to continue working on the project.

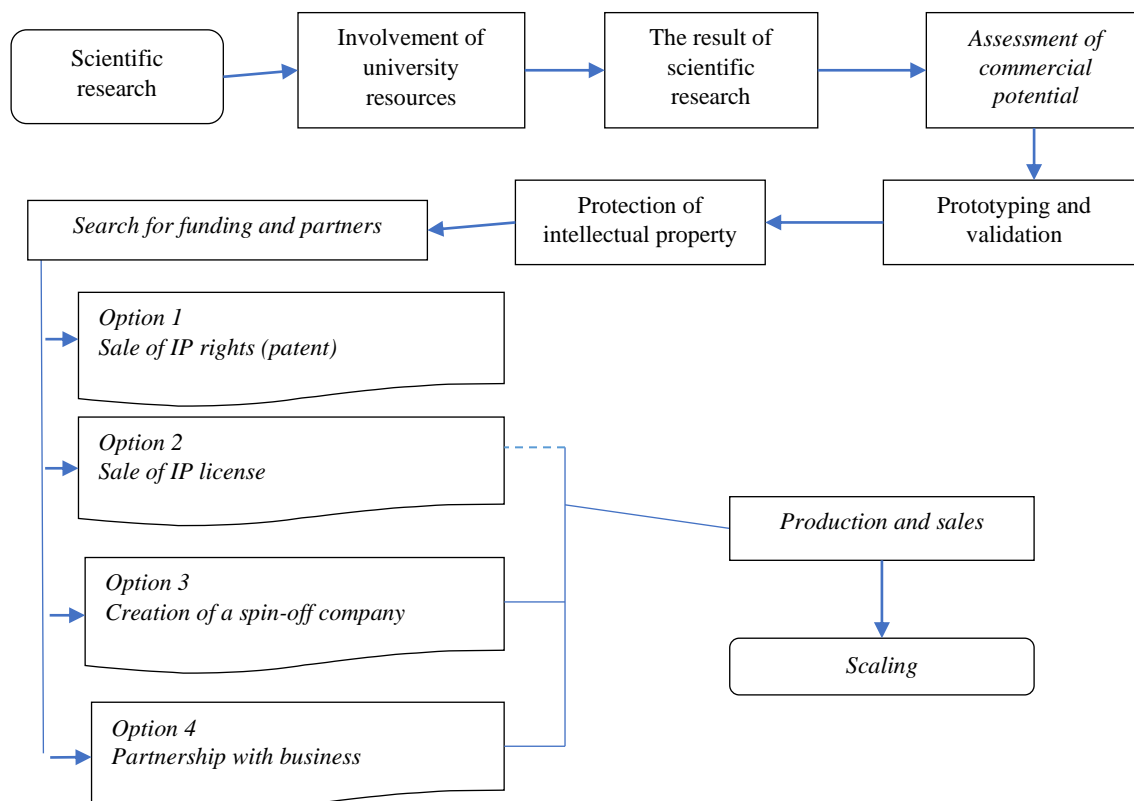


Figure 5. The classic algorithm for the commercialization of scientific research in the world universities

Source: developed by the authors

Universities play a crucial role in developing innovations that lead to the creation of new products, processes, and services. Research results can be commercialized through licensing, spin-off and startup companies, and direct industry partnerships (Etzkowitz & Leydesdorff, 2000; Shane, 2004). However, not all scientific discoveries achieve commercial success, and market orientation can be a determining factor in this process (Markman et al., 2005).

Market orientation requires universities to understand market needs and develop research that meets these needs. According to Siegel et al. (2003), universities that actively interact with the industrial sector and identify commercial applications of their research are more likely to succeed in commercialization. The enterprise's activities in the field of innovation should include interrelated research, technical and commercial processes that cover the adoption and implementation of decisions necessary for the effective transfer of a new product or service from the idea stage to market entry (Kosenko et al., 2019).

It is necessary to put the business interests of the university first in the algorithm of commercialization of applied scientific research. Therefore, the following business algorithm for commercializing scientific research in universities is proposed and submitted for discussion (Figure 6).

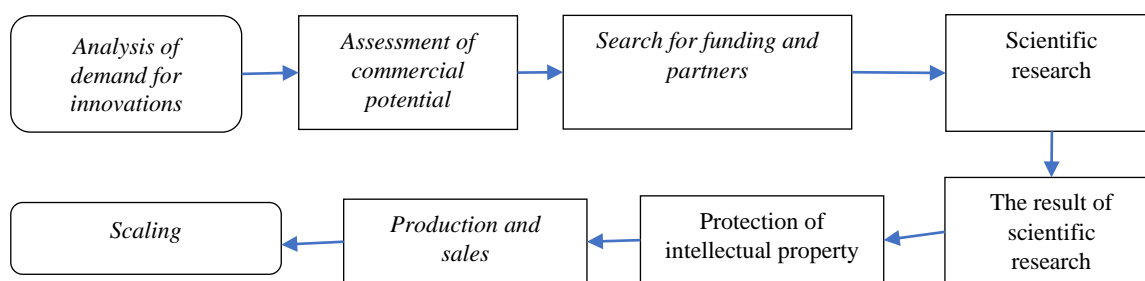


Figure 6. The business model of the algorithm of commercialization of scientific research in universities

Source: developed by the authors

The level of effective commercialization in universities that conduct research oriented to market needs is higher because such research has more excellent commercial value and is more quickly applied to business (Wright et al., 2008). Universities must develop strategies promoting close engagement with industry and creating products that meet market needs.

Research developed with specific market demands is more likely to find rapid adoption because it meets the actual needs of businesses and consumers (Lockett et al., 2003). The involvement of external investors and partners in the early stages of research can provide a better understanding of market requirements and priorities.

Collaboration with industry increases the chances of successful commercialization as it facilitates the sharing knowledge and resources. Universities can use business connections in relevant sectors to establish contacts with potential buyers and consumers of technology.

Market orientation allows universities to focus on creating innovative products that can be commercially successful. Products that solve specific consumer problems or significantly improve existing technologies are more likely to receive funding and enter the market.

Also, universities can sell and license their inventions to companies that have the resources for their further development and commercialization. The creation of spin-off companies based on university research can be an effective route to commercialization, especially when experienced entrepreneurs and investors back these companies.

Universities that provide support in the form of incubators, accelerators, and advisory and financial services can significantly increase the chances of success for their researchers. Educational institutions can also aid in

patenting inventions and protecting intellectual property. Establishing clear metrics for evaluating the commercialization process can help universities identify successful strategies and areas for improvement.

5. Conclusions

Analyzing the commercialization of scientific research in universities as a systemic phenomenon allows us to determine effective mechanisms for integrating entrepreneurial culture into the scientific environment and identify barriers and incentives for entrepreneurship development among scientists and students.

Commercialization knowledge, which ranges from Etzkowitz and Leydesdorff's "Triple Spiral" theory to Wright's classification, is a multidimensional process covering the creation, evaluation, protection, and transfer of intellectual property, including different scopes, fields of application, types of knowledge, stakeholders in the process and implementation strategies which reflects the diversity of approaches of scientists and researchers to this concept.

The commercialization of scientific research in universities reflects a variety of approaches. It is determined by the context in which scientists work, but its goal - creating economic benefit - remains unchanged. Effective commercialization requires coordination between different sectors of society and thoughtful management of intellectual property that considers the global and local dimensions of innovative activity.

Ukrainian scientists face multi-layered challenges in commercializing research, which include organizational and resource constraints, legal complexities, and social barriers. Solving these problems requires creating an infrastructure for innovation, reducing bureaucracy, attracting investment, and improving education. Effective strategies like university collaboration to facilitate patenting, develop educational programs, and boost international trade can enhance commercialization and promote economic growth.

As for the importance of market orientation for effective commercialization of scientific research in universities, our analysis confirms that university research based on the current and future market demands has more excellent commercial value and effectiveness in implementation. It was proved that such an orientation contributes to attracting external funding, the development of partnership relations with industry, and increasing the number of successful commercial initiatives.

The results obtained during the study indicate that universities should actively work on improving the interaction mechanisms with the market to ensure that their research is relevant to market needs. This may include developing specialized programs that support innovative research with high potential for commercialization and creating effective platforms for exchanging knowledge between universities and industry.

Universities must also implement systematic approaches to evaluating and monitoring commercialization processes to identify successful strategies and areas for further development. Given the growing role of universities in the global innovation ecosystem, further research in this area is urgently needed to understand how academic resources can best be used to drive economic growth and development.

In the future, it is planned to describe in detail the commercialization algorithm in Ukrainian universities and to consider and describe its various options, considering the attraction of investments from different sources at different stages.

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Open Access

**Publisher**<http://jssidoi.org/esc/home>**SENIOR TOURISM FROM THE POINT OF VIEW OF CUSTOMERS' PREFERENCES*****Viera Papcunová^{1,2}, Michal Levický^{3*}, Jarmila Hudáková⁴, Alexandra Gelnická⁵**¹*Institute of Economics and Management, Constantine the Philosopher University in Nitra, Nitra, Slovak Republic*²*Department of Regional Economics, Masaryk University, Brno, Czech Republic*^{3,4,5}*Institute of Economics and Management, Constantine the Philosopher University in Nitra, Nitra, Slovak Republic**E-mails:* ^{1,2} vpapcunova@ukf.sk; ³ mlevicky@ukf.sk; ³ mlevicky@gmail.com (Corresponding author);⁴ jhudakova@ukf.sk; ⁵ alexandra.gelnicka@student.ukf.sk*Received 10 September 2023; accepted 13 November 2023; published 30 December 2023*

Abstract. The ageing of the population has brought the concept of the silver economy to the economy and senior tourism to the tourism. This paper aims to evaluate seniors' preferences for tourism based on selected indicators in the context of various socio-economic characteristics. The perception of senior tourism was analysed based on a questionnaire survey. At the same time, we tested hypotheses regarding the relationship between seniors' socio-economic characteristics and travel preferences. Our research has shown that most seniors travel for relaxation, for health, i.e. visiting a spa or wellness centre, for culture or tourist activities. Less significant reasons for seniors to travel were to visit relatives, religion, shopping, social interaction, dining or business travel. Hypothesis testing revealed that men and women perceived length of stay, price of stay, discounts on visit, or motive or type of accommodation equally when planning a holiday. However, women plan holidays with more time in advance than men. Similar results were obtained by testing selected indicators in the context of respondents' place of residence - urban and rural. We did not observe any differences in holiday planning across age groups of respondents.

Keywords: senior tourism; population ageing; customer's preferences

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1. Introduction

One of the most significant demographic trends in the contemporary societies of developed countries is the ageing of the population. This ageing is becoming a critical demographic issue and a social, economic, health and even cultural one due to its scale, impact and almost universal presence. An ageing population is widely believed to have adverse consequences, such as an increase in the old-age dependency ratio, a reduction in the labour force and a decline in the birth rate (Šprocha & Ďurček, 2019; Xu et al., 2023)—demographic processes, such as changes in birth and death rates or increasing life expectancy cause population ageing. The proportion

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of the elderly population is also growing due to various other factors, such as technological, economic and medical advances (Cursaru, 2018). Among the most essential factors prolonging human life are social factors. These are, first of all, the level of civilisational development of society, the technical level of society, the level of social infrastructure, the economic opportunities of society, the standard of living of people and political events.

In contrast, life expectancy is shortened by the state of the environment and morbidity (Dvořáčková, 2012). As life expectancy increases, mortality is shifting to older ages, and there is an overall increase in population ageing. The average age is rising, and people are in better physical and mental condition as they get older. Longer lives will give older people opportunities to pursue new activities such as further education, new careers or exploring neglected hobbies - which can include tourism (WHO, 2022). As Jantan (2020) noted, many countries are experiencing a new demographic transition. This new type of demographic transition is characterised by longevity, where the size of the working-age population does not provide an increase in life expectancy but by people of retirement age. Unless an additional mechanism to regulate social security for older people is implemented, a steady rise in the population's life expectancy may damage the stability of public finances and overall economic welfare. In such circumstances, the state is forced to look for potential solutions to the situation on the ground (Urbanikova & Stubnova, 2018). This is confirmed by Lukyanets et al. (2021), who state that the increase in older people entails deepening problems related to their financial support, ensuring a minimum acceptable standard of living and government spending for these purposes.

The term senior comes from the Latin word 'senex' (old), the second degree of which 'senior' denotes an elderly person. Senior is, therefore, a term associated with the period of ageing and old age. However, the perception of the term needs to be more consistent in the literature. The most common definition of seniors is by age. However, The age used varies between authors and is somewhere between 50 to 65 years (Eusébio et al., 2016). A significant number of studies assume that the market's senior segment comprises individuals over the age of 50. At the same time, other researchers believe that the minimum age is 55, 60 or 65. These approaches have implications at different levels, particularly regarding the methodological procedures used in the sample, the selection and interpretation and the validation of the results (Santos & Santos, 2021). The European Commission and the United Nations also identify different age limits for seniors. The European Commission defines seniors as people aged 55 and over, while the UN identifies the elderly population as people aged 60 and over. These differences generally depend on each country's retirement time, the social and political reforms in place, and individual cultural conditions (Francescato et al., 2017). Kotíková (2013) and Patterson (2018) add that terms such as Older adults, Woppies (well-off older people), Muppies (mature, upscale, post-professionals) or even third-age tourists are used to refer to seniors. This means that the perception of seniors is changing to that of active people, where they are no longer labelled as the 'silent generation' or the 'grey generation'.

The evolution of the old-age-dependency ratio confirms the ageing of the population in Europe. In 2011, there were 26.6 seniors for every 100 working-age people in the EU-27; by 2022, there will be 33 seniors. In 2011, Germany and Italy had the highest number of seniors per 100 working-age inhabitants, with 31.4 and 31.3 seniors, respectively. In contrast, the lowest number of seniors per 100 working-age people in 2011 was 17.2 in Ireland and 17.5 in Slovakia. In 2022, the number of seniors per 100 persons of working age will increase even more in Germany to 34.7 and in Italy to 37.5 seniors. All European countries have aged significantly in 2022 compared to 2011 (Figure 1). In 2022, the number of seniors per 100 working-age inhabitants increased considerably in Finland (37.4), Portugal (37.2), Croatia and Greece (35.6) and Bulgaria (34.0). In these countries, this represents an increase of 40% on average. In the V4 countries, the most significant increase in the number of seniors in 2022 compared to 2011 was recorded in the Czech Republic at 32.6, representing a 46% increase (Figure 1)

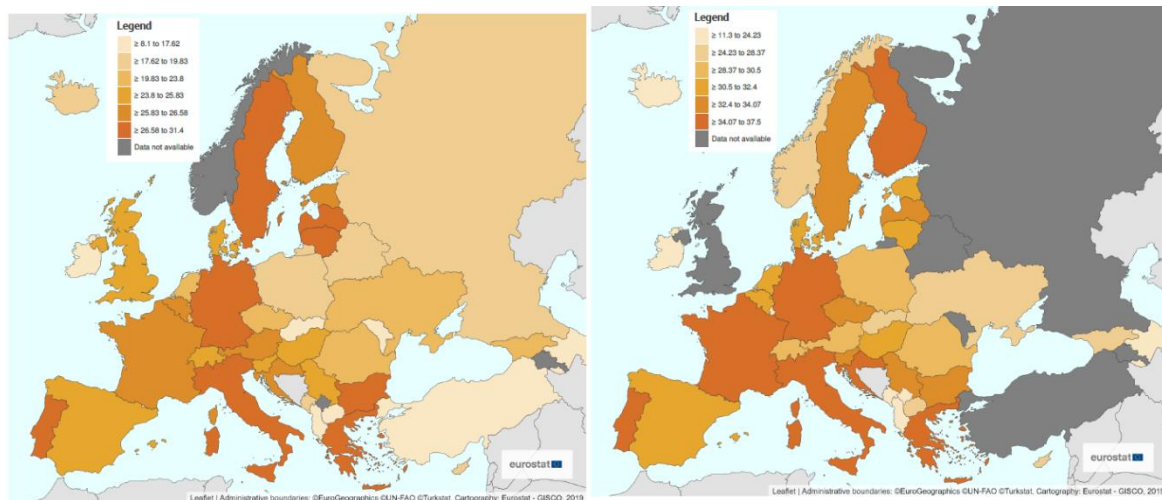


Figure 1. Old-age dependency ratio (population 65 years over or over to population 15 to 64 years)

Source: Eurostat database

* This indicator is the ratio between the number of people aged 65 and over (the age at which they are generally economically inactive) and the number of people aged 15 to 64. The value is expressed per 100 persons of working age (15-64).

This shows that seniors are becoming an essential part of the market, and there is increasing talk of a 'silver economy'. This situation also has a significant impact on tourism. In this context, Alén et al. (2012) identified the following age categories of older tourists in the tourism sector based on age differences in the definition of senior: a) persons aged 50 years and over, b) persons aged 55 years and over, c) persons aged 60 years and over, d) persons aged 65 years and over. In recent years, there has been a significant increase in the number of older tourists. In 1999, more than 593 million international tourists aged 60 and over. At that time, they accounted for approximately one-third of the total amount spent on holidays in that year. By 2050, seniors will account for 2 billion holidays per year (Patterson, 2018). According to research across all age groups, seniors spend the most on travel and holiday leisure (Vigolo, 2017). In 2014, seniors took about 442 million trips, 56% of the total. Of these, 225 million were for day trips, and 217 million were for multi-day vacations. 70% of senior tourists spent their holidays in their home country, and the remaining per cent preferred to travel abroad. Based on this 2014 research, seniors, on average, travelled seven times during the year on day trips and five times on vacations lasting multiple days (Francescato et al., 2017). However, travel options for the elderly population are strongly influenced by national culture and the economic situation of seniors; the higher the income and the longer the leisure time, the stronger the desire to travel (Tuo et al., 2022). According to Kotíková (2013), only individuals can afford to travel. Nowadays, seniors like to invest in travelling abroad, often to exotic destinations. Seniors with less financial means prefer to travel within domestic tourism.

2. Theoretical background

One of the key sectors affected by an ageing population is tourism. The over-65 population certainly has different tastes and preferences for tourism compared to the younger generation, and this issue may lead to a decline in tourism demand (Xu et al., 2023). Senior tourism, also known as grey tourism/silver tourism, is a very important form of tourism developing at a high rate worldwide. To date, there is no agreement on a clear definition of the concept of senior tourism (Yazan et al., 2017). Senior tourism creates new market opportunities and has a large socio-economic impact. This form of tourism targets tourists in their old age, seniors. It mostly includes health, physical and mental well-being services or exploring a selected culture. The tourist motivations of seniors differ from those of other age groups because this population group is most often looking for rest and relaxation, unlike younger generations who want to experience adventure and gain new experiences. However, these differences are changing due to the changing lifestyles of seniors. Tourists' motivation is essential for their trip satisfaction, as it is influenced by their reasons for travelling and the attributes of the destination itself (Moniz et al., 2020). Patterson (2018) cites the desire to experience and gain valuable experience as motivation

for seniors to travel. By travelling, seniors are reminded of the years of their young lives, during which they can also make new friends, positively affecting their mental health. This is confirmed by Parreira et al. (2021) research, which found that seniors from Portugal, Spain and France emphasise enjoying leisure time, reducing physical and mental tension, learning more about the destination and making connections with others. However, older tourists from non-European countries show similarities to those from Germany in terms of positive surprise or enjoyment, which visitors from the UK, Ireland and Spain value. Another motivating factor is curiosity, the opportunity to experience new experiences and the desire for an active holiday (Tomka et al., 2013). The economic situation of older people is a major factor in determining participation in tourism. Seniors have sufficient financial resources, but this statement applies primarily to the older population in developed countries, as a significant percentage of older persons in developing countries still do not and will not have sufficient resources to travel (Spasojević & Božić, 2016). In addition to the economic situation, Sibi (2017) states that seniors' health is an important condition for travel. Nowadays, travel for seniors is nevertheless becoming more and more accessible, thanks to technological advances in healthcare. With the increasing level of medical care, the demands of the senior segment on travel as consumers are changing in seeking a more active form of vacation (Nikitina & Vorontsova, 2015). Another factor influencing the consumer behaviour of the older population in the tourism industry is the amount of time. Although seniors are known to have a lot of free time, some of them may feel a lack of it. This is because they need more time to cope with routine responsibilities and also because some of them have a lot of responsibilities, such as helping their children and grandchildren, taking care of pets, gardening or pursuing their hobbies and interests (Kotíková, 2013). The lack of a travel companion can also be one of the barriers to senior tourism. Older tourists prefer to travel with someone close to them (Sibi, 2017). As travellers get older, they are more likely to be widowed or lose friends and potential partners for participation in the travel industry. Therefore, the absence of a travel partner is a common reason seniors do not want to travel (Lee & Bowes, 2016). Another barrier to senior travel is the safety concern. Seniors are also concerned about traffic problems and unexpected events during their holidays. They are worried about whether they will be able to cope with the organisational issues of the trip and whether they will be able to adapt to local conditions and customs (Kotíková, 2013). Older tourists also fear being understood in a foreign language, which can also be a barrier to a trip abroad (Wen et al., 2020). Manipulating the Internet and making online bookings also influence seniors' travel behaviour (Patterson, 2018). Unlike previous generations, many of today's seniors are more experienced and have clearer ideas about what they expect from travel and services. This will make it more difficult for all stakeholders to develop a product or service that will interest and pleasantly surprise seniors. According to Patterson & Balderas (2018), tourism offerings for the older population should be personalised, offering exotic destinations, memorable experiences, the opportunity to learn something new, and space for social interaction and self-development. Experienced older tourists will seek the authenticity of the destination and new experiences. Liew et al. (2021) note that a destination's climate influences seniors' consumption behaviour. For many seniors, the type of transport they use to travel to a destination is critical. The choice of means of transport depends on the distance to the destination and the reason for the trip. Most often, seniors travel by car and aeroplane. However, as they get older, they tend to travel by bus. Older people who most prefer bus transport are senior couples (Alén et al., 2012). Nowadays, the Internet is influencing the overall travel experience. Using the Internet, searching for information about a destination, sharing experiences or making online bookings is possible. The older population usually does not use the Internet due to a lack of trust (Vigolo, 2017; Markovic et al., 2022). Nevertheless, the Internet is becoming a more important source of information discovery among seniors. Research showed that 26% of respondents used the Internet to find tourism information. Further, 30.2% used the services of a travel agent, 23.5% relied on their previous experience, and 22.1% relied on recommendations from friends or family. Although the Internet is becoming important among seniors, this segment still prefers information from friends or family, so-called 'word of mouth' (Alén et al., 2012; Sibi, 2017). Another phenomenon of seniors is that they like to use organised tourism services rather than travel individually. They like to use organised tour programmes of travel agencies because such travel gives them a sense of security and safety. The reason why they prefer the services of tour operators is the necessary socialisation, i.e. making new friends and possibly lack of knowledge of a foreign language, where they are not able to communicate abroad (Kotíková, 2013; Estrada-González, 2020). A deeper understanding of the new leisure motivations of older tourists can assist industry practitioners and policymakers in developing promotional and marketing campaigns for the successful development of this tourism segment (Li, 2012; Lukac et al., 2021). Bulut & Nazli (2023) and Severova et al. (2021) note that it is significant for hotels, travel agents and tour operators to offer diversified, interesting products and services, tourist experiences

and other great opportunities to the relatively unknown senior market, taking into account their economic status and willingness to travel to destinations they have never been to before. Tourism organisations and marketers should analyse older tourists, especially the more affluent ones (Beresecka, 2013). They should try to understand their travel motivations, needs, inspirational factors and desires, and real health concerns and offer creative solutions to their unique demand before travelling. Confirming this, Diekmann et al. (2020) and Chang et al. (2022) believe that the tourism industry should evolve to a new paradigm to provide new offerings, such as social tourism, for older people. Based on the concept of well-being, the tourism industry can design new packages to counter the ageing population phenomenon. According to Nikitina & Vorontsova (2015) the main trends associated with the ageing population that tourism organisers should address in 2014 are the creation of a new "senior tourism" segment, the creation of high-tech hotel and resort complexes with a wide range of geriatric care, promoting active ageing, and, of course, the widespread adoption of Telehealth and Telecare technology that will support the desire of older people to travel and encourage their active lifestyles. Ashton et al. (2015) add that tourism contributes to developing positive experiences and improving the skills of older people, facilitating their social integration and overcoming the difficulties associated with the ageing process, especially when older tourists engage in leisure, recreational and entertainment activities. Tourism businesses should also adapt to this trend (Lincenyi et al., 2023), catering to the special needs of seniors while ensuring price competitiveness and product uniqueness to attract as many elderly tourism consumers as possible (Chen & Zhou, 2014). Parreira et al. (2021) add that tourism organisations need to increase their efforts to anticipate the emotional needs of the senior tourism market segment while determining how to meet the needs of both younger and older seniors. The significant growth of this market - coupled with higher life expectancy - makes this tourism area attractive. However, the overwhelming power of social media also means that bad experiences can be shared quite quickly among potential older tourists, putting the commercial development of destinations at risk, regardless of their potential. This risk further highlights the need to understand the motivations of older travellers. According to Yao & Hou (2019), the senior tourism industry is becoming a new economic form in an ageing society. Coping with the ageing population has become an important main direction of economic restructuring and transformation of economic development in the conditions of an ageing society. Senior tourism can not only promote the new growth of the tourism economy but also, to some extent, weaken the influence of the off-season tourism market on related industries and fill the seasonal income gap of the tourism economy.

3. Research objective and methodology

The results of the primary data collection can contribute to identifying the dimensions of factors that influence seniors' holiday choices. The following variables were chosen for the research: motive for travel participation, length of holiday, cost of holiday, discounts and off-season promotions when choosing a holiday, the lead time in which seniors plan their holiday, and type of holiday accommodation. As part of the research, we also tested hypotheses aimed at identifying differences in the perception of holidays in terms of gender structure, economic status of pensioners, and their type of residence (urban-rural).

The data collection process was conducted continuously from November 2021 to January 2022. The baseline sample includes respondents aged 60 years and older in Slovakia. The sample was selected randomly. Respondents completed questionnaires in Google forms. Methodologically, we focused on respondents' psychological barriers to completing content- and technology-intensive questionnaires. Based on this, we designed the most appropriate questionnaire with a reasonable number of questions as simple as possible. In designing the questionnaire items, we emphasised their symbiosis with each other. Pilot testing was conducted on a small sample of respondents to obtain feedback on the comprehensibility of the questionnaire. After slight modifications, the result was four socio-demographic and twenty vocational questions related to the problem.

Of the 401 respondents, 57,86% were female, and 42,14% were male (Figure 2). In terms of age, the majority of respondents in the survey were aged 60-70 years old (55,11%). This was followed by the category of 71-80 years old (33,42%) and then the category of respondents who were over 81 years old (11,47%) (Figure 3).

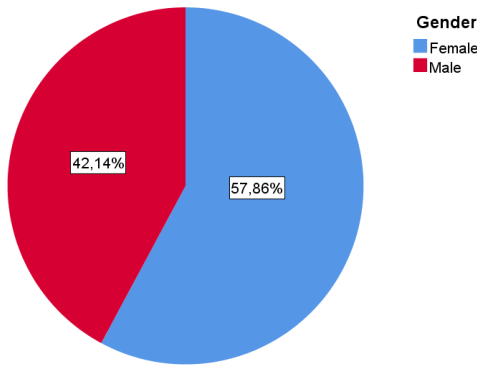


Figure 2. Gender structure of the respondents
Source: questionnaire survey, own processing

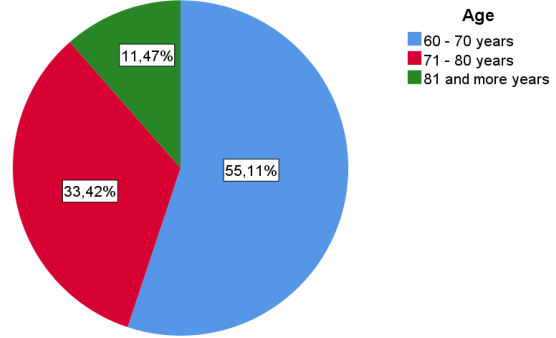


Figure 3. Age structure of the respondents
Source: questionnaire survey, own processing

Of the total respondents, 55.86% live in urban areas and 44.14% live in rural areas (Figure 4). Based on economic activity, most of the respondents are retired (72.32%), 20.95% are working, and 6.73% are working pensioners. None of the respondents were unemployed (Figure 5).

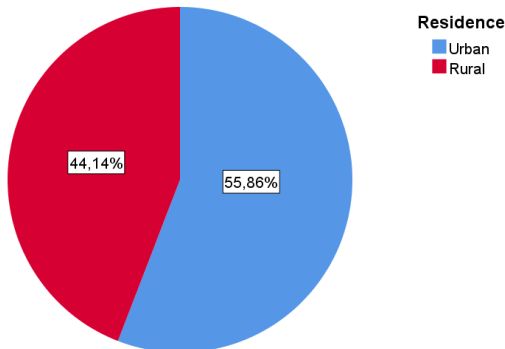


Figure 4. Respondents' place of residence
Source: questionnaire survey, own processing

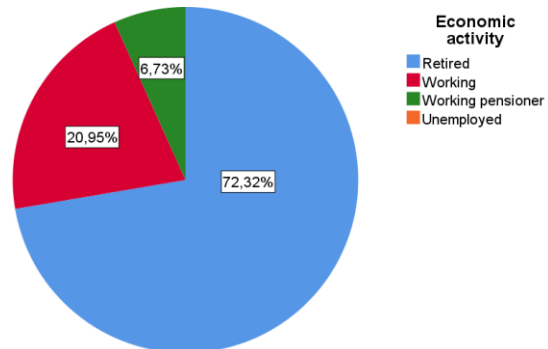


Figure 5. Economic activity of the respondents
Source: questionnaire survey, own processing

We will evaluate the dataset from the questionnaire survey using appropriate statistical tests. Statistical analysis was performed in the SPSS 22 program. Through appropriate statistical tests, we assess the validity of the stated hypotheses based on the calculated p-values, which represent the probability of the error we commit if we reject the null hypothesis. The significance level is set at 5% for all tests.

We use chi-square test of independence to detect the dependence of two nominal variables (Řezanková, 2011; Rakesh & Singhal, 2015). It is based on the assumption that if two features are independent, then the distribution of the counts in the contingency table is proportional to the row and column marginal counts. These frequencies are called expected frequencies. Suppose we denote the relative abundance in the base set as π_{ij} . In that case, we write the null hypothesis of independence in the form $H_0: \pi_{ij} = \pi_{ij,0}$, where $\pi_{ij,0}$ is the relative abundance expected in the case of independence, given by the relation $\pi_{ij,0} = \pi_i + \pi_j$. We test this null hypothesis against hypothesis $H_1: \pi_{ij} \neq \pi_{ij,0}$ for at least one pair i, j ($i \neq j$). The Pearson chi-squared statistic can be used as a test criterion, which is expressed by the relation:

$$\chi_P^2 = \sum_{i=1}^R \sum_{j=1}^S \frac{(n_{ij} - m_{ij})^2}{m_{ij}} \quad (1)$$

The prerequisite for using this test is that the expected frequencies in each contingency table cell do not fall below a value of 5 in at least 80% of the cells and that the remaining cells have values of at least 1. If this prerequisite is not met, we use the Fisher-Freeman-Halton test, which can be thought of as a generalisation of

Fisher's exact test for the R x S table (Van Auken et al., 2021; Ozturk et. al, 2021). If the data sets are too large or unbalanced, we will use Monte Carlo simulation to increase the reliability of the asymptotic results (Mehta & Patel, 2011; Cengiz et al, 2009). Cramer's V coefficient is used to find the degree of dependence between qualitative traits. Cramer's V is an alternative to Phi Coefficient in tables bigger than 2×2 tabulation. Cramer's V varies between 0 and 1 without any negative values. Like Pearson's r, a value close to 0 means no association (Akoglu, 2018; Prematunga, 2012). If the sampling results are arranged in a contingency table of type r x s, then Cramer's V is defined by the relation:

$$V = \frac{\chi^2}{\min\{(r-1), (s-1)\}.n} \quad (2)$$

when χ^2 is the Pearson test statistic and $n = \sum_{i=1}^r \sum_{j=1}^s n_{ij}$.

Assuming a normal distribution of the dependent variable and assuming equality of variances, we will use the Independent Samples t-test to test the hypothesis about the difference in the means of independent groups. If the sample is small (less than 30 in each group) and the variable does not have a normal distribution in the groups, we use the non-parametric Mann Whitney U (Hudec et al., 2019). It is used instead of the t-test comparing the means of two basic sets in case the condition of normality is not met. Through this test, we verify the hypothesis that two independent sample sets come from the same base set.

4. Results and discussion

Rest and relaxation, spending time and interacting with family are the most important factors in seniors' holiday choices, while weather and climate, beaches and water sports, and beautiful scenery and attractions are also the most important attributes (Oliveira et al., 2018). Seniors often travel outside the main tourist season because they have retired or have grown-up children, so they are not tied to the dates of their holidays, so they can spend their free time travelling at any time (Balderas-Cejudo et al., 2016). This fact, therefore, represents a good tool for the tourism offer to reduce seasonality in the destination and thus prolong the income during the year (Sibi, 2017). Travelling in the low season offers older tourists several advantages: better prices, fewer other tourists, a quieter atmosphere and milder climatic conditions. In coastal areas, for example, they start looking for stays in early June or September (Patterson & Balderas, 2018; Kotíková, 2013). Many older travellers are more willing to travel in the off-peak season, when it is cheaper, and to be away from home for longer than previous generations. As older travellers have more spending power due to higher incomes, many also value the quality of service provided (Balderas-Cejudo et al., 2019). However, all these attributes of holiday choices may be perceived differently by men and women. Our research confirmed this, which showed that men and women have different preferences for length of stay. Women prefer longer holidays (Table 1). The results also showed that up to 77.6% of women and 67.5% of men prefer holidays of 4 to 7 days (Table 2).

Table 1. Expression of the relationship between the gender structure of the issues related to the respondents and the length of stay on holiday

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Length of vacation is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	,012	Reject the null hypothesis.

Source: SPSS 22 program

Table 2. Length of stay on holiday

Length of holiday * Gender Crosstabulation				
% within gender		Gender		Total
		Female	Male	
Length of holiday	One day	7.8%	13.0%	10.0%
	2 - 3 days	4.3%	10.7%	7.0%
	4 - 7 days	77.6%	67.5%	73.3%
	More than 7 days	10.3%	8.9%	9.7%
Total		100.0%	100.0%	100.0%

Source: questionnaire survey, own processing

Although men and women perceive the length of stay of a holiday differently, we did not confirm our hypothesis that this affects the price of a holiday. Based on our testing (Independent Samples t-Test; $p=0,559$), we found no difference between how men and women perceive the price of a holiday, despite women prefer longer stays (Table 2). 41.8% of women and 40.8% of men are willing to spend between 301 € - 500 € on a holiday (Table 3).

Table 3. Price of holiday

Price of holiday * Gender Crosstabulation				
% within gender		Gender		Total
		Female	Male	
Price of holiday	Less than 300 €	29.7%	28.4%	29.2%
	301 - 500 €	41.8%	40.8%	41.4%
	501 - 1.000 €	27.2%	28.4%	27.7%
	More than 1.000 €	1.3%	2.4%	1.7%
Total		100.0%	100.0%	100.0%

Source: questionnaire survey, own processing

At present, when the economic situation of not only working people but also seniors has worsened due to the current worsened economic conditions (inflation, rising energy prices, war conflicts in the world), we were also interested in whether there is a difference in the use of discounts and off-season promotions in the context of the gender structure of seniors. In this case, our research has shown that men and women have the same preferences for using discounts when planning a holiday (Table 4).

Table 4. Expression of the relationship between the gender structure of the issues related to the respondents and the discount of a holiday

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Use of discounts is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	,171	Retain the null hypothesis.

Source: SPSS 22 program

The same situation with the choice of discounts arose in the question asking how far in advance they shop for their holidays. In the questionnaire, they had a choice of periods ranging from less than one month to more than 6 months of advance holiday planning. We assumed that seniors would take advantage of discounts and plan their holiday as far in advance as possible. The survey showed (Table 5) that most men and women plan a holiday within 1 to 3 months (65.9% female and 64.5% male).

Table 5. Date of purchase of holiday

Date of purchase of holiday * Gender Crosstabulation				
% within gender		Gender		
		Female	Male	Total
Date of purchase of holiday	Less than 1 month	14.2%	25.4%	19.0%
	1 - 3 months	65.9%	64.5%	65.3%
	4 - 6 months	18.5%	8.9%	14.5%
	More than 6 months	1.3%	1.2%	1.2%
Total		100.0%	100.0%	100.0%

Source: questionnaire survey, own processing

In their research, several authors cite different reasons seniors go on holiday. For example, Beránek (2013) reports that seniors most often prefer recreational tourism, health tourism, hiking, cultural and sightseeing trips or boat trips. Otoo & Kim (2020) identified 13 domains of motivation in older tourists, each further subdivided into subdomains. For example, socialisation includes being with family and friends and interacting with others. This is confirmed by Zhao et al. (2013), who report that many older people travel to enrich their leisure time and feel mentally satisfied. While travelling, they can enjoy the scenery, broaden their horizons, expand their knowledge, enjoy life and eliminate the loneliness caused by the abandonment of their family. The second domain is the ego, through which tourists receive recognition and respect from others and, therefore, feel privileged to travel. Escape, routine, stress, and obligations are other important motivational domains. Another category is destination attractiveness, which includes the cultural attractiveness of the destination, the natural or scenic environment, and the weather. Other vital domains of motivation for seniors are acquisition of knowledge, well-being, relaxation and comfort, opportunity to travel, novelty, hedonism, quality of life, updating and nostalgia, etc. (Otoo & Kim, 2020; Dusek, 2018). Teruel-Sanchez et al. (2021) add that the most sought-after type of tourism for seniors is sun and sand, followed by nautical activities and golf. These types of tourism, primarily sun and sand, bring a concentration of tourists at certain times of the year because they are linked to the climate and the natural environment; in other words, seasonal tourism. Udrea (2023) notes that pilgrimage tourism is part of senior tourism. The research found that almost half of the seniors surveyed chose religious tourist attractions as a motivating factor in choosing a holiday. The results of our research showed that there is no difference in the perception of the different motives for holidays. Considering the nature of the variables, the size of the contingency table and the fulfilment of the established assumptions, we performed the testing using the Chi-square test or by Fisher-Freeman-Halton test. Due to the nature of the contingency table, Monte Carlo simulation was used in the Fisher-Freeman-Halton test. The testing was carried out at a significance level of 5%; that is, if the p-value is less than the chosen significance level $\alpha = 0.05$, we reject the tested hypothesis at the significance level $\alpha = 0.05$. The null hypothesis assumes independence of the investigated nominal variables. The calculated p-value was at the level of 0.045, which means that we reject the null hypothesis. A statistically significant difference exists between men's and women's travel motives. Considering the result of testing the relationship between the gender of the respondent and the motive for travel, we determined the degree of relationship between these variables. Considering the nature of the variables as well as the scope of the contingency table, we chose to use the non-parametric Cramer's V coefficient. The null hypothesis assumed no dependence between the investigated nominal variables. Based on the calculated p-value, the null hypothesis can be rejected ($p=0.047$). The alt alternative hypothesis was confirmed, based on which there is a statistically significant dependence between the investigated variables. The calculated value of Cramer's V coefficient was 0.206, which indicates a weak to moderate dependence between the location of the respondent's residence and the motive for participation in tourism. Silva et al., 2021) reported in their research that women mainly, were more motivated to enjoy the Azores' natural beauty cultural and historical richness than men. In our study, females preferred relaxation (24.1%), sport and tourism (22.0%) and culture and history (16.4%) as holiday motives. Males also preferred relaxation (21.9%), but also health (19.5%) and sport and tourism (16.6%) as a motive for holiday (Table 6).

Table 6. Motive for participation in tourism

Motive of involvement in tourism * Gender Crosstabulation		Gender		
% within gender		Female	Male	Total
Motive for participation in tourism	Culture, history	16.4%	12.4%	14.7%
	Relaxation	24.1%	21.9%	23.2%
	Health	13.8%	19.5%	16.2%
	Sport and tourist	22.0%	16.6%	19.7%
	Social interaction		1.2%	0.5%
	Gastronomy	0.9%	1.2%	1.0%
	Shopping	3.4%	2.4%	3.0%
	Adventure	2.6%	7.7%	4.7%
	Religion	8.6%	7.1%	8.0%
	Visiting friends, family	8.2%	8.3%	8.2%
	Work		1.8%	0.7%
Total		100.0%	100.0%	100.0%

Source: questionnaire survey, own processing

Regarding the choice of accommodation, according to Alén et al. (2012) seniors prefer to stay in a hotel, a guesthouse and, to a lesser extent, a cottage in the countryside. They also like to stay with friends or acquaintances during their holidays (Alén et al., 2017); note that senior tourists mostly prefer hotels. In another study, they prefer residences and friends' apartments (Alén et al., 2014). According to the study of Martínez-García & Raya (2008), senior tourists prefer holiday apartments that contribute to extending their length of stay in a specific destination. Hypothesis testing revealed no difference between the type of accommodation preferred by men and women. The testing was carried out using the chi-square test with Monte Carlo simulation with a p-value of 0.207, which means that we cannot reject the null hypothesis that there is no difference in the preference for the type of accommodation according to the respondent's gender.

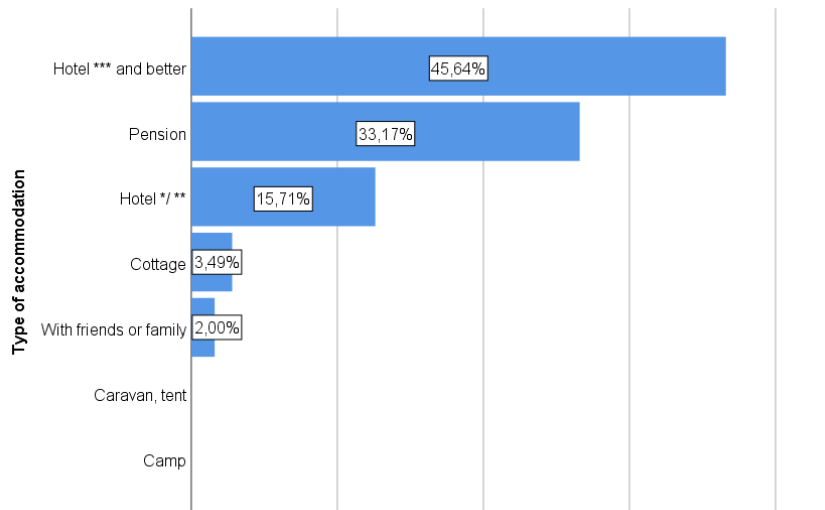


Figure 6. Type of accommodation

Source: questionnaire survey, own processing

Most respondents, regardless of gender, preferred hotel*** and better (45.64%) or pension (33.17%) for accommodation. None of the respondents imagined a holiday in a caravan or a camp (Figure 6).

Regarding the length of stay of seniors in a destination, the general perception is that they have enough free time compared to other age groups and stay on holiday longer (de Oliveira Santos et al., 2014). Neuts et al. (2016) revealed that seniors prefer longer trips (between 10 and 14 days), as opposed to non-seniors who require a duration of between 3 and 7 days (Atef & Balushi, 2017). However, some authors note that the length of stay for an older adult can range from 1 to 3 nights, 4 to 5 nights, or up to 9 nights. Thus, there is no correspondence

with the typical duration of a senior's holiday, probably due to the heterogeneity in the segmentation of this tourism market (Alén et al., 2012). Length of stay is an essential factor determining tourism development in a destination. If tourists stay more days in a destination, the economic benefits of tourism will increase (Sibi, 2017). Therefore, in the next part of the research, we focused on whether seniors' place of residence impacts the length of leave. We hypothesised that seniors living in rural areas might prefer shorter stays due to having their farm to care for. And it is seniors who live in cities who would choose longer holidays. However, the results of the hypothesis testing showed no difference in the preferences of seniors living in rural or urban areas regarding the length of stay (Table 7). Seniors from rural and urban regions mostly preferred a stay of 4-7 days (Table 8).

Table 7. Expression of the relationship between the respondents' place of residence related to the length of holiday

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Length of vacation is the same across categories of Residence.	Independent-Samples Mann-Whitney U Test	,623	Retain the null hypothesis.

Source: SPSS 22 program

Table 8. Length of holiday

Length of holiday * Residence Crosstabulation				
% within residence		Residence		
		Urban	Rural	Total
Length of holiday	One day	8.9%	11.3%	10.0%
	2 - 3 days	7.6%	6.2%	7.0%
	4 - 7 days	73.2%	73.4%	73.3%
	More than 7 days	10.3%	9.0%	9.7%
Total		100.0%	100.0%	100.0%

Source: questionnaire survey, own processing

The next part of the research tested whether rural seniors perceive the cost of holidays differently than seniors living in the city. The results showed no difference in the preferences of seniors living in the urban and those living in the rural regarding the price of their holiday (Table 9). Most urban and rural seniors spend 301 € - 500 € on holiday (34.4% urban, 50.3% rural) (Table 10).

Table 9. Expression of the relationship between the respondents' place of residence related to the cost of holiday

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Price of vacation is the same across categories of Residence.	Independent-Samples Mann-Whitney U Test	,050	Retain the null hypothesis.

Source: SPSS 22 program

Table 10. Price of holiday

Price of holiday* Residence Crosstabulation				
% within residence		Residence		
		Urban	Rural	Total
Price of holiday	Less than 300 €	29.5%	28.8%	29.2%
	301 - 500 €	34.4%	50.3%	41.4%
	501 - 1.000 €	33.5%	20.3%	27.7%
	More than 1.000 €	2.7%	0.6%	1.7%
Total		100.0%	100.0%	100.0%

Source: questionnaire survey, own processing

The total price of the stay is also related to the search for discounts or the length of time seniors plan to travel. As part of testing hypotheses related to perceptions of discounts and the length of time before planning a holiday, we were interested in whether the type of residence - rural or urban - affects these factors. The survey results showed that while the type of residence does not influence the search for discounts, urban seniors plan their holidays further in advance (Table 11). Table 12 shows that urban and rural seniors plan their holiday 1 to 3 months in advance (63.8% urban, 67.2% rural).

Table 11. Expression of the relationship between the respondents' place of residence related to the plan of holiday

Independent Samples Test				
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
Date of purchase of holiday	Equal variances assumed	,043	,126	,062
	Equal variances not assumed	,042	,126	,062

Source: SPSS 22 program

Table 12. Date of purchase of holiday

Date of purchase of holiday * Residence Crosstabulation				
% within residence		Residence		
		Urban	Rural	Total
Date of purchase of holiday	Less than 1 month	17.0%	21.5%	19.0%
	1 - 3 months	63.8%	67.2%	65.3%
	4 - 6 months	17.9%	10.2%	14.5%
	More than 6 months	1.3%	1.1%	1.2%
Total		100.0%	100.0%	100.0%

Source: questionnaire survey, own processing

Huber, (2019) argues that how individuals perceive their age, particularly how much time they think they have until death, strongly influences their travel. For younger seniors with relatively healthy physical and mental health, hiking activities may be more important, leading to more frequent and longer trips. A significant shift occurs in later years when seniors become more vulnerable due to declining health and mobility and the perception of impending death. In this sense, we tested for selected indicators in relation to the different age categories of seniors. Neither hypothesis showed any differences in the perception of motive, length of stay, type of accommodation, price of holiday, search for holiday discounts, or timing of holiday planning. Considering the nature of the variables, the size of the contingency table and the fulfilment of the established assumptions, we performed the testing using the Chi-square test or Fisher-Freeman-Halton test. Due to the nature of the contingency table, Monte Carlo simulation was used in the Fisher-Freeman-Halton test. The testing was carried out at a significance level of 5%; if the p-value is less than the chosen significance level $\alpha = 0.05$, we reject the tested hypothesis at the significance level $\alpha = 0.05$. The null hypothesis assumes independence of the investigated nominal variables. The calculated p-value was at 0.000, which means we reject the null hypothesis. There is a statistically significant difference between what motives seniors have for travelling with regard to their economic activity. Considering the result of testing the relationship between the gender of the respondent and the reason for travel, we determined the degree of relationship between these variables. Considering the nature of the variables as well as the scope of the contingency table, we chose to use the non-parametric Cramer's V coefficient. The null hypothesis assumed no dependence between the investigated nominal variables. Based on the calculated p-value, the null hypothesis can be rejected ($p=0.000$). The alternative hypothesis was confirmed, based on which there is a statistically significant dependence between the investigated variables. The calculated value of Cramer's V coefficient was 0.344, which indicates a moderate to strong dependency between the motive of participation in tourism and the economic activity of the respondent.

Table 13. Motive for participation in tourism

Motive for participation in tourism * Economic activity Crosstabulation		Economic activity			
% within motive for participation in tourism		Retired	Working	Working pensioner	Total
Motive for participation in tourism	Culture, history	81.4%	18.6%		100.0%
	Relaxation	66.7%	25.8%	7.5%	100.0%
	Health	75.4%	7.7%	16.9%	100.0%
	Sport and tourist	72.2%	22.8%	5.1%	100.0%
	Social interaction	100.0%			100.0%
	Gastronomy	50.0%	50.0%		100.0%
	Shopping	83.3%	16.7%		100.0%
	Adventure	57.9%	42.1%		100.0%
	Religion	84.4%	12.5%	3.1%	100.0%
	Visiting friends, family	66.7%	21.2%	12.1%	100.0%
Total		72.3%	20.9%	6.7%	100.0%

Source: questionnaire survey, own processing

In the category of working pensioners, most seniors prefer health (16.9%) or visiting friends, family (12.1%). Working seniors prefer gastronomy (50%) and adventure (42.1%). Retired seniors prefer social interaction (100%)

Conclusions

The global population ageing brings new challenges for national economies to address. On the one hand, there is increasing pressure on social and health services, and on the other, seniors who have enough free time and are willing to spend money on travel. Our research showed that most seniors travel for relaxation and health, i.e., to spas or wellness centres for culture or tourist activities. Our results are the same as those of other studies, according to which seniors most often prefer recreational tourism, health tourism, hiking, cultural and sightseeing trips or boat trips (Beránek, 2013). Less important reasons for seniors to travel were visiting relatives, religion, shopping, social interaction, dining or business trips. According to Udrea (2023), the research result was not confirmed, according to which almost half of the seniors cited pilgrimage attractions as a motivating factor (in our case it was only 8% of respondents). According to Alén et al. (2012) seniors prefer accommodation in a hotel or boarding house, to a lesser extent in the countryside. We reached the same results in our research.

However, researches differ on the duration of the vacation (Neuts et al., 2016; Atef & Balushi, 2017; Alén et al. 2012). Our results show that 73.3% of seniors prefer a length of stay of 4 to 7 days. Hypothesis testing revealed that men and women perceived the length of stay, the price of the stay, discounts for the stay, or the motive or type of accommodation in the same way when planning a vacation. However, women plan their holidays more in advance than men. Similar results were also obtained by testing selected indicators in the context of the respondents' place of residence - urban and rural. We did not notice differences in vacation planning across the age groups of the respondents. From the point of view of the economic activity of seniors, we state that pensioners prefer relaxation (21%), sports and tourism (20%). Among working pensioners, most seniors prefer relaxation (29%) and sports and tourism (21%). Working pensioners prefer health (41%) and relaxation (26%). Only 1% of retirees perceive social interaction as a motive for vacation. The number of respondents is a limiting factor of the research, which does not allow generalising conclusions about consumer preferences in senior tourism in Slovakia. In this case, it was a pre-test, based on which the questionnaire was subsequently modified and expanded to include other activities in the field of senior tourism. In the future, the data will be supplemented by personal interviews with travel agency owners about tour offers for seniors. Subsequently, a comparison will be possible in several European countries.

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**Publisher**<http://jssidoi.org/esc/home>**SUSTAINABLE INNOVATIVE TECHNOLOGY SOLUTIONS FOR THE ENERGY SECTOR****Kristina Baziene ^{1*}, Justinas Gargasas ²**^{1,2} Vilnius Gediminas Technical University, Department of Mechanical and Materials Engineering, Saulėtekio al. 11, LT-10223, Vilnius, LithuaniaE-mails: ^{1*} kristina.baziene@vilniustech.lt (Corresponding author); ² justinas.gargasas@vilniustech.lt

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Abstract. Innovation is a process by which new ideas, technologies, or developments from different fields are turned into abilities, implemented in the market, and can be reached by any person in the world. That is also called technology-based innovation. Primarily, an innovative product means a product that encourages the establishment of new niches for the market or is significantly different from past products. At the same time, innovative products can be reached without changing the product's principal technological scheme but by improving the quality of the product. For now, Europe still needs to provide itself with energy resources fully. It imports 60.3% of gas, 41.2% of solid fuels, and 82.6% of oil. Still, for example, a World oil production peak could occur in the next ten to fifteen years if it has not already happened, and decisions to be made soon will have a significant impact on our quality of life over the coming decades. The need for energy is divided into sectors like industrial, power generation, transportation, domestic, and commercial, and it generates emissions in the air. Researchers try to foresee the right actions through different calculations, models, analyses, monitoring, policy research, and exploration of various acts from society, economy, and available technologies. This work aims to create a system dynamics model that can capture the dynamics of innovative energy technology development and its impact on the production, distribution, and demand side of the energy system. The focus of the model is on renewable energy technologies, distributed generation and storage systems, and smart energy systems that help to reduce the carbon intensity of the energy supply. A posed hypothesis of the work is that in the future, more and more requests will be for renewable energy sources. As demand increases, the energy cost will reduce, creating a more considerable source demand. Households could be as well as energy consumers as producers. Due to the vital role of energy in manufacturing, saving energy should be included as an essential element of production plans, especially for manufacturing plants that are energy-intensive. To predict the possibilities, of what can reduce impact on the environment, different analyses should be done to reach a concrete action plan that is directed to energy sustainability. A system dynamics model that can capture the dynamics of innovative energy technology development and its impact on the production, distribution, and demand side of the energy system. The focus of the model is on renewable energy technologies, distributed generation and storage systems, and smart energy systems that help to reduce the carbon intensity of the energy supply. Afterwards, the model can be used for testing in different countries.

Keywords: renewable energy; smart energy system; systemic dynamic model; planning; case study; Latvia**Reference** to this paper should be made as follows: Baziene, K., Gargasas, J. 2023. Sustainable innovative technology solutions for the energy sector. *Entrepreneurship and Sustainability Issues*, 11(2), 215-226. [http://doi.org/10.9770/jesi.2023.11.2\(15\)](http://doi.org/10.9770/jesi.2023.11.2(15))**JEL Classifications:** R150**Additional disciplines** are environmental engineering, energetics and thermoenergetics.**1. Introduction**

One of the biggest struggles is to find the best technology or combination that satisfies all involved parts – environment, society, and economy. Comparing solar collectors with natural gas for cogeneration, there are different advantages and disadvantages for both energy suppliers. As from technical-economic dimension in

Table 1 can be seen, the specific cost of power generated or saved and installation cost is bigger for solar collectors (Udaeta et al. 2016).

Table 1. Comparison of solar collector and natural gas for cogeneration (Udaeta et al. 2016).

Criterion	Unity	Solar collector	Natural gas for cogeneration
Cost of power generated/saved	EUR / MWh	20.06	19.49
Reliability of the resource	%	70	75
Time for implementation	Time (days/years)	7 days	1 year
Lifetime	Years	10	20
Ease of installation, operation, and maintenance	EUR/hour	5.73	17.20
Installation cost	EUR/KW	573.28	321.32

However, the reliability of resources and lifetime are lower for solar collectors, which explains energy irregularity. However, overlooking other data, ease of installation, operation, and maintenance is three times lower for solar collectors, and the time for implementation is 52 times shorter. The conclusion from Table 1. can be made that each energy supplier has some benefits and advantages. It is hard to say – one significant technology is the best or right choice. Still, the most common researcher's conclusion from articles is that non-renewable resources are economically profitable, but in the long term, these technologies require higher investment and labour. So, adjusting modern strategies and increasing environmental benefits from the cost scene is the worst economic performance Chicco & Mancarella 2009), (Udaeta et al. 2016).

For making different technologies into a fully working system, one of the technological solutions is provided. That is called smart energy systems. These systems are an accession to combine and coordinate smart electricity and heating for optimal solutions in every energy-using field - electricity, heat, cooling, hydrogen, various chemical substances, etc. This system is sustainable, a cost-effective and secure scheme in which, for example, renewable energy production can be prioritized, and consumption is subjected or based on users, enabling technologies and energy services. The system optimally interacts with available resources to reduce environmental burdens, economically expose energy supply, and provide optimal comfort level – without houses overheating or insufficient heat provision (Chicco & Mancarella 2009). The smart energy system increases the conversion efficiency and the consumption of resources and reacts to the electricity market prices; through an optimal market, promotes optimal energy production deployment for resource selection; increases power system flexibility; provides energy reserves or allows the use of available and flexible storage systems; operates in individual buildings, regions and even in countries. This system aims to facilitate an overview of the different types of energy producers and use selections and discussions about specific actions. The system is operating by an independent program that is based on the three values - society, economy, and environment, even including geographical latitude analysis (Mancarella 2014).

Less known and more innovative are the mentioned energy storages. Moreover, since there exist more cheap and efficient options than electricity storage, there are better solutions for large inflows of variable renewable energy. Electricity storage is also not feasible from an economic view because the storage will only be used sometimes enough to cover investments. Compared to electricity storage, thermal storage is about a hundred times cheaper per unit of storage capacity. However, liquid fuel storage is cheaper and can be stored for years (Lund et al. 2016), (Lyden et al. 2022).

Trends in research and development demonstrate storage technologies in the future, and these energy systems will play an important role. It would be necessary to provide electricity by renewable energy supply continuously or when electricity storage inputs and outputs are not electricity. Still, it is converted to another form of energy. That leads to integrating transportation, biomass, and cooling into the energy system. So, to find the least cost and most efficient storage to approach a Smart Energy System, it is requisite to look at the proper use of storage. Likewise, electric vehicles can be used as electrical fuel storage (Faiz et al. 2016), (Tomc & Vassallo 2016), (Krajačić et al. 2011), (Barabino et al. 2023).

As one of the significant problems using solar energy is energy variation at daytime and nonexistence at dark times of day, solar energy storage systems are one of the constant energy problem solvers. Heat, the same as electricity, can be stored in various ways. In research of Solar systems integrated with absorption heat pumps and thermal energy storages was mentioned in three ways – sensible and latent heat storages that are physical processes and thermochemical one that consists of chemical processes (Leonzio 2017).

Studies regarding cleaner catalyst with environment-friendly waste, for example, the use of biomass and biodegradable waste is getting more topical. Digestion processing of domestic biogas heat-only boiler supply varies in types among compositions of produced biogas and yields, but the essential structure is more or less similar. Outputs from biogas digesters are gas and slurry, so at the same time, it is possible to get gas for house heating or cookers and slurry as natural fertilizers. It is not only environmentally friendly but economically favourable and, in addition, provides the benefits of public employment as there is needed maintenance from skilled labour (Yasar et al. 2017).

The situation in cold regions is different and not optimistic due to the digester temperature, which, in winter, without a heating system, cannot work effectively. Using the hybrid heating system to increase the optimal slurry temperature, the biogas production amount could be increased by an average of $0.42 \text{ m}^3 / (\text{m}^3 \cdot \text{d})$, and choosing glass-reinforced plastic as biogas heat-only boiler insulation increase can be higher. This research hybrid system consists of circulating the solar, biogas boiler, and digester heating loops. This system is more advantageous because the solar heating loop substitute's biogas consumption of the boiler and its maintenance and lifetime indicators are improving. Additionally, this system reduces the biogas production effectiveness in winter, is more sustainable, and reduces the pressure on the environment (Zhang et al. 2016).

Energy demand and supply depend on various factors and are mainly divided into sectors like commercial, residential, industrial, transportation, and disaggregated. Factors for these sectors, as previously described, can be socially or economically, as well as dependent on the environment and politics. A wide range of analysis types not only for energy production and consumption but also generally comprehensive. For example, Ecoindicator 99, analyzes the life cycle of a product or any activity itself. The model evaluates the impact of the systems on the environment, which can be done in four main steps – definition of goal and scope, analysis of inventory, impact assessment, and interpretation (Otsuki, 2017), (Pazoukib and Haghifam, 2016).

It is more sufficient to look at the energy system from all energy use impacts together. Energy system analysis generally starts from people's needs and opportunities because we are the ones who regulate the energy balance behaviour (if we are looking at the population as a number). The main factors that make energy dependent on the aforementioned population change their environmental, social, and economic indicators, energy prices, and income. In one research, the goal of Integrated Energy Resource Planning and Full Cost Assessment described the energy balance from four main dimensions – not only social but also society-made dimensions like technical-economical, environmental, and political, which can be considered as main dimensions of socioeconomic and human development (Modarres and Izadpanahi 2016 Mahlia), (Udaeta et al. 2016).

Modelling is the basis of energy optimization. Existing models are based on theoretical or empirical knowledge. The difference is in the system dynamics model, where you can combine these two parts. Energy modelling includes not only energy demand but all systems together – energy demand and supply, prices, technologies, and pollution. Every model must consist of two points – energy producers and consumers, who can be added to the third one - prosumers. Prosumers are consumers and producers at the same time. Of course, energy balance is mainly calculated by energy demand, which plays the central role of all systems (Zhang et al. 2015).

The summary from the literature review helped to understand the model's desired appearance. Creating a model based on the literature analysis should consider innovative energy technologies and their prognosis for future development. As the aim of the developed system dynamic model is to show the energy consumption and production changes in the future, it was essential to understand which technologies can be used. Soon, natural gas, wood and coal plants or cogeneration plants are predicted to have higher income from solar collectors and

panels and wind power stations, which still exist but can be called innovative technologies because of nonstop development and more immense installation amounts in the future.

2. System dynamics models

System dynamics is a complex exploring method for any system dynamic development made by Jay Wright Forrester in the 20th 50's. It can be quite a powerful tool for dynamic research and feedback behaviours. Mainly, modelling focuses on feedback loops between diverse systems (Mirzaei & Bekri 2017).

Over 30 years, system dynamics has played a notable role in planning energy policy. Model main key concepts or qualitative tools are stocks and two flows – inflow and outflow as seen in Figure 1.

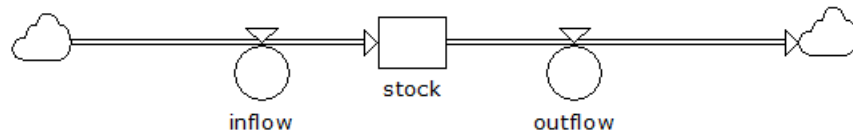


Figure 1. System dynamics simple structure of flows and stock.

Source: (Blumberga et al. 2011)

This modelling system makes it possible to predict the changes in stock if the inflows and outflow rates are known. Adding feedback loops from stock to inflow makes more accurate changes in stock because the provided information at stock helps to change the actions of inflow. For example, if it is known that in stock is enough energy for consumers, it is possible to stop or reduce production. Flows are changed by constants (indicated by lozenge) and parameters (indicated by circle) that are connected by information loops, which also can be delayed loops. Delays are divided into material delays – construction and material extraction time and information delay – in society or elsewhere, information is not directly used in behaviour (Blumberga et al., 2011).

In system dynamics, multiple boundaries have been defined multiple boundaries for sustainable development of supporting decisions and making policies. There is recommended a "boundary adequacy" test where three questions are to be answered:

- Is the model aggregation corresponding?
- How is the model transforming if the model boundary readjusts policy recommendations?
- Does the model answer all relevant questions which it is designed for?

However, all boundary judgments are essential for sustainability by the effective use of System Dynamics (Nabavi et al. 2017).

To create the model, there are some specialized steps to be made. The scheme of model steps is featured in Figure 2.

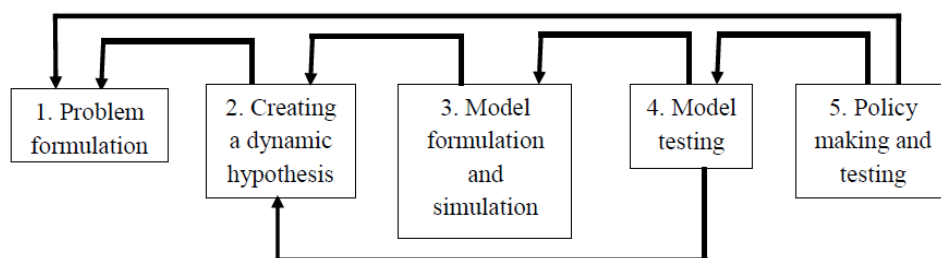


Figure 2. Steps of the system dynamics modelling process.

Source: (Blumberga et al. 2011)

Recommendation for making a model starts with problem formulation, which includes the answers to the aim, role, and type of the model - linear/non-linear or static/dynamic. It is essential to define research agendas for

easier preformation of system analyses clearly. Afterwards, based on problem formulation, it is suggested to create a dynamic hypothesis that is the expected answer to a defined problem. At the end of modelling are obtained conclusions and the solution to the problem and confirmation or denial of the hypothesis.

For model visualization, causal loop diagrams consist of variables and arrow loops with pluses and minuses. Plus, the sign means that two correlated variables are changing similarly, and thereby, minus – variables change oppositely. As in Figure 3, energy production is visualized due to the availability of resources.

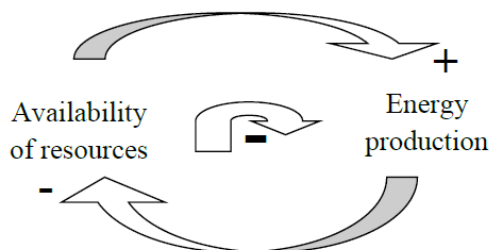


Figure 3. Causal loop diagram example.

Source: (Blumberga et al., 2011)

When the availability of resources simultaneously increases energy production, the increase in output reduces the availability of resources. By this, it is said that those two components interact, making a negative loop type visualized in the middle of the loops (Walrave & Raven 2016).

One of the most significant energy-integrated models used in 20 countries, focusing on Canada and the United States, is called Energy 2020. In the List of Clientele are companies such as Latvenergo, from Latvia, and Lithuanian State Power. The model overlooks sectors of energy demand, supply, and pollution accounting. The model energy demand part consists of categories like:

- Multi-family, single-family, and agricultural holdings;
- Industrial and over 40 commercials;
- Transportation services, like off-road, passenger and freight.

All energy users need heat for processes, water and space heating and electricity for lighting, refrigeration, conditioning, etc., provided by natural gas, coal, oil, biomass, solar, and electric products. Transportation contains different components - transport types, cogeneration, energy-based feedstock, fungible demands, and end-uses. However, the model does not include the number of households, vehicles, square meters of buildings or even population as a driver. Supply parts include similar parts to demand - natural gas, coal, oil, ethanol, refined petroleum products, landfill gas, ethanol, and electricity. If supply is not needed to model, it offers a simplified product price (Backus & Amlin 2009).

One part of the model simulates primary energy production and related emissions from them, and the other one - is energy distribution. Another – is the changes in energy use and output, what is regulated by different aspects. The transfer of information is unmanageable and creates a gap between the decision-makers and the model. The model allows the user to insert a future case, so there are many degrees of freedom (Backus & Amlin 2009) (Ibanez-Lopez et al. 2017).

Because of environmental impacts, energy security is getting more pressing, and the main topic has come to coal-chemical industries, particularly affected coal-chemical industry areas highly dependent on resource availability and demand. The system dynamics model analyzes economic changes caused by the warring of coal and oil prices and the effect on the regional evolution of the economy by different policies. Researchers established three scenarios for oil and coal prices scenario. The first one was a simulated coal price slump. They went on to conclude that the coal industry's oversupply will stay at the same level as it is now, and prices from the baseline scenario of 2015 will fall by around 5%. The second scenario is an oil price slump. Because of America's shale gas, oil prices will continue. The last one – simultaneous price slump also was a base scenario

where industrial output profit and value are the lowest. They also investigated five policies on how the price decrease can be reached – reduce the value-added tax and production limit, increase the financial support and technological investment, and develop alternative industries. By increasing technological investment, production value will be the highest, but by reducing the value-added tax – the lowest. Together with everything, the model showed that the oil and coal prices between other resources would be the lowest, and by different policies, it is easy to make them even more down. So, because of incomparably low prices, there is needed immense pressure on environmental policies; otherwise, traditional material society will choose the most economically advantageous option (Lunney et al. 2016), (Wang et al. 2017).

Another system dynamic analysis is based on the simple framework of China's oil supply chain. They concluded that for the Chinese government, the rates of new refinery buildings should be diminished. However, upgrading the existing refining facility with innovative technologies would be the best option to balance the environmental requirement and capacity. The model is made for crude oil import disruption in the future and reveals the strategic ability to cope with supply risks and petroleum reserve interactions. Besides that, the model design could be used to determine system dynamics for other energy supplier analyses of security and capacity-relevant problems (Mahlia et al. 2014), (Pan et al. 2017).

A system dynamic model looks at the effects of the economy, energy production and consumption, and environment from 2000 to 2025 by variables like CO₂ emissions, energy intensity, and others. The model included Vensim PLE software and was made for the situation in Iran. The energy production part of the model is made from production limit rates and energy demand. Furthermore, the need arises from energy consumption, which includes data from previous years on future variable functions. One of the model scenarios' aims was to reduce energy intensity and consumption, which could lead to lower environmental costs. To reach the model target, there were set two optimization policies – five and ten percent of energy intensity reduction, which led to conclusions that both policies are short-term effective for reducing energy consumption. Energy consumption changes from 2157 million barrels in 2025 to 1975 from 5% energy intensity reduction scenario and 1867 million barrels from 10%. Still, the results show that Iran will be largely charged with increased CO₂ emissions and energy production, and energy consumption will increase faster than energy production, which will foster more CO₂ emissions (Mirzaei & Bekri 2017), (Zhao et al. 2022), (Kirikkaleli et al. 2023).

Research about government and municipality-owned buildings was aimed at a dynamic description of the energy efficiency in these buildings by changing policy tools to reach the energy efficiency targets. They made an integrated system dynamics-based model, where results show that in the short term, the most significant impact on energy efficiency increase can be made by CO₂ tax policy implementation. However, the goal for 2016 still needs to be reached. The CO₂ tax is easy to implement and can work long-term. Also, study shows that when all of the financial support is spent, the energy efficiency increase of buildings will dramatically decrease. Because the funds mostly compensate around 50% of all investments, and by this support, inhabitant investments pay off around 10 years, which is a safer future investment than it would be for 20 or more years. Still, there exists another energy-saving possibility – monitoring of these financed buildings. The real saved energy must be equal to or lower than what is written in the building energy certification; otherwise, money must be refunded. By this kind of punishment, inhabitants must consider more useful energy use. Otherwise, in most cases, after renovation, the temperature in the building increases, but instead of reducing heating power, people for cooling use ventilation or just open the windows (Blumberga et al., 2011), (López-González et al 2016), (Luckow et al. 2016).

3. Results and discussion

Results of the model show the indicative values of total unit production costs, produced energy, used area, investments, and released CO₂ emissions in air from 2017 to 2050. Starting with the indicative total unit production cost overview, as shown in Figure 4, the changes for each technology are different. Almost all simulation time cheapest technology is solar collectors, which in time between 2018 and 2020 are almost at the same value as for wood cogeneration plant. At first, solar collector produced energy cost was 14.53 EUR/MWh, which is increasing because of investments made, but when it is paid off, from around 2041, thermal energy production is almost for free – 0.18 EUR/MWh.

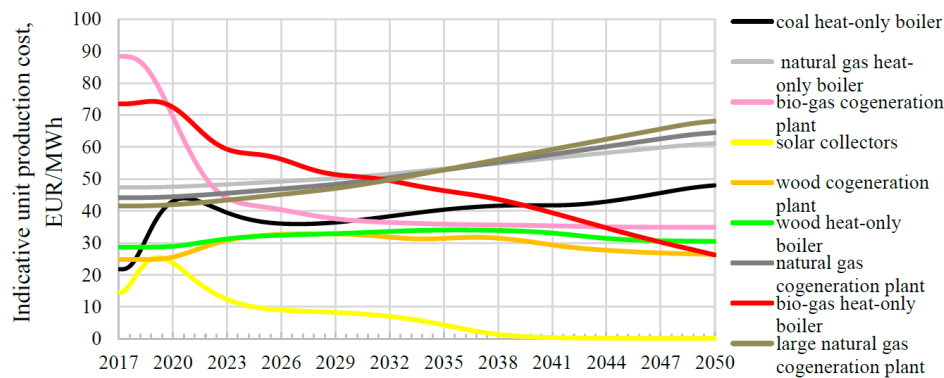


Figure 4. Total indicative thermal energy unit production cost for different technologies

Produced thermal energy cost from wood cogeneration plants, compared to other technologies, is also low. Passing the time, it stays at the same value around 29.50 EUR/MWh. A similar situation is for a wood heat-only boiler, whose average price is 32 EUR/MWh. This difference is because of the cost mentioned above changes, which make the income from sold electricity. In the beginning, coal heat-only boiler cost was only around 3 EUR/MWh lower than wood cogeneration plant. Still, with investments, this technology costs increased over large natural gas cogeneration plant costs. Hence, the requirement for this technology dropped, and the cost stayed higher than for wood heat-only boilers. In technologies that use natural gas, indicative unit production costs are changing similarly. Passing the time, it is slowly increasing from around 44 EUR/MWh to 64 EUR/MWh, because of the increase in CO₂ emission and operation and maintenance cost changes. Compared to other technologies, the indicative unit production cost stays high, so investments for new capacity building are not made. From natural gas users, the cheapest one is a large natural gas cogeneration plant, then the natural gas cogeneration plant and most expensive one – a natural gas heat-only boiler for the same reason as a wood heat-only boiler. Large natural gas cogeneration plant unit cost is lower because it produces more electricity than a natural gas cogeneration plant.

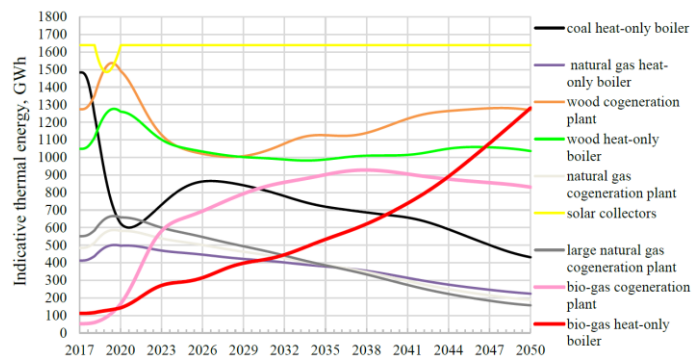


Figure 5. Indicative thermal energy output from different technologies

Initially, a coal heat-only boiler would be required for production, but it will drop fast. The next one is the wood cogeneration plant, which, also by solar collector investments, could produce more because of changes in indicative total unit costs. However, after investments in its capacity increase, the thermal energy output drops. As was written before, these thermal energy outputs are impacted by total unit production costs, so when the price increases, the energy output drops, but when the price gets lower, the energy output increases. The same can be seen in interactions in Figures 4 and 5. As the rise of natural gas technology prices is made, the thermal energy output drops. An opposite situation would be in bio-gas heat-only boilers – price drops, so the energy output increases.

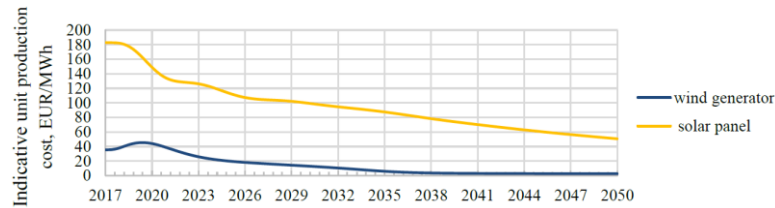


Figure 6 Total indicative electricity unit production cost for different technologies.

Another part of the model concerns indicative electricity production and its technology interaction. If we overlook the indicative total unit production cost in Figure 6, in this case, the price was divided between two technologies. The results show a big indicative unit cost difference between solar panel and wind generator costs per one production unit. Solar panel cost at the beginning is 182.61 EUR/MWh, even more than the electricity price for consumers in Latvia. In the case of wind generators, the price is lower than the market price even at the beginning – 35.48 EUR/MWh, which would drop to 2.59 EUR/MWh in 2050. So, this technology is starting to pay off in the first year of installation.

As this technology is less expensive than solar panels, it is installed more, which makes it a necessary investment. Comparing indicative investments between those technologies, as in Figure 7, the wind generator together in all simulation time asks for 5053.05 million EUR.

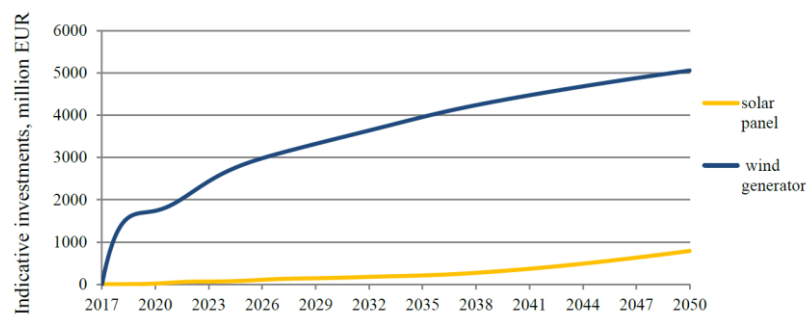


Figure 7. Indicative cumulative investment changes for electricity producers.

As the requirement for a wind generator was the biggest, it also would produce most of the electricity. The next highest producer would be the hydroelectric power plant, which was set as a constant energy producer without any investments or profit. After time passes, the bio-gas cogeneration plant could produce the third biggest amount of electricity. The rest of the technologies – large natural gas cogeneration plants, natural gas, and wood cogeneration plants produce 607GWh in 2050, from which the most minor producer is the natural gas cogeneration plant, which would produce 90GWh. The next one is a large natural gas cogeneration plant that produced indicative electricity of 147GWh, and the biggest one – a wood cogeneration plant – 370GWh.

As electricity output changes, the electricity import and export, as Latvia, for now, cannot produce enough amount of electricity for its consumption. By this model results and investments, it is possible to provide electricity for ourselves and even export it, as shown in Figure 8.

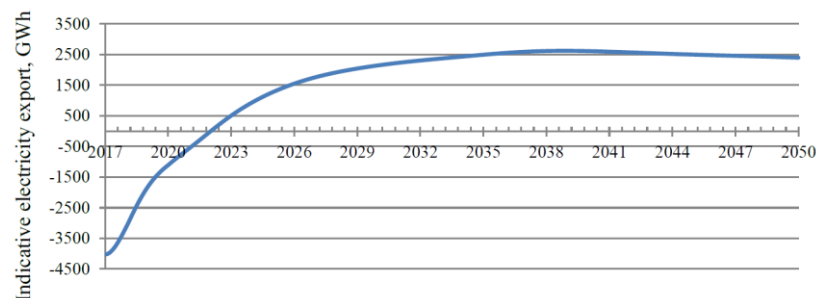


Figure 8 Indicative electricity export changes.

At first, 4025GWh of electricity was imported, but the installation of wind generators (mostly) made changes, and from 2022, it will be possible to export more energy than import. And in 2038, reach value smoothing around 2400GWh.

Looking at the impact on indicative area use and what causes new technology building, wind generators request quite a large amount of area. In total, is needed 357.65 km² with a maximum point of 2041. Almost half of the area would be required by the year 2022. Together it is only 0.55% of all country's land. The following most significant area requirement is for solar collectors – 31.09 km² (0,05%), which is needed already in 2020, and the lowest amount is for solar panels – 8.80 km² (0,01%), which is a small amount number, but quite a big. If we compare it to lakes, it is almost the same size as "Lielais Ludzas" lake, the 17th largest lake in Latvia.

Of course, these energy production changes also impact the indicatively released CO₂ emissions; CO₂ emission amounts would change the same as produced energy amounts in Figure 3.1. In 2017, coal heat-only boilers would make 635GtCO₂ emissions, but lately in 2021, it will drop to 259GtCO₂, which again increases till the year 2026 to the amount of 370GtCO₂, and later it would slowly decrease till 2050 of value 184GtCO₂. All other technologies gradually reduce released emissions after solar panel reaches their maximum point in around 2020. So, these changes are because of the reduction of indicatively produced energy. At first, natural gas heat-only boilers made 92GtCO₂, natural gas cogeneration plants – 160GtCO₂, but large natural gas cogeneration plant 239GtCO₂, which in 2050 smoothed around equal amounts of 60GtCO₂.

Conclusions

From different case results, it can be seen that the main thermal energy production part goes to solar collectors. Also, a big market share goes to wood plants for all simulation time. The lower requirement is for natural gas plants. In electricity production, a big range of cost differences are between solar panels and wind generators, so more requested is wind power. Most of the total investments go to wind generators and bio-gas heat-only boiler installation, but there is no need for investments in natural gas plants. As there are extensive requirements for wind power, it also requests for area.

Overlooking different scenarios, in cases of emission tax changes, the lowest amount of released emissions are in high tax cases, but it requires the most significant investments. Supporting the bio-gas cogeneration plants, there are released emissions almost the same amount as in the high tax case, but it costs even more than in the case of the high emission tax case. In the case of solar panel support, there are needed the biggest amount of investment, and it makes no changes in released emissions. Combining support for renewable energy sources and increased emission tax impact on the environment could be reduced even more, and a result would be better than doing only one activity.

Scientific novelty/practical value of the findings

Due to the vital role of energy in manufacturing, saving energy should be included as an essential element of production plans, especially for manufacturing plants that are energy-intensive. To predict the possibilities, of what can reduce impact on the environment, different analyses should be done to reach a concrete action plan that is directed to energy sustainability.

Using the model in various countries, it is possible to calculate which type of energy is the most financially efficient and the most environmentally sustainable. According to the created module, it is possible to optimize and adjust the integration of renewable energy into the existing system. Afterwards, the model can be used for testing energy systems in different countries.

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FACTORS INFLUENCING CUSTOMERS' DECISION TO BUY IN ONLINE STORES**Margarita Išoraitė^{1*}, Gintarė Gulevičiūtė²***Vilniaus kolegija / Higher education Institution, Saltoniškių Street 58, Vilnius, Lithuania**E-mails: ^{1*} m.isoraite@vyf.viko.lt (Corresponding author); ² g.guleviciute@vyf.viko.lt**Received 15 August 2023; accepted 14 November 2023; published 30 December 2023*

Abstract. This article explores the factors influencing customers' decision to buy in online stores. The literature analysis showed that previous studies related to the factors influencing the decision of customers to buy in online stores focused on risk perception, online shopping features, price, convenience, online customer loyalty programs and online accessibility. Qualitative research – in-depth interviews were used by incorporating participants from a broad spectrum of online shopping categories (universal shop, food and beverage, clothing, consumer electronics, personal care and beauty, digital services). The research questions were related to the purpose of the research. The authors seek to clarify which factors of online stores influence the purchase decision. The study results showed more in-depth characteristics of online shopping and discovered the link between online shopping and consumer intentions. After the research, product categories mainly focused on e-commerce, factors leading a consumer to make a repeated purchase in an online shop, and factors encouraging consumers to shop online in the future were defined.

Keywords: marketing; online decision; buyer; customer decision to buy

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JEL Classifications: A20, A22, C40, C83, I21, L80, M20

Additional disciplines: management, Information and communication

1. Introduction

Recently, increasing competition has encouraged online stores to look for more effective and long-term ways of achieving competitive advantage in the electronic space. In the electronic area, the success of a business depends on the factors that influence the decision of consumers to buy in online stores. Therefore, to gain a competitive advantage, it is relevant to understand the user experience and satisfaction with their services. Although more and more attention has recently been paid to the factors influencing consumers' decision to buy in electronic stores, where particular emphasis is placed on the creation of user experience, which has an impact on creating solid company-consumer relationships, there is a lack of scientific research on the factors influencing consumers' decision to buy in electronic stores from the experts' point of view.

Scientific issue. Online shopping is becoming increasingly popular worldwide, so it would be relevant to identify the factors that encourage consumers to shop online. The topic of the determining factors of consumers' decision to buy online is constantly changing, and the latest changes still need to be widely explored in the scientific literature.

The research aims to investigate the factors influencing the decision of customers to buy in online stores.

Objectives of the research:

- to present the theoretical background of customer decision-making to buy.
- to analyze factors influencing the decision of customers to buy in online stores.
- to evaluate in more depth the characteristics of online shopping and to discover the link between online shopping and consumer intentions.
- to create recommendations based on the research result to define the latest factors influencing customers' decision to buy in online stores.

2. Theoretical background of customer decision-making to buy

Companies are studying consumer buying decisions in detail to answer the questions: what consumers buy, where they buy, how, how much, when they buy, and why. Companies can find answers to most of those questions by researching customer purchases. However, finding the answer to the question "why?" and understanding the consumer's purchase decision process is not easy because the answers are often in the consumer's head.

Marc et al. (2022) mentioned that each country has its cultural characteristics, and these cultural differences affect consumer perceptions, attitudes, and purchasing behaviour. According to Marc et al. (2022), consumers from different countries show different attention towards the same product and have other emotional dispositions towards the same product.

Kiran et al. (2019) stated that customers tend to copy, imitate, and follow each other as defined in social learning theory. According to Kiran et al. (2019), they also talk to each other to get more information and feedback. Users share detailed information and their opinions based on their experiences with others, which influences new customers to buy or not buy a brand or product by word of mouth or face-to-face.

Jaakkola (2007) argues that consumer and organizational decision-making is related to selecting and using products and services. Jain (2019) stated that consumers may feel a tendency towards impulse buying. Impulse buying means buying without doing a lot of planning and thinking just because you want to purchase the product. Jain (2019) argues that a packet of crisps on the counter makes him feel hungry, and he can buy it without a second thought. Oke et al. (2015) agreed that consumer behaviour indicates how people make personal or household choices of products using available resources such as money, time, and effort. Consumer behaviour in an all-inclusive approach is the activities and processes through which people buy or discard products or services based on their experiences and ideas.

Willman-Iivarinen (2017) mentioned that the basic idea of consumer choice is that each solution strategy can be characterized by its accuracy (low error rate) and the effort required. Gómez-Díaz (2016) stated that the decision-making process should be a problem solution; not all products are solutions for specific users. For example, running out of toothpaste is a common situation that drives purchasing behaviour; however, it can be a problem for cultures that use this species of toilet cleaners, but for some others, it is not a consumption problem.

3. Factors influencing the decision of customers to buy in online stores

Nowadays, with the increasing popularity of online shopping, one factor that determines a consumer's purchase decision is emotion. Emotions have a significant impact, as a customer in a positive mood is willing to spend more money than a customer in a negative attitude. In an online store, website design, ease of use, quality information, and customer feedback become essential. Delivery time is crucial for online shoppers. Delivery time should be quoted as is. Promotions and discounts also work for consumers' decisions to buy. However, price is not the only factor that determines the purchase decision. The quality and durability of products are essential to the buyer, so they usually look for the best quality-price ratio. Merchants also use tricks to sell in online stores. For example, a reasonable price for one product is presented in the context of other - higher -

prices when other, much more expensive products are placed next to the product to be sold. Reviews on social networks greatly influence consumers' decision to buy and if such an option is available on the company's website. Companies strive to make the user experience favourable and rewarding. User experience is becoming the most critical marketing tool that shapes a merchant's success.

Nawi et al. (2019) stated that their research can help to encourage and enhance online consumerism. In addition, scientists intended to provide new ideas and knowledge to Internet users. Their study may raise awareness of perceived risk in online shopping and the effects of perceived risk. In addition, the findings may offer consumers ideas for reducing their risk perception when shopping online.

Baubonienė et al. (2015) mentioned that there are factors when shopping online:

1. Technological factors: preference to be a power user.
2. Consumer-related factors: shaping attitudes towards online shopping and changing customer attitudes.
3. Pricing factors of online shopping.
4. Product/Service Factors: availability of product information website, product type.

Skaržauskienė et al. (2015), citing Cheah et al. (2015), separated the factors influencing the decision to buy in online stores into channel characteristics (including quality services, associated risks, and trust characteristics of online shopping), seller and product characteristics (including special offers and price discounts) and consumer characteristics (including personal, social and psychological characteristics and online shopping experience). Davidavičienė et al. (2021) mentioned that the most essential features of an e-store are e-store design, e-store informativeness, e-store convenience, e-store security, and e-store popularity. From the perspective of product characteristics, researchers and business practitioners focus on product design and packaging, price, branding, customer feedback, and delivery time.

Fernandes et al. (2021) mentioned that marketers have recognized the effectiveness of word-of-mouth (WOM) as an influential factor in driving consumer choice and purchase decisions. According to Fernandes et al. (2021), because of the importance of WOM in increasing sales, marketers are using the Internet to create an online platform for consumer opinion, thereby expanding traditional WOM into an online environment related to product and service reviews, known as electronic WOM. Mican et al. (2020) stated that the extent of certain factors such as product characteristics, trust in the online store, specialist/customer reviews about the product, product price, customer opinions, trust in sources, convenience of the online store, attitude and brand loyalty, product popularity, customer loyalty programs, WOM and eWOM influence and affect the purchase decision.

Kidane et al. (2016) stated that trust and consumer attitudes have the most substantial direct effects on online purchase intentions, and convenience, price, wider product choice, and earnings also indirectly solidly impact online shopping intentions through online shopping attitude as a mediator. According to Kidane et al. (2016), impulse purchase intentions, consumer quality orientation, brand orientation, online trust, and shopping experience are positively related to online customers' prior purchase intention.

Wang et al. (2008) stated that online shopping features are the relevant factors showing the characteristics different from the past. First, online transactions between users and retailers faced various risks from opening the network. Second, preserving Internet privacy in shopping was another critical factor. Third, consumer awareness was another vital element. Finally, the consumer computer and Internet experience also influenced online shopping.

Khan et al. (2011) argue that shopping convenience, customized products and services, lots of information, better prices, and many other factors drive online shopping. According to Khan et al. (2011), more selection, customized products and services, lower prices, fast delivery, availability of information, participation in auctions, the ability to communicate with electronic communities, and no sales tax (in most countries) there are electronic advantages of commerce to consumers.

Bucko et al. (2018) mentioned that perceived risk, price, and promotion positively affect customers' willingness to purchase a product. At the same time, Daroch et al. (2020) mentioned that essential factors such as detailed

information, convenience and calm shopping, less time consumption, and easy price comparison influence consumers to shop online. According to Daroch et al. (2020), factors such as variety, fast service and discounts, and feedback from previous customers make customers buy online instead of traditional shopping.

Mastana (2023), citing Al-Debei et al. (2015), states that online accessibility also includes user-friendliness and navigation, as well as accessibility and contact elements, and therefore often relates to website availability, accessibility, interoperability, usability, and information about pricing, performance, quality and other element characteristics. Wu et al. (2023) mentioned that consumers always want to buy good quality products at a lower price, and at live events, streamers offer discount coupons and special offers. Wu et al. (2023) mentioned that users complain that the prices are too high and lower prices can be negotiated with the streamer in real time.

Azami (2019) conclusions of the study showed that the Internet environment, product characteristics, and promotional offers had a significant relationship with the online shopping behaviour of buyers. However, online safety and trust and product price had no meaningful relationship with the online purchasing behaviour of shoppers, although the existing effect between the variables was positive but insignificant. According to Ganapathi (2015), regression analysis shows that convenience, security, site features, and time-saving positively and significantly impact consumer buying by one per cent.

Hasan et al. (2022) investigated that consumer beliefs about high prices of online products, service quality and responsiveness, increased consumption of consumer resources, website design, high-risk perception, and poor payment process significantly impact the adoption of online transactions. Observing how consumers' perception of online products influences their decision to accept online transactions is interesting. Mahmud et al. (2014) study showed that website reliability, website design, website customer service, and website expertise are the four dominant factors influencing consumers' perceptions of online shopping.

Al Hamli and Sobaih (2023) identified a list of incentives to encourage customers to buy online from e-retailers through their research. These incentives are competitive prices, fast Internet, proper education, bank availability of a credit card, retailer website design including complete specifications, presence of physical store, online payment options other than a credit card, government support, supervision, and control. Fakunle and Ajani (2021) underline importance of Internet availability and stability.

Phanrat et al. (2019), citing Raghubir et al. (2004), suggested that consumers prefer to buy products when sellers offer a promotion. Phanrat et al. (2019) state that price promotion refers to providing a low price for a product or offering more products at the same price to create a sale. This may include a freight discount, a cash voucher, price deduction, and discount promotions from sellers, including a free express delivery fee; reducing the shipping fee is a favourite among consumers. Santhosh (2020) stated that from the factor analysis, it can be concluded that the most predominant factors influencing customers' purchase intentions when buying books online are better discounts, convenient shopping experiences, alerts about new arrivals, and quick resolution of complaints.

Swapana et al. (2017), citing Khare et al. (2012), stated that when shopping online, users expect and prefer a website with no accessibility violations. Swapana et al. (2017) mentioned that many online retailers offer accessible technologies such as voice recognition software, screen readers, magnifiers, etc., and it helps people with physical disabilities easily shop online. Increased accessibility standards drive customers to shop online.

Kim et al. (2012) stated that numerous studies have attempted to determine the factors that determine the success of e-commerce, emphasizing customer value creation, online customer management, e-business service quality improvement, customer retention, e-business strategy, and website quality. Al Haml et al. (2023) study identified five key factors, such as convenience, psychology, trust, payment method and product variety, which influence consumers' buying behaviour. At the same time, Victor et al. (2018) results of the exploratory factor analysis have determined shopping experience, dynamic pricing awareness, privacy issues, buying strategy, fair price perception, revenge intentions, and self-preservation intentions are potentially significant factors influencing consumer behaviour and their future purchasing decisions.

Hidayat et al. (2021) mentioned that users generally think quality, price, and product reputation determine the purchase decision. According to Hidayat et al. (2021), knowledge about factors influencing online purchasing decisions can help the industry develop strong relationships. Buying decision factors are also helpful in developing and implementing e-commerce strategies to achieve long-term goals such as customer loyalty. Valdez-Juárez et al. (2021) stated that website security, website quality, internet user satisfaction, and the ability to learn are and will be determining factors in purchasing behaviour analysis.

Warganegara et al. (2022) argue that internet-based economic growth influences consumer behaviour, lifestyle, and activities. According to the authors, consumers use the Internet when shopping because they value time, efficiency, and cost savings. They also don't have to visit physical stores and interact directly with sellers. Online shopping allows consumers to shop through online stores and transact directly on the same platform. Despite the numerous types of research, a gap still exists, and the most recent factors affecting the inclination to buy online have yet to be discovered.

4. Research methodology and methods

Research method. An individual (in-depth) expert interview method was chosen in line with the study's objective. According to Gaižauskaitė and Valavičienė (2016), in-depth interviews allow one to grasp the nuances of the topic, understand its essence, and discover unexpected and unknown aspects.

The content analysis method was also used to analyze the data from the qualitative research. Content analysis is a research method for subjectively interpreting the content of textual data through a systematic process of classification, coding and identification of themes or patterns. According to Elo and Kyngäs (2008), content analysis involves defining the research question and selecting the sample, data collection, preparation of the data for analysis, development of a coding system, application of the coding framework to the data, and interpretation of findings.

Research instrument. The research instrument used was a semi-structured interview. The aim of structuring the interview in this way was to make it flexible and responsive to the course of the interview, which would lead to additional questions and the discovery of new, as yet undiscovered aspects of the topic. The study aimed to assess the characteristics of online shopping and discover the link between online shopping and consumer intentions. The main guidelines for the discussion questions covered the following topics:

- perception of online and traditional shopping;
- factors that primarily influence the consumer's decision to shop online;
- areas primarily focused on e-commerce;
- factors leading a consumer to make a repeated purchase in an online shop;
- factors encouraging consumers to shop online in the future.

Research sample. In view of the study's objective, the criteria for selecting the study participants were defined. Purposive sampling was chosen, characteristic of qualitative research, by strategically and purposefully selecting the most informative participants in line with the study's objectives. It was also chosen to adapt the selection of participants based on the defined criteria:

- relevance of the topic (people working with online shopping);
- diversity (CEO of e-commerce, managers, developers, etc.);
- and at least 5 years of experience in the field of online shopping.

The sample size of the study was selected based on the principle of data saturation, where interviews are conducted until the information provided by informants starts to repeat itself, and new aspects related to the research objectives are no longer revealed (Gaižauskaitė, Valavičienė, 2016). Using purposive and case sampling, data saturation was achieved by including 12 respondents.

Organization of the research. The search for potential informants was carried out using LinkedIn (by a personal message inviting them to participate). All those invited agreed to participate in the study - there were

no refusals. As the aim was to interview professionals (working people with strict agendas), the informants were allowed to choose a date and time that suited them and the type of contact they wanted to have with the researcher. The choice was between a face-to-face interview and an interview where the researcher and the participant interact through communication, either by telephone call, a remote meeting or a written question. Data collection took place between September-October 2023.

Data analysis. The analysis of the results started with the transcription of the voice recordings. The transcriptions were analyzed, and highlights and quotes were defined. Thematic data analysis was used based on the steps outlined by Clarke and Braun (2013): familiarity with the data, data coding, generation of initial themes, review of themes, and defining and combining themes.

5. Research results analysis

The research involved the active participation of 12 informants, comprising 7 females and 5 males. Below is the anonymized list of participants with their working category of online shopping and experience working in e-commerce (see Table 1).

Table 1. The characteristics of the participants

Participant	Working category of online shopping	Experience of working in e-commerce	Participant	Working category of online shopping	Experience of working in e-commerce
P1 (M)	Universal e-shop	10 years	P7 (F)	Consumer Electronics	6 years
P2 (M)	Food and beverage	7 years	P8 (M)	Clothing	5 years
P3 (F)	Clothing	5 years	P9 (M)	Universal e-shop	12 years
P4 (F)	Consumer Electronics	12 years	P10 (M)	Personal Care and Beauty	7 years
P5 (F)	Personal Care and Beauty	7 years	P11 (F)	Digital services	10 years
P6 (F)	Digital services	15 years	P12 (F)	Food and beverage	9 years

To guarantee a comprehensive perspective during research, participants were intentionally incorporated from a broad spectrum of online shopping categories (universal shop, food and beverage, clothing, consumer electronics, personal care and beauty, digital services). This diverse selection was rooted in capturing various expert groups' viewpoints and insights.

First, it was essential to define the advantages of online shopping from the experts' point of view. Convenience, wide variety, price comparison, accessibility, reviews and recommendations were the most important factors (see the results in Table 2 below).

Table 2. Category – approach on advantages of online shopping

Category	Subcategory	Empirical study statements
Advantages of online shopping	Convenience	“<...> Online shopping allows to shop from anywhere with an internet connection, eliminating the need to travel to physical stores <...>” (P1, P2, P3, P5, P6, P7, P8, P9, P12); “<...> it is saving time - quickly browse and make purchases without the need to physically move from store to store <...>” (P4, P10, P11).
	Wide Variety	“<...> Online stores often offer a wider range of products and brands, making it easier to find specific items or explore new options <...>” (P2, P3, P4, P5, P7, P9, P10, P11, P12); “<...> It is possible to buy different products from one e-shop <...>” (P1, P2, P6);
	Price Comparison	“<...> Online platforms make it easy to compare prices across different retailers, helping to find the best deals and discounts <...>” (P1, P2, P3, P4, P5, P7, P10, P12); “<...> at the beginning of online shopping lower prices were the most important factor, now those prices are not lower all time, but the price comparison is much easier compared to traditional shopping <...>” (P6, P8, P11).
	Accessibility	“<...> Online shopping is accessible 24/7, allowing to shop at any time that suits your schedule <...>” (P8, P11).
	Reviews and Recommendations	“<...> Online reviews and product ratings can provide valuable insights into the quality and performance of products, aiding decision-making process <...>” (P1, P3, P4, P5, P6, P8, P9, P11).

The next question was focused on areas mainly focused on e-commerce. The participants defined digital media, grocery and food, fashion and apparel, consumer electronics, health and beauty as the most popular e-commerce categories. Other categories were also mentioned, such as furniture, appliances, cookware, and home décor, sporting equipment (see the results in Table below).

Table 3. Category – product categories mainly focused on e-commerce

Category	Subcategory	Empirical study statements
Product categories mainly focused on e-commerce	Digital media	"<...> e-books, audiobooks, and digital media like music and movies are commonly purchased online today <...>" (P2, P3, P4, P5, P7, P9, P10, P11, P12); "<...> Netflix and Spotify are number one brands, which increased the popularity of digital media usage online when paying subscription fee <...>" (P1, P6); "<...> Amazon is the first brand, which was focused on selling e-books, that was the beginning of spread of digital media in online shopping <...>" (P9).
	Grocery and Food	"<...> Online grocery shopping has seen significant growth, with both perishable and non-perishable goods available for delivery <...>" (P1, P2, P3, P4, P5, P7, P11, P12); "<...> During pandemic customers got used to buying groceries online, and now they still do that <...>" (P2, P12, P10).
	Fashion and Apparel	"<...> Clothing, shoes, and accessories are commonly purchased online. Many online fashion retailers offer a wide variety of styles and sizes<...>" (P1, P2, P3, P5, P6, P7, P8, P9, P12); "<...> AboutYou, Zalando, Asos are the brands, which ensured that customers got used buying clothes online in Lithuania <...>" (P3, P8).
	Consumer Electronics	"<...> smartphones, laptops, tablets, and other gadgets are highly competitive and rapidly evolving segment of e-commerce <...>" (P1, P2, P3, P4, P5, P6, P7, P8, P9, P12);
	Health and Beauty	"<...> Cosmetics, skincare products, supplements, and personal care items are frequently sold online <...>" (P1, P3, P4, P5, P7, P8, P9, P11); "<...> There are plenty of new cosmetics brands in Lithuanian market and most of them are focused on online shopping <...>" (P5, P10).
	Other categories	"<...> Products such as furniture, appliances, cookware, and home decor items are popular in e-commerce due to the convenience of shopping from home <...>" (P1, P2, P10, P12); "<...> Sporting equipment, apparel, and fitness products have a strong online presence <...>" (P5, P7).

Factors leading a consumer to make a repeated purchase in an online shop and factors encouraging consumers to shop online in the future were also essential research topics. The interview participants mainly mentioned mobile shopping, social media and influencer marketing, sustainability concerns, convenience features, cybersecurity measures, and pandemic effects (see the results in Table 3 below).

Table 3. Category – factors leading to shop online in the future or repeat the purchase

Category	Subcategory	Empirical study statements
Factors leading to shopping online in the future or repeating the purchase	Mobile shopping	"<...> The widespread use of smartphones allows consumers to shop on the go, which will be even more popular in the future. <...>" (P2, P5, P6, P7, P9, P11). "<...> Mobile apps and mobile-optimized websites make it even easier for people to make purchases from their devices <...>" (P1, P4, P8).
	Social media and influencer marketing	"<...> Social media platforms and influencers play a significant role in promoting products and driving online sales. This trend is likely to continue in the future <...>" (P1, P8, P11); "<...> In Lithuania, most profitable are the online shops opened by influencers, this is also leading to repeated purchases on influencer e-shop <...>" (P4, P7, P12).
	Sustainability concerns	"<...> As more consumers become environmentally conscious, they may prefer online shopping compared to traditional retail, as long as e-commerce companies continue to make efforts to reduce their environmental impact <...>" (P3, P8, P9, P11).
	Convenience features	"<...> always implementing new features like one-click purchasing, easy returns, and subscription services make the online shopping more appealing to consumers <...>" (P1, P2, P3, P10).
	Cybersecurity measures	"<...> As online security measures continue to improve, consumers may feel more confident in making online transactions, reducing concerns about fraud <...>" (P1, P3, P5, P11).
	Pandemic effects	"<...> The COVID-19 pandemic accelerated the adoption of online shopping due to safety concerns. While the pandemic have passed, the habits formed during the pandemic are likely to persist for many consumers <...>" (P5, 7, P10, P12).

Conclusions

When presenting the theoretical background of customer decision-making to buy, it is crucial to mention cultural characteristics, customers' tendency to copy, imitate, and follow each other, impulse buying and available resources as the factors influencing customer decision-making. While analyzing theoretical aspects of factors influencing the decision of customers to buy in online stores, there can be defined plenty of factors: low-risk perception; technological factors such as online shopping features; price; online store design, convenience, security, popularity; trust in the online store; customer reviews about the product; online customer loyalty programs; online accessibility such as user-friendliness and navigation; time-saving; alerts about new arrivals; quick resolution of complaints; accessible technologies such as voice recognition software, screen reader; product variety.

Ultimately, the choice between online and traditional shopping depends on personal preferences, the type of products customers are looking for, and specific circumstances. Many people opt for a combination of both, taking advantage of the strengths of each method. Qualitative research of 12 informants with experience working in e-commerce showed that convenience, wide variety, price comparison, accessibility, reviews and recommendations are the essential advantages of online shopping. The most popular product categories in online shopping are specific e-commerce categories such as digital media, grocery and food, fashion and apparel, consumer electronics, health and beauty. Mobile shopping, social media and influencer marketing, sustainability concerns, convenience features, cybersecurity measures, and pandemic effects are the main factors leading a consumer to make repeated purchases in an online shop and encourage consumers to shop online in the future.

The study's novelty is based on a definition of factors that most influence the consumer's decision to shop online, focused on the view of experts. Limitations of the study - the study examined the online shopping factors in Lithuania, and the conclusions cannot necessarily be applied to other countries.

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FAMILY BUSINESS SUCCESSION IN ICT-BASED INDUSTRIES

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Abstract. Succession in family businesses represents an essential stage in the company's life, but also of the family, the success of the process being linked to the family heritage. Transferring the business to the next generation is a complicated process that involves careful analysis of all elements involved (family, management, ownership). These elements will undergo substantial changes following the succession process. Even if the studies on family businesses have become more numerous in recent years, the research on the succession process and succession strategies is relatively limited. Conversely, the general conclusions are related to large businesses in the second or third stage of business transfer to the next generation. Consequently, this study aims to address some specific issues related to the ICT-based family business succession process in Romania from the last decade, when family businesses reached the point of the first business transfer. Specifically, there are three research questions: (Q1) What are the new succession strategies, given the significant changes in the economic sector in recent years? (Q2) Is the level of formal education a sufficient criterion to decide the successor in an ICT-based family business? (Q3) Is succession a way of implementing innovative strategies to ensure business continuity and growth? The study is based both on secondary research (survey of articles and studies published in recent years) and primary research: questionnaire-based surveys of founders and successors of ICT-based family businesses in the book publishing industry, but also in other technological fields of interest (serving as a base of reference). The findings provide clarifications or suggestions for successfully developing the succession strategies in the ICT-based family businesses in Romania.

Keywords: succession strategies; succession process; family business; ICT-based family business; digitalization; book publishing industry; management succession; ownership succession

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1. Introduction

In a globalized economy shaken by multiple crises, family businesses represent relative stability and an essential segment of a country's economy by significantly contributing to the creation of GDP and employment. (PwC, 2018; 2022; Stănciulescu, Scarlat and Stroe, 2019) A rigorous domain analysis can only be done with a clear definition of the family business.

According to European Family Business (2022, p.8): "the common feature of these companies is that of the family dimension, where business and ownership are intertwined. European family businesses have been widely equated to Small and Medium-Sized Enterprises (SMEs) in public and policy discussions. However,

this neglects the fact that there are also large family businesses. A firm of any size is a family business if: (i) The majority of decision-making rights have the natural person(s) who established the firm or in possession of the natural person(s) who has/have acquired the share capital of the firm or in possession of their spouses, parents, child or children's direct heirs; (ii) The majority of decision-making rights are indirect or direct; (iii) At least one representative of the family or kin is formally involved in the governance of the firm; (iv) Listed companies meet the definition of family enterprise if the person who established or acquired the firm (share capital) or their families or descendants possess 25% of the decision-making rights mandated by their share capital."

Law no. 300/2004 (art.1-4) regulates family businesses in Romania. These are defined as businesses established by an entrepreneur and may include family members, including children over 16 and relatives up to the 4th degree of consanguinity.

OECD (2004) outlines ICT-based family businesses as those that meet the requirements of a family business and have digital, information and communications technology as the basis of their activity. At the same time, succession strategies represent an essential element of the existence of these businesses. Still, the need for more literature on this subject makes a thorough analysis of ICT-based family firms challenging.

Most economic analysts (Brockhaus, 2004; Daspit et al., 2016; 2017; Cho et al., 2021; 2022; LeCounte, 2020) link the short lifespan of family businesses to the lack of concern for the business future and especially for the preparation of succession process.

As far as Romania is concerned, analysis of family businesses is limited by the need for more official data due to the disinterest of the political class in this significant economic segment. It is estimated, unofficially, that over 65% of Romanian companies are family businesses, of which 12-15% are ICT-based firms (Ernst &Young, 2017; PwC, 2015; 2017), but the percentage is volatile due to the lack of specific and coherent legislation, a fact that leads to a critical bankruptcy rate.

Most family businesses are micro-enterprises or individual subsistence enterprises; their founders are mainly concerned with current activities to keep the business afloat, failing to make a minimum of short- or medium-term strategies, let alone long-term. The desire for short-term business survival postpones developing and implementing succession strategies, which could come with improvements or an innovative vision of business activity. (KPMG, 2019; 2020; 2022; PwC, 2017; 2018; 2022)

Due to Romania's economic and political realities, few businesses have adapted to digital transformation (KPMG, 2022) or rapid, sometimes dramatic, changes in business conditions. This also happened due to the population's loss of traditions and entrepreneurial skills during the communist period. (Ernst&Young, 2017; PwC, 2015; 2017)

The forecasts of specialists in the field (Ernst &Young, 2016; 2017; PwC, 2015; 2017; 2022; KPMG, 2018; 2019; 2022) indicate a higher economic performance of family businesses in the long term, which is an essential argument for the sustainable economic development of every nation and, in particular, of succession strategies.

In conclusion, the long-term development of a family business requires an innovative and succession approach based on digital transformation (KPMG, 2022). These elements form the basis of this article and will be researched to highlight the current situation of ICT-based family-owned businesses in Romania.

Therefore, the remainder of this paper is structured as follows: a literature review with an emphasis on the succession process in family businesses (peculiarities, success, difficulties and the Romanian situation), the materials and methods used to create the article, results and discussions based on three questions on three critical topics (succession strategies, successor education and innovative strategies for maintaining and growing the business), followed by conclusions, recommendations and future research.

2. Literature review

2.1. The peculiarities of the succession process in recent years

The succession process is a general phenomenon specific to human society at any level. The process involves transferring material, experience, and spiritual values to the succeeding generation. The phenomenon is determined by three significant causes that put pressure on the elderly generation: (i) Awareness of the limited duration of life; (ii) Responsibility for the future of descendants; (iii) The desire of the elderly generation to leave behind a tangible legacy that will survive and develop as long as possible after its demise (Ernst & Young, 2016; 2017; PwC, 2015; 2017)

The steps involved in the process are generally the same, the differences only stemming from the complexity of the family, the inheritance and the interests pursued. All this makes succession in an ordinary family less complicated than in a royal family, which must obey social norms, legislation, traditions and customs.

A particular social category that must carry out the inheritance transfer to the next generation is that of the ICT-based family business leaders, which are particularly important in achieving society's material well-being and social progress.

Succession is an essential stage in the life of any family business. The future development of the company depends on the success of this operation. In some European countries, only those that have passed the first succession are considered family businesses. Many family businesses (>70%) do not reach a lifetime of more than 10 years (Daspit et al., 2016; Cho et al., 2022).

One of the main causes of short life is the need to carefully prepare the business transfer to the new generation (Handler, 1994). The multitude of objective and subjective factors involved in this process make it difficult to devise a general strategy to follow, which would ensure the success of the transfer of the family business. Many aspects of the succession process (Matthews, Moore and Fialko, 1999) have been analyzed by researchers in the field (Fox, Nilakant and Hamilton, 1996; Michael-Tsabari and Weiss, 2015; Lee, Makri and Scandura, 2019; Richards, Kammerlander and Zellweger, 2019). All those involved in a succession process aim to keep the business in the family heritage and develop the company for future generations (Gagné et al., 2019; Dibrell et al., 2019). Most emphasized the difficulty of the process, resulting in a low percentage of business continuity after the succession (Ward, 1987).

The aspects analyzed were diverse, starting with the family's perspective on the succession of the leader, continuing with the influences given by the type of property, management, traditions, religion, values, family, etc. (Lansberg, 1988; Sharma, Chrisman, and Chua, 1996). All these aspects are of great importance because they require essential changes in the family business, relationships between family members, and relationships between successors, managers and employees.

Family business analysts have described four critical stages in carrying out the succession process, namely: (i) The initiation stage of the process; (ii) Preparation of the succession; (iii) Selection of the successor; (iv) Training the successor to take over the management of the business (Murray, 2003; Brockhaus, 2004; De Massis, Chua and Chrisman, 2008).

The authors analyze the sequence from multiple angles and have different approaches to the activities undertaken at each stage. Most studies refer to medium and large family businesses in the third or fourth succession (Brockhaus, 2004). Also, planning the first succession was intensively studied (Handler, 1994; Murray, 2003). Many articles (Murray, 2003; Sharma, Chrisman and Chua, 2003; Brockhaus, 2004) analyze the succession process from psychological, emotional, and cultural perspectives. Other studies (De Massis, Chua and Chrisman, 2008; LeCounte, Prieto and Phipps, 2017; LeCounte, 2020; Cho *et al.*, 2022) analyze the general stages of succession according to the leadership style of the leader who has full responsibility for the process.

Succession represents an opportunity for changes in the family business (Zhang et al., 2021; Cho et al., 2022) and has to: maintain cohesion within the family; keep the business in the family heritage; preserve assets and jobs.

2.2. Success in the succession process

The success of the succession process is determined by the existence of a carefully developed succession plan. A conceptual model of the succession plan for family business founders is described by KPMG (2018).

However, an analysis by specialists from Deloitte (2019) shows that globally, at the level of family business leaders, 41% of leaders do not trust succession plans, and 25% only have a management succession plan. These data underline the low interest of family business leaders in succession preparation, which explains the decreasing rate of success of this process: approximately 40% for the first transfer, 10-15% for the second succession and 3-6% for the third and the fourth sequence (Cho et al., 2021; 2022) – averaging the lifespan of family business at about 10 years (Daspit et al., 2016).

The success of the succession process can be appreciated after 2-3 years from the realization (Kim et al., 2017) and is evaluated from two perspectives: the founder and the successor perspectives.

From the leader (founder) perspective, the following strategies count:

- awareness of the importance of the succession process and its role in the success of the process (LeCounte, 2020);
- maintain a climate of trust and involvement of family members in the business (Bettinelli *et al.*, 2017; Odom *et al.*, 2019);
- achieve a climate of trust and employee attachment to the company through incentives and demonstrating compassion and understanding of their problems (Alonso, Kok and O'Shea, 2019; LeCounte, Pietro and Phipps, 2017);
- the method for selecting the successor, the relationship with him and the way his professional and psychological training for taking over the business management. (Sharma, Chrisman and Chua, 2003)

From the successor perspective, they are essential:

- their commitment to taking over the control of the family business (Cater and Young, 2019; Schell et al., 2020);
- successor's solid training in the digitalization, technical, economic and financial fields (Umans et al., 2019; LeCounte, 2020);
- cooperation with the leader for an in-depth understanding of the operation of the business, relations with the economic-social and political environment and the values and objectives of the company (Odom et al., 2019; Casillas et al., 2018; Lude and Prügl, 2019);
- close relationships with managers and company staff.

2.3. Difficulties in carrying out the succession process

In reality, the succession process does not follow the path described by the field analysts for at least four reasons.

First, most researchers do not come from family business leaders and have never faced real problems in companies or the business environment in general.

The second reason is the great diversity in family businesses, family types, and their values and traditions.

Third, the theories issued 20-30 years ago generally refer to medium and large SMEs in the second or third succession; they discuss many secondary elements and do not consider the extremely rapid evolution of the economic-social environment and politics.

Fourth, the conclusions of these studies are often irrelevant or even contradictory, and they are not a practical guide for the actors involved in the succession process.

In most family businesses, there is no succession plan; this is only done in case of a significant crisis in the company (retirement, incapacity, disappearance of the leader or reorganization of the company as a result of new medium or long-term strategies) (LeCounte, 2020). This is one of the crucial causes that lead to the failure of the process and generates big problems for the development and even the company's existence (Villegas, Jimenez and Hernandez, 2019). An essential role in this situation is the involvement of the family, interested in maintaining control of the business and in the growth and development of the company (Fitz-Coch and Nordqvist, 2017).

The essential factor in the succession process is the existence of a successor who is capable, prepared and motivated to take control of the business and has the family's support. From this point of view, family business leaders can have significant difficulties, at least in the case of the first succession, due to the small number of successors, age, professional and managerial training or lack of interest in the family business.

The small number of offspring is determined by the socioeconomic conditions of the current period: women's desire to build a professional career, which delays their marriage after the age of 25 and the appearance of children around the age of 30; the alarming increase in the level of infertility, generally in the most educated categories of the population, due to stress, overwork, drug abuse and highly processed food.

Regarding children's education, most education systems are based on formal education, the accumulation of knowledge through drill and memorization. Much of the knowledge gained in school needs to be updated, entirely out of step with current scientific and technical development, most of which could be more helpful in forming a career in the business sector. In addition, the school needs to pay more attention to developing young people's digital skills, which is an essential component for career success at the current stage of society's development. Developing these skills must be included in a national education strategy in Romania. *One solution* is to increase the share of informal education, mentoring activity and education through projects, which will develop imagination, creative and innovative thinking, responsibility and courage in approaching and making opportunities come to fruition, fundamental elements that characterize a leader's personality.

Entrepreneurial education, especially in ICT-based family businesses, must develop skills, concepts and knowledge strictly necessary for starting and developing viable companies (OECD, 2019; Stănciulescu and Scarlat, 2020; 2021).

In the current socioeconomic and political conditions, which are highly unpredictable, economic and competitive advantages are relative and temporary, generating significant financial risks and not encouraging the development of a family business (Covin et al., 2020).

The significant difficulties in finding a successor who is prepared, capable and willing to get involved in the management of the business are also given by the characteristics of the millennial generation who, although they mostly have digital skills and are familiar with ICT, are not willing to approach an activity that involves involvement, constraints and responsibilities, preferring to have their career in an agreed domain.

In recent years, several negative global phenomena might have an impact on succession process: the Covid-19 pandemic with the associated phenomena – social distancing and isolation, technical unemployment and the drastic decrease in the population's income; the explosive increase in the price of energy, material resources and food, determined by specific policies to influence the mentality and consumption of the population to reduce the effects of global warming; war in Ukraine, which led to the reduction or even interruption of energy and material resource flows from these countries to Europe – associated with economic sanctions imposed on Russia to limit its ability to support the invasion.

Disruptive phenomena in the economic sector in recent years, such as the Covid-19 crisis and the increase in energy and material resources, have been severe blows to family businesses, especially those based on ICT. KPMG (2022) estimates significant global effects:

- 86% of CEOs predict a global recession;
- 71% of them anticipate that companies' revenues will decrease by up to 10%;
- 76% took measures to counteract the recession.

This situation has led to the delay or even stagnation of the succession in many companies, their leaders – as the main responsible – considering that it is not a favorable time to start such a process or they do not have a successor well enough prepared to take over the management of the business under these conditions. On the other hand, the successors – even those involved in the decision-making process in the company, hesitate to assume the responsibility of its management, not being convinced of the favorable evolution of the company in these difficult economic conditions.

A significant impediment in carrying out the ownership succession strategies is represented by the lack of financial liquidity because, in addition to inheritance taxes and other legal fees, the business leader must also have at his disposal the sums necessary to compensate the claims of the heirs who do not want shares in the company nor to get involved in its management (KPMG, 2020).

These difficulties, also highlighted in the researchers' studies, demonstrate that business succession, company management or ownership succession are not the top priorities of business people in young market economy states, who are focused on growing the company and maintaining it in the market in an increasingly unstable economic environment (KPMG, 2019).

2.4. The succession process in Romanian family firms

The analysis of the succession strategies in ICT-based family firms in Romania is complicated due to the small volume of authorized data and the legislative ambiguities regarding their inclusion in the SME category. The official statistics analyze their economic aspects and possibly specific trends of their future evolution. The succession process, characteristic of family businesses, is rarely present with substantiated statistics in the analyses of Romanian researchers. Concerning ICT-based family businesses, they need to be more present.

Studies on ICT-based family businesses in Romania were carried out by PwC (2015; 2017) and Ernst & Young (2016; 2017), consulting companies in family businesses.

Unfortunately, official data are incredibly scarce, and for certain aspects of the process of transferring family businesses to successors, they are nonexistent. Any rigorous study based on specific data cannot be carried out during this period due to the lack of interest of the political-administrative factor (ONRC) in creating a particular database.

The data published by ONRC (2022) in 2018 indicated more than 900,000 active businesses owned by natural persons, and their average number of associates was 1.47, without specifying their degree of kinship.

Hategan, Curea-Pitorac and Hategan (2019) estimated that in 2019, the year of maximum economic growth after the 2008–2012 recession, approximately 65% of companies owned by individuals are family businesses. The majority of associates (over 55%) were between the ages of 30 and 49, with over 35% over the age of 50 and over 16% over the age of 60. This shows that about a third of leaders had to think about business succession and involve their successors in managing it.

The statistics of the active private businesses and the distribution by age category of business partners are presented in Table 1 and Table 2.

Table 1. Distribution of active private business partners by age category

Year	Age of partners					
	Total number of holders	< 29 years	30–39 years	40–49 years	50–59 years	> 60 years
2018	425.770	50.354	109.431	133.160	80.075	63.808
2019	414.678	44.836	104.027	118.471	81.688	65.653
2020	429.464	44.282	105.208	122.659	86.768	70.529
2021	453.934	48.518	108.309	127.877	93.054	75.686
2022 (Oct. 31)	466.629	49.381	110.516	130.174	98.023	78.632

Source: Adapted from ONRC (2022)

The analysis of Table 1, regarding the set of private businesses, reveals two important aspects, namely: (i) the number of businesses owned by young people under the age of 29 represents around 40% of the businesses owned by those in the following two age categories, which implies that they do not have material and financial means, or they are not interested in engaging in a risky activity; and (ii) there is a constant increase in the number of leaders over the age of 50, obviously for natural reasons, their percentage increasing from 33.8% in 2018 to 41% in 2022. This fact puts a lot of pressure on them to consider making the succession. The statistics of the Romanian small family businesses in the last 5 years is presented in Table 2.

Table 2. The situation of small family businesses in Romania in the last 5 years

Year	Totally active family business	Total number of holders	% owners/family businesses	Women	Men
2018	392.548	425.770	1,085	167.555	258.215
2019	378.742	414.678	1,095	164.929	249.749
2020	393.586	429.464	1,091	170.554	258.910
2021	416.090	453.934	1,091	180.060	273.874
2022 (Oct. 23)	429.543	466.629	1,086	185.277	281.352
Average percentage	—	—	< 1,1	≈ 40%	≈ 60%

Source: Adapted from ONRC (2022)

Small family businesses are classified under IF, II, PFA. The table shows that less than 10% of family businesses have two or more founders (owners), probably husband-wife or parent-descendant.

Strinu (2021) shows that 44% of family business leaders are considering transferring the business, but 22% have not viewed any plans, focusing only on the current business development activity.

Deloitte (2019) and Oancea (2019) show that 41% of family business leaders need to see the importance of a succession plan, considering it a measure specific to old family businesses in Western European countries. The percentage of those concerned with the business transfer to the new generation is close to that of leaders over 50.

This behavior is also noted by LeCounte (2020), who claims that succession is rarely planned in family businesses, which is a cause of business transfer failure. This is generally because in this period of rapid

market transformations, changing or blocking the flows of raw materials and energy that have caused alarming increases in costs, especially in ICT-based family businesses, leaders/managers are focused primarily on keeping the company in the market, reducing costs and developing strategies for growth and optimization of production.

The current leaders of family businesses are unwilling to hand over control of the companies to the next generation due to the difficulties they have suffered during the recent pandemic and the current situation generated by the war in Ukraine. The leaders need more confidence in the skills of the new generation to take over and grow the business in the current uncertain situation (PwC, 2022).

While existing studies have delved into various aspects of succession planning, there still needs to be a notable gap in exploring the strategies adopted in family businesses. There is no research done so far in Romania on succession planning in ICT-based family companies, nor on current succession strategies, successor education for taking over ICT-connected firms, or innovative strategies accelerated by this process.

This study seeks to address this gap by conducting a detailed analysis of the relationship between leaders and successors of Romanian family-owned businesses on the threshold of the first transfer of management and ownership.

Furthermore, examining the mentality of Romanian leaders regarding the succession process and the successors regarding taking over the company will offer valuable insights into the succession process and the difficulties encountered during the transfer.

By filling this gap in the literature, this study aims to improve the succession process in Romanian family firms by pointing out the problems and essential aspects that must be carefully followed in this process, aspects discovered after the in-depth analysis of the businesses presented below.

All this information, together with the following analysis of several ICT-based family-owned businesses in Romania, contributes to an overview of the current Romanian situation from the point of view of the succession process and the strategies for achieving it.

3. Materials and Methods

This article outlines some aspects of the strategies adopted in the succession process in recent years in family businesses. The research area is limited to ICT-based family businesses in Romania preparing or completing the succession process. The interest is given by the particularities of succession strategies in the conditions of the economic crisis generated by the Covid-19 pandemic and the generalized recession provided by the significant changes in market conditions (very high prices for energy, raw materials, food, etc.).

The research objective is to argue specific succession strategies determined by the concrete conditions of recent years.

The study attempts to answer the following research questions:

Q1. What are the new succession strategies, given the major changes in the economic sector in recent years?

Q2. Is the level of formal education a sufficient criterion to decide the successor in ICT-based family business?

Q3. Is succession a way of implementing innovative strategies to ensure business continuity and growth?

In the last 4-5 years, studies on ICT-based family businesses in Romania have been few and focused mainly on companies' strategies to limit losses as a result of the consequences of the pandemic.

The lack of specific secondary data and substantiated empirical analyses required the realization of a qualitative, exploratory study based on articles and comments from various publications, as well as internal documents of the companies (websites).

The primary research consisted of the qualitative analysis of information obtained by interviews and questionnaire-based surveys with leaders (founders and managers) of technology-based family businesses between January 2021 and October 2022. These interviews and surveys are part of extensive research that aims at various aspects of ICT-based family businesses in Romania. To answer the article's questions, the following data sets collected from leaders were selected:

- General data about the company and owners;
- Company dynamics: development strategies;
- Succession problems in the company;
- Post-succession development strategies of ICT-based family firms.

Respondents were selected from eight family businesses divided into two groups, namely: (i) a group of four family businesses active in the book publishing industry; (ii) another group of four family businesses active in other technology-based industries (transport, food processing/bakery, hospitality / HORECA and information technology).

4. Results and discussions

This chapter briefly presents the 8 ICT-based family businesses in Romania, the general characteristics of the succession process, as well as discussions and responses to research questions (Q1-Q3).

4.1. Brief presentation of eight ICT-based family-owned businesses from Romania

For this study, a sample of eight Romanian family-owned companies established between 1990 and 2000 was chosen, i.e. 20-30-year-old businesses, which in this period are on the verge of succession or have even partially or completed succession. Data extracted from the interview notes and questionnaires completed by leaders addressed several aspects of family businesses. They were conducted for more in-depth research on ICT-based family-owned businesses in Romania. These businesses are grouped into two categories: (i) publishing houses – as businesses based on cutting-edge digital technology; (ii) family businesses from other industries than publishing, based on various technologies specific to industries (Table 3).

Table 3. Eight ICT-based family businesses in Romania

Industry		Publishing				Transport	Bakery	HORECA	IT
Company's name		ORZ	MPR	CAN	IMA	COM	BRM	QUE	ROM
Year of establishment		1990	1993	1993	1993	1994	1994	1992	2001
Company's size (no. of employees)	as an SME	SCS Small	SRL Small	SRL Medium	SRL Medium	SRL Medium	SRL Large	SRL Small	SRL Small
	appreciation of leaders	Medium	Medium	Medium	Medium	Large	Large	Small	Small
Founders		Husband Wife	Brother Sister	Husband Wife	Father Daughter	Husband Wife	Husband Wife	Husband Wife	Husband Wife

Significant changes in the socioeconomic landscape in recent years have created complex issues for ICT-based family business leaders. They had to face the additional demands necessary to keep the business in the market during the economic crisis caused by the Covid-19 pandemic, price increases and inflation. In addition, established companies in the 1990-2000 period must also prepare for the first-generation change in the company's management. Under these conditions, the leaders (founders) must adopt appropriate and effective succession strategies.

Due to the relatively young age of family businesses in Romania, there must be a relevant tradition in successfully carrying out the business succession process. Thus, the strategies adopted regarding the type, stages, and concrete ways of carrying out the business transfer are oriented in most cases towards maintaining it in the family's inheritance, being also correlated with the company's financial performance.

In the following, some of the succession strategies adopted by ICT-based family-owned business leaders will be analyzed.

4.2. General characteristics of the succession process in ICT-based family businesses in Romania

From the analysis of specialist studies in recent years and the author's research based on questionnaires and interviews with the leaders and successors of ICT-based family businesses, some common characteristics for the succession process have emerged, which can be traced in Table 4.

Table 4 is a synthesis of the data obtained from the leaders regarding the aspects related to the succession process (successors, education, succession plan, organization and causes of the process, the founder's role, and mode of ownership transfers).

Table 4. Succession in the eight family businesses

Field of activity	Book Publishing				Transport	Bakery	HORECA	IT
Company's name	ORZ	MPR	CAN	IMA	COM	BRM	QUE	ROM
Number of descendants	2	2	2	1	2	3	2	1
The stage of the succession	NO	YES Management			YES Management			NO
Is there a succession plan?	YES – partly for management				YES – partly for management			NO
Paternalism and traditionalism in the succession process								
Initiate the succession process	Founder				Founder			
Coordinate succession	Founder				Founder			
Causes of succession Initiation	Founder's age, founder's health, prepared successor, successor's desire to take over the business							
Mode of ownership transfer	Shares according to the law							
Will you achieve succession in the current conditions?	NO				NO			

The *general strategy* in starting and carrying out the succession is concentrating the responsibility exclusively on the founder (leader) of the business, who imposes his personality and leadership style in all stages of the process. The strategy adopted by leaders, in general, is to implement a simplified, paternalistic and traditionalist process. All interviewed founders and managers support and adopt this strategy, representing a tacitly accepted practice, at least in family SMEs.

The *simplification* is a consequence of the small number of successors, the founder's direct descendants. Leaders are generally people with severe professional training, many even having higher education; they have a small number of well-educated followers, many with their career in mind, not being attracted to the family business. The successor selection depends only on his desire to take over the family business, their leadership qualities and competence in the company management. For these reasons, leaders design low-complexity succession strategies for management transfer.

The founder's involvement in the succession process gives the paternalistic attitude in which s/he has the primary role. The leader plans the succession, determines the successor from among his descendants, and establishes the succession phases and other family members' roles. Next, the founder plans the heirs' positions in business management and ownership, financial compensations for family members and his role after the succession. According to the laws in force, the founders of the eight ICT-based family businesses declare that ownership succession will be done in shares, so there are no further disputes.

The *traditionalism characteristic* of the ICT-based family business succession process in Romania results from leaders' answers to questionnaire questions, by the fact that the founders don't envisage the business alienation (the successor being his direct descendant) and the compensations divided in ownership succession should be done correctly so that no heir is prejudiced. Many leaders see ownership division done according to the laws in force to exclude later claims.

It is noted that all the businesses analyzed in this study were founded by a single family (husband-wife, father-daughter), close relatives (parents, siblings, etc.) or external associates were not involved for fear of losing control of the company. Maintaining sole authority keeps the firm in a limited stage of development, both due to a lack of outside capital and professional management. The only large company in the analyzed group is the BRM bakery group, where the founders accepted (after the establishment) associates from outside the restricted family, allowing them to develop at a regional level.

Further, the article focuses on aspects related to research questions (Q1-Q3).

4.3. (Q1) What are the new succession strategies, given the major changes in the economic sector in recent years?

4.3.1. Q1 results

From the perspective of family businesses in Romania, the following business succession strategies result: (S1) Preparing the successors following the requirements and needs of the business; (S2) Early integration of the successors in the company's activity (horizontal and vertical integration); (S3) Strategies for maintaining successors in the company; (S4) Postponing the succession until the economic environment becomes stable and predictable; (S5) Succession strategy of ownership business; (S6) Gaining experience in other ICT-based firms; (S7) Adopting professional management starting with the second successive generation. From the perspective of the eight family businesses analyzed, *only some strategies are valid*, the last two succession strategies needing to be agreed upon for reasons related to the safety of keeping control of the firm.

4.3.2. Q1 discussions

S1. Preparing the successor/s. In training the successors, the leader's family generally believes they must be prepared for life and have solid technical-economic training to offer them more opportunities. They are oriented towards completing their studies in intellectual capacities and the family's material possibilities. The strategy adopted for training the Romanian family business successors aims for education to be correlated with the type of business, its size and the level of technology, according to Table 5. This applies principle only to successors convinced by family to continue the business activity. The others are supported to continue their studies toward the pursued career (CAN, COM, ROM). Founders' descendants of the analyzed companies with higher training adequate to take on some responsibilities in the business and, even if they are not currently active in the business, want to return and integrate as soon as possible (MPR, BRM).

Table 5. The situation of the successors' involvement in the eight ICT-based family businesses

Company	No. of successors	Work in company	Position in company	Education level	Don't work in company	Education level	Want to return to company
ORZ	1	1	General manager	Technical	–	–	–
MPR	2	1	Department manager	Economic	1	Economic	YES
CAN	2	1	General manager	Technical+ Economic	1	Economic	NO
IMA	1	1	General manager	Economic + Artistic	–	–	–
COM	2	1	Department manager	Technical	1	Economic	NO
BRM	3	2	Department manager	Economic	1	Economic	YES
QUE	2	2	Department manager	Economic	–	–	–
ROM	1	–	–	–	1	Medicine	NO

S2. Early integration of the successor/s. The successor in the company is trained by working alongside the founder (horizontal integration) and gradually taking over his duties. At the same time, the integration of the successor can be vertical, as he acquires experience in several departments of the company.

S3. Strategies for maintaining successors in the company. The leaders of ICT-based businesses care that the successors are well trained in the company's field of activity and have superior technological, economic and financial skills, as a guarantee of the company's development in the future. In addition, they must possess strong digital skills at the level of business requirements. The articles and analyses of recent years emphasize that the education level of successors of ICT-based family businesses in Romania is correlated with the size of the business, complexity, level of technology and financial capacity. Table 5 shows that in small and medium-sized businesses, the succession took place quickly, in a simplified way, at the time set by the founder and accepted by the successor. In general, there were no problems of competition among the successors, but their education was directed towards the current and future needs of the company. Therefore, to keep the successors in the company, they are given management responsibilities in different company departments.

S4. Postponing the succession until the economic environment becomes stable and predictable. Some family business leaders believe their successors must be sufficiently prepared for performance management in the current economic conditions. In addition, all leaders agree that during major changes in the economic landscape, they would delay starting the succession process.

S5. Succession strategy of ownership business. All leaders want to avoid future discussions, misunderstandings and conflicts and try to share the family inheritance as balanced as possible. In the case of ownership, the practice is to divide into shares according to the law.

S6. Gaining experience in other companies. In general, gaining experience in other companies for the successors is not widespread for fear of their recruitment. However, most young professionals are recruited by large and international companies right out of college, and the income and additional benefits make only some of them want to take over the responsibility of the family business.

S7. Adopting professional management. The idea of adopting professional management is rejected by the business leaders, who believe that they will lose control over it, and by the employees, who see their jobs in jeopardy.

4.4. (Q2) Is the level of formal education a sufficient criterion to decide the successor in an ICT-based family business?

4.4.1. Q2 results

The second research question analyzes the leaders/general managers' opinion regarding the formal education of successors and whether this is a sufficient condition for selection as a successor.

Table 6. Successor training and selection criteria in family businesses

Field of activity	Book Publishing				Transport	Bakery	HORECA	IT
Company's name	ORZ	MPR	CAN	IMA	COM	BRM	QUE	ROM
Formal education of Successors	Higher education				Higher education			
	Technical	Economic	Technical Economic	Economic Artistic	Technical Economic	Economic	Economic	Medicine
How to integrate the successor into the company?	Horizontal and vertical integration				Horizontal and vertical integration			
Successor selection criteria	Descendants of the founder, ICT skills, managerial abilities				Degree of kinship (sons), ICT competencies, managerial skills			

From the answers provided by the leaders of the eight family businesses, briefly presented in Tables 4 and 6, the paternalistic-traditionalist but also realistic and cautious type of thinking is noticeable.

4.4.2. Q2 discussions

All leaders agree that higher level formal education and ICT skills are strictly necessary for the successor at this stage of very rapid technological development. In addition, it is considered that an essential step of his education is the vertical and horizontal integration in the company. The successor must know the company's

departments well, work for a sufficient period alongside the founder (horizontal integration) and gradually take over his duties (shadow work).

The general managers (successors) of the companies CAN, IMA, COM, emphasized that the period of integration in the company prepared them more than the academic studies for taking over the company's management without significant problems. They believe that the influence of the family, the attitude and the support of the employees represented confirmations for the leader's final decision. In addition, the successor must have managerial and ICT skills and experience in recognizing opportunities, taking advantage of them and devising strategies for restructuring and streamlining the company.

It is recognized that the main criterion for choosing the successor is the degree of kinship, generally a direct descendant (son, daughter), and the shared vision of the company's future development strategies from the point of view of activity, digitalization, and technology.

There is a clear difference between the family businesses in the book publishing industry and those in the technology-based industries presented in this study. This difference comes from the opinion of the leaders in the non-book publishing industry who believe that an essential criterion for the selection of the future leader consists in his (the successor's) native inclination towards the company's essential activity (COM - technical inclination towards machines and specialized equipment, HORECA – the inclination to cook, BRM – the inclination to prepare bakery products, ROM – the inclination towards IT). They emphasized that their passion (inclination towards the basic activity) pushed them to establish the business.

In parallel, the leaders of the book publishing industry consider the successor's abilities to manage the company and discover new opportunities to be more critical.

However, the leaders conclude that in the end, higher education of the successors is necessary because the business environment is much more advanced now and the competition is fierce, which implies multiple skills of the successor so that the company can be seen.

This choice ensures the maintenance of the business in the family heritage and increases its cohesion and the degree of involvement in the business.

4.5. (Q3) Is succession a way of implementing innovative strategies to ensure business continuity and growth?

4.5.1. Q3 results

Through the succession process, it is generally not only the business transfer to the next generation that is aimed at but also the development of the business in the future. Thus, the leaders of the two business groups interviewed stated that the post-succession strategic changes, also agreed by the successors, can be grouped into three categories:

- Modernization and digitization of the business;
- Efficiency of the activity;
- Business growth and development.

In the following tables (Table 7a and Table 7b), the post-succession strategies pursued in the book publishing industry (a) and the non-publishing industry (b) are briefly presented.

Table 7a. Post-succession strategy changes (Book Publishing Industry)

Strategy	Modernization of publishing activity		Restructuring and streamlining		New products
Domain Publishing house	Digital technology	Specialized software	Online activity	Redundancies / Reorganizations	E-books personalized editions
ORZ	Yes	Text/image editing; Video communication applications	E-marketing; Work from home	Technical unemployment	–
MPR	Yes	Text/image editing; Video communication applications	E-marketing; Work from home	Technical unemployment	E-books 2016 - 2017
CAN	Yes	Text/image editing; Video communication applications; ERP software	E-commerce platform; E-marketing	Technical unemployment; Redundancies	–
IMA	Yes	Text/image editing; Video communication applications; ERP software	E-commerce platform	–	–

Table 7b. Post-succession strategy changes (Non-Book Publishing Industry)

Domain Family business	Refurbishment	Digital technique	Activity efficiency	Business growth	Reorganization
COM	Fleet expansion of trucks and machinery	Laptops, Truck racing software	Optimization of truck races and fuel consumption	New contracts and shipping lines	Yes, redundancies
BRM	Modernization of milling machines; Car fleet expansion	Laptops, Printers, ERP software	Activity reduction in unprofitable sectors; Temporary work in 2 shifts	Market expansion; Product diversification	Yes, redundancies
QUE	Replacement of specific HORECA equipment	Laptops; Management software	Reduction of current expenses	Technical unemployment; Redundancies	Yes, technical unemployment
ROM	Digital technology for working from home	Laptops; Video communication applications	Reduction of current expenses	New contracts and IT programs	–

4.5.2. Q3 discussions

a) Discussions about the Book Publishing Industry

The development and qualitative leaps of the book publishing industry in recent years have been based almost exclusively on the facilities offered by digital technology. Thus, all stages of book production are based on computers, peripherals, and specialized software, just like the economic-financial activity.

Modernization of publishing houses involves using the latest digital technologies and high-performance software (for editing, graphics, and ERP), according to Table 7a. A significant leap in the book publishing industry is expected from incorporating artificial intelligence (A.I.) into the publishing activity in content production and launching new products such as e-books based on works created by A.I.

Restructuring and streamlining book production and sales is an ongoing concern of publishers due to the high costs of distribution and sales and the ever-decreasing interest in reading. Interest is low due to the competition of various forms of entertainment promoted by the media and the Internet and the meager incomes of the majority population.

The ways to optimize the activity are laying off redundant staff, working from home and transferring some departments and activities, such as promotion, sales, etc., to the online environment. The transfer to the online environment, working from home and implementing digital and ICT solutions have allowed restructuring by reducing the book value chain.

During the isolation period from the pandemic, most publishing houses applied technical unemployment by rotation but also made layoffs due to the drastic decrease in book sales.

The hope of growth and development of the publishing business has been reduced for small and medium-sized firms due to the general economic conditions (reduced market, language without international circulation, drastic decrease in population income).

The strategy of publishing house leaders focused on specialized software acquisition for the book offer diversification, the careful selection of published authors and children's books. The e-book field is underdeveloped due to the high competition from Internet sites that offer millions of free books.

b) Non-book publishing industry discussions

Table 7b shows that the strategies of non-publishing industry leaders are focused on re-engineering the business, adopting digital technology for the technical-economic and financial records of the company, as well as restructuring and developing the business.

Business re-engineering aims to renew or supplement the technology used with superior technology, ensuring increased activity efficiency.

The concern for business digitalization is also understood as business modernization, significantly increasing business efficiency. This fact implies the provision of laptops, peripherals, specialized software, and telecommunications equipment for decision-making and maintaining the connection between departments.

The activity efficiency is a constant concern of these enterprises, reached in the current economic conditions at the limit of profitability. The adopted strategies aim at digitization, reorganization, reduced expenses and consumption, restructuring and staff redundancies.

Business development is seen in a particular way by each business:

- COM – expansion of transport lines and offer adaptation to customer requirements;
- BRM – expansion of product sales market and diversification of the product offer;
- QUE – the opening of a new HORECA unit;
- ROM – acquisition of new IT program contracts with companies and institutions.

5. Strategic implications and recommendations for family business leaders

The issue of succession in ICT-based family businesses in Romania has been quite challenging in recent years due to rapid and unpredictable changes in the market. Thus, the Covid-19 pandemic, the increase in the prices of energy and raw materials and the war in Ukraine have caused significant disruptions to the economic environment, with no prospects of recovery in a short period.

Family businesses in Romania have been established since 1990, and some have achieved or are in the process of attaining the first succession. Most leaders need to be more experienced in leading this process, and many need to be made aware of its importance to the future of the ICT-based firm. These are the most important causes for the failure of business transfer to a new generation.

Founders don't have many options for selecting a well-trained successor because of the reduced selection base of the successor due to the small number of successors who want to take over the management of the company and due to the Romanian system of technical and entrepreneurial education, not sufficiently adapted to the current and future requirements of society.

Even if the passion of the leaders leads to a business establishment, for the success of the business transfer process to the next generation, they must focus equally or less on the successor's inclination on the field and more on preparing successors for their future leadership role by ensuring a superior/higher technological education in the field of companies' activity and by completing studies with specializations in the economic-financial field. The high speed of the emergence of new knowledge in various areas requires periodic updating of knowledge by participating in courses, conferences, etc., on issues of interest to the company (continuous learning/long-life learning).

It is also necessary for the successors' involvement through horizontal integration (shadow-work) in the strategies development regarding re-technology, digitization, diversification of the range of products and services and market expansion so that they gain confidence in their capabilities.

The management problems of family businesses and companies, in general, will only improve once Romanian higher education is reformed according to established models from technologically advanced countries.

Conclusions

The characteristic aspects of the succession process in ICT-based family firms in Romania have remained the same during this period of significant changes in the economic field.

Tiny, subsistence businesses, which often do not provide or only supplement family income, are run by people who have only attended elementary school, a vocational school or high school. Small businesses with a few employees outside the family count on successors with economic or management studies. The leaders and successors of medium and large companies, especially those in technology, possess technological, economic, and financial skills, sometimes acquired at higher schools abroad.

The model of the succession process is also correlated with the size and complexity of the business and the company's future development strategy. This model will focus on three essential aspects: the proper successor, their training, and their involvement in the activity.

Given the need for more Romanian family business leaders' experience in business succession, they are reluctant to approach new, unverified strategies in the current economic conditions. Under these conditions, most founders resort to the traditionalist, simplified succession strategies, also demonstrated by the opinions of the eight family business leaders.

All succession strategies are designed around three fixed landmarks: (i) Choosing the successor within the family, (ii) the superior training of it and (iii) early involvement in the business. *Establishing the successor* (i) is a challenging problem due to fear of losing business control and because of the small number of descendants eager to take over the business management. *The successor preparation* (ii) is directed, in essence, to areas that will first ensure access to as many career opportunities and secondly for knowledge of interest for the business. The condition fulfillment implies a great diversity regarding certain aspects of succession strategies. The current trend is to prepare the successors in the essential fields necessary for the business (economic, financial, technological) and the ICT-based industry that ensures the connection between the critical components in current society, economy, administration, and research. If in the Book Publishing Industry, the ITC-based component is essential (the field is based on cutting-edge digital technology), in technology-based companies, this is just a critical help and an aspect of modernity. The modalities of *successors' involvement in the business* (iii) are strategic aspects of their preparation for the future leader's role in the company. Early involvement leads to a thorough knowledge of the activity, and the new generation mentality can bring significant improvements thanks to the updated notions and ICT skills acquired in universities in the country and abroad.

In this period of incredible economic transformations, due to the international situation that creates significant uncertainties in the short and medium term, even finding the ideal successor and carrying out the succession does not guarantee the business success and growth in the future due to the increasingly aggressive competition from the networks of business people, politicians and repressive bodies (police, judiciary) and control and regulatory bodies of the state. That is why family business leaders (managers) are primarily focused on keeping the company in the market and reducing costs. Succession is not a priority concern in times of global economic recession. For these reasons, the succession situation in family businesses in Romania is much delayed, and there are no definitive studies on this process.

Analyzing the responses of the two groups of businesses reveals a relatively identical view and practices towards the succession stages. Thus, the process is characterized by paternalism, traditionalism, care towards successors and the common heritage, these being also fundamental elements of Romanian people's education. Also, the strategy for maintaining control of the family business is that the designated successor be one of the

leader's direct descendants and accept the extended family. An important thing to mention is that the leader establishes the strategy for preparing the successor to take over the company management.

The strategy of adopting professional management, as well as attracting investors from outside the family, are seen as safe ways of decreasing or even losing control over the family business. However, digitization represents a common strategy of all analyzed companies, essential for modernization.

To clarify the research questions, the conclusions that emerged from discussions with leaders of the two groups of family businesses are presented below.

Q1: Given the significant changes in the economic field in recent years, *new strategies have yet to appear* in the succession process compared to those presented above. Instead, leaders emphasize the formal and informal education of successors, the training level being an essential element of the succession strategy. In this situation, many founders consider there are better times to carry out the business succession. They must be convinced that their successors are sufficiently well prepared to deal with the problems generated by an unstable and unpredictable economic environment. The strategy adopted by them in the matter of succession is to postpone or even block the process and prepare the successors for activity in a turbulent market.

In conclusion, the two analyzed companies' leaders had similar strategies regarding the succession process. The succession strategies were oriented towards superior training of successors in areas of interest for the business, their responsibility through early involvement in firm management and postponing the succession process in the current unstable economic conditions. The leaders use these succession strategies in ICT-based family businesses because they consider the successors' skills in ICT, economic and financial fields, as well as familiarity with the firm's processes, as the most critical assets in the takeover of the business.

Q2: All leaders agree that higher education alone, regardless of level, is *not a sufficient condition* for selecting a successor in an ICT-based family business, both because of its lack of adaptation to the present and future requirements of high-performing management and the lack of leadership training programs for economy, administration, politics, etc. Indeed, a successor with a solid economic-financial education, with digital skills, who understands the evolution of the market, the technological impact, the business environment, the regulations of the political factor and in addition, has leadership skills in recognizing opportunities, taking advantage of them and in developing business restructuring strategies, represents the person sought by any leader to succeed him in controlling the business.

However, these aspects do not guarantee the success of the succession process nor the development of the business in the future due to the specific political and economic conditions in Romania, as well as the interests and expectations of the family, often in contradiction with the strategic needs of the business.

Q3: Post-succession strategies are focused in this period on the re-technology, digitization and restructuring of companies as essential steps in their modernization and efficiency. The development of artificial intelligence and the inclusion of specific segments in business activity will substantially change the technology-based and ICT-based family business sector, significantly influencing education and social life.

In conclusion, due to the objective conditions in the Romanian book publishing industry and the rapid evolution of the digital technology that is the basis of the book publishing activity, the post-succession strategies of the analyzed publishing houses focus in particular on the business modernization and digitization, increasing the quality of the finished product (the written book) and maintaining market position through niche publications. Today's accelerated development of A.I. programs will pressure the book publishing industry's artistic and production departments. Adopting these facilities will radically change the field, allowing content authors and graphic artists to "take off". A.I. will be essential in the successors' training program in developing new publishing products (works created by A.I.) and establishing new hierarchies in the book market.

As for ICT-based family businesses in the non-book publishing industry mainly aim to adapt to the technological level in the field to stay in the market. The general trend is towards digitization and computerization of enterprises for activity efficiency and interaction with authorities.

Therefore, managers of ICT-based family businesses use or have used the succession process to implement new strategies adapted to the development of their firms.

The novelty of the study consists of an overview of the challenges and positives that must be considered by family business leaders who wish to begin the succession process. The originality of the research comes from analyzing ICT-based family businesses in the book publishing industry.

7. Limitations and further research

The *limitations* of this article result from the lack of studies and official data regarding the succession process in family businesses in Romania, the strategies adopted by leaders to maximize the beneficial effects of the process, and the vague information presented by the studies of foreign analysts, which do not allow a clear picture of the phenomenon and the problems related to its development in the current period to be outlined.

At the same time, the small number of cases analyzed and compared following our research through online questionnaires and face-to-face discussions with leaders did not reveal new aspects or innovative strategies in implementing the succession process.

Another area for improvement is the small amount of data analyzed due to the leaders' disinterest in responding to requests, evasive answers and even avoidance of answers to specific questions.

The data obtained did not allow a rigorous analysis of some aspects of the succession process, their interpretation being more subjective.

Future research should aim to create a consistent database on technology and ICT-based family businesses, succession strategies and status.

In most ITC-based businesses, the succession strategy will emphasize the assimilation and continuous use of newly emerging ICT knowledge. Thus, future research identifies and emphasizes the importance or influence of being an ICT-based business in choosing the succession strategy.

Another future research consists of finding a link between the type of succession strategy and how ICT-based family business is.

Preparing databases about family businesses in Romania, ITC-based or technology-based businesses, and their classification according to their industries represents future research necessary for creating articles and studies based on accurate and constantly updated data. Comparative studies of the succession process in the book publishing industry in Romania and other Eastern European countries could also be conducted.

Last but not least, predictions can be made on the expected results following the implementation of artificial intelligence in the book publishing industry and other technology-based industries, including the ICT-based industry.

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List of abbreviations

Abbreviation	Explanation
AI	Artificial Intelligence
BRM	Symbol of a company active in the food processing (bakery) industry (anonymized)
CAN	Symbol of a company active in the publishing industry (anonymized for confidentiality)
COM	Symbol of a company active in the transport industry (anonymized for confidentiality)
ERP	Enterprise Resource Planning
GDP	Gross Domestic Product
II	Individual enterprise (according to the Romanian law)
IF	Family enterprise (according to the Romanian law)
IMA	Symbol of a company active in the publishing industry (anonymized for confidentiality)
MPR	Symbol of a company active in the publishing industry (anonymized for confidentiality)
OECD	Organization for Economic Cooperation and Development
ONRC	Office of the National Trade Register
ORZ	Symbol of a company active in the publishing industry (anonymized for confidentiality)
PFA	Natural person authorized to run own business (according to the Romanian law)
QUE	Symbol of a company active in the hospitality (HORECA) industry (anonymized)
ROM	Symbol of a company active in the information technology industry (anonymized)
SME	Small and Medium Size Enterprise
SRL	Limited liability company (according to the Romanian law)

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THE TRANSFORMATION OF THE COUNTRY'S HIGHER EDUCATION SYSTEM UNDER THE INFLUENCE OF MIGRATION PROCESSES*

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Abstract. A high level of instability in world processes characterises the 21st century. This is caused by innovations in scientific and technological progress and the negative consequences of political and economic crises. New challenges have arisen for the higher education system, which determines the need to transform a traditional university into an entrepreneurial structure that must adapt to changes in the external environment. Migration processes significantly influence countries' higher education systems (HES), and their analysis and modelling aim to create competitive advantages for HES and universities. The article is devoted to analysing and forecasting trends in the development of universities in Ukraine and Slovakia, depending on the preferences of general and educational migration. Research methods include systematic and conceptual approaches, monographic analysis, index and cluster analysis, econometric modelling, taxonomy method, and statistical data analysis. It is substantiated that migration processes have a steady upward trend, and the progressive growth of migration of Ukrainians to Europe is provoked by Russian aggression against Ukraine. It has been determined that the search for countries with a high quality of life and education causes the migration preferences of the population. An analysis of the attractiveness of HES in Ukraine and Slovakia was carried out, and the strengths and weaknesses were identified. Models of the level of attractiveness of HES in Ukraine and Slovakia have been constructed, and promising directions for their development have been identified.

Keywords: higher education system; migration; HDI; GKI; educational migration trends; conceptual model; cluster analysis; integral indicator; adaptive short-term forecasting method

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JEL Classifications: A22, C01, C32 E02, O11, O15

1. Introduction

The current stage of development of the world's higher education system (HES) is characterised by significant challenges provoked by political and economic instability in various regions of the world and technological changes of the 21st century. Global shocks such as COVID-19 and military conflicts in Asia and Europe (for example, the Russian and Ukrainian conflict) have created a new round of economic instability in countries

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worldwide, powerful migration flows that pose new challenges to higher education. The HES of countries that are at the focus of such conflicts, in particular Ukraine, are faced with both financial problems caused by the deteriorating state of the economy and the problems of a significant outflow of applicants, students, and teachers caused by a sharp decline in the quality of life and the general situation threats to life. Against this background, universities must not only localise the consequences of crisis phenomena but also maintain the ability to adapt to modern information and communication innovations to support the quality of the educational process.

Migration is and will remain one of the globalising problems of the world in the 21st century. Openness to the world, on the one hand, provided the citizens of the countries with new opportunities. Still, on the other hand, it created new risks, primarily associated with mass emigration of the population abroad. Today, European countries are criticised for the lack of a coherent and coordinated policy in the face of the refugee crisis and for insufficiently thought-out response mechanisms, which seriously limits timely decisions and effective implementation of migration policy. As a result, the volume of international migration is rapidly increasing and significantly impacting the sphere of economy, education, and social processes. In the economic sphere, migration can contribute to the expansion of the scale of the shadow economy, worsening the situation in the labour market and displacing workers from among residents.

The emergence of educational migration is a manifestation of migration movements in the educational environment. The deepening of the internationalisation of economic relations and the development of integration processes led to the expansion of opportunities for study and academic exchanges abroad and the demand for high-quality international education services. The growing role of intellectual capital in developing national economies actualises studying the causes, consequences and prospects of international educational migrations and academic mobility. Since most migrants are young people, that is, the most active part of the population, prone to self-development and adaptation in a multicultural environment, their loss has extremely negative socio and economic consequences for any economy. In addition, the globalisation of the world educational market has caused a new round of competition between universities for "young minds". High-quality higher education in the conditions of a significant increase in the demand for a knowledge-intensive workforce, on the one hand, becomes a critical competitive advantage of the state and, on the other hand, creates a competitive advantage of the attractiveness of a particular university for applicants. Therefore, analysing the impact of migration processes on the further development of the country's HES is an urgent scientific research problem.

2. Literature review

The problems of transforming the HES are the focus of research by modern scientists. The emergence of the phenomena of the "knowledge society" and the "knowledge economy", the global trend of digitalisation of society and the economy, the rapid diffusion of information and technological innovations into all spheres of life of civilisation, the growing demand of the labour market for a knowledge-intensive workforce - these are a few of the challenges that require a radical transformation of countries' higher education systems and adaptation of the activities of universities to them. In these new conditions, universities must perform their historical function in a new way - to be a source of new knowledge and its transfer to future generations.

A characteristic feature of the transformation of the global higher education system in recent decades is the transformation of a traditional university into an innovative and active entrepreneurial organisation open to technological changes and the digitalisation of society's socio and economic processes.

Universities around the world are facing the challenges of digital transformation. They must adapt to them while maintaining and improving the quality of educational services for students, employees, and key stakeholders. This requires the development of a strategy for digital transformation both at the state level and at the level of a separate higher education institution, the formation of new information and communication skills among students and teachers, and the digital maturity of society as an environment in which the university operates. According to many scientists (Berman and Bell, 2011; Shelepaeva, 2023; Bucata, Popescu, Tileaga, 2022; Toktarova, Rebko, Semenova, 2023), the success of such a transformation and overcoming challenges depends on the readiness of universities for changes, the availability of resources to improve the quality of educational

services and the expansion of partnership relations between HES and stakeholders. Today, more than ever, countries face the problem of forming a state migration policy capable of minimising risks and, at the same time, promoting the use of the positive effect of migration. Doing so in the face of resource scarcity and economic instability is extremely difficult but vital for every country. The issue of migration, the legal aspects of regulating migration processes, and the development of an effective migration policy have been studied at various times by both domestic and foreign scientists, namely Górny, Kaczmarczyk (2019), Vollmer (2017), Buckler, Swatt, Salinas (2009), Malynovska (2022), Libanova (2018), Libanova, Pozniak, Tsymbal (2022), Simakhova, Tserkovnyi (2022) and others. In particular, Hobolt (2018) notes in his research that migration began to be actively discussed at the national level in connection with the so-called "refugee crisis" and the Brexit referendum. Karolewski and Benedikter (2017) emphasise that public debates on migration issues are becoming increasingly important and determine the solution to new migration policy issues. The problems of external labour migration in different periods were studied in detail in the works of such scientists as Theoharides (2020), Coulombe, Trembley (2006), Haan, Jin, Paul (2023) and others. However, analytical studies of migration processes since the start of the COVID-19 pandemic are fragmentary. Problems and challenges of educational mobility and educational migration are presented in the works of Arif (2022), Hatton (2014), Cichorzewska (2022), Zatonatska et al. (2022). The authors consider educational migration as a tool for implementing strategic human capital management and the degree of influence of international educational migration on territorial economic systems. In addition, today, the market for educational services is characterised by fierce competition for applicants, which, of course, activates educational migration, especially the departure of young people abroad to study. A large number of scientists, namely Suleiman (2023), Ozturgut (2011), Balalaieva et al. (2023), believe that one of the problems of educational migration is the low level of quality of education in the country. That is why all aspects of the impact of educational migration processes on the country receiving migrants and on the donor country in terms of both the national economy and individual regions of the world require in-depth research.

3. Research objective and methodology

The study is devoted to analysing and forecasting trends in the development of the HES in Ukraine and Slovakia, depending on the preferences of general and educational migration.

To achieve the goal of the study, the following tasks are solved:

1. Study of the characteristic features and trends of migration processes in the world, identifying the dominant causes of migration;
2. Classification of countries of the world according to the level of quality of life and quality of education using the human development index (HDI) and the global knowledge index (GKI);
3. Determination of trends in educational migration in Slovakia and Ukraine;
4. Analysis of trends in the development of the HES in Ukraine and Slovakia;
5. Modeling changes in HES of Ukraine and Slovakia, analysis of results.

The solution to the tasks is based on the proof of the following hypotheses:

1. The transformation of countries' HES should correlate with trends in the development of civilisation, global processes of digitalisation of the economy and society, and current and future demands of the labour market.
2. Increased political and economic instability in the world is provoked by increased migration processes, including educational migration processes, which, in turn, require the modernisation of HES in each country.
3. Global and national processes of educational migration are sensitive to the quality of life and the quality of the country's HES, which determines the migration preferences of the population.
4. The countries' governments should determine the readiness of the countries' HES for the transformations of the 21st century to create a favourable legislative and regulatory environment for such changes and the readiness of universities to introduce information and communication innovations into their processes.
5. Tools for monitoring and modelling development trends in the country's HES need constant improvement, depending on the specific trends in changes in the world's HES.

Research methods include system and conceptual approaches, monographic and comparative analysis, analysis and synthesis, index and cluster analysis, econometric modelling, taxonomy method, statistical data analysis, and visualisation tools. The conceptual model of the study is shown in Figure 1. To solve the above problems,

the study used international indices, namely the HDI and the GKI, education statistics from the UNESCO Institute for Statistics and the World Bank, Eurostat statistics for the period 2000-2022, migration statistics from UNHCR (UN Agency for refugees) for the period 1992-2022. To classify countries by quality of life, the study used the *Human Development Index (HDI)*. The HDI is a comprehensive measure of a country's level of human development and is, therefore, sometimes used synonymously with concepts such as "quality of life" or "standard of living". It was developed in 1990 and published by the United Nations Development Program in the Human Development Reports.

Contents of the model stages

Model and statistical research tools

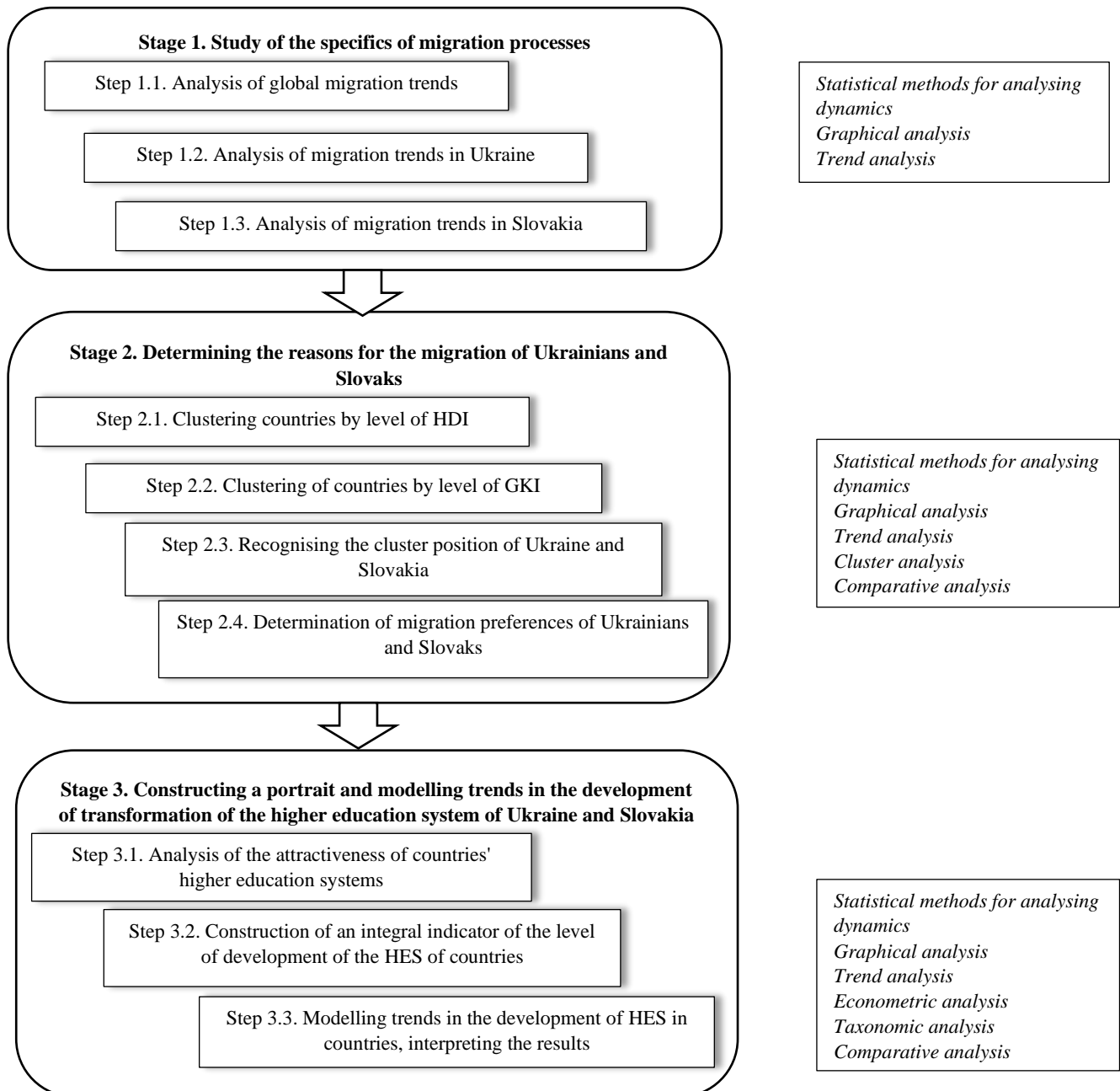


Figure 1. Conceptual research model
Source: compiled by the authors

The index measures the country's achievements in the field of healthcare, education, real income of its citizens and when calculating, it takes into account indicators in the following areas:

- Long and Healthy life, measured by life expectancy at birth.
- Knowledge, measured by adult literacy rate and gross enrollment ratio.
- A decent standard of living, measured by gross domestic product (GDP) per capita in US dollars at purchasing power parity (PPP).

The formation of this index is evolutionary. Thus, until 2013, the HDI was called the "Human Development Potential Index". The following indices are currently calculated (Human Development Report 2021/2022):

- *Human Development Index (HDI)*.

$$HDI = \langle \text{Life expectancy index, Education index, GNI index} \rangle$$

- *Inequality-adjusted Human Development Index (HDII)*.

$$HDII = \langle \text{Inequality-adjusted life expectancy index, Inequality-adjusted education index, Inequality-adjusted income index} \rangle$$

- *Gender Development Index (GDI)* contains these indicators for women and men.

$$GDI = \langle \text{Human Development Index (female), Human Development Index (male)} \rangle$$

- *Gender Development Index (GII)*.

$$GII = \langle \text{Female gender index, Male gender index} \rangle$$

- *Multidimensional Poverty Index (MPI)*.

$$MPI = \langle \text{Intensity of poverty, Headcount ratio} \rangle$$

To calculate a country's HDI, the formula for the geometric average of the three indicated indicators is used. HDI values range from 0 to 1, making it possible to rank countries according to the quality of the population's life.

The *Global Knowledge Index (GKI)* is used to measure the performance of a country's education system. It was created in 2017 and is calculated for 132 countries. The index allows you to systematically monitor the impact of knowledge on the socio and economic development of the country.

In 2022, this index was modified. Table 1 shows the structure of the index and changes in its components.

Table 1 shows that changes in the structure of the index occurred in the composition of its pillars, which is aimed at increasing the degree of accessibility of information while maintaining the maximum number of countries in the survey. The total number of indicators by which the index is calculated is 155.

They are monitored based on data from 40 international databases, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO); the World Bank; the International Telecommunication Union (ITU); the World Economic Forum (WEF); the International Monetary Fund (IMF); the Organisation for Economic Co-operation and Development (OECD); the International Labour Organization (ILO) and other United Nations agencies and international organisations.

All this makes it possible to use this index in studies of the effectiveness and impact of knowledge on the country's development.

Table 1. Global knowledge index structure

Sectoral indices/ Sub- indices	2017	2022
	Old pillars	New pillars
Pre-university education	knowledge capital	knowledge capital
	educational enabling environment	educational enabling environment
Technical and vocational education and training (TVET)	formation and professional training	TVET components
	features of the labour market	TVET labour market
Higher education	inputs	inputs
	outputs	learning environment
Research, development and innovation (RDI)	research and development	inputs
	innovation in production	outputs
Information and communications technology (ICT)	Societal innovation	impact
	ICT inputs	infrastructure
	ICT outputs	access
		usage
Economy	knowledge competitiveness	economic competitiveness
	economic openness	economic openness
Enabling environment	financing and value-added	financing and domestic value-added
	political and institutional	governance
	socio-economic	socio-economic
	health and environment	health and environment

Source: Human Development. Report 2021/2022 (UNDP, Human Development Report)

The general structure of the index can be represented by the following tuple:

$$GKI = \langle \text{Sectoral indices}; \text{Pillars}; \text{Sub-pillars}; \text{Variables} \rangle$$

The weight of each sector index is 15%, and the weight of the Enabling Environment sub-index is 10%. The formula for calculating GKI is as follows:

$$CI = \sum_{j=1}^n w_j * SC_j$$

where CI - proposed composite indicator to be computed (sub-index, pillar or sub-pillar); w_j - the relative weight of the sub-component SC (pillar, sub-pillar, or variable); n - the number of sub-components aggregated to form the composite indicator. To determine the direction of development of the HES in the country, the study uses the "Higher Education" sub-index. In fact, the HES is a key element of economic knowledge. It forms the knowledge and skills necessary for the modern and, most importantly, future development of civilisation, the labour market and society's needs. The tuple structure of the sub-index (I_{HE}) and its component is as follows:

$$I_{HE} = \langle \text{Input (Expenditure, Enrolment, Resources); Learning environment (Diversity and academic freedom, Equity and inclusiveness); Output (Attainment, Employment, Impact)} \rangle$$

The total number of indicators that assess the level of development of higher education in the country and its impact on the development of society is 19 indicators. The information base of the GKI study is made up of reporting data "The Global Knowledge Index" 2020-2022, which was developed by the United Nations Development Programme (UNDP) Regional Bureau for Arab States (RBAS), One United Nations Plaza, NEW YORK, NY10017, USA and Mohammed Bin Rashid Al Maktoum Knowledge Foundation (MBRF) [The Global Knowledge Index 2020-2022].

To identify groups of countries that are homogeneous in terms of GKI level, the study used *cluster analysis*, namely the *k-means method*. This made it possible to identify stable groups of countries according to the quality of education and its impact on the development of society. The k-means method belongs to the group of iterative

methods of non-hierarchical clustering. Non-hierarchical clustering consists of iteratively dividing a set of initial data into a certain number of individual clusters, which the researcher specifies. The advantages of this method are simplicity and speed of use, clarity and transparency of the algorithm. The clustering quality is checked using the following functionals (Table 2).

Table 2. Clustering quality functionals

Functional name	Calculation formula
The sum of squared distances to the center of the cluster	$F_1 = \sum_{l=1}^k \sum_i d^2(X_i, \bar{X}_l), \quad F_1 \rightarrow \min$
The sum of internal cluster distances between objects	$F_2 = \sum_{l=1}^k \sum_j d_{ij}^2, \quad F_2 \rightarrow \min$
Total within-cluster variance	$F_3 = \sum_{l=1}^k \sum_j \sigma_{ij}^2, \quad F_3 \rightarrow \min$

To analyse and model trends in the development of the HES of Ukraine and the Slovaks, the study has used the *taxonomic method of the development level* (Pluta, 1989). This method was developed by Polish scientists and allows one to assess the level of development of the analysed object in n-dimensional space of indicators. The tool of this method is an integral indicator that reflects the synergistic effect of the influence of various indicators of an object's behaviour from a systemic point of view. The integral indicator varies within the range $[0 \div 1]$ and is interpreted as follows: the higher the indicator value is reduced to 1, the higher the level of development of the object.

The formula for calculating the integral indicator (D_i) is as follows:

$$D_i = 1 - \frac{C_{i0}}{C_0}$$

$$\text{where } C_0 = \bar{C}_0 + 2 * S_0, \quad \bar{C}_0 = \frac{\sum_{i=1}^w C_{i0}}{w}, \quad S_0 = \sqrt{\frac{\sum_{i=1}^w (C_{i0} - \bar{C}_0)^2}{w}}, \quad i = [1 \div w] - \text{number of objects}$$

4. Results and recommendations

Stage 1. Study of the specifics of migration processes

In the conditions of the spread of dynamic globalisation processes, migration is a natural phenomenon and the main feature of the development of all world countries, which threatens the sustainable development of the country's national economy (hypothesis 2). Migration movements are the population's response to changes occurring in any society's political, social and economic life. The appearance, spread and volume of such phenomena indicate the stability or, on the contrary, the instability of political and economic development in the state. To confirm/refute this hypothesis, the study analysed general migration processes in the world and Ukraine and Slovakia from 1992-2022. The source of statistical information is the World Data Atlas and UNHCR.

Step 1.1. Analysis of the number of international migrants in the world made it possible to distinguish two periods (Fig. 2):

The 1st period - 1992 - 2005 is characterised by a tendency to decrease the number of migrants. During this period, the number of migrants decreased by 45%;

The 2nd period - 2006 - 2022 is characterised by a rapid increase in the number of migrants. So, as of the end of 2019, the total number of international migrants was 272 million people (3.5% of the world population), and the largest group among them was labour migrants. In 2013 - 2017, their share in the overall structure of world migration flows was 40%. Thus, during this period, the total number of migrants worldwide increased by a record 35% (8.9 million people), and in 2022 it reached 34.8 million.

In recent years, Europe, including Turkey, has received more than a third (36%) of the world's migrants. Turkey remains the country that received the largest number of migrants. Thus, as of the end of 2022, it was home to

3.6 million refugees, which is more than 10% of all international migrants. Germany is the second country that received almost 2.1 million people, that is, 6% of refugees in the world. The number of migrants in European countries increased to 12.4 million in 2022, compared to 7 million in 2021. This rapid increase was mainly due to the fact that refugees from Ukraine were fleeing the international armed conflict in the country.

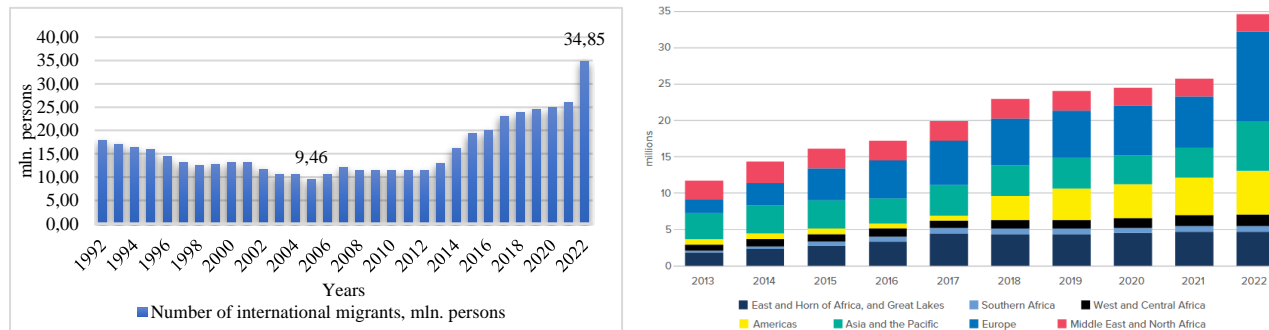


Figure 2. The general trend of international migrants for 1992-2022, million people
Source: compiled by authors based on World Data Atlas and UNHCR

Analysis of the nationality of migrants allowed us to conclude that more than 87% of all international migrants by the end of 2022 came from only 10 countries. Almost 1 in 5 international migrants were Syrians, totalling 6.5 million people. Over 77% of Syrians lived in neighbouring countries, including Turkey (3.5 million), Lebanon (814.700) and Jordan (660.900). However, at the end of 2022, Ukrainians became one of the main migrants in the world, the number of which amounted to 16% of refugees in the world.

Step 1.2. Migration processes are not a new phenomenon for Ukraine itself. The migration of Ukrainians abroad, especially to Europe, continued throughout the period after 1991. It was mainly labour migration and, as a variant of it, pendulum migration, in which Ukrainians worked either seasonally or part-time; some labour migrants also worked for a long time and worked abroad without returning to the country. The accelerated growth of emigration of citizens causes many negative consequences, the main ones of which are a decrease in the economic growth rate of Ukraine, acceleration of the "ageing of the nation", and slowing down of population reproduction processes. These consequences pose a threat to the economic security of Ukraine in the long term. From 2000 to 2017, 6.3 million people left Ukraine and did not return (3.1 million left through the western border and 3.2 million through the eastern border). In the 2017 Migration Report of the UN Special Commission, it is stated that 5.9 million people have left the territory of Ukraine and are currently in the status of labour migrants in other countries of the world (Fig. 3) (World Data Atlas and UNHCR).

Ukrainian refugees increased from 27.3 thousand in 2021 to 5.7 million in 2022. It was the fastest outflow of refugees since World War II, triggered by the outbreak of full-scale war in Ukraine following the Russian invasion in February 2022. Almost 2.6 million refugees from Ukraine were resettled in neighbouring countries and another 3 million in other European countries and beyond (Fig. 4).

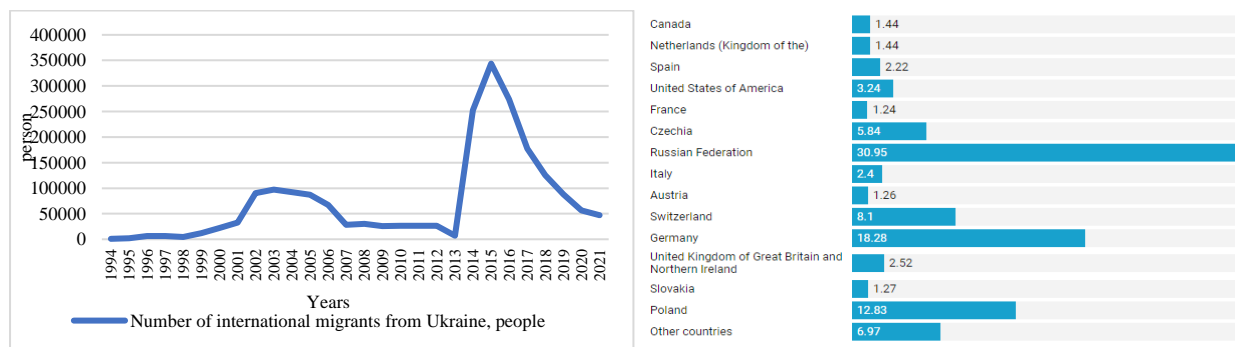


Figure 3. The trend of international migrants from Ukraine for 1992-2022
Source: compiled by authors

Figure 4. The percentage of migrants from the total number of people who left Ukraine for the period 1994 - 2022
Source: compiled by authors

Thus, between 1994 and 2022, 7.49 million people left Ukraine. The analysis made it possible to identify 5 countries to which the largest number of Ukrainians left: the Russian Federation - 2.32 million people (30.95%), Germany - 1.34 million people (18.28%), Poland - 0.96 million people (12.83%), the Czech Republic - 0.44 million people (5.84%) and the USA - 0.24 million people (3.24%).

Step 1.3. Slovakia is considered one of the most economically successful countries in the Central and Eastern region of Europe. Economic reforms and accession to the EU, combined with a significant inflow of foreign direct investment, led to sustained economic growth and new jobs, contributing to a decrease in the number of emigrants (Fig. 5).

For the period 1994-2022, four stages can be distinguished in the migration flows of Slovakia:

1) periods of increased migration from 1992 to 2002 and from 2014 to 2021;

2) periods of decline in migration from 2002 to 2007 and from 2021 to the present.

However, the country has developed a trend of increasing migration, which reflects the outflow of skilled labor abroad. Considering that the aging index of Slovakia is one of the most dynamic in Europe, migration processes pose a threat to the economic development of the country.

For Slovaks, the higher income level in the EU countries compared to Slovakia is a sufficient motivation for emigration. For example, in 2004, Slovakia joined the EU, which improved the country's economic situation and reduced migration flows.

During the period 1994-2022, 14,500 people left Slovakia. Among the migrants is an educated and young workforce. This is the main reason for implementing state measures to reduce the outflow of skilled labour abroad (Fig. 6).

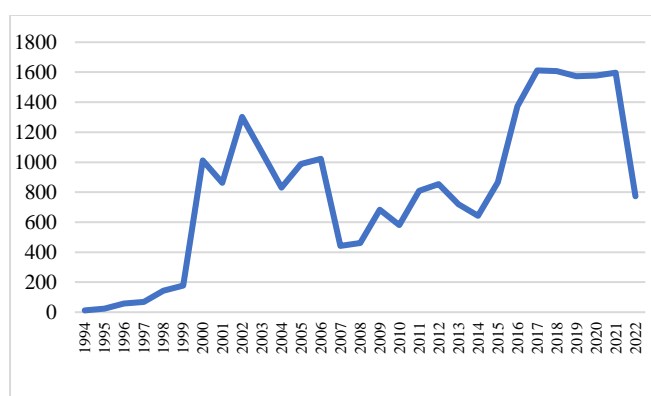


Figure 5. The trend of international migrants from Slovakia for 1994 – 2022

Source: compiled by authors

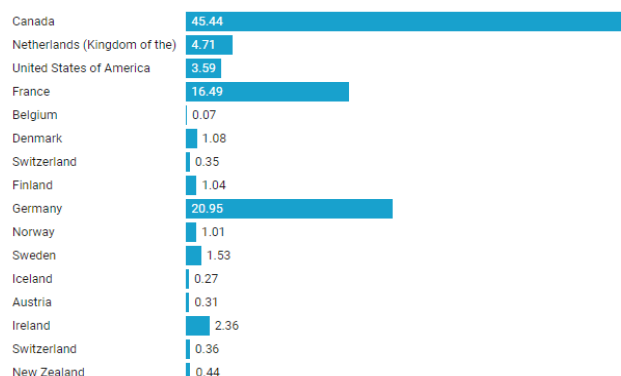


Figure 6. The percentage of migrants from the total number of people who left Slovakia for the period 1994 - 2022

Source: compiled by authors

Almost half of those migrating from Slovakia went to Canada - 36.6 thousand people, which is 45.44% of the total number of migrants. In addition to Canada, the following countries are popular among Slovaks: Germany - 20.95% (3.05 thousand people), France - 2.4 thousand people (16.49%), the Netherlands - 686 people (4.71%) and the USA – 522 people (3.59%).

Comparing migration trends in Ukraine and Slovakia, the following can be noted. Political crises have a significant impact on the volume of migrants from Ukraine. Thus, the surge in the number of migrants in 2014-2015 is due to the situation with the Crimea, Donetsk and Luhansk regions. After 2016, Ukrainians gradually returned home. The trend of migration flows for Slovakia is constantly increasing, which indicates a constant outflow of population to countries with a high quality of life.

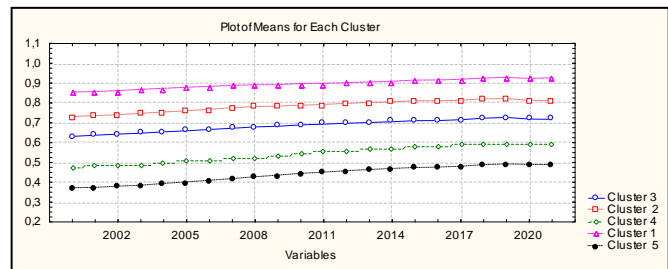
Stage 2. Determining the reasons for the migration of Ukrainians and Slovaks.

One of the research hypotheses (hypothesis 3) is that the population migrates to countries with higher standards of living and education since education significantly impacts a high standard of living in the future. To prove/refute this hypothesis, two international indices were selected in the study - the HDI and the GKI.

Step 2.1. In the study, HDI values were analysed for the period 2001-2021, which made it possible to identify stable groups of countries according to the quality of the population's life. The characteristics of cluster groups and the quality of their division are shown in Fig. 7.

Cluster number	Cluster name	Cluster means
1	the highest level	0.84 – 0.92
2	high level	0.72 – 0.81
3	medium level	0.63 – 0.72
4	low level	0.48 – 0.59
5	the lowest level	0.36 – 0.48

a) Characteristics of cluster groups



b) Cluster mean plot

Figure 7. Characteristics and quality of cluster partitioning

Source: compiled by authors

Fig. 1 shows that 5 clusters were obtained, which have a high quality of partitioning because graphs of average values for the entire analysed period do not intersect. The results of grouping countries into clusters are presented in Table. 3.

Step 2.3. Table 3 shows that Ukraine and Slovakia have been classified as countries with a high standard of living for 10 years.

Despite belonging to the same cluster, the positions of Ukraine and Slovakia have specific differences. Slovakia's average annual HDI growth for 1990-2021 was 0.66%; a similar figure for Ukraine is 0.19% (Human Development Index)

Table 3. Grouping of countries into clusters: HDI

Cluster number	List of countries
1 cluster - the highest level	Japan, Korea, Andorra, Switzerland, France, Luxembourg, Malta, Italy, Spain, Netherlands, Poland, Belgium, Sweden, Czechia, Denmark, Austria, Greece, Estonia, Ireland, Lithuania, Norway, Iceland, Finland, United Kingdom, Slovenia, Liechtenstein, Germany, Canada, United States, Australia, New Zealand, Hong Kong, China, Singapore, Cyprus, Qatar, Qatar, Israel
2 cluster - high level	Libya, Mauritius, Seychelles, Kazakhstan, Armenia, Sri Lanka, Georgia, Barbados, Cuba, Costa Rica, Panama, Trinidad and Tobago, Bahamas, Belarus, Bulgaria, Hungary, Portugal, Romania, Slovakia , Latvia, Russian Federation, Croatia, Ukraine , North Macedonia, Albania, Bosnia and Herzegovina, Serbia, Mexico, Palau, Malaysia, Brunei Darussalam, Venezuela, Argentina, Chile, Uruguay, Bahrain, Kuwait, Oman, Iran, Saudi Arabia, Turkey
3 cluster - medium level	Algeria, South Africa, Egypt, Gabon, Cabo Verde, Tunisia, Botswana, Morocco, Mongolia, Tajikistan, Kyrgyzstan, Uzbekistan, Azerbaijan, Maldives, China, Dominica, Saint Lucia, Saint Lucia, Dominican Republic, Jamaica, Nicaragua, Belize, El Salvador, Moldova, Tonga, Samoa, Fiji, Philippines, Thailand, Viet Nam, Indonesia, Brazil, Colombia, Peru, Ecuador, Paraguay, Bolivia, Guyana, Iraq, Syrian Arab Republic, Jordan
4 cluster - low level	Congo, Ghana, Angola, Kenya, Comoros, Cameroon, Benin, Eswatini, Equatorial Guinea, Zimbabwe, Zambia, Madagascar, Sao Tome and Principe, Mauritania, Namibia, Pakistan, Bangladesh, India, Nepal, Guatemala, Honduras, Micronesia, Kiribati, Papua New Guinea, Solomon Islands, Lao People's Democratic Republic, Myanmar, Cambodia
5 cluster - the lowest level	Rwanda, Guinea, Lesotho, Central African Republic, Burkina Faso, Togo, Sierra Leone, Liberia, Djibouti, Gambia, Cote d'Ivoire, Ethiopia, Burundi, Mali, Chad, Sudan, Malawi, Mozambique, Niger, Tanzania, Senegal, Uganda, Afghanistan, Haiti, Yemen

Source: compiled by authors

Table 4. Values of HDI for Slovakia and Ukraine (2021)

Index Object	HDI	Inequality-adjusted HDI	GDI	GII
Slovakia	0.850	0.803	0.999	0.180
Ukraine	0.773	0.726	1.012	0.200
World	0.732	0.590	0.958	0.465

Source: Human Development Report 2021/2022

Development Report 2021/2022]. As of 2021, Slovakia's rating is 0.85, and Ukraine has a rating of 0.77. Table 4 presents the values of the human development index and its modifications for two countries. Tables 5-7 show the values of the components of these indices for Ukraine and Slovakia.

Table 5. Inequality-adjusted HDI

Index Object	Coefficient of human inequality	Inequality in life expectancy	Inequality- adjusted life expectancy index	Inequality in education	Inequality in income	Inequality- adjusted income index	Gini coefficient
Slovakia	5.2	4.7	0.805	1.7	0.819	9.1	23.2
Ukraine	6.0	5.8	0.748	3.6	0.758	8.5	25.6
World	19.4	13.2	0.686	21.7	0.503	23.2	

Source: Human Development Report 2021/2022

Table 6. Gender Development Index

Index Object	HDI (F/M)	Life expectancy at birth(F/M)	Expected years of schooling(F/M)	Mean years of schooling(F/M)	Mean years of schooling(F/M)
Slovakia	0.847/0.848	78.4/71.5	15.0/14.0	12.9/13.0	24.9/36.8
Ukraine	0.776/0.766	76.7/66.5	15/14.9	11.5/10.7	10.37/16.61
World	0.715/0.747	74/68.9	12.9/12.7	8.4/8.9	12.241/21.21

Source: Human Development Report 2021/2022

Table 7. Gender Inequality Index

Index Object	Maternal mortality ratio	Adolescent birth rate	Share of seats in parliament	Population with at least some secondary education (F/M)	Labour force participation rate (F/M)
Slovakia	5	26.3	22.7	98.9/99.2	47.8/62.0
Ukraine	19	15.6	20.8	96.2/95.8	48.1/63.6
World	225	42.5	25.9	64.2/70.3	46.2/71.7

Source: Human Development Report 2021/2022

Data analysis tables 4-7 allowed us to draw the following conclusions:

1. Slovakia and Ukraine have HDI values above the world average, which indicates their position in the cluster of countries with a high level of human development.
2. Both countries have Inequality-adjusted HDI values above the world average. This is a negative trend. The data in Table 5 shows that countries have problems with only 2 components of the index: Inequality-adjusted life expectancy index and inequality in income. Therefore, governments must create conditions that will reduce inequality in income and life expectancy.
3. The HDI values for Ukraine and Slovakia practically coincide and correspond to the level of the world average, which indicates the existence of equal opportunities for the development of men and women in the

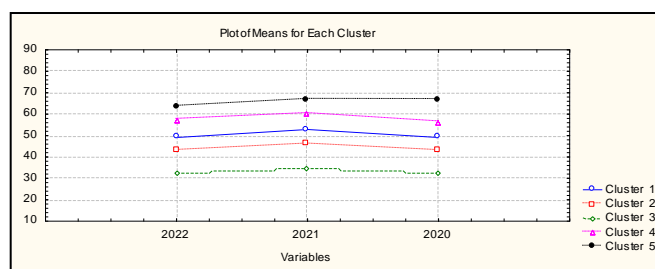
countries (Table 6). A slight decrease from the world average level is observed in Ukraine for the Mean years of schooling (F/M) component, but this does not affect the country's high position in this direction.

4. The values of the Gender Inequality Index components diagnose the absence of inequality in human development for men and women (Table 7). In Ukraine and Slovakia, the state pays close attention to the observance of rights for different gender groups, which creates a society of equal opportunities.

Step 2.2. To identify homogeneous groups of countries according to the level of quality of education and its impact on the development of society, the study used the GKI. The characteristics of cluster groups and the quality of their division are shown in Fig. 8.

Cluster number	Cluster name	Cluster means
1	the highest level	63 - 67
2	high level	57-61
3	medium level	49-53
4	low level	42-46
5	the lowest level	32-35

a) Characteristics of cluster groups



b) Cluster mean plot

Figure 8. Characteristics and quality of cluster partitioning

Source: compiled by authors

Considering that the graphs of average values for cluster groups do not intersect, we conclude that the grouping of countries is of high quality. Table 8 shows the results of classifying countries for the analysed period.

Table 8. Grouping countries into clusters: GKI

Cluster number	List of countries
1 cluster - the highest level	Sweden, Finland, Denmark, Netherlands, Norway, New Zealand, Germany, Australia, Switzerland, Ireland, United States, United Kingdom, Belgium, Iceland, Austria, Hong Kong, China, Estonia, Luxembourg, Japan, Singapore, France, Israel, Korea, Rep, United Arab Emirates
2 cluster - high level	Canada, Spain, Czech Republic, Hungary, Slovenia, Italy, Malta, Lithuania, Slovakia , Portugal, Cyprus, Poland, Latvia, Croatia, Qatar, China
3 cluster - medium level	Greece, Chile, Barbados, Bahrain, Romania, Bulgaria, Uruguay, Trinidad and Tobago, Russian Federation, Ukraine , Belarus, Mauritius, Kuwait, Thailand, Georgia, Moldova, Oman, Malaysia, Serbia, Saudi Arabia, Costa Rica
4 cluster - low level	Brazil, Argentina, Panama, South Africa, Turkey, Bosnia and Herzegovina, Armenia, Mexico, Kazakhstan, Peru, Jordan, Colombia, Guyana, Tunisia, Azerbaijan, Lebanon, Albania, Mongolia, Botswana, El Salvador, Dominican Republic, Paraguay, Philippines, Iran, Islamic Rep, Kyrgyz Rep, Algeria, Egypt, Arab Rep, Ecuador, Bolivia, Sri Lanka, Morocco, Cabo Verde, Vietnam, Uzbekistan, Indonesia, Honduras, India, Kenya, Ghana, Rwanda, Cambodia
5 cluster - the lowest level	Venezuela, RB, Guatemala, Tajikistan, Senegal, Pakistan, Uganda, Zimbabwe, Lesotho, Malawi, Burkina Faso, Benin, Mali, Tanzania, Madagascar, Mozambique, Lao PDR, Cameroon, Mauritania, Nepal, Cote d'Ivoire, Bangladesh, Ethiopia, Guinea, Angola, Myanmar

Source: compiled by authors

Step 2.3. Table 8 shows that Slovakia ranks higher than Ukraine. Thus, Slovakia belongs to cluster 2 – countries with a high level of knowledge development, and Ukraine is in cluster 3, which is typical for countries with an average level of knowledge development. Analysis of these GKI values for Slovakia and Ukraine over three years shows a stable position for each country. To determine the reasons for this condition, a comparative analysis of the index values with the world average and the highest values was carried out.

Table 9 reflects a comparative description of each GKI sub-indices and the world average value for 2022.

Table 9. GKI sub-indices values: Ukraine, Slovakia, world and highest level (2022)

Sub- indices	Level of Ukraine	Level of Slovakia	Mean level of world	The highest level
Pre-university education	79.82	78.17	62.73	85.54 (Belarus)
Technical and vocational education and training (TVET)	49.9	68.99	51.88	70.05 (UAE)
Higher education	43.47	56.87	45.7	66.83 (Switzerland)
Research, development and innovation (RDI)	23.94	27.17	26.46	54.32 (Switzerland)
Information and communications technology (ICT)	48.92	53.55	44.83	73.09 (Singapore)
Economy	44.82	58.43	52.91	81.6 (Singapore)
Enabling environment	54.4	70.18	57.52	88.65 (Norway)

Source: The Global Knowledge Index, 2022

A detailed study of the GKI sub-indices for Slovakia and Ukraine as of 2022 allows us to draw the following conclusions:

1. The overall value of the GCI of Ukraine (46.95) is almost equal to the average state of the GKI in the world (46.47). This means that Ukraine ranks on average, 63rd among 132 countries in the world and 27th among 41 countries with a high level of human development (Table 3). Slovakia has an overall GKI value of 55.85, which is 9 points higher than Ukraine and the global average.

2. The subindex "Pre-university education" is most important for Ukraine and Slovakia. Because of this sub-index, both countries are included in the 15 countries in the world with a high level of population literacy, which ensures that these countries have an effective preschool and school education system. The index value for Ukraine is 1.7 points higher than in Slovakia.

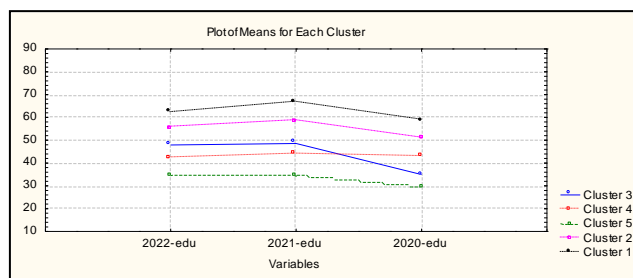
3. All other sub-indices have different meanings for Ukraine and Slovakia. The sub-indice values for Ukraine are close to the world average. This indicates the need to direct government efforts to create conditions that stimulate the development of innovative information technologies and the expansion of colleges and technical schools to improve technical and vocational education and training. Unlike Ukraine, Slovakia has a well-structured system of secondary technical education, which allows the value of the sub-index "Technical and vocational education and training" to practically reach the highest level of this value in the United Arab Emirates (Table 9). 4 out of 7 sub-indices occupy an intermediate place between the world average and the highest values, which is evidence of the significant influence of knowledge on the development of all spheres of the country's society.

4. For Ukraine, the most significant gap is observed in the "Economy" sub-index (the value is 8 points lower than the world average). The reason for this situation in 2022 is Russian military aggression. However, analysis of this sub-index in 2020 shows that the situation was similar. Therefore, we can conclude that there are deeper reasons for Ukraine's low position. The Government of Ukraine should optimise tax legislation, strive to increase gross value added, look for ways to effectively use labour, stimulate the attraction of foreign direct investment, increase the openness of the national economy, and promote infrastructure investment. For Slovakia, the sub-index "Research, development and innovation" has the lowest value (the sub-index value is equal to the world average). Consequently, the country's government should create conditions to stimulate financing of R&D by firms, increase Gross domestic expenditure on R&D (GERD) as a percentage of GDP, strengthen international patent protection, facilitate access to technical information, etc.

The sub-index "Higher Education" is of particular interest to the study. The clustering of the analysed countries was carried out to determine the position of Ukraine and Slovakia on this sub-index. Figure 9 reflects the results of the partition quality, which also shows the high quality of homogeneity of the resulting groups of countries; Table 10 presents the results of the grouping of countries.

Cluster number	Cluster name	Cluster means
1	the highest level	58.7-67
2	high level	50-58.5
3	medium level	44.9-48.5
4	low level	42-44
5	the lowest level	29-34.5

a) Characteristics of cluster groups



b) graph of cluster averages

Figure 9. Characteristics and quality of cluster division for the sub-index “Higher Education”

Source: compiled by authors

Table 10. Grouping countries into clusters: the sub-index “Higher Education”

Cluster number	List of countries
1 cluster - the highest level	Sweden, Finland, Denmark, Netherlands, Norway, Canada, Germany, Australia, Switzerland, United States, United Kingdom, Belgium, Iceland, Austria, Estonia, Luxembourg, Portugal
2 cluster - high level	New Zealand, Ireland, Hong Kong, China, Spain, Singapore, France, Czech Republic, Israel, Slovenia, Italy, Malta, Lithuania, Slovakia , Cyprus, Poland, Latvia, Croatia, United Arab Emirates, Romania, Bulgaria, Qatar
3 cluster - medium level	Greece, Chile, Uruguay, Oman, Trinidad and Tobago, Belarus, Hungary, Mauritius, Panama, Ukraine , Georgia, Bosnia and Herzegovina, Armenia, Peru, Guyana, Lebanon, Albania, Botswana, Dominican Republic, Paraguay, Philippines, Bolivia, Cabo Verde, Indonesia, Ghana, Malawi
4 cluster - low level	Japan, Korea, Rep., Bahrain, Malaysia, Serbia, Saudi Arabia, Costa Rica, Russian Federation, Macedonia, FYR, Brazil, Argentina, Kuwait, South Africa, Mexico, Kazakhstan, Jordan, Colombia, Moldova, Tunisia, Azerbaijan, China, Kyrgyz Rep, Algeria, Egypt, Arab Rep, Ecuador, Pakistan, Tanzania, Lao PDR
5 cluster - the lowest level	Thailand, Turkey, Mongolia, Venezuela, RB, El Salvador, Iran, Islamic Rep., India, Kenya, Senegal, Uganda, Lesotho, Burkina Faso, Benin, Mali, Rwanda, Madagascar, Mozambique, Cambodia, Cameroon, Mauritania, Nepal, Cote d'Ivoire, Bangladesh, Ethiopia, Guinea, Angola, Myanmar

Source: compiled by authors

As the analysis shows, Ukraine and Slovakia occupy different positions: Slovakia entered the cluster with a high level of development of the HES, and Ukraine belongs to cluster 3, that is, a group of countries with an average level of development of the HES. For a more in-depth analysis of this sub-index, we will conduct a comparative analysis similar to the GKI analysis (Table 11).

Table 11. The values of the pillars of the “Higher education” sub-index: Ukraine, Slovakia and the highest level

Pillars	Level of Ukraine	Level of Slovakia	The highest level
Input	32.15	45.37	63.42 (Norway)
Learning environment	44.32	70.45	83.84 (Luxembourg)
Output	51.93	54.79	76.33 (Switzerland)

Source: The Global Knowledge Index, 2022

Analysis of the results obtained allowed us to draw the following conclusions:

1. The general position of Slovakia and Ukraine in the "Higher Education" sub-index among the 132 analysed countries is as follows:

- Slovakia ranks 26th (value 56.87) and belongs to the group of countries with a high level of development and the influence of the HES on the socioeconomic development of the country;
- Ukraine ranks 73rd (value 43.47). It is included in the group of countries with an average level of development of the HES and an average level of its influence on society and the economy.

2. The “Input” pillar reflects those factors that allow HES to achieve their development goals. These factors include various funding sources and human resources, including students and teachers. Ukraine has a value of 32.15 (rank 100), below the world average factor value. The country's government needs to pay attention to optimising the process of state financing of higher education, stimulating teachers to conduct research, and increasing the proportion of the population aged 18-24 years to enter HEI. Slovakia has a value of 45.37, slightly above the world average. The Slovak government needs to pay attention to government funding per student, encouraging applicants to enrol in undergraduate studies, and motivating teachers for scientific and technical research.

3. The “Learning environment” pillar includes factors related to academic freedom, equality, and inclusiveness of education. Ukraine has a value of 46.32 (rank 81), corresponding to the world average. The direction for further improving the country's position in this subindex is increasing gender equality among higher education teachers, expanding academic freedom at universities, and increasing the speed of incoming student mobility. Slovakia occupies a high position in this sub-index (value 70.45, rank 13), characterising a high level of academic freedom at universities, gender equality among university teachers, and a high level of incoming student mobility.

4. The “Outputs” pillar reflects the results of the HES's influence on graduates' economic condition and social status. Here, Ukraine (value 51.93) has problems with the employment of graduates, with the need to direct government efforts to stimulate interaction between universities and industry in the field of R&D and increase the citation rate of scientists' publications. Similar problems are inherent in Slovakia (value 54.79). The country has a low impact of higher education on the development of the economy and society, and it is also necessary to increase the percentage of graduates at both the bachelor's and master's levels. Thus, research has shown that Slovakia has a higher level of GKI and its sub-index “Higher education”, making the Slovak Republic attractive to Ukrainian migrants.

Step 2.4. To determine the country's preference for population migration from Slovakia and Ukraine, we will compare clustering results by HDI and GII with the results of migration flows. Fig. 10 presents the results of the analysis for Ukraine.

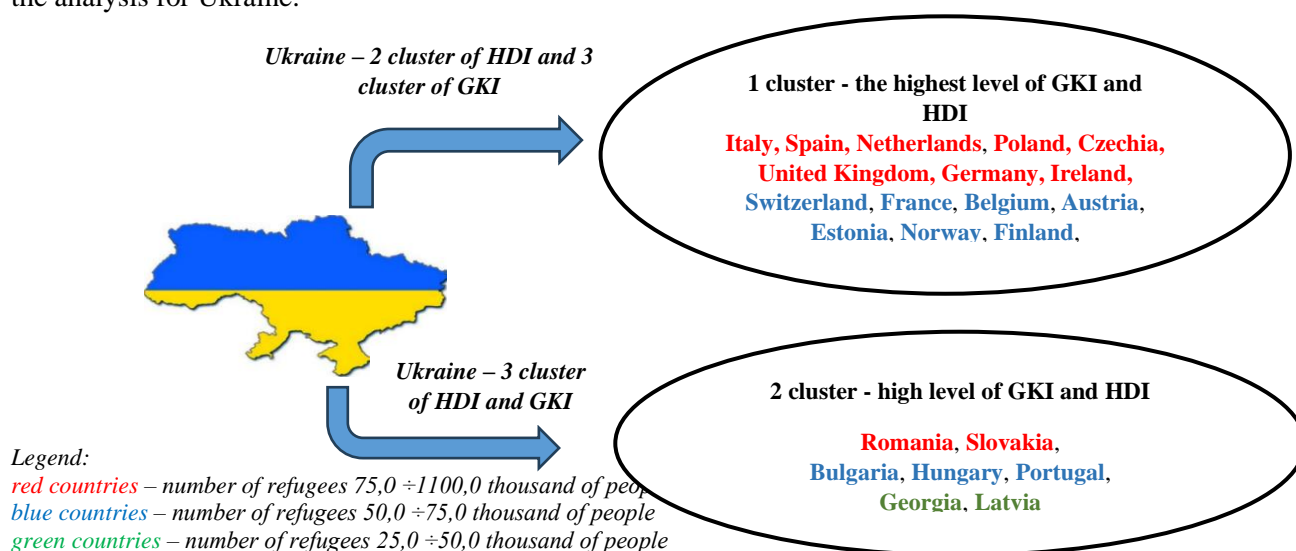


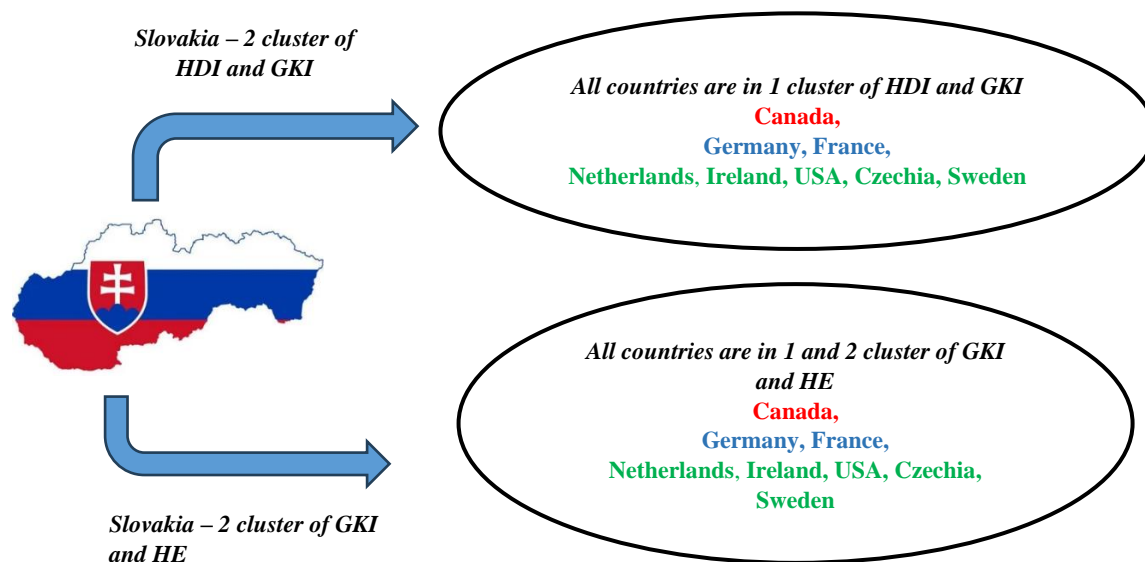
Figure 10. Migration of Ukrainians to countries around the world

Source: UN Refugee Agency, The GKI, 2000-2022; World Data Atlas, Human Development Index, 2000-2021, compiled by authors

As shown in Fig. 9, Ukrainian refugees choose countries with a higher level of development as their host country, not only for Ukraine but also for the world community (clusters 1 and 2). As noted above, a large proportion of migrants are people with professional and higher education who, when choosing a host country, want to have the opportunity to have decent employment (on a temporary or permanent basis). In addition, an analysis of the gender aspects of migration from Ukraine showed that the majority of refugees from Ukraine are

women with children of different ages who choose countries with a high level of education, including higher education. Mothers understand that a good education for their children is the key to the sustainability of their future lives.

Fig. 11 presents the results of the migration analysis for Slovakia.



Legend:

red countries – number of refugees and asylum-seekers more 10,0 thousand of people

blue countries – number of refugees and asylum-seekers 2,0 ÷ 4,0 thousand of people

green countries – number of refugees and asylum-seekers 0,3 ÷ 2,0 thousand of people

Figure 11. Migration of Slovaks to countries around the world

Source: UN Refugee Agency, The GKI, 2000-2022; World Data Atlas, Human Development Index, 2000-2021, compiled by authors

The analysis of migration from Slovakia allowed us to draw the following conclusions:

1. Slovaks, like Ukrainians, prefer to move to a place with a higher standard of living and quality of education. Since Slovakia belongs to cluster 2 (a group of countries with a high standard of living), migration goes to countries of clusters 1 and 2.

2. The migration process can be divided into 2 stages:

Stage 1 - 1994-2008: European countries were attractive, namely Germany, the Netherlands, Sweden, France, Denmark, Finland, Ireland, and France. Interest in moving to the US is growing;

Stage 2 – 2009 - 2021: there is a steady increase in migrants to France and the USA.

3. The most attractive country to live in is Canada. For the period 1994-2022. 12.130 people migrated to Canada.

Stage 3. Constructing a portrait and modelling trends in the development of transformation of the higher education system of Ukraine and Slovakia

Step 3.1. The attractiveness of a country's HES is a complexly structured concept that depends on many factors influencing it. The main factors include the quality of education, accessibility of education (primarily financial), the image of universities, promoting the mobility of students and teachers, the implementation of the national HES into the world system (comparability of degrees, the presence of three main cycles of education - bachelor's, master's, postgraduate, availability of the ECTS system, international recognition of diplomas and qualifications). In addition, the attractiveness of the HES has internal and external subsystems; that is, the assessment process should include indicators that reflect the level of attractiveness of the HES for the nation and for the international community.

The study identified such indicators as:

- to assess the *internal attractiveness of the HES*:

a) Share of schoolchildren enrolled in HEI, which is calculated using the following formula:

$$= \frac{\text{Share of schoolchildren enrolled in higher education institutions enrolment in tertiary education, all programmes, both sexes (number)}}{\text{School age population, tertiary education, both sexes (number)}}$$

b) Outbound mobility ratio, all regions, both sexes (%)

- to assess the *external attractiveness of the HES* - Inbound mobility rate, both sexes (%).

Sources of information are statistical data from the UNESCO Institute for Statistics and The World Bank for the period 2000-2022. Figures 12 and 13 show the trend of changes in indicators of the internal attractiveness of HES for Ukraine and Slovakia.

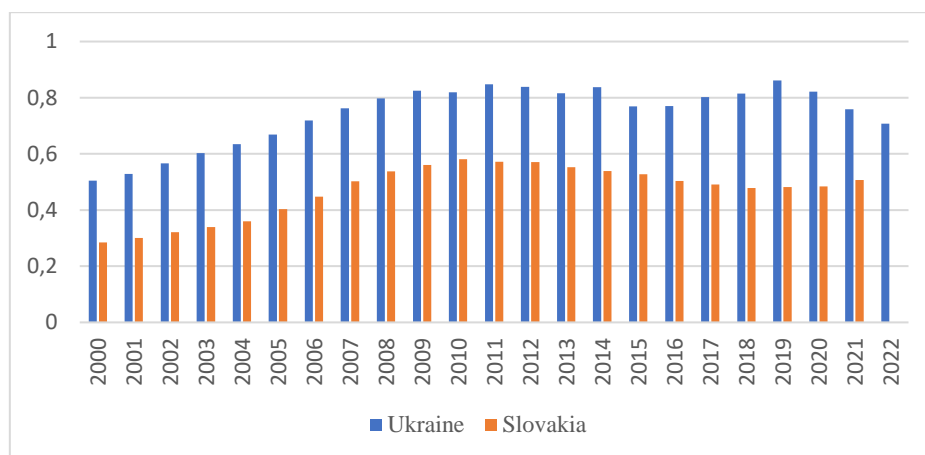


Figure 12. Dynamics of changes in the indicator Share of schoolchildren studying in HEI of Ukraine and Slovakia

Source: UNESCO Institute for Statistics, The World Bank, authors' calculations

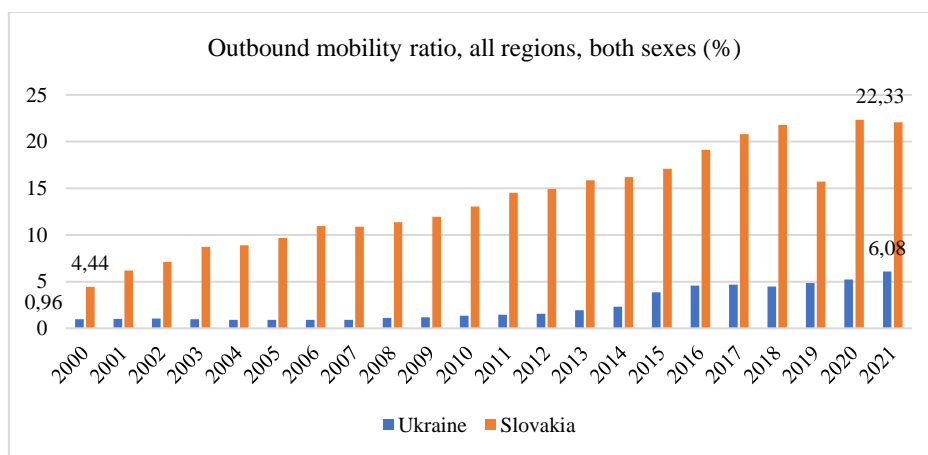


Figure 13. Dynamics of changes in the indicator Outbound mobility ratio, all regions, both sexes (%) of Ukraine and Slovakia

Source: UNESCO Institute for Statistics, The World Bank

Analysing the data in Fig. 12 and 13, the following conclusions are drawn regarding the internal attractiveness of HES countries:

1. In Ukraine, schoolchildren constitute the dominant age group of all applicants who enter universities. For 2000-2022, the share of schoolchildren varied in the range $[0.5 \div 0.85]$; the average value is 0.74. This means that 74% of university applicants are high school graduates. The dynamics of change in the indicator has a nonlinear, increasing trend with a growth rate of 1.4. That is, during the analysed period, the value of this

indicator increased by 40%, which indicates an increase in the internal attractiveness of higher education in Ukraine.

2. In Slovakia, the attractiveness of higher education among schoolchildren is, on average 40% lower than in Ukraine. For the period 2000-2022, the average value of the indicator is 0.47, the range of changes in its values is $[0.28 \div 0.58]$. This is proof that less than half of schoolchildren see the need to obtain higher education for their future development. Despite this, the trend of change in the indicator is also upward; the growth rate is 1.8, indicating an increase in higher education attractiveness for school graduates.

3. The outbound student mobility indicator reflects the percentage of students in a country who went abroad to obtain an education out of the total number of students studying at universities in their home country. Suppose changes in this indicator are characterised by either large volumes of students or increasing trends. In that case, the attractiveness of the country's HES is falling, which poses a threat to the activities of higher education institutions. During the analysed period, a trend towards increasing values of this indicator was formed in Ukraine and Slovakia. However, the qualitative characteristics of these trends are different. In Slovakia, the percentage of outgoing students increased 5 times and in 2021 amounted to 22.06% of the total number of students studying at universities in the country (a fifth of all students in the country); in Ukraine, the growth rate of the indicator was 6.3 and in 2021 reached the level of 6.1%, which is 4 times less than in Slovakia. Consequently, despite the homogeneity of the indicator trends, the attractiveness of the Ukrainian HES is higher than that of the Slovak HES for national students.

Figure 14 shows the dynamics of the external attractiveness indicator HES of Ukraine and Slovakia - Inbound mobility rate, both sexes (%).

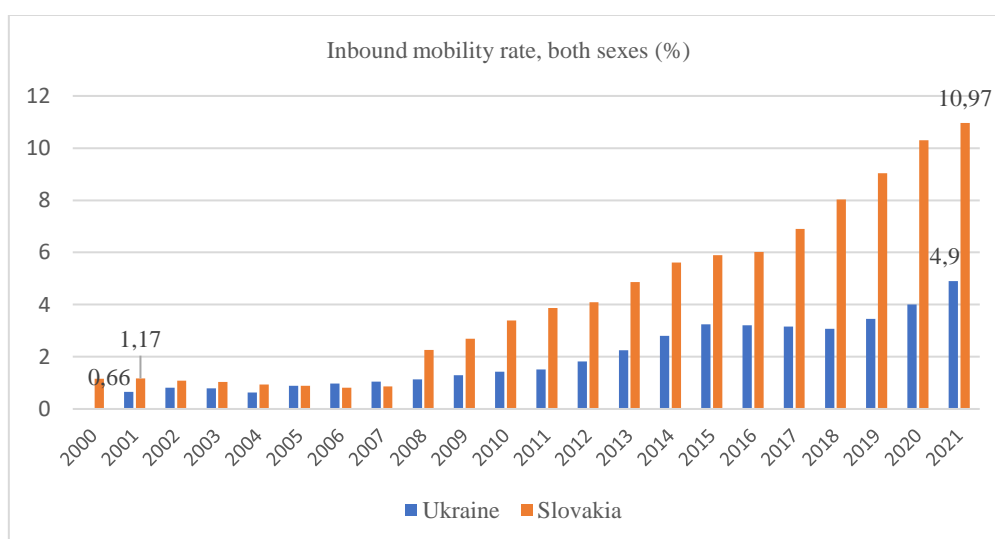


Figure 14. Trends in the external attractiveness of HES in Slovakia and Ukraine

Source: UNESCO Institute for Statistics, The World Bank

This indicator shows the number of foreign students who study in the country, of the total number of all students, expressed as a percentage. This indicator is a key indicator of the attractiveness of the country's HES, latently reflects the quality of education and requires constant monitoring by the state and the individual university. Data analysis shows that the external attractiveness of HES in Slovakia for 2021 is 2 times higher than in Ukraine. Slovakia and Ukraine have homogeneous, increasing trends in this indicator, which can be divided into two stages:

Stage 1 – 2000 – 2007. The value of the indicator is low; for the two countries, they change in the same range $[0.7 - 1.1]$, which characterises a rather low level of attractiveness of HES countries for foreign students;

Stage 2 – 2008 – 2021. A tendency has emerged for a significant increase in incoming students. For Slovakia, the number of foreign students increased 5 times, and for Ukraine – 6 times. As of 2021, 11% of foreign students

from the total number of students in the country studied in Slovakia; in Ukraine, the indicator value reached 5%. It should be noted that 2022 has significantly changed these trends, associated with the Russian and Ukrainian conflict and a significant increase in migration flows to Europe, which requires additional study.

Step 3.2. To effectively manage structural and qualitative changes in the country's HES, it is necessary to permanently monitor the factors that provoke these changes and have effective tools for their analysis and modelling (Hypothesis 4, 5). The study proposes the use of an integral indicator to assess the level of HES development of a country, which is calculated based on the following indicators: Enrolment in tertiary education, all programs, both sexes (number), Gross enrolment ratio for tertiary education, both sexes (%), Inbound mobility rate, both sexes (%), Percentage of enrolment in tertiary education in private institutions (%), School life expectancy, tertiary, both sexes (years), Teachers in tertiary education programs, both sexes (number), Government expenditure on tertiary education as a % of GDP (%), Initial government funding per tertiary student as a percentage of GDP per capita, School age population, tertiary education, both sexes (number), percentage of schoolchildren enrolled in higher education institutions. The calculations are based on statistical information from the UNESCO Institute for Statistics and the World Bank for the period 2000-2020.

Figure 15 shows the trend in this indicator for Slovakia and Ukraine. Calculations were carried out in Statistica 11.0 software.

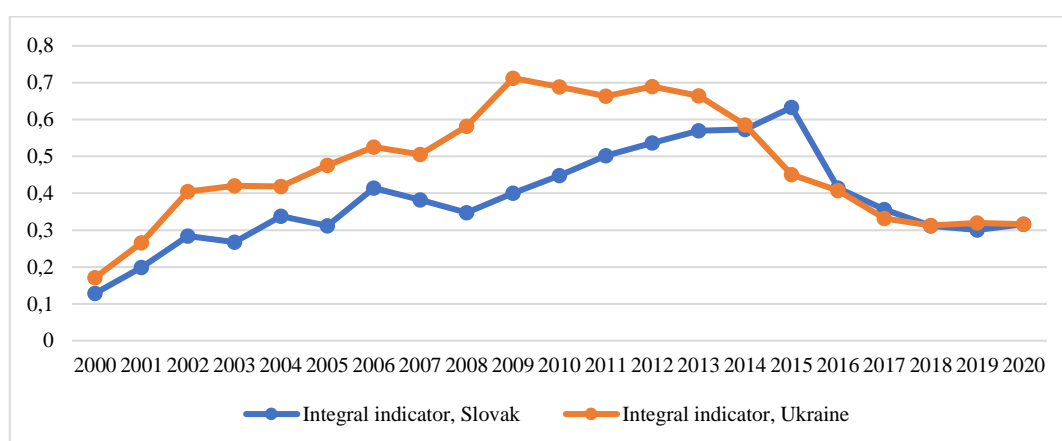


Figure 15. Dynamics of changes in the integral indicator of the attractiveness of HES in Slovakia and Ukraine

Source: compiled by authors

Changes in the integral indicator of the level of development of the attractiveness of HES countries have a unidirectional trend at high values of the indicator, which characterises a fairly high level of quality of the education system of Ukraine and Slovakia. The values of the integral indicator vary in the range: for Slovakia [0, 13 ÷ 0.63]; for Ukraine [0.17 ÷ 0.71].

For Ukraine, HES remains the country's key competitive advantage despite the high political and economic instability. The strengths of HES are funding from government and non-government sources. Thus, the average value of the indicator Government expenditure on tertiary education as a % of GDP (%) for the period 2000-2020 in Ukraine is 1.7%, which is 50% higher than in Slovakia (for Slovakia - 0.86%); and the value of the indicator Initial government funding per tertiary student as a percentage of GDP per capita in Ukraine is 36% higher than in Slovakia. In Ukraine, compared to Slovakia, the indicator value Percentage of schoolchildren enrolled in higher education institutions is 38% higher, 43% higher than the value of the Gross enrolment ratio for tertiary education, both sexes indicator (%).

Slovakia's strength is the external attractiveness of its HES. The values of the indicator Inbound mobility rate, both sexes (%) on average for the period 2000-2020 are 2 times higher than in Ukraine; high values of the indicator Percentage of enrolment in tertiary education in private institutions (%) are observed.

Step 3.3. Using a taxonomic integral indicator as a tool for assessing the country's HES development trends allows the diagnosis of these trends and the modelling of the development process based on economic dynamics methods. Since this indicator varies from 0 to 1 and the higher its value towards 1, the higher the attractiveness and quality of the country's HES, researchers can unambiguously interpret the prospect of changes in its values. Analysis of the dynamics of the integral indicator for Slovakia and Ukraine allowed us to draw a conclusion about the nonlinear nature of its changes, which, in turn, suggests the possibility of using nonlinear models to predict the values of the integral indicator.

In the study, using Statistica 11.0, a series of model experiments were carried out, resulting in the best model for short-term adaptive forecasting - the exponential smoothing model. Table 12 presents the calculation results and criteria for the approximation quality.

Table 12. Results of modelling the integral indicator of the attractiveness of HES in Ukraine and Slovakia

Model	MAPE	Forecast
Ukraine		
Exponential smoothing, Damped trend, no season, Alpha=1,0 Gamma=0,084 Phi=0,803	10.5%	0.31 (2021)
Slovakia		
Exponential smoothing, Damped trend, no season, Alpha=0,51 Gamma=1,0 Phi=0,355	15.3%	0.305 (2021)

Source: compiled by authors

As calculations have shown, the values of the integral indicators for Slovakia and Ukraine are almost the same (0.305 and 0.31, respectively), reflecting the formation of a stable trend over the past 4 years. These indicator values correspond to the average level of attractiveness of HES, which poses the challenge for universities in countries to increase their innovative and entrepreneurial activities, actively implement information and communication technologies, search for new interactive learning methods, etc.

However, the following should be noted. Russian aggression against Ukraine has significantly changed the development trends of countries, causing a substantial fluctuation in the form of mass migration of Ukrainians to Europe, including Slovakia. Therefore, forecasting trends in the attractiveness of HES requires additional research, model experiments and the search for special forecasting methods that can consider the high stochasticity of the external environment.

Conclusions

The conducted research allowed us to draw the following conclusions:

1. The current stage of development of the HES of the world and countries is characterised by serious changes caused by global political and economic instability and the rapid diffusion of information technologies into all spheres of society and the economy. In this regard, universities are faced with the need to transform a traditional university into a digital university of an innovative and entrepreneurial type. This requires a constant search for funding sources for its activities based on improving the quality of scientific and educational processes, forming a national and international image of the university, and close contact with the main stakeholders. Achieving these goals involves constant monitoring of the current and future needs of the labour market, priority trends in the development of civilisation and national economies, and the search for effective approaches, methods and methods of educational, scientific and practical activities.

2. It is substantiated that migration processes significantly impact the development of HES countries. They can either increase or decrease the attractiveness of HES. The results showed that the level of quality of life and the quality of education, in particular higher education, play a key role in the choice of migration preferences of the population. The study used international indices, namely HDI, GKI, and HE sub-index, to assess the migration of Slovaks and Ukrainians. According to the index, Ukraine and Slovakia occupy consistently high positions

and are in a cluster with a high quality of life and education. At the same time, these countries' populations choose countries with the highest levels of these indices to move to another country.

3. An analysis of global migration trends was carried out, and it was determined that migration has an increasing trend. This means that in the context of globalisation, the population is moving to countries with higher quality of life in search of decent work, high-quality education, and a safe life. An analysis of the migration preferences of the population of Slovakia and Ukraine allowed us to conclude that there is a growing trend in migration. For Ukraine, migration over the last two years has been forced, which is due to military aggression from Russia.

4. An assessment of the internal and external attractiveness of HES Ukraine and Slovakia was carried out. The results showed that Slovakia has a higher level of external attractiveness of HES, and Ukraine ranks high in internal attractiveness of HES.

5. To assess and predict the attractiveness of HES countries, the study proposes an integral indicator of the level of development. It identifies trends in the development of HES in Ukraine and Slovakia. The results showed that changes in integral indicators have the same nonlinear development trend. The relevance of using adaptive short-term forecasting models, namely the exponential smoothing model, was proven based on model experiments. The models built for the countries are of high quality, which made it possible to obtain predictive values of the attractiveness of HES.

Further areas of research are related to a more in-depth study of the characteristics of educational migration, its impact on the economic development of donor and recipient countries, the choice of methods and models for forecasting highly fluctuation processes, reflecting the political and economic instability of global and regional development, with the search for ways to overcome challenges, that they face the HES.

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SUSTAINABILITY REPORTING ISSUES

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Abstract. For a long time, investors and other interested parties have not been satisfied with the only financial achievements of companies - profitability, dividend payments and other financial indicators. Today, investors are interested in the long-term sustainability of companies - social and environmental responsibility, which becomes the basis for making investment decisions. With the efforts of the governments and financial institutions of the world's leading countries, significant work has been done on defining and evaluating ESG sustainability principles and creating unified global international standards. As of today, the International Sustainable Standards Board (ISSB) has developed draft standards, which are still under review, requiring analysis, implementation and taxonomy with IFRS standards - presentation and disclosure requirements. Familiarization with the ESG principles of sustainability and the IFRS S1 and S2 sustainability reporting projects developed by ISSB; understanding the importance of prospective scenarios for the information on climate change risks (physical and transition); and studying the issues of consolidation with IFRS standards. Guiding recommendation materials of ISSB, international audit companies ("Big Four"), scientific articles, methods of systematization and comparative analysis. The concepts of sustainable development are familiarized; ISSB projects and the "Big Four" methodological materials are analyzed. Furthermore, corporations will be required to submit sustainability reports commencing in 2024.

Keywords: ESG-principles; Non-financial risks; ISSB Projects; Physical and transition risks of climate change.

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JEL Classifications: M4, M41

1. Introduction

At present, sustainable development is the focus of shareholders and investors of all large corporations; they are interested not only in the financial indicators of business but also in their business and ethical behavior – the sustainability of corporations and the management of associated risks. Sustainable development of commercial activities is based on three principles of so-called ESG (Environmental, Social, and Corporate Governance; i.e., A set of management characteristics of a company in which the involvement of this company in solving environmental, social and governance problems is achieved): responsible attitude towards the environment, (Environment), high social responsibility (Social); and high degree of corporate governance (G).

Environmental principles determine how the climate changes, how much the company cares about the environment, and how it seeks to reduce damage caused to the environment. Social principles relate to employees' working and remuneration conditions, gender equality, and the company's attitude towards personnel, suppliers, partners, and customers. Businesses should take care of the quality of working conditions, monitor gender balance, and invest in educational and social projects. The corporate governance principles require conducting business in good faith and as transparent as possible, which impacts the quality of the company's management: transparency of reporting, management salaries, a healthy environment in offices,

relations with shareholders, and anti-corruption measures. Sustainable development principles affect business reputation and financial health (Bainbridge, 2021; Hussain et al., 2022). Comprehensive sustainable reporting should include non-financial information on these three key aspects, providing investors, government institutions and the general public with information on the goals and objectives of business responsibility.

2. Sustainable Development Reporting Standards

2.1. Creation of TCFD

It is generally accepted that the economy of the 21st century must be efficient and sustainable. At the same time, creating a "green planet" poses a significant challenge to the economy, ecology, and climate. Climate change is an urgent, global and systemic problem that can threaten the sustainability of organizations, markets and economies. It contains physical risks (such as severe weather conditions) and transition risks (associated with transitioning to a low-carbon economy, which may influence asset values or lead to higher business running costs). Transitioning to low-carbon technologies will change how the economy works, creating uncertainty and significant opportunities. Climate change requires reliable assessment of climate risks, flexible business practices, and the disclosure of high-quality information to support fighting against climate change and support adaptation (IFAC, 2023).

The International Organization of Securities Commissions (IOSCO) and others require transparent information on the impact of climate change risks on businesses and business sustainability. Disclosure of essential information about significant risks and opportunities related to companies' sustainability has become crucial for investors to assess business value and implement new investments.

In this regard, in 2015, the leaders of the "Group of Twenty" (G20) appealed to the Financial Stability Board (FSB) with a request to analyze the possible consequences of climate change on the global economy. It became necessary to study the issue in two aspects: the risks that lead to climate change and the risks of a new type of low-carbon transition to a low-carbon economy.

As a result of studies, it became obvious that the disclosed information is unsatisfactory, which is a factor in the instability of the entire world economy. The FSB immediately established the TCFD (Taskforce for Climate-related Financial Disclosures) in response.

The main goal of TCFD is to disclose financial impact information on climate risks and opportunities so that investors and creditors can understand how climate-related risks and opportunities will affect companies' future financial position, allowing them to make sound financial decisions (Carney, 2017). The main essence of the recommendations developed by the TCFD lies in the approach itself: this is the disclosure of information about the impact of climate change on the company's activities and not on the environmental effects of the company.

The ultimate goal of TCFD is to disclose financial information, but the main tool is non-financial information. The reasons for this are the variety of possible climate scenarios and the difficulties of digitizing their financial results.

According to TCFD recommendations, information on the impact of climate on the activities of companies is disclosed in four main areas: Governance; Strategy; Climate Risk Management; Key and Target Indicators (quantitative indicators of the level of climate impact on the company's activities, monitoring and analysis of their behavior). During its work, TCFD, as earlier as in 2017 published its recommendations, which received the support of more than 3,000 companies and 92 countries around the world. The project received special support from the "Group of Seven" (G7).

The impact of climate change on the environment and business income is unconditioned. So, in the US in 2021, companies' losses due to climatic conditions amounted to \$145 billion. Business executives need information about the impact of climate change to manage risk and look for new opportunities. At the request of the US Securities and Exchange Commission (SEC), all public companies whose shares are sold on the US Securities Exchange (annual stock trading amounts to \$82 Trillion) (Dasgupta, 2022) are obliged to disclose information about the impact of climate risk changes on income.

According to the results of the United States Stock Exchange equity surveys conducted by the EGS Sustainability and leading consulting firm Governance and Accountability Institute (G&A), 92% of companies listed in the S&P 500 index and 70% of the Russell 1000, published Sustainability Reporting in 2020 (G&A Institute, 2022).

Leading companies, such as Apple, Best Buy, Coca-Cola, Cargill, Ford, Gap, Hilton, and Starbucks, have disclosed information about climate change-related risks, including in their production-sale chain. Oil giants such as Shell, Total Energies and Equinor have accumulated experience in greenhouse gas emission reporting in their value creation chain. However, businesses use different approaches to climate risk assessment and disclosure, while most do not publish this information at all, although they manage it. As a result, environmental and social risks and their consequences are unknown to investors.

The analysis of the quality of the disclosed information shows that non-financial information, in accordance with the ESG principles, does not include unified and comprehensive indicators prepared based on the unified methodology and is submitted in various forms: it is published within the framework of an annual report, in the form of an independent sustainable development report like Corporate Social Responsibility (CSR) Report (which is the most common approach) or is a form of integrated report. Due to such a condition, information loses its degree of comparability in most cases. Analytical agencies indeed assess the effectiveness of companies according to ESG principles. Still, due to the lack of a unified assessment methodology, the assessment of the same companies in different ratings can be distinguished. Therefore, the need to develop a unified methodology for disclosing non-financial information is on the agenda.

2.2. Necessity for ISSB formation

In 2021, the UN Climate Conference in Glasgow COP26 announced the formation of ISSB (International Sustainability Standards Board). The Board aims to create uniform standards for disclosure of non-financial information in accordance with the basic ESG principles and requirements to assess risks and opportunities by investors. In the same year, the G7 Summit noted the importance of this Board and expressed support for creating global reporting standards (George, 2022). Following the Summit, central banks and major companies of G7 member states undertook Environmental Policy and financial stability risk assessments (Moody's Analytics, 2021), which will contribute somewhat to reach by 2050 the "Zero Emissions Level" under the Paris Agreement. In particular, the Summit Communique recorded the countries' consent to submit mandatory climate reporting.

In April 2021, the European Union adopted a new draft on corporate reporting - Proposal for a Corporate Sustainability Reporting Directive (CSRD) (European Commission, 2023), which extends the requirements for Sustainable Development Reporting. The new directive came into force in 2023 of 5 January, and applies to all large and all public companies. According to the new directive, a detailed reporting standard has also been developed and reporting audits will become mandatory. In addition to General Data, it imposes additional obligations on each industry. For example, in the automotive or aviation industry, there are five important common themes within ESG: Product safety, labor practices, fuel economy and emissions, the origin of materials, and efficiency of use and recycling the materials.

The G7 summit in 2022 noted that despite new social and economic problems -the COVID pandemic which continues, and Russia's war in Ukraine, which is exacerbating the cost and access to food and energy, the "Climate Protection: remains a long-term priority (George, 2022).

2.3. Structures and Concepts for Developing ESG Reporting

Currently, through the efforts of governments and institutions worldwide, the following leading structures of sustainability reporting standards developers are operating. Their current goal is to harmonize existing sustainability concepts - to bring them into line within a single report. These include:

The UN Sustainable Development Goals (SDG) - The "2030 Agenda for Sustainable Development" approved by the UN in 2015. The document focuses on global issues such as the eradication of poverty and hunger, health

and well-being, quality education, gender equality, decent work, economic growth, the fight against climate change, etc. (Government of Georgia, 2019, i.e. In 2015, Georgia, along with all other UN member states, expressed a desire to implement the Sustainable Development Goals and Objectives set for 2030. Considering the country's challenges and national context, all 17 goals and 93 sustainable development objectives (base and target indicators of 201 indicators by 2030) have been identified as national priorities. Decree of the government of Georgia #2328 dated 12 November 2019);

GRI (Global Reporting Initiative, established in 1997) published the CSR - the most widely used Corporate Social Responsibility business model in the world, which helps companies to be socially accountable to themselves, their stakeholders and society, and in 2000 published the Sustainability Reporting Standards (GRI) The GRI Standards are the most widely recognized and widespread standard in the world. According to the 2020 survey, two-thirds of the world's largest and medium-sized companies and three-quarters of the largest 250 companies use the GRI standard for Sustainable Development Reporting (Threlfall et al., 2020);

The SASB (Sustainability Accounting Standards Board – 2011) focuses on rules for reflecting sectoral specifics in sustainability reporting. In particular, determine the environmental, social and governance issues that are most important for the financial performance of various industries and the value of the enterprise (Hummel, Schlick & Fifka, 2019);

Taskforce for Climate-related Financial Disclosures (TCFD), which was established in 2015 and in June 2017, presented the final variant of the disclosure recommendations;

International Sustainability Standards Board (ISSB 2 2021) is involved in the creation of uniform standards for the disclosure of non-financial information;

IIRC (International Integrated Reporting Council) - One of his work programs is the development of unified corporate integrated reporting. This reporting pays special attention to the business's ability to create "new value" based on E.BC. The concept of "integrated thinking". Such global companies as Danone, Deloitte, HSBC, KPMG, Microsoft, Coca-Cola, Unilever, Volvo and others actively support this concept.

Thus, scientists and practitioners express the opinion that reporting based on sustainability concepts will contribute to the disclosure of high-quality and accurate information, reduce the risk of "symbolic behavior" (Hummel & Schlick, 2016), and increase the transparency and reliability of the information. Presenting such information to external consumers will help prevent the "greenwashing" of products, brands and reputations - misleading consumers from unfounded and dubious ecological positioning (Avi, 2022).

3. Further development implications

In general, the reports will disclose information about how the company carries out its operations in accordance with the worldwide recognized principles of sustainable development, established international standards and documents (Ibáñez-Forés et al., 2022). The report also reflects promising information in all areas of sustainability, including climate strategy information: quantitative assessment of climate risks, new energy management and energy efficiency solutions, use of renewable energy sources and generation of own electricity.

It is in the interests of the Board of directors and management of corporations to present information relevant to ESG objectives and to assess their contribution to the Sustainable Development Goals, which will contribute to raising their ratings. Companies that do not pay attention to ESG risk lose investors' confidence, access to the capital market and a reputation for sustainable business (Khatri & Khatri, 2023).

3.1. ISSB Projects

ISSB aims to create a comprehensive global international sustainability disclosure system that will provide investors and other capital market participants with information on sustainability-related risks and opportunities for companies to help them assess business value and make informed decisions (International Sustainability Standards Board, 2021).

In view of these goals and taking into account the recommendations of the TCFD, in March 2022 the ISSB published two draft standards for consideration (IFRS Foundation for the convenience of interested parties, 2022). The first includes general requirements for Disclosure of Sustainability Information (Exposure Draft on IFRS S1 general Requirements for disclosure of sustainability-related Financial Information), and the second concerns climate-related disclosure requirements (Exposure Draft on IFRS S2 Climate-related Disclosures). As a result of the initial consideration of the project, the council received more than 1300 responses from state, academic, public bodies, investors and audit associations. Public discussion of the projects took place on 14-15 December 2022.

3.2. S1 – General Requirements

The draft general requirements presentation states that an accountable enterprise should be required to disclose relevant and substantive information about all significant sustainability-related risks and opportunities to which it is exposed (Al-Shaer & Hussainey, 2022). Such information will be useful to the main users of general-purpose financial statements when making decisions about the enterprise's resources. The merits of information are assessed by users of general-purpose financial statements in the context of information necessary to assess the value of the enterprise.

Companies are required to disclose up-to-date and reliable information about corporate governance, strategy, risk management, performance and goals. The usefulness of the information provided increases if it is comparable, verifiable, timely and perceptible.

When financial information related to sustainability cannot be quantified but can only be evaluated, using reasonable estimates is an important part of preparing sustainability disclosures and does not violate the usefulness of information if estimates are clearly and accurately described and explained (Shad et al., 2020). When sustainability disclosures include financial data and assumptions, they should be reconciled as far as possible with the relevant financial data and assumptions in the financial statements.

According to TCFD, a company's financial statements should include a complete, unbiased and accurate description of ESG - risks to help the users of financial statements predict future cash flows and valuation of companies.

3.3. S2 - Climate

The Board focuses on climate-related reporting due to the general urgency of this issue and the requests for information from investors, banks and lenders on other ESG issues.

Climate change is an urgent, global and systemic problem that can threaten the sustainability of organizations, markets and economies. Climate change causes physical and transition risks. Physical risks generate financial losses associated with natural disasters and gradual climate changes (temperature changes, rainfall amounts, sea levels, constant glacial melt, etc.). Financial losses from physical risks are property depreciation, price increases, income reduction, bankruptcy, etc.

The transit risks generate financial losses associated with the transition to a low-carbon economy, which can affect asset values or lead to higher costs of running a business. Transit to low-carbon technologies will change how the economy works, creating uncertainty and significant opportunities.

Climate change requires reliable climate risk assessments, flexible business practices, and the disclosure of high-quality information to help fight climate change and support adaptation (IFAC, 2022).

Some experience in disclosing climate change risk information has already been accumulated in the banking, insurance, and asset management sectors, while the information disclosed in 2019 by energy sector companies, according to the compliance and quality of TCFD recommendations, was considered the best.

International audit company EY (Ernst & Young) in 2018-2019, with the recommendations of the TCFD, conducted a survey of disclosed climate change information, which covered 34 companies from 970 countries. The analysis found that only 54% of the companies under consideration disclosed information to this or that degree about the risks associated with climate change, and the quality of the information itself was estimated from 100%, which means taking into account all recommendations, by 27%. The highest rate of the degree of disclosure of information was observed in US companies - 63% compared to the average 27% (Nelson, 2020).

The survey has shown that companies are trying to determine the financial impact of climate change risks and opportunities by exposing risk scenarios for transitioning to a low-carbon economy rather than physical risk impact scenarios for climate change. Estimates are often formed in isolation from climate scenarios. Companies do not use climate scenarios, which reduces their ability to test the impacts of climate risks on their business and make a prospective assessment of its sustainability in the face of the transition to a low-carbon economy (Kang & Kim, 2022).

4. Conclusions and recommendations

On 5 January 2023, the Corporate Sustainability Reporting Directive (CSRD) came into force, replacing the NFRD (Non-Financial Reporting Directive). The new directive has updated and tightened the rules for companies to submit social and environmental information that ensures detailed and standardized disclosure of ESG information and its independent verification and audit.

CSRD requirements will gradually cover 50,000 state and non-public companies. The first companies will have to apply the new rules for the first time in fiscal year 2024 for reports published in 2025. The new rules ensure that investors and other stakeholders can access the information they need to assess investment risks related to climate change and other sustainable development issues. They will also create a culture of transparency regarding the impact of companies on people and the environment (European Commission, 2023).

Information on how the company conducts its operating activities in accordance with the principles of Sustainable Development established by international standards and documents will be disclosed in the reporting. Also, the report reflects promising information in all directions of sustainability, including climate strategy, quantitative assessment of climate risks, new energy management and energy efficiency solutions, use of renewable energy sources and generation of own electricity (Alghamdi & Agag, 2023).

It is in the interests of the Board of directors and management of corporations to present information relevant to ESG tasks, and evaluate their contribution to the Sustainable Development Goals, which will contribute to raising their ratings. Companies that do not pay attention to ESG risk may lose investor's confidence, access to the capital market and a reputation for sustainable business.

Companies must present information about their resilience to risks - the risks of transitioning to a low-carbon economy and the physical risks associated with climate change. In addition to climate risk management, information on prospective climate change impact scenarios and integration of climate risk management into the overall risk management process of the company is essential.

Disclosure and analysis of information on climate change risks and their capabilities (legislative, reputational, technological, market, physical) will improve understanding, macroeconomic analysis and modeling of the macroeconomic consequences of climate change (G7 Germany, 2022). Uniform rules for assessing and disclosing climate risks provide quality information, an equal competitive environment and the right investment decision.

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STUDENTS' PERCEPTIONS OF THE EFFECTIVENESS OF ENTREPRENEURSHIP EDUCATION: A HUMAN CAPITAL PERSPECTIVE*

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Abstract. The purpose of this study was to establish students' perceptions and expectations of entrepreneurship education. A quantitative research method was adopted for the study, and data was collected using a structured questionnaire. Data was collected from students of the two universities in South Africa with different characteristics. Regarding the demographic, one was in the city, and the other was in a rural area. Data analysis was computed using Stata version 15. The findings indicate that the students are agreeable that entrepreneurship education is important to provide an understanding of entrepreneurial activities. They further stated that it inspires them to start the businesses either during and/or after completing their qualifications. It is further noted that the students from the city university are more optimistic about entrepreneurship education than those in a rural university setting. It can be concluded that students perceive entrepreneurship education as a way of inspiring them to take entrepreneurship as a career.

Keywords: entrepreneurship education; entrepreneurial self-efficacy; entrepreneurial intention

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JEL Classifications: M13, M16

1. Introduction

Entrepreneurship has been recognised globally as an indicator of economic growth, job creation, and addressing poverty alleviation challenges. (Egerová, et al., 2017). As highlighted in Badri and Hachicha (2019), entrepreneurship has emerged as a significant driver of economic growth, and various stakeholders are under intense pressure to meet this goal, defined by the creation of new jobs. As a result of this recognition, higher education institutions play a critical role in the development and implementation of entrepreneurship education. In

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this regard, universities face the challenge of providing students with the necessary knowledge and skills for starting and running a business. Although the number of universities offering entrepreneurship education (EE) has grown over the last decade, there is still no [universal] agreement on the appropriateness of content and approaches that can be used in EE (Kuratko, 2005). This attestation may imply that scholars have not reached a pedagogical approach to teaching EE, and this results in pursuing a study to determine the students' perceptions of the offering of EE. The understanding of focusing on EE is to enhance entrepreneurial knowledge to enable the trainees to be effective in the future and, in this regard, to be able to establish business ventures (Nazari & Rani, 2022). Entrepreneurial competencies are essential for the students to foster new ventures, and lack thereof would result in difficulty for them to start new ventures and ensure the sustainability of the business. Notably, entrepreneurial competencies could be developed through education and training, which are important to enhance entrepreneurial quality.

The effectiveness of EE in promoting entrepreneurship among university graduates has been debated globally by scholars, policymakers and academics. Scholars in entrepreneurship education have long argued the point of EE that could assist society in promoting entrepreneurship (Ahmed, et al., 2017). Promoting entrepreneurship has been regarded as a stimulant for entrepreneurship development, and with this, the government hopes to boost the economy and employment (Thomas, 2022). Kuratko (2005) indicates that universities can play a vital role in spearheading entrepreneurship by transferring knowledge. There is a rising interest in EE, which led to several empirical studies assessing its effect on the participants' intentions to start business ventures (Fayolle, et al., 2006). This becomes important for the universities to understand how the EE is influencing the students' decision to start the ventures either during their tenure at the universities or upon completion of their respective study programmes.

There is a notion that entrepreneurship can be learned through training. In this regard, EE becomes an essential vehicle for enhancing personality traits, abilities and skills requisites to become entrepreneurs (Drucker, 1985; Kuratko, 2014). EE is seen as a mechanism that can trigger entrepreneurial initiatives by enhancing the entrepreneurial mindset among the students and subsequently creating entrepreneurial self-efficacy. It is noteworthy to understand that the significant role of EE is to capacitate the students with adequate knowledge, skills, and aptitudes pertinent for start-ups and how to operate and manage a new business successfully (Dutta & Merenda, 2011; Costa et al., 2018). Accordingly, EE is regarded as an intervention that can provide students with an understanding of business, its purpose and the structure required for successful implementation. Therefore, this paper sought to determine students' perceptions and expectations of entrepreneurship education concerning entrepreneurial self-efficacy.

2. Literature

Many studies, such as one conducted by Aboobaker and Renjini (2020), focused more on the effect of entrepreneurial training on the perceived human capital and entrepreneurial intention of students. However, the results are fundamental for the entrepreneurship-related outcome where scholars can understand what effect EE has on the overall intentions of the students to embark on the start-ups. On the other side, previous studies also provide mixed findings, which call for further investigation; hence, the current study aims to determine the perceptions of students regarding the EE as offered by their universities and whether they create entrepreneurial self-efficacy.

Most authors have attempted to define EE with anticipated outcomes (Mwasalwiba, 2010; Badri & Hachicha, 2019). The outcomes per se are characterised by (i) a positive impact on business opportunity identification – this is important for the students to understand and acquire relevant knowledge since this is important in entrepreneurial activity (Costa et al., 2018). (ii) risk propensity-

this refers to when a person is willing to take a chance concerning possible loss in the business, and this is usually a calculated risk, which means that the risk is not high or low. (iii) perceptions of desirability and feasibility of starting a business -. Entrepreneurial passion – this involves an assumption that individuals experience a singular entrepreneurial passion that motivates them to think and act like an entrepreneur (Huyghe et al., 2016). (iv) entrepreneurial action and job creation – the idea here is that once an opportunity has been identified, the student and or/ nascent entrepreneurs should aim to start a business with the view of creating some employment prospects.

Though entrepreneurship education has evolved, some issues still need to be further investigated, particularly the effectiveness of entrepreneurship education on entrepreneurial self-efficacy. In this regard, Ebewo, Rugimbana and Shambare (2017) studied the effect of entrepreneurship on university students to start new enterprises, and the findings showed that three antecedents of entrepreneurial intention have a direct influence on entrepreneurial intention. The investigation could provide fundamental information that scholars and universities could use to improve the offering of entrepreneurship. On the same note, Lekoko and Rankhumise (2012) argue that “entrepreneurship education needs to provide a critical theoretical knowledge of entrepreneurship and prepare students with managerial skills necessary for an entrepreneurial career.” Entrepreneurship education should stimulate interest from students to pursue entrepreneurship as a career and think deeply about establishing their business ventures. The argument concurs with what other scholars attested, for instance, that entrepreneurial education can equip individuals with the essential skills to demonstrate their capabilities and high self-belief, and their ESE will increase (Shahab et al., 2019).

Entrepreneurship education

There is a never-ending debate on how entrepreneurial education is defined. Entrepreneurial education is a development process that explains the growth of knowledge, skills, attitudes, and personal character related to entrepreneurship. These efforts would result in an increased entrepreneurial mindset among students. Mitra (2017) believes that entrepreneurship education is based on the notion that it contributes to developing students' entrepreneurial confidence, aptitude and self-efficacy, not considering the discipline (Passaro et al., 2018). Other scholars view entrepreneurial education as a vehicle that could increase entrepreneurial aptitude positively and position EE as an effective means of developing business knowledge and skills (Costin et al., 2022). Concomitantly, the university and academics have a positive perception that when students are subjected to entrepreneurial education, they will likely acquire knowledge and skills that would encourage them to start their businesses (Cabagnols et al., 2022). Researchers concur with this notion, and it would be interesting to understand what perceptions the beneficiaries hold on entrepreneurship education.

Self-efficacy

Self-efficacy is an important aspect relating to how one judges oneself, and this could be attained through either performance or cognitive learning. Accordingly, Bandura defines self-efficacy as “a judgment of a person's ability to perform a specific behaviour pattern” or the “personal evaluation of the ability to fulfil a certain level of performance.” In other words, self-efficacy can be seen as being motivated and having self-confidence in carrying out a particular action. Furthermore, self-efficacy beliefs determine how much effort an individual will take or spend on a task and how long they will persist (Alvarez, 2008). The task as such could relate to the commitment to starting a new business, which is part of the objective of entrepreneurship education. Notably, studies have indicated that people with strong self-efficacy beliefs put more effort into mastering a challenge, whilst those with lesser self-efficacy views would probably not take much action and may subsequently abandon the efforts (Alvarez, 2008). Rankhumise (2014) explains that “Self-efficacy is regarded as psychological self-confidence in carrying out specific tasks.” In the context of how self-efficacy is defined, the essence is that once the students are exposed to entrepreneurship education, it is anticipated that upon completion, the students will develop self-confidence to focus on business start-ups.

Entrepreneurial self-efficacy

Entrepreneurial self-efficacy plays an essential role in the creation of a new venture. Notably, individuals establish intentions of directing entrepreneurial activities if they strongly believe in success. Other scholars such as Liu, Lin, Zhao and Zhao (2019) define entrepreneurial self-efficacy as entrepreneurs' self-confidence concerning their capability to start new ventures and their belief in having the abilities needed to do so, that is, the entrepreneur's self-confidence that they should be able to complete a specific task related to entrepreneurship." In the context of this study, the students exposed to entrepreneurship education should develop entrepreneurial self-confidence that would stimulate interest in them to start their businesses either during or after their studies. Based on the above articulations, it is imperative to understand the entrepreneurship education students' perceptions and expectations of entrepreneurship education.

3. Methods

The study adopted a quantitative research method, which was cross-sectional. Kothari (2004) and Creswell and Creswell (2018) have indicated that quantitative study is a method for evaluating the connection between variables to evaluate objective theories. These variables can then be measured using equipment, allowing numerical data to be analysed using statistical methods. Furthermore, they have indicated that research design is the process of combining relevance to the study purpose with procedural efficiency when collecting and processing data. Data collected were measured on a visual-analogue scale, with Zero and 10 indicating strongly disagree and strongly agree, respectively. Thematic questions were labeled b1, b2, ..., and b20 (see Tables 1 and 2). For data encoding and management, a combination of Stata Release 15, Excel, and Epi-Info was used. Stata Release 15 was used to analyse the data. To compare the two study groups, Wilcoxon rank-sum test was used. Ordinarily, this type of test is used to compare two groups of nonparametric (interval or not normally distributed) data, such as those that are not measured precisely but instead fall within certain limits (Rankhumise et al., 2020). The findings were presented in tabular form. The data was interpreted at a 0.05 error rate. In other words, a p-value less than 0.05 indicated that the observed difference between the study groups was significant, implying that the hypothesis that the distributions of the two groups were similar was rejected in favour of the alternative hypothesis that the distributions differed significantly.

The students in the survey were chosen only from the courses focusing on entrepreneurship education. Therefore, a purposive sampling scheme was used to select suitable participants for this study. The participants were all registered students in the entrepreneurship programmes. The participating universities had two demographics (one from a city - TUT, and the other from a rural setting - WSU). This study followed the ethical protocol described by the two universities, and all applicable ethical principles were adhered to. Ethical approval was granted by the Tshwane University of Technology research ethics committee (clearance number: Ref#2018=04=005=Rankhumise et al., 2016).

4. Results and discussion

This study included 484 students in total. TUT had a slightly higher number of participants than WSU (279 [57.64%] vs. 205 [42.36%]). Tables 1 and 2 show the distributions of the first and last ten items, respectively. The tables show the 25th, 50th, and 75th percentiles, as well as the interquartile range [IQR], which is the difference between P75 and P25. The IQRs in Table 1 ranged from 2.5 to 3, while those in Table 2 ranged from 3 to 4. As presented in Tables 1 and 2, the medians [P50] ranged between 7.5 and 9. This may indicate that the participants held positive perceptions of items b1 to b20.

Table 1. Distribution of the first 10 items [b1 to b10]

Item	Explanation/Description	P25	P50	P75	IQR
b1	Entrepreneurship education increases my understanding of generating innovative ideas.	6.5	8.5	9.5	3.0
b2	Entrepreneurship education increases my understanding of an entrepreneurial environment.	7.0	8.5	9.5	2.5
b3	Entrepreneurship education increases my understanding of financial provisions for entrepreneurship.	6.5	8.0	9.5	3.0
b4	Entrepreneurship education increases my understanding of business planning	7.0	8.5	10.0	3.0
b5	Entrepreneurship education increases my understanding of marketing research for entrepreneurship	6.5	8.0	9.5	3.0
b6	Entrepreneurship education increases my understanding of the attitude of entrepreneurs	7.0	8.5	9.5	2.5
b7	Entrepreneurship education increases my understanding of the importance of entrepreneurship in society and individuals	7.0	8.5	9.5	2.5
b8	Entrepreneurship education enhances my understanding of the characteristics of entrepreneurs	7.0	9.0	10.0	3.0
b9	Entrepreneurship education inspires the belief that entrepreneurship is possible for me	7.0	8.5	10.0	3.0
b10	Entrepreneurship education increases my understanding of the motives involved in entrepreneurial activities	6.5	8.0	9.5	3.0

Table 2. Distribution of the last 10 items [b11 to b20]

Item	Explanation	P25	P50	P75	IQR
b11	Entrepreneurship education increases my understanding of building a network	5.5	7.5	9.0	3.5
b12	A creative entrepreneurship education inspires my entrepreneurial mindset	6.5	8.5	9.5	3.0
b13	The lecturer inspire my entrepreneurial mindset	5.5	7.5	9.5	4.0
b14	Guest speakers inspire my entrepreneurial mindset	5.5	7.5	9.5	4.0
b15	Successful local entrepreneur stories inspire my entrepreneurial thinking	6.5	8.5	9.5	3.0
b16	Entrepreneurship education increases my knowledge of how to develop a business plan	6.5	8.5	9.5	3.0
b17	Entrepreneurship education increases my ability to manage business projects	6.5	8.0	9.5	3.0
b18	Entrepreneurship education increases my ability to handle risks and unpredictability	6.5	8.0	9.5	3.0
b19	Entrepreneurship education increases my ability to distribute provisions	6.0	7.5	9.0	3.0
b20	Entrepreneurship education improves my overall entrepreneurial skills	6.5	8.5	9.5	3.0

Table 3 indicates that students' perceptions in the two universities differed significantly. The results suggest that the TUT students scored the items higher than their WSU counterparts. In other words - as compared to their WSU counterparts, TUT students believed in the statements more than the WSU's ($p < 0.05$). Notably, the TUT students have a high level of optimism compared to those of WSU. The variances could be due to the locations of the two universities. Ordinarily, students who are located in a city can identify opportunities with ease.

Table 3. Significant differences between the two study arms

Institution	Item	Rank sum	p-value
TUT	b1	57445,0	0,0000
WSU		53240,0	
TUT	b2	59951,0	0,0119
WSU		50734,0	
TUT	b3	57314,0	0,0000
WSU		52874,0	
TUT	b4	55665,5	0,0112
WSU		44910,5	
TUT	b5	60840,0	0,0166
WSU		50788,0	
TUT	b6	59364,0	0,0015
WSU		50851,0	
TUT	b8	59794,5	0,0039
WSU		51361,5	
TUT	b10	59569,0	0,0026
WSU		50646,0	
TUT	b13	56025,5	0,0000
WSU		53693,5	
TUT	b16	59853,5	0,0156
WSU		49892,5	
TUT	b17	59913,0	0,0042
WSU		50772,0	
TUT	b18	58429,5	0,0102
WSU		50848,5	
TUT	b19	58019,5	0,0001
WSU		52195,5	
TUT	b20	60143,0	0,0271
WSU		49603,0	

Table 4. Insignificant differences between WSU and TUT

Institution	Item	Rank sum	p-value
TUT	b7	63044.5	0.4276
WSU		48111.5	
TUT	b9	61127.0	0.0738
WSU		49088.0	
TUT	b11	65983.0	0.0910
WSU		43763.0	
TUT	b12	63406.0	0.4203
WSU		43547.0	
TUT	b14	63193.0	0.8775
WSU		46085.0	
TUT	b15	61520.0	0.1358
WSU		47758.0	

The students in the two institutions held similar perceptions of items in Table 4. That is, there were no significant differences between the two study groups with respect to b7, b9, b11, b12, b14, and b15, for their respective p-values were greater than the nominal 0.05. In other words, students from the two universities hold similar views on the statements. Similarly, they perceive entrepreneurship increases the imperative of entrepreneurship and inspires them to start their businesses. These observations of opportunity identification are not surprising when considering the ambitiousness and innovativeness of the city students.

Conclusions

The purpose of this study was to establish students' perceptions and expectations of entrepreneurship education. The results have successfully provided a more descriptive view of entrepreneurship education as expressed by the students. It can be concluded that TUT students are more optimistic about entrepreneurship education than the students from WSU. The high level of optimism from TUT students is likely due to the locus of the university, which is in a city dominated by opportunities, compared to students from WSU, which is located in a rural university. It is further noted that entrepreneurship education provides students with relevant experiential experiences, competencies and progressive ways of thinking and acting entrepreneurially. Finally, it emerged that educating for entrepreneurship can assist start-ups by developing students' skills and knowledge to enable them to pursue entrepreneurship as a career.

The findings of this study have practical implications for academia. The perceptions that the students share is essential for the academics to understand how the student view entrepreneurial education. This will assist them to rethink their way of offering the subject. The students on entrepreneurial entrepreneurship express positivity because it could help them create self-efficacy to start their businesses, either upon completion or during their studies and allow the academics to enhance what they are currently doing.

The research has shared important information associated with how students perceive entrepreneurship education and their propensity to start their businesses. The limitation is that the study was cross-sectional. Those who did not take part in the study could have provided a different perspective on the study. The study was conducted at two selected universities in South Africa. Therefore, no claim can be made for the generalisability of the findings. It would be essential to consider a broader study to cover other universities to get different perspectives. Another pertinent limitation is that the targeted population consisted of students who enrolled in entrepreneurship. To thoroughly examine the effectiveness of EE, graduates who started or have grown a business should be considered for future research.

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BASIC PRINCIPLES IN EVALUATION OF FAST-GROWING COMPANIES OPERATING IN INNOVATION-INTENSIVE INDUSTRIES*

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Abstract. In recent years, when the world economy has been recovering from the crisis caused by the pandemic, the opportunities for economic development have taken on a new meaning and started to sound relevant again. Fast-growing firms may be considered a similar opportunity, especially those operating in innovation-intensive sectors of the economy. Their example can serve both academics and practitioners to analyze the characteristics and features that predetermine their rapid growth and, on this base, to create a model that startup companies can use. The preset paper aims to define such factors and specifics that describe fast-growing companies operating in innovative-intensive sectors of the economy.

Keywords: fast-growing companies; innovations; innovative-intensive sectors

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JEL Classifications: D22, L21, L24, L25, L26, M14, M15, O3, O49

1. Introduction

Today's business world is complex and dynamic, challenging to predict and, therefore - complex to plan. In the years when the world is recovering from the crisis of the pandemic, other crises have occurred very quickly - the war in Ukraine and the conflict in the Gaza Strip, which are reflected in the general dynamics and the lack of sugar in the economy on a global scale. In this consideration, the possibilities through which an enterprise can develop and achieve strategic sustainability become particularly relevant. A possible solution in this direction can be extracted from fast-growing enterprises operating in the economy's innovation-intensive sectors. Their experience and specific features can be an example for other business organizations and startups. Because of this, the definition of common characteristics can lead to creating and developing a model that will create a comprehensive national and/or European policy to promote entrepreneurship and innovation.

The modern business world is faced with enormous challenges - on the one hand, these are the extremely growing demands of consumers; on the other hand - the highly competitive environment, in which there is almost no difference between competing products and services, and consumers make their choices for seemingly secondary reasons (such as a better image of the organization, social responsibility policy, recyclability

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of packaging, the responsible and supportive policy as an employer etc.). On the other hand, there is the business environment's complexity, uncertainty and unpredictability, which business organizations must also consider when setting their goals for development, growth and sustainability. In this context, the experience of fast-growing companies operating in innovation-intensive sectors can be crucial and serve as an example in preparing strategies and programs for economic development.

2. Theoretical background

Despite its undeniable importance for the overall development of the economy, there still needs to be more in-depth research focusing directly on fast-growing business organizations. One of the possible reasons for this observation could be explained by the fact that there are fast-growing business organizations in different economic sectors (usually characterized by great dynamism and innovation intensity), which leads to difficulty in comparison and in-depth analysis of the results achieved by the companies.

Some scholars (Connell, Lemyze, McGill, 2021) find a direct connection between a targeted policy of increasing talent recruitment in the organization and their subsequent result, which leads directly to the company's rapid development. In this line of consideration, other authors pointed out that the talents' ability to productively improve is a crucial factor for a company's success (Guarino et al, 2022). At the same time, many scientific researchers have developed different aspects of the interaction between talent and a company's performance. Kaliannan et al. (2023) focus on the inclusive policy of talent development and this reflection on the company's performance; Pantouvakis and Vlachos (2020) consider that leadership and talent directly impact the company's performance. Ali and Ullah (2023) also explore the role of leadership but in the context of laissez-faire concept towards talents. They found that laissez-faire leadership positively affects talents in several critical aspects, including their attraction, retention and performance. Pan and Tang (2021) claim that managerial morality and talent both are essential and contribute positively to the performance of the company; Baltrunaite, Bovini and Mocetti (2023) explore specific aspects of the dynamic connection between talent and managerial practice and conclude that both directly reflect to the company's performance. Still, there is evidence that they have complementary characteristics. Some authors reveal that the modern company's significant effort (including from a financial point of view) is to retain talent rather than attract ones (Guerra, Danvila-del-Valle, Méndez-Suárez, 2023).

The ability of enterprises to develop and implement different innovations is also a vital element for fast growth and success. For Qian, Liang, and Liu (2023), the ability of managers to make risky decisions for innovations leads to improved company performance. Scholars also examine the role of cooperation and entrepreneurial agility and the level of innovation performance and conclude that there are positive impacts between cooperation and innovation performance of the company. Still, organizational agility has to be considered as not so well developed in this relation line (Guo, Yin, Liu, 2023). Others explore the link between innovations, entrepreneurial skills and abilities and knowledge management to achieve a good synergy effect and overall company performance (Ta'Amnha et al., 2023). For other authors, the business environment has a moderating role in the company's innovation policy, including its innovation spirit (Yin et al., 2023). Some define the idea of sustainable innovation, which is logically connected to the company's sustainable growth. For instance, Lu, Li and Yuen (2023) found digital transformation a reliable instrument for sustainable innovations. For Robertsone and Lapiņa (2023), the companies' digital transformation could be considered a tool for sustainability and innovation. Almost the same opinion is shared by Avelar et al. (2024), who also explore the characteristics of sustainable entrepreneurship along with innovations and the level of digitalization of the companies. For Wang et al. (2023), digital platforms could help companies to provide sustainable innovations. How to achieve sustainable innovations, but this time through partnership and in the context of intellectual property rights, is developed by Siltaloppi and Ballardini (2023). Rauter, Globocnik and Baumgartner (2023) provided interesting research on the interrelations between organizational control and sustainability of innovations implemented and developed by organizations. They found out that formal control supports and facilitates the sustainability of a company's innovations and even more. This effect could be even stronger when some form of social control complements such type of control.

Indeed, the rapid development of some business organizations is in the scientific community's focus and interest, and many studies try to explain precisely why such growth is due. For instance, Belitski et al. (2023) pointed out the crucial role of knowledge spillovers in the company's rapid growth. Their thesis is supported by Sergio, Iandolo and Ferragina (2023), who specifically explore the knowledge spillovers in high-tech sectors and found that innovations and ICT agglomerations enhance and support further specialization in these sectors. Sharing knowledge and knowledge distance are considered by some scholars as factors that could mediate impact the company's innovation performance in the context of supply chain partnerships (Shan et al., 2023). Considering the company's supply chain and innovation performance, Chen et al. (2023) suggest the leading role of government support. Xu et al. (2023) also explore the government's important role in developing innovation.

On the other hand, Wang, Han and Li (2023) claim that knowledge reorganization has a critical role when it comes to manufacturing enterprises and their efforts to improve the open innovation performance of the company. For some scholars, entrepreneurial management could be the key explanation for company growth, especially in times of crisis (Kusa, Duda, Suder, 2022). For Day (2023), strategic innovations could accelerate the company's growth. Bhutto, Jamal and Ullah (2023), who explore the bank sector comprehensively, conclude that service innovations along with supportive human resource practices could lead a company to sustainable growth. Some authors also pay attention to the role of innovation organization climate and policy for career development for the company's overall performance (Miao, Bozionelos, Bozionelos, 2023). Other researchers have a more general starting point and explore on macroeconomy level between technological innovations and its impact on economic growth at the national level (He et al., 2023; Li, Hou, Jia, Li, 2023).

In summary of the literature review, the question of how companies can become fast-growing, whether the introduction of innovations guarantees their rapid growth, whether growth depends on the economic sector in which the company operates, and the intensity of the sector itself is complicated and should be examined from different perspectives, taking into account various factors from both the external and internal environment of the company.

3. Methodology of the research

To determine the basic workable in-practice principles that we could use to evaluate the fast-growing companies in innovation-intensive industries, which is the primary goal of the current research, we first analyze the existing ratings of companies. After a profound exploration, we decide to explore ratings at different levels – national, European and on the world scale, to help outline the basic indicators used to evaluate the companies. We selected 3 relevant for our study ratings, analyzed data and used indicators. Then, based on the information and our analysis, we make a justified proposal for the basic indicators that could be used to properly assess the companies in innovative-intensive sectors of the economy and their level of development and speed of growth. Graphically, our methodology is presented in Fig. 1.

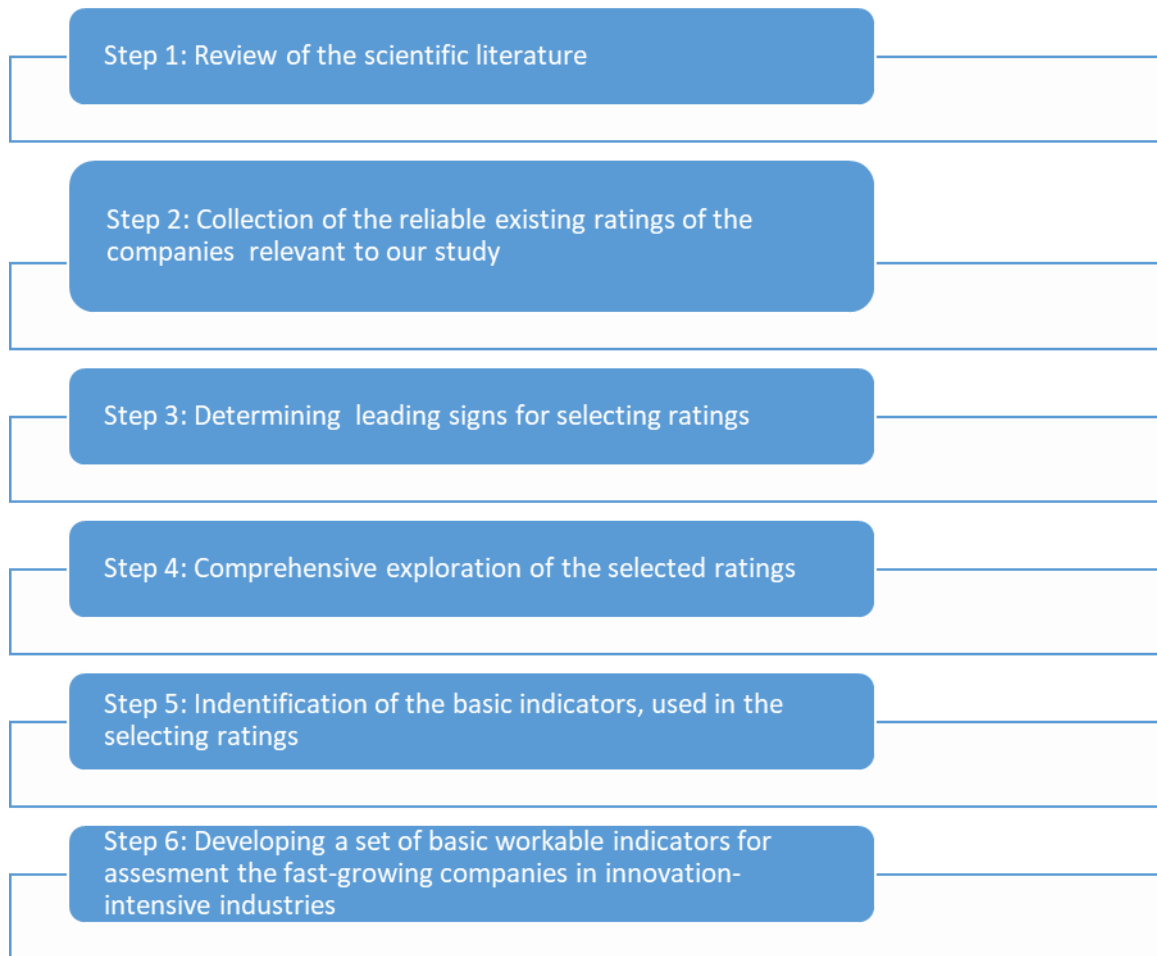


Fig. 1. Methodology of the research

4. Trends in classifications of the Fastest Growing Companies

Several interesting rankings classify companies according to their performance and concrete results on a regular base. For the aim of our paper, we will focus on three different rates to analyze their major indicators for rating. These three classifications have different scopes and subjects of comparison. Still, they will help us analyze and conclude the basic indicators for evaluating fast-growing companies, which have to be applicable to any scale.

4.1. Rating on National Scale

The first one is the rating of the biggest companies on the national level for 2023. This ranking is prepared regularly on an annual basis by Capital Media Group, and the classification refers to official company reports. Results of the first 10 biggest companies on the national level (based on their growth) are presented in Table 1.

Several interesting observations can be drawn based on the data presented in Table 1. First of all, it is striking that in the top ten of the ranking of the largest Bulgarian enterprises, most companies (in fact 6 out of 10) are in the energy sector and two deal with fuels and biodiesel (relatively closed sectors). Only two companies are in completely different sectors - metals and glass, and the interesting thing in this case is that they occupy first and last place in the considered ranking.

Table 1. Top 10 of the biggest companies in Bulgaria

2022 Rate N	2021 Rate N	Company	Sector	Revenues 2021	Revenues 2022	Change % 2021/ 2022	Profit/ Loss 2021	Profit/ Loss 2022	Profit- ability 2022
1	1	Aurubis BULGARIA	Metals	3,399,681	4,214,408	23.96	149,337	255,266	6.06
2	3	Astra Bio- plant	Biodisel	1,706,122	3,932,842	130.51	116,126	63,672	1.62
3	4	Lukoil - Bulgaria	Fuels	1,649,732	3,771,733	128.63	38,527	76,292	2.02
4	5	Kozloduy NPP	Energy	1,390,037	3,099,193	122.96	455,205	372,968	12.03
5	21	AXPO – Bulgaria	Energy	504,971	3,077,977	509.54	8,726	19,585	0.64
6	2	NEK – National Energy Company	Energy	2,105,513	2,697,845	28.13	332,389	553,860	20.53
7	6	Bulgargaz	Energy	1,091,937	2,520,004	130.78	32,674	Minus 51,349.55	-
8	13	TPP Maritsa East 2	Energy	686,073	2,049,764	198.77	Minus 70,264.8	608,298	29.68
9	50	MET Energy Trading Bulgaria	Energy	373,255	1,900,637	409.21	19,666	14,336	0.75
10	8	BA Glass Bulgaria	Glass	1,027,619	1,457,874	41.87	64,758	94,336	6.47

Source: Capital Media Group, and authors calculations 2023 (Thousands of Euros)

At the same time, the traceability of the companies' results for two consecutive years makes it possible to compare their growth during this period. In this line of consideration, AXPO – Bulgaria and MET Energy Trading Bulgaria have realized the biggest change. AXPO – Bulgaria achieved the most significant change in incomes for the two years (509.54%), while MET Energy Trading Bulgaria made the most significant jump - from 50th place in 2021 to 9th place in 2022.

In terms of revenues, Aurubis Bulgaria is the leader for both 2021 and 2022 years. Still, in terms of profit for 2022, the leader is the National Energy Company (NEK), while in terms of profitability, the first place goes to the TPP Maritsa East 2.

For the specific purpose of our current research, we will focus on the indicators used in the considered ranking to identify the biggest companies at the national level. These indicators are graphically presented in Fig. 2.

When we explore the company's growth, several financial indicators have to be used – these are as follows: company's revenues (annual base), company's profit or loss (annual base) and based on this – the indicator for profitability.

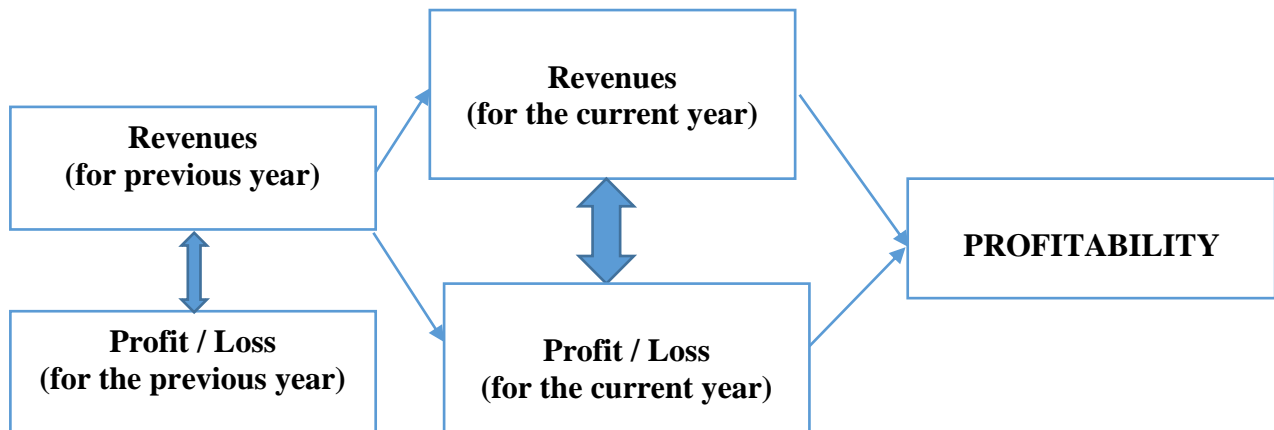


Fig. 2. Basic indicators used for identification of the biggest companies on the national level

4.2. Rating on European Scale

The second ranking we will explore is the European Fastest Growing Companies rating for 2023. Here, in addition to the indicator for financial indicators (revenue and Compound Annual Growth Rate - CAGR), we also have information for the number of employees (Table 2).

Table 2. Ranking of the Fastest European Growing Companies, 2023

N	Name of the Company	Founded	Country	Industry	Number of employees		CAGR %	Revenue (Euro)	
					2021	2018		2021	2018
1	Tripledote Studios	2016	United Kingdom	Leisure & Entertainment	172	18	794.65	83,062,822	115,197
2	Marshmallow	2016	United Kingdom	Fintech, Financial Services & Insurance	220	8	659.85	94,346,611	201,333
3	WeCo	2015	Italy	Manufacturing	12	2	433.07	61,882,913	408,518
4	Silverstream Technologies	2010	United Kingdom	Professional, Scientific & Technical Services	48	8	426.43	17,259,314	118,306
5	Gift & Go	2017	United Kingdom	IT & Software	13	2	408.3	17,344,060	123,642
6	GT Classic Cars	2012	France	Retail	9	1	383.68	14,039,007	124,072
7	illimity Bank	2018	Italy	Fintech, Financial Services & Insurance	725	138	353.9	271,184,000	2,900,000
8	Inkitt	2014	Germany	Leisure & Entertainment	82	19	335.18	11,978,636	144,343
9	Onto	2017	United Kingdom	Automotive	113	13	334.08	15,048,654	172,252
10	Elettrosmart	2017	Italy	Wholesale	8	4	325.01	49,159,967	640,359

Source: Statista <https://r.statista.com>

In this ranking, there are 4 Bulgarian companies: the best place is for the Eushipments.Com (rank 316 with CAGR 80.38) which operates in Logistics & Transportation sector, followed by Amco-Bulgaria (rank 374 with CAGR 73.27) in Retail; third place is for Pontica Solutions (rank 716 with CAGR 47.22) in Professional,

Scientific & Technical Services sector of economy and on the fourth place is Storpool (rank 743 with CAGR 45.99) which is in IT & Software.

Again, several interesting observations must be outlined based on the information in the table above. First, 50% of the companies in the top 10 of this ranking are from the United Kingdom, which has a favorable business climate supporting the company's fast growth. Another interesting finding is that Italy has 3 companies in top 10, while the two national European economies regularly considered the leading economies in the European Union – Germany and France – are presented with only one company in the top 10.

Unlike the first ranking explored in this study, this ranking is much more diverse in terms of the economic sectors in which the fastest-growing enterprises in Europe operate for 2023. This observation is relatively easy to explain, having in mind several keys: the first one is based on the scope of the ranking, which covers the entire Europe. On the other hand, the fact that all 5 companies from the United Kingdom and all 3 from Italy are representatives of different sectors of economy speaks for the overall policy of supporting the companies' growth of both countries. There are only two sectors that have two representatives of companies in the top 10 (Fig. 3) – these are Leisure and entertainment (Tripledote Studios from the United Kingdom and Inkitt from Germany) and Fintech, Financial Services & Insurance (Marshmallow from the United Kingdom and illimity Bank from Italy). Their growth for 2018 and 2022 is impressive, and some additional calculations could help better understand the growth logic according to the sector.

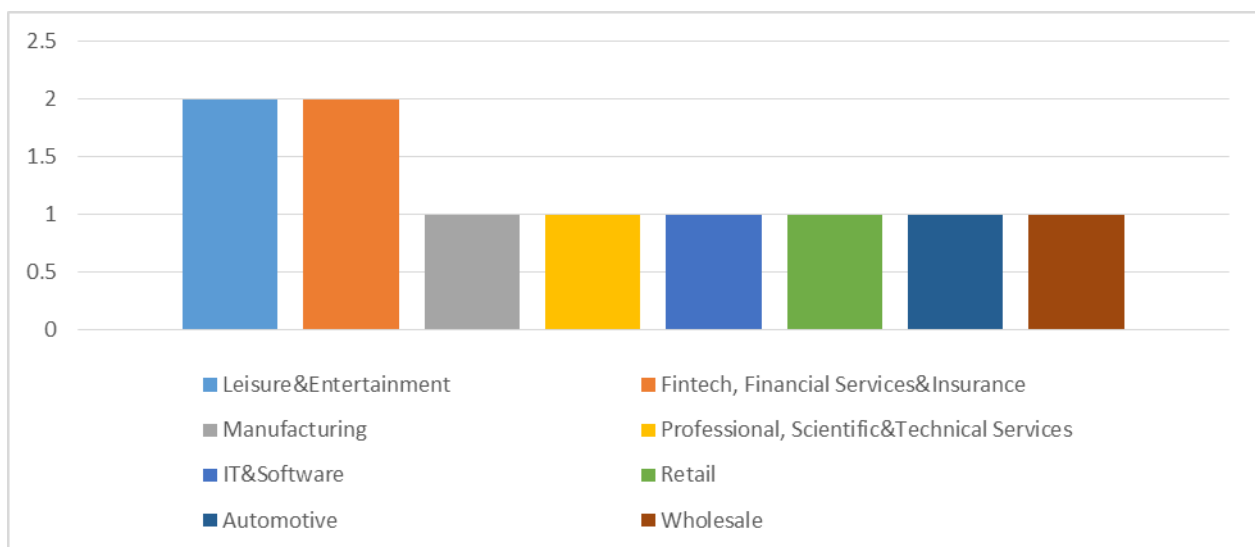


Fig. 3. Distribution by economic sector of the top 10 fastest-growing companies in Europe for 2023

Source: Statista

An interesting comparison of the two sectors can be made in terms of the growth rate based on the number of employees in these companies from 2018 to 2022 (Table 3).

Table 3. Growth based on the number of employees in two sectors

Sector of Economy	Name of the company	Number of employees		Rate of growth	Average for the sector
		2018	2022		
Leisure and entertainment	Tripledote Studios	18	172	9,55	6,93
	Inkitt	19	82	4,31	
Fintech, Financial Services & Insurance	Marshmallow	8	220	27,5	16,37
	illimity Bank	138	725	5,25	

Source: Statista, authors calculations

Based on the growth of the number of employees, the average rate of growth achieved by the companies in the Leisure and Entertainment sector is 6,93, while for the Fintech, Financial Service & Insurance, this score is

16,37. This observation can be interpreted through several main lines. First, it should be noted that the human factor is extremely important when talking about fast-growing companies in Fintech, Financial services and Insurance industries. The direct correlation between the overall growth of the company and the level of hiring of new employees is evident there. Therefore, when we consider the basic principle for assessing the company's fast growth, the indicator covering the number of employees and their development for a concrete period has to be included in it. The second line of consideration is the specification of the economic sector. Here on the table we have 2 totally different sectors, offering product and services to different types of clients, with totally different strategies of the business models. Therefore, it is completely reasonable to ask the question, in addition to defining basic indicators for the evaluation of fast-growing companies, to consider the possibility of determining different coefficients depending on the specifics of the industry in which the companies operate. In this situation, for instance, the growth of the number of employees in Fintech, Financial services and Insurance industries has to be considered a key indicator for these companies. And at the same time, in these sectors of economy, where there is more reliance on automation, artificial intelligence, technological innovation, it is possible that the number of people in the company is not as crucial to its development as their abilities and expertise.

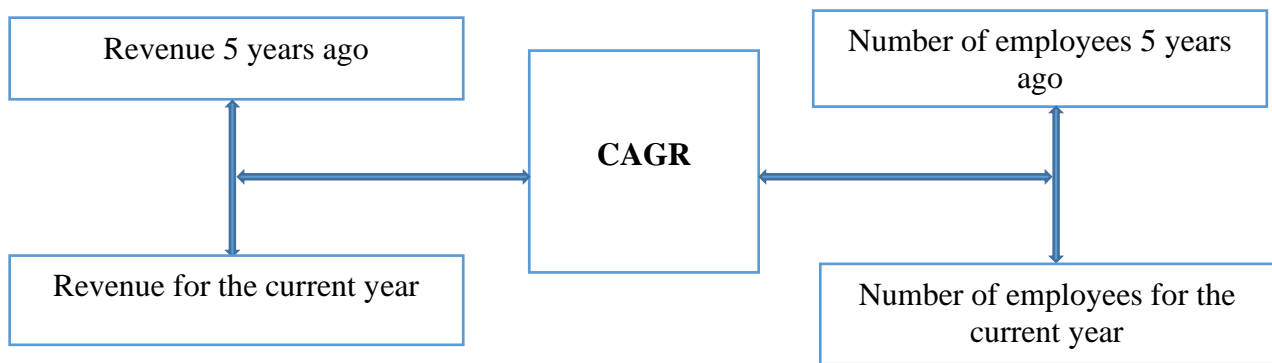


Fig. 4. Basic indicators used for identification of the fastest growing companies in Europe, 2023

4.3. Rating on Global Scale

The third and final ranking we chose to explore for the specific purpose of the current research is the fastest-growing startups on a global scale. This rating is prepared by an analyst company Exploding Topics (www.explodingtopics.com), whose clients are global brands such as Apple, Microsoft, Samsung, Amazon, Netflix, Google, Airbnb, etc. The ranking has several indicators with the help of which the analysts determine the ranking order (Table 4.).

Table 4. Global ranking of top 25 fastest growing startups in 2023

N	Name of the company	Year Founded	Location	Sector / Specifics	5-year Search growth	Search growth status	Funding \$
1	Zerotier	2015	Los Angeles, California	IT & Software	531%	Exploding	\$3.7M
2	Cradlewise	2019	San Francisco, California	Manufacturing (Smart furniture)	2300%	Regular	\$7M
3	OnlyFans	2016	London, UK	Leisure& Entertainment	9100%	Exploding	Undisclosed
4	StackBlitz	2018	San Francisco, California	IT & Software	379%	Exploding	\$7.9M
5	Linktree	2016	Melbourne, Australia	Social Media, e-commerce	8200%	Regular	\$165.7M
6	Fandom	2004	San Francisco, California	Leisure& Entertainment	209%	Regular	\$145.4M
7	Preply	2012	Brookline,	Education	1720%	Exploding	\$170.1M

8	Labster	2011	Massachusetts Copenhagen Denmark	IT & Software Virtual learning	410%	Regular	\$150.5M
9	Oura	2013	Oulu, Finland	Manufacturing (Smart rings)	7900%	Exploding	\$148.3M
10	Tailwind	2012	Oklahoma City, Oklahoma	Social Media, E-commerce	1229%	Exploding	\$10.7M
11	Gumroad	2012	San Francisco, California	Social Media, E-commerce	361%	Exploding	\$16.1M
12	Clockify	2017	Palo Alto, California	IT & Software	1300%	Exploding	Undis- closed
13	Glow Up	2020	Khobar, Saudi Arabia	Beauty & Style	809%	Exploding	Undis- closed
14	Brightwheel	2014	San Francisco, California	IT & Software Childcare management software	286%	Exploding	\$88.8M
15	Manscaped	2016	San Diego, California	Trade & Manufactur- ing	414%	Regular	\$500K
16	Shiprocket	2017	New Delhi, India	E-commerce logistics platform	2225%	Exploding	\$399.1M
17	Saie	2019	New York, New York	Beauty & Style	388%	Exploding	Undisclosed
18	Boddle	2018	Tulsa, Oklahoma	Gamified math learning platform	99X+	Exploding	\$5.6M
19	Liquid Death	2018	Santa Monica, California	Manufacturing Water DTC startup	2200%	Exploding	\$200.6M
20	Printify	2015	San Francisco, California	Marketing & Adver- tising	2600%	Exploding	\$54.1M
21	Melio	2018	New York, New York	Accounting IT & Software	591%	Exploding	\$504M
22	Adalo	2018	St. Louis, Missouri	IT & Software	4500%	Exploding	\$9.8M
23	The Farmer's Dog	2016	New York, New York	Manufacturing Pet food	542%	Exploding	542%
24	Elegoo	2015	Shenzhen, China	Manufacturing	567%	Exploding	Undisclosed
25	Givebutter	2016	WashingtonDist rict of Columbia	Fundraising software startup	1900%	Exploding	\$7M

Source: Exploding Topics and authors` search 2023

Based on the information in the table, several observations could be made. First, despite the relatively different sectors of economy and diverse service and products that the first 25 startup companies on a global scale offer to their customer, there is one horizontal characteristic which refers to almost any enterprise of this rating – this is the usage of ICT technology for developing and offering the service or product. Therefore, it could be concluded that ICT technologies play a critical role in these companies' development speed. Secondly, the margin of 5-year search growth varies on a big scale between different companies, even between companies in one sector (for instance: 286% for Brightwheel and 4500%, achieved by Adalo in IT& Software; 209% for Fandom and 9100% achieved by OnlyFans, representing the sector Leisure & Entertainment). On the next line of consideration comes the differences in terms of the year of foundation of the companies in this rating. It is generally accepted belief that startups are enterprises that do not have a very long history and, therefore, have a good/stable credit and financial rating. On the other hand, Ries (2011) offers another interpretation of a startup - an organization dedicated to creating something new under extreme uncertainty. This definition explains from one side the critical role of innovations and ICT (as we already mentioned) and – the relatively big variety of the startup companies' foundation years included in this rating (Fig. 5).

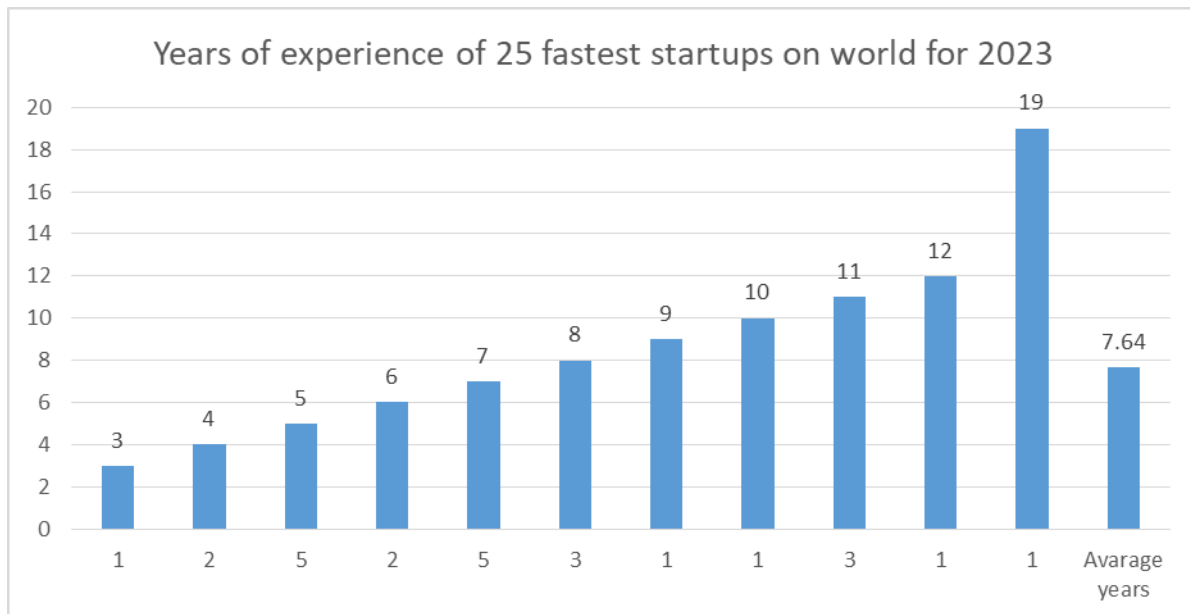


Fig. 5. Distribution of the number of companies in top 25 fastest-growing startups in the world for 2023, based on the number of years of experience

Source: Exploding Topics, authors calculations

When we proceed to a deeper exploration of this graphic, we could outline the following observations: 24% of startups included in the rating have 10 or more than 10 years of experience. This fact justifies the definition, perceived by Ries, that startups could be enterprises offering something new to the market in the very complex and uncertain business environment. Here, the most experienced (in terms of years of existing) company is Fandom (USA), which has operated since 2004 in the sector of Leisure & Entertainment and offers services for wiki hosting mainly for entertainment culture. At the same time 5 companies have 5 years of experience, which makes 19% of the companies in the rating. A curious fact is that 4 of these 5 enterprises operate in the IT & Software and only one is in Manufacturing and Trade.

On the other hand, this sector domination could be easily explained by the fast development of the ICT industries. Another peculiar "peak" is among companies with 7 years of experience. The diversity of economic sectors among startups with seven years of experience is significantly greater than among five-year startups (Fig. 6). Here, in contrast to the five-year startups, where we have a significant dominance of the Software & IT sector, in the seven-year startups we observe almost parity between the sectors in which the enterprises operate. The only exception is the Manufacturing & Trade sector, where we have two companies - The Farmer's Dog (USA) and Manscaped (USA). The product of Both companies in this sector, at first glance, are almost regular.

But on the other hand, both companies have something new used to attract customers. The Farmer's Dog offers high-quality food for dogs by taking the healthy eating trend for people and extending it to pet food. Manscaped focuses on very "edgy" advertising in social media to sell its products, which could be one reason for its fast development.

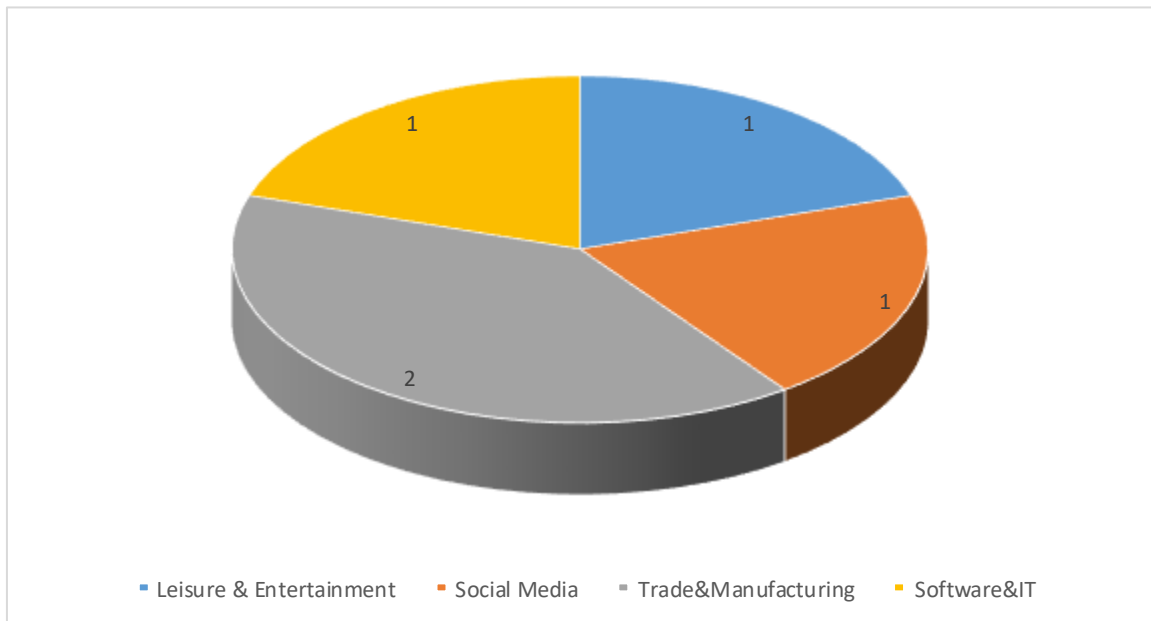


Fig. 6. Diversity of economic sectors among 7-years startups in top 25 fastest-growing startups in 2023
Source: Exploding Topics

The distribution by economic sector of the top 25 fastest-growing startups in 2023 on a global scale is presented in Fig. 7. In a comprehensive exploration of this information, we could make the following observations: IT & Software sector is leading with almost 30% of the top 25 fast-growing startups in world, followed by manufacturing and trade sector.

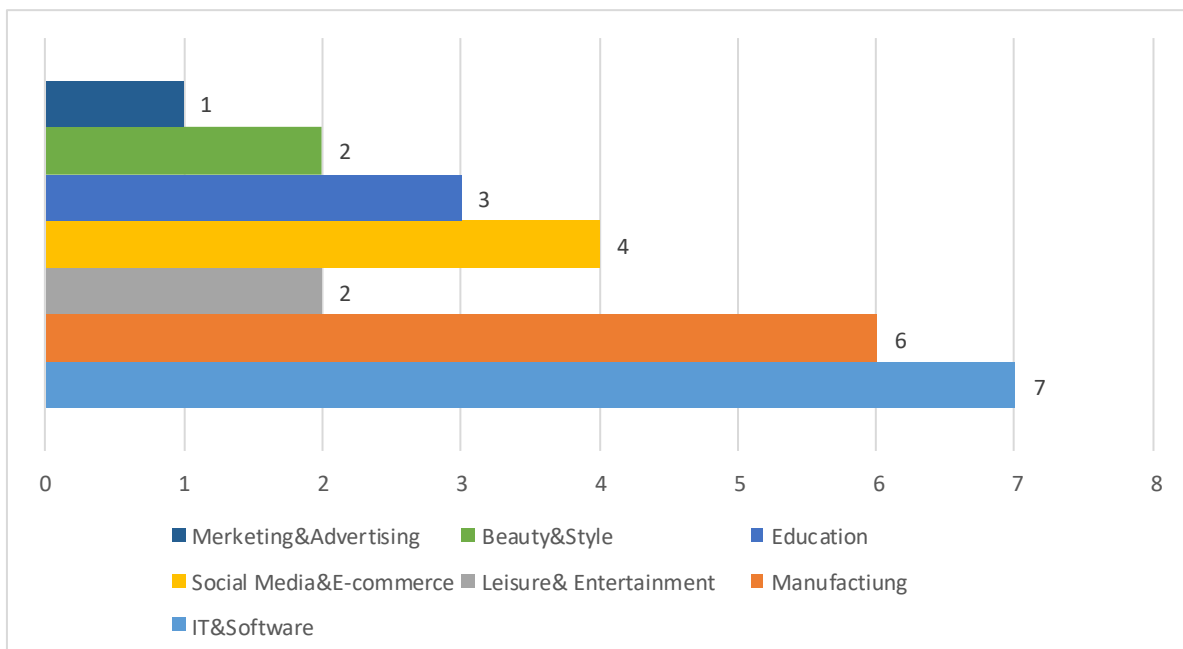


Fig. 7. Distribution by economic sector of the top 25 fastest-growing startups in 2023
Source: Based on the information of the rating, developed by Exploding topics

On the other hand, it should be noted that the representative companies in this sector participated in the rating do not produce and sell typical products. Very strong example of this are Cradlewise (USA), which produces smart bassinets for babies, able to take care of smooth sleep of babies, as well as Oura (Finland), which manu-

factures smart rings that monitor specifics of human heart, pulse, temperature of the body, characteristics of sleep etc. Therefore, some of this sector's companies are also connected to the ICT industry.

In third place comes Social Media and E-commerce, which sector is also very closed and depends on ICT solutions, followed by Education. In a more comprehensive look at the startup companies in this sector, we will notice that their products are also based on ICT, offering virtual learning, gamified math learning platforms, and language tutoring services connecting students and tutors from all over the world.

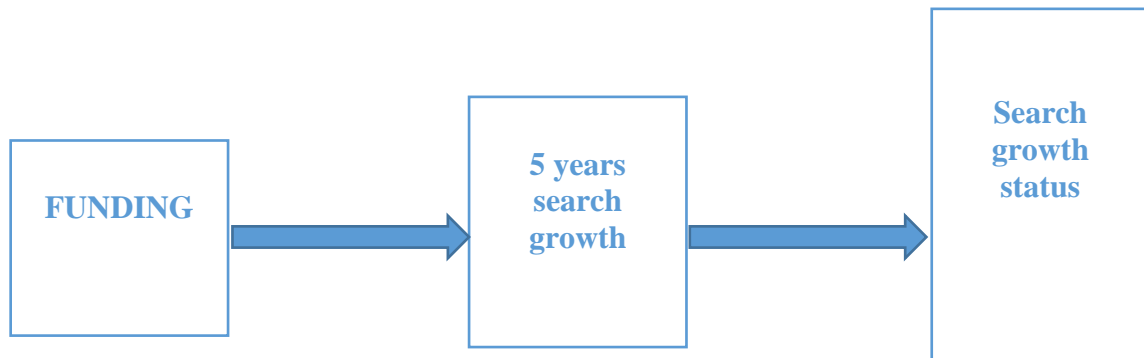


Fig. 8. Basic indicators used for identification of the top 25 fastest-growing startups in the world for 2023

In summary of all the ratings considered so far, determining whether an enterprise is developing rapidly and achieving fast growth is not an unambiguous process. Still, it should be considered in depth, taking data for a specific period. Indeed, when assessing the company's rapid growth, the financial situation and its development should be of primary importance. Still, on the other hand, some other non-financial indicators should also be taken into account - such as, for example, the number of people working in the enterprise, their expertise and ability for creativity and innovation potential, etc.

5. Basic principles in the evaluation of Fast-Growing Companies operating in Innovation-Intensive Industries

To develop our set of workable basic principles for evaluating fast-growing companies that operate in innovative-intensive industries, we will use the Balanced Scorecard, developed by Kaplan and Norton (1996), as a base model. They defined four critical directions for the enterprise's strategic development and growth: Finance, Clients, Business Process, Employees.

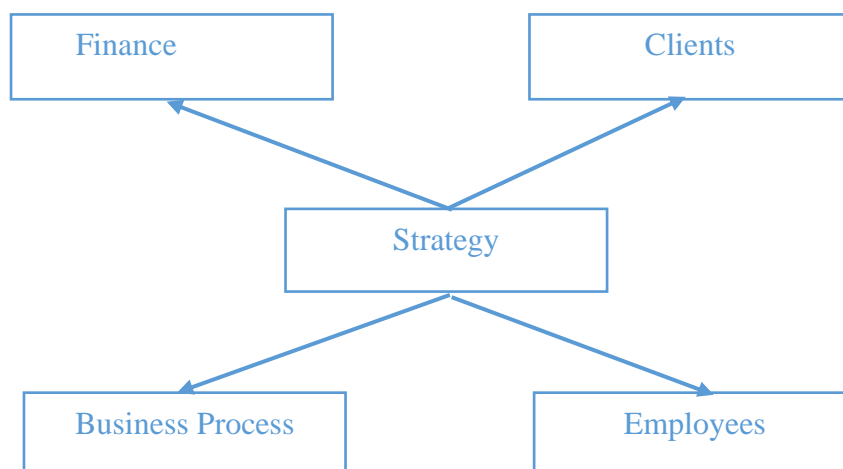


Fig. 9. Balanced Scorecard for evaluation of strategic development of the enterprise
Source: Kaplan, Norton (1996)

Conclusions

In enterprises with a high degree of innovation, modern requirements and priorities are imposed, which are decisive in producing goods and services with a high added value. The effective management of business processes and the implementation of innovative production technologies are a prerequisite for competitiveness and added value.

With the development of the COVID-19 pandemic and the transformation of the business model from conventional to digital, many enterprises have transformed the business process from cheap labor and automation to production with added value for the customer. New trends in business are associated with complex requirements that reflect the strategy and policy of enterprises with high levels of innovation. The company now must strive for knowledge and innovative technologies to increase the efficiency of its economic activity.

In a knowledge economy, investments are needed in human capital, which is the basis of high technology and global changes in the business space. To accelerate the effect of business improvement by introducing new technologies, enterprises with high innovation levels should consider various environmental adaptation indicators.

As a result of the transformation of the business model from conventional to digital, enterprises with high levels of innovation have had to consider different guidelines for optimizing the business process, analyzing the critical mechanisms for adding value to customers and looking for reserves for effective management of scientific- the technical activity.

In the current research, we propose a set of basic indicators for assessing the fast-growing companies operating in innovative-intensive economic sectors. Their role is important due to the fact that with the intensity of their development, they could positively affect and impact companies in other sectors of the economy. Therefore, once they can be identified and evaluated, developing an overall policy to further their development and create a favorable business environment is possible.

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**Publisher**<http://jssidoi.org/esc/home>**LOW ENERGY BUILDINGS: MULTIFUNCTIONAL STRATEGIES AND SOLUTIONS****Justinas Gargasas¹, Kristina Baziene^{2*}, Pawel Dzienis³**^{1,2} Vilnius Gediminas Technical University, Department of Mechanical and Materials Engineering, Saulėtekio al. 11, LT-10223, Vilnius, Lithuania³ Bialystok University of Technology, Department of Dynamic Systems, Wiejska 45 C Street, 15-351 Białystok, PolandE-mails: ¹ justinas.gargasas@vilniustech.lt; ^{2*} kristina.baziene@vilniustech.lt (Corresponding author); ³ p.dzienis@pb.edu.pl

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Abstract. EU directive on the Energy Performance of Buildings states that by 2020 new construction buildings must be Nearly Zero Energy Buildings (NZEB). These are common goals for the EU, however, it creates a challenge for northern countries where climate requests higher energy efficiency materials and respectively the costs. NZEB achieves low energy consumption, solar gains, and reduces heat losses, therefore, has very high energy performance. Passive solar heat gains and its utilization is widely used to reduce energy consumption, especially, through windows in the South façade. Research and experiments of solar simulation models deliver results that allow evaluating potential gains from solar thermal façade systems; in addition, it reduces heat losses for buildings to reach the requirements of NZEB. The goal of the research is to assess latent and sensible energy storage in building envelopes using phase change material (PCM) as a heat accumulator and Fresnel lens as a solar concentrator. A new passive solar thermal façade system model is designed that consists of a Fresnel lens as solar concentrator, PCM as heat accumulator, and copper as heat transfer enhancer to accumulate thermal energy received from the Sun or solar simulator. This research is an example that biology can be integrated with architecture via biomimicry principles and nature has countless multi-functional, complex, and highly responsive mechanisms, strategies, and solutions. Biomimicry in architecture remedies existing errors of efficient system design and products, by taking into the fact that outer shells in nature face the same weather conditions and have the same functions and tasks as reducing heat loss via thermal envelope (insulation, metabolism, hibernation), storing and generating energy, avoiding indoor from overheating.

Keywords: renewable energy; solar energy; biomimicry for façade systems; phase change materials; multifunctional strategies, solutions**Reference** to this paper should be made as follows: Gargasas, J., Baziene, K., Dzienis, P. 2023. Low energy buildings: multifunctional strategies and solutions. *Entrepreneurship and Sustainability Issues*, 11(2), 314-330. [http://doi.org/10.9770/jesi.2023.11.2\(22\)](http://doi.org/10.9770/jesi.2023.11.2(22))**JEL Classifications:** R20**Additional disciplines** are physics; ecology and environment; construction engineering; transport engineering; environmental engineering; and energetics.**1. Introduction**

During the last decades, low-energy building design has been separated into two alternative strategies: active technologies and passive design. The first approach aims to improve sustainability in the building environment by integrating innovative technical devices most commonly used for decentralized energy systems, energy supply generation from renewable energy sources, or resource conversion at greater efficiency. Passive design is associated with building construction design and building shape. Passive design aims to capture, store, and evenly distribute renewable energy sources mainly wind and solar energy. It also replaces non-renewable energy for indoor heating, conditioning, and lighting. Successful building design is becoming an increasingly complex task, due to a growing demand to satisfy more ambitious environmental, societal, and economic performance

requirements. The application of climate adaptive building shell (CABS) has recently been put forward as a promising alternative within this strive for higher levels of sustainability in the built environment. Compared to conventional façades, CABS offer potential opportunities for energy savings as well as improvement of indoor environmental quality. By combining the complementary beneficial aspects of both active and passive building technologies into the building envelope, CABS can draw upon the concepts of adaptability, multi-ability, and evaluability (Aelenei et al. 2016). The energy-efficient external building envelope is key for cold climates to reach NZEB requirements by 2020. The strategy to reach NZEB requirements can involve utilizing low-energy geothermal, solar, and other renewable energy resources to provide heating and cooling for the indoor environment. Full or partial usage of renewables would not only create certain independence from energy suppliers but also cut costs that occur during the heating season in cold climates where the average heating season is 200 days (Ručevskis et al. 2020).

Building shell is a boundary between indoor and outdoor environments and is subject to various conditions. For example, weather changes throughout the day and season, the same applies to indoor environments based on building type, occupancy, and comfort requirements. Static buildings have no capability to act to any changes. Therefore, a shift to CABS would create an opportunity to transform from a manufactured indoor climate to a mediated one. By integrating the CABS principle and combining passive design with active technology, CABS reduces energy consumption, while improving indoor air quality (IAQ), and thermal and visual comfort levels (Aelenei et al. 2016). The switch from static to adaptive building facades is a complex engineering process during the construction and operation phases. Building design nowadays not only means monumental building creation but is an assembly of a complex model that has a certain function. It is not efficient enough to add adaptive features to an existing system, CABS should create a new design to meet the needs and use as much free energy and light as possible. It happens that separate building envelope systems or elements are integrated together to meet a requirement. CABS also should find a balance between various opposites, for example, daylight and glare, overheating heat gains, proper air circulation, and draught (Hayes et al. 2019), (Kannan and Vakeesan 2016).

CABS is only one label of a concept, several synonyms of the term ‘adaptive’ exist as active, advanced, dynamic, intelligent, interactive, kinetic, responsive, smart, etc. Yet the terms have slightly different meanings, they are interchangeably used in the literature. Every CABS influences multi-physical behavior by blocking, filtering, converting, collecting, storing, or passing via various energy fields. To characterize CABS differences and similarities, four domains are distinguished in Table 1.

Table 1. Physical domains description of CABS (Aelenei et al. 2016).

Thermal	Adaptation causes changes in the energy balance of the building via conduction, convection, radiation, and storage of thermal energy
Optical	The adaptive behavior influences occupants’ visual perception via changes in the transparent surfaces of the building shell
Air-flow	A flow of air across the boundary of the façade is present, and adaptive behavior is influenced by the direction and speed of the wind
Electrical	Building-integrated energy generation takes place on the façade level, or electricity consumption is an essential part of the adaptation mechanism

Strong coupling exists between thermal and optical domains. Solar radiation is an environmental factor with high variability and direct consequences for thermal and visual comfort, in addition to daily, monthly, and seasonal weather-related fluctuations. Efficient CABS should be able to perform on these solar radiation fluctuation responses, prevent overheating and glare, and sustain efficient energy operation within the building. CABS involves innovative technology integration that results in challenging and costly projects with relatively high risk. Project creators have the tendency to have more conservative attitudes toward implementing new technology because of the risks that involve disproportionate payback times caused by higher investment, maintenance, or failure costs. Adaptive building envelopes improve building energy efficiency and economic matters because of their ability to change behavior in real-time based on various parameters of materials, components, and systems located indoors and outdoors (Aelenei et al. 2016).

As façade is main parameter that impacts building energy performance, elements of façade should be designed to ensure required flexibility of a building in terms of energy flow and thermal comfort. Existing standards determine that building envelopes act as energy-efficient mechanical systems that can react to non-continuous, non-predictable, and changing external conditions and temperatures. In other words, the façade needs to change and adapt to the environment to fulfill its function and be efficient enough. For this reason, including adaptive façades in building construction plan have the potential to increasingly reduce energy use of building and CO₂ emissions. In the meantime, it ensures thermal and visual comfort. Different adaptive façade concepts have been presented and demand increase has been forecasted for emerging and innovative solutions within the next decade. Adaptive façades consist of multifunctional highly adaptive systems where the physical separator between indoor and outdoor environment (building envelope) can change its functions, features, and behavior over time in response to transient performance requirements and boundary conditions, aimed to improve overall building performance [62]. According to the definition, multi-functional adaptive facades ensure the response to changes indoors and outdoors to improve envelope function of heat, air, IAQ, water vapor flow, rain penetration, solar radiation, noise, fire, strength, stability, and aesthetics. The Façade ensures controlled insulation and thermal mass, radiant heat exchange, ventilation, energy harvesting, daylighting, solar shading, and humidity control. For a building to meet NZEB requirements and be integrated into the smart city concept this type of facade is crucial. Since interest in the design and development of adaptive building materials and dynamic façade systems has risen, they have been classified by different concepts with common features and properties. Review papers published different categories of four adaptive façade concepts adaptive glazing, phase change material (PCM), solar façades, and daylighting systems (Moss et al. 2018). It is vital to characterize and determine adaptive façades purpose, response function, components, degree of adaptability, and other factors as in Fig. 1. before façade material performance evaluation and testing.

The authors of the study analyzed a representative sample of 130 buildings most of which were in warm and maritime temperate climates. Considered external factors were solar radiation, outdoor temperature, wind, humidity, precipitation, and noise. Authors highlighted that a great challenge for adaptive façade is to do both – respond to external factors and ensure a comfortable and stable internal environment that includes thermal comfort, energy performance, indoor air quality, acoustic performance, visual performance, and durability. It was found that the most common external factors are solar radiation coupled with outdoor temperature. These factors have the most direct influence on thermal and visual comfort and on the energy performance of buildings (Moss et al 2018).

Purpose	Responsive function	Operation	Components (materials and system)	Response time	Spatial scale	Visibility	Degree of adaptability
Thermal comfort	Prevent	Intrinsic	Shading	Seconds	Building material	No	On-off
Energy performance			Insulation	Minutes	Facade element		
IAQ	Reject		Switchable glazing	Hours	Wall		
Visual performance	Modulate	Extrinsic	PCM	Days	Window	Low	Gradual
Acoustic performance			Solar tubes	Seasons	Roof		
Control	Collect		Integrated solar systems	Years	Whole building		

Fig. 1. Overview of characterization concepts for envelope adaptivity

Source: Moss et al. 2018

Recent trends in envelope system design has evolved using dynamic systems to adapt layered building facades. Each of this layer has a specific function, therefore, the layered façade has a certain level of complexity. Dynamic and kinetic systems are automatically controlled shutters, adaptive skin, climate-adaptive building shells, interactive architecture with robotic and kinetic design, acclimated kinetic envelope, adaptive building skins, and kinetic systems in architecture. They all improve energy efficiency and occupant flexibility for controlling non-static buildings. Most building skins are a system that reacts and performs based on the user's need and adapts to weather conditions by automatic control concepts that are also adjusted by users (Kuru et al. 2019). Lopez (López et al. 2015) is of strong opinion that learning from nature is the answer. Biology has always presented new paradigms in numerous areas, including engineering and medicine. Worth mentioning, that it is also a novel basis for technological thinking. Biology can be integrated with architecture via biomimicry principles that consider nature as countless mechanisms and strategy databases for design. Solutions that are based on biology are multi-functional, complex, and highly responsive; they replace conventional static building envelopes and in a new adaptive form improve energy performance. The biological solution approach helps for building envelope to be more responsive and adaptive to indoor and outdoor environments and satisfy thermal, light, and air quality comfort. Biomimicry has countless opportunities to adopt sustainable building design, however, it creates a challenge to transfer knowledge from biology to engineering, architecture, or technology (Al-Obaidi et al. 2017). In recent biomimetic research on building, thermal envelopes are compared to outer shells that exist in nature. Outer shells in nature face the same weather conditions and have same functions and tasks as reducing heat loss via thermal envelope (insulation, metabolism, hibernation), storing and generating energy, and avoiding indoor overheating (Erebor et al. 2021), (Sommese et al. 2023).

Nature solves various mechanical and structural problems, most notably it does not generate residual and active wastes. To mimic nature, it requires a high level of understanding between biological and technical systems. Even their evolution is similar. As we know biological systems have been evolving for millions of years and are based on genetic codes that are governed by natural selection. Meanwhile, technical systems have been developing for only a few centuries and are developed based on human design to perform and ensure functions (Cohen et al. 2014). Kennedy (Kennedy 2017) defines biomimicry as a new field in science that combines sustainable solutions and innovation with research and industry development by evaluating invention suitability with ecologically based criteria. The author also states that understanding nature as a mentor, measure, and model will be crucial to successfully implementing biomimicry applications (Kennedy 2017). Biomimicry levels are categorized into three phases: form, process, and ecosystem. The first phase is copying attributes and features from any existing organism as appearance, shape, materials, etc. The second phase is on a deeper level to replicate biological systems to mimic natural processes. The third phase is a set of processes that tries to duplicate the ecosystem from a combination of forms and processes. Mazzoleni (Mazzoleni 2013) stated that biomimicry follows certain analogies and performs on diverse stages as organisms, behavior, and ecosystems. Biomimicry as emerging research in architecture faces some issues that limit its further progress. Biomimicry implementation in areas of engineering and technology is limited due to limited knowledge transfer of technological aspects from biology to design. Nature has various mechanisms and strategies that can be adopted via biomimetic approach and types of biomimetic designs available, however, it creates a great challenge to obtain the most successful architectural design (Al-Obaidi et al. 2017).

Biomimicry in architecture tries to remedy existing errors when designing efficient systems and products. Biomimicry integration in architectural design has diverse directions and classifications and the most common depends on obtained outcomes from research. The basic design approach that has also been widely utilized by researchers and practitioners are the bottom-up and top-down approaches. The bottom-up approach applies as an indirect and solution-based approach and it refers to biology to design where the biological principle is the source for design ideas. It relies on biological property adaptation to human technology to find answers and then identify human design problems. Specific characteristics or behaviors are searched in existing organisms or ecosystems after that the characteristic or behavior is shaped and used as a guideline for developing either architectural designs or industrial products. The top-down approach seeks answers from nature for a specific problem based on analogy or a problem-based direct approach. The approach is based on challenges to biology design problems and finding answers in other organisms or ecosystems with similar problems to solve human problems. An advantage of this approach is that searching for a suitable solution does not require in-depth

scientific understanding and makes it easier to translate biological information into technical systems (Kuru et al. 2019), (Sommese et al. 2022).

Hayes and others (Hayes et al. 2019) address six principles how ecosystems function and it could be translated to any system, as an example taking building skins:

- Dependence on contemporary sunlight: usage of renewable and contemporary energy from solar light based on spatial and time mechanisms.
- Optimisation of the system instead of its components: energy is transferred efficiently between systems and components as form follows the function. Energy and materials used in the same system are applied for multiple functions.
- Dependency on local conditions and situations: materials are sourced locally and adapt to specific environments.
- Diversity in components, relationships, and information: obtaining resilience and diversity is required. Relationships are complex and operate in various hierarchies which lead to self-organization and distribution; as a result, emergent effects occur.
- Creation of conditions favorable to sustained life: Systems are functioning and from an environmental perspective begin improving the biosphere.
- Adaptation and evolution at different levels and at different rates: obtaining the balance of non-equilibrium from constant flux. An ecosystem produces creative mechanisms when limited and ecosystems achieve self-heal capability.

Reichert identified five principles for biomimicry adaptation effectiveness: adaption, material systems, evolution, form and behavior, and emergence. In addition, the author classified biomimicry levels in architecture into nine types: concept, process or behavior, morphology, form, structure, skin, material, expression, and symbolism (Reichert et al. 2015). One of the methods is introduced by Garcia-Holguera et al. (Garcia-Holguera et al. 2016) called Ecomimetic. Conceptual approach or theoretical framework based on previous methods. The approach is a helix model capable of obtaining interactive exercises to integrate feedback. The method focuses on two levels –abstraction and transference of biological principles and is divided into six phases: architectural design goals, ecological solution searching, abstraction and ecological systems representation, the correlation between ecological and architectural systems, transference from ecosystem's principles to the architectural system, and modeling and benchmarking.

Lebdioui (Lebdioui 2022) in research classified biomimicry-based materials into four clusters:

- smart materials that change and react in response to external stimuli,
- surface modifications with innovative surface structures and improved functions,
- nature-inspired material architectures that are focused on innovative forms and structural arrangements,
- technologies that improve current systems by deploying specific adaptive parameters

Smart, responsive, and adaptive concepts are terms that have been used interchangeably and have caused confusion to many professionals. Firstly, smart building skins are referred to as fully or partially automated self-monitoring systems and deploy integrated instruments within a building. Smart building skins can be regarded as self-aware and grid-aware mechanisms that have embedded smart sensors that operate in four main areas user's comfort during different times of the day and year, building use changes, occupancy characteristics variations, and variations in external weather conditions based on collected yearly averages. Responsive building skins on the other hand are defined as a simple form of adaptation with functional and performance characteristics that are similar to smart building skins. The meaning of responsive proposes that environmental conditions are controlled with the usage of computational algorithms. The third term, adaptive building skin refers to a morphogenetic evolution and real-time physical adaptation of a design to its surrounding environment. It is more complex because adaptivity is combined with multi-scalar factors to reach a symbiotic energy-efficient design solution. Adaptive walls ensure a breathing envelope and influence air pressure on the surface to imitate the inhaling–exhaling process. Thermo-regulating envelope maintains an adequate balance between heat gain and heat loss without seeking air-tightness and water-tightness. Light-regulating envelope improves the visual comfort of the indoor environment (Al-Obaidi et al. 2017).

While designing adaptive building skin it requires low-technology and low-energy adaptive material systems. Consequently, the selected materials should require physical properties and structures that generate movement and adapt to real-time environmental changes. Various criteria should be considered in adaptive systems design as workability, responsiveness to stimulus, durability, resistance to corrosion, and achievable movements to impress force. Furthermore, materials should possess performative and self-actuating abilities, adapt to the system, and react to changes in the environment. Many adaptive materials are mimicked from nature, for instance, conifer cones that have repetitive opening–closing cycles and structural properties to respond to humidity. Civioc et al (Civioic et al. 2022) classified the materials into four areas: temperature-reactive materials, light-reactive materials, humidity-reactive materials, and carbon dioxide-reactive materials. The author classifies 13 smart materials, and 13 adaptive materials and lists their stimulus. Smart materials differ from adaptive materials. Smart materials in order to function, require external stimuli based on conventional energy sources, while adaptive materials function naturally in existing environmental conditions as in nature does plants. In this material classification combination of custom optics and PCM is a smart material with a heat source provided by solar radiation stimulus. Meanwhile, PCM as a material is listed as an adaptive material with temperature-reactive stimulus (Al-Obaidi et al. 2017).

2. Methodology and laboratory test

The main goal of the experimental study is to evaluate solar simulation experiment results and assess latent and sensible energy storage in the building envelope. Another goal is to evaluate 6 material combinations of solar models and determine the most efficient combination of solar façade systems. To reach the goals and test certain materials additional experiments were carried out to test aerogel transparency (Experiment 1) and mechanical (Experiment 2) properties.

It is always of great importance how heat losses can be maximally reduced. Heat loss reduction from sunlight receivers is considered for many applications; it also is meaningful for solar power concentration and converting sunlight into heat.

The volumetric radiation shield needs to be spectrally selective and should allow sunlight to pass while absorbing or reflecting IR radiation. Additionally, low thermal conductivity would be needed and the outer surface would have a significantly lower temperature than the absorber. The material that describes these properties is aerogel. Heat losses are greatly reduced while keeping high solar transparency. This means that aerogel allows the system to run at higher efficiency or receiver efficiency is obtained at lower optical concentrations (Aghabararpour et al. 2018). Silica aerogel has a cross-linked internal structure of SiO₂ chains with many air-filled pores. Due to high porosity, aerogel is the lightest solid material – skeleton density is approximately 2200 kg/m³. Pores are microscopic from 5–70 nm and take up to 85–99.8 % of total volume, depending on purity and fabrication method. Because of microscopic pores and high porosity, aerogel has advantageous physical, thermal, and optical properties. Even more, because of the combination of as low thermal conductor and high daylight and solar energy transmitter, aerogel is a qualitative transparent insulation material (Westgate et al. 2018). Aerogel's low thermal conductivity results from low solid skeleton conductivity, low gaseous conductivity, and low TIR of 0.85 (McEnaney et al. 2017).

Two laser pointers were located on a box 8.5 cm in height, both facing Fresnel lens (poly-methyl methacrylate (PMMA) (127x127 mm) with focal point 71 mm). The distance between lasers was 5 cm and the distance between lasers and lenses was 13 cm. Fresnel lens and its construction has a width of 7 cm. The focus point is located outside the Fresnel lens construction, approximately, 8 cm behind the lenses. The distance between the back of the lens construction and the screen (white A4 paper) is 15 cm.

The experiment was carried out in 2 parts – laser light ray projection on the screen without aerogel and ray projection filling Aerogel LUMIRA® LA 1000 CABOT (Civioic et al. 2022) (translucent and hydrophobic aerogel granules ranging in size from 70 µm to 4 mm, thermal conductivity 18 mW/(mK)) in Fresnel lens construction with 7 cm aerogel layer between Fresnel lens and focus point.

What mechanical exposure can be on aerogel? The advantages of aerogel are its very low density, nanostructure, and characteristics as amorphous and mesoporous. Because of its structure, the material has remarkable physical, thermal, optical, and acoustical properties. Silica aerogels are load-bearing with a high compression strength of up to 3 bars, however, the disadvantage is very low mechanical strength and fragility (McEnaney et al. 2017). Aerogel has high strength to mass ratio – it can support up to 1600 times its own mass. A downfall is that this brittle material has a fracture toughness of only 0.8 kPa m^{1/2}.

Experimental setup. 25 ml of Aerogel LUMIRA® LA 1000 CABOT (Civioc et al. 2022) (translucent and hydrophobic aerogel granules ranging in size from 70 µm to 4 mm, thermal conductivity 18 mW/(mK)) was measured and placed in a glass jar. An example of aerogel was taken for testing under the microscope with 40 x zoom to take pictures of aerogel before mechanical exposure (Guo et al. 9021).

Even though aerogel can be easily crushed, mechanical exposure does not destroy its porous structure. Meaning, the material grounds into powder and occupies approximately the same space as the original sample (Tafreshi et al. 2022).

The experiment demonstrates that mechanical exposure to aerogel did not damage the material and validates that the pore structure of the material does not change significantly. No critical volume changes occurred during the experiment. A loss of 3 ml appeared due to material placement from the measuring glass to the jar. It was observed that between the tests aerogel became electrified, complicated to capture and to make precise measurements. Aerogel was not drastically damaged by mechanical exposure – it can be explained as it is a light and durable material that did not split into small pieces. Even though the pictures show that aerogel particles have split of various sizes. Different-sized aerogel particles were found in each microscope viewing – from large aerogel parts to small size dust. One observation was that with each mechanical exposure, aerogel became more and more electrified, and aerogel particles pushed against one another. Another observation was that small dusty particles of aerogel that had split off the material greased the surface and the material was abrasive after mechanical exploration. It leads to the conclusion that aerogel after certain mechanical exposure could smudge the surface and lower ray transmittance.

3. Results and discussion

Ray's position in the screen located a certain distance from the Fresnel lens was captured without aerogel fill in Fresnel construction but they were not captured when the Fresnel lens construction was filled with aerogel. The focus point exists at a certain distance from the Fresnel lens without aerogel filling in Fresnel construction. Experiment results prove aerogel's opaque and transparency properties as no focus point exists and aerogel breaks light rays. As mentioned in the literature, aerogel has small pore sizes and high porosity. The experiment demonstrated that the material has high thermal and optical properties. In addition, because of its combination of low thermal conductivity and a low transmittance of daylight and solar energy (including IR spectrum), the material is a remarkable translucent and transparent insulator.

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Solar radiation is kept constant at 560 W/m^2 for 6 hours and 10 minutes. Fig. 2 below shows solar radiation values read by a pyrometer that was located between the boxes at the same distance of 1520 mm from halogen lights. During solar radiation, outside temperatures reached 29°C in front of the boxes and 26.2°C at the back of the boxes, data logger temperature measurements for outside temperatures are very inconsistent experiencing about 1-degree differences between 2 readings in 2–5 minutes period time. This was especially noticed after the lights were turned off and outdoor temperatures were varying due to cooling cycle. The highest value in conus is reached with variation aerogel and PMMA acrylic glass of 71.91°C . The next higher temperature of 55.2°C is reached in conus with PMMA acrylic glass. This in the only variation where conus reaches its peak temperature before solar radiation is turned off. The temperature of 55°C was reached on the 330th minute and kept constant for 25 minutes, experiencing a temperature drop after the lights were turned off. Reference box insulation reached the temperature of 42.3°C and was the first one to reach 13.2°C after 7 hours (1270th minute) while other temperatures in conus was between $14.5\text{--}17.7^\circ\text{C}$. In the 1440th minute reference box insulation had reached 13°C , while other temperatures in conus was between $14.3\text{--}14.9^\circ\text{C}$ and 17.3°C in the model of conus shape and Fresnel lens.

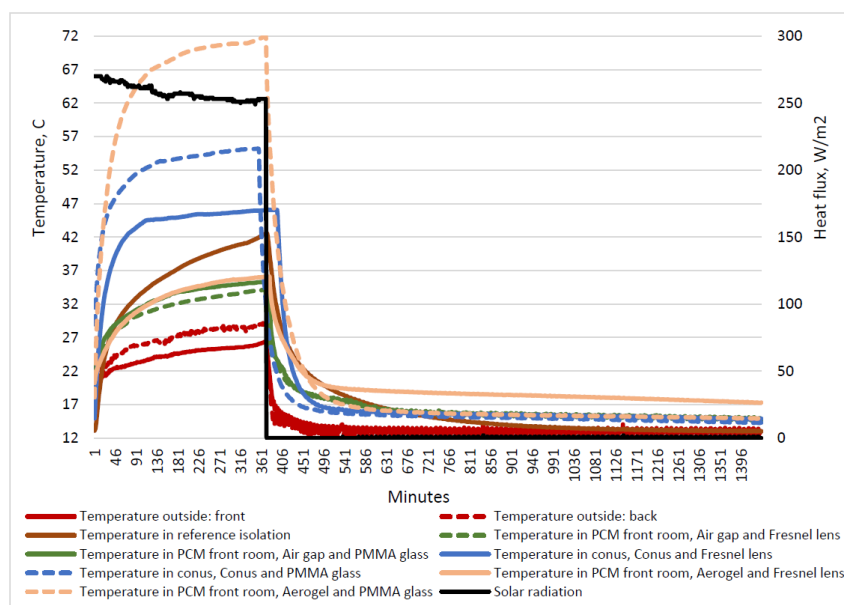


Fig. 2. Solar radiation and temperatures in PCM cone and reference insulation

Both air gap variations results are described below, and graphs are illustrated in Fig 3 of the air gap model with Fresnel lens and Fig 4 of the air gap and PMMA acrylic glass.

Temperature and heat flux results of the first variation with air gap and Fresnel lens can be read in Fig. 3. Temperatures in reference box insulation reach the maximum value of 41.9°C and the reference room is heated up to 27.7°C . During solar radiation heat flow in the reference box rises and heat moves inwards the room, overheating it up to 27.7°C , while the outside temperature is 29°C . The heat flow rate in the reference box rises within the first 100 minutes after that it reaches the peak of $5\text{--}5.7 \text{ W/m}^2$ till the 380th minute when solar radiation is switched off. 110 minutes later, in the 450th minute, heat flow has reached an equilibrium of 0 W/m^2 that continues till the 1440th minute. After solar radiation has stopped opposite process is happening, meaning that heat in the room and insulation gradually evens until room temperature and insulation have similar temperatures and heat flow is zero. Worth mentioning, that heat flow values even reach negative values slightly below zero, respectively, reference insulation receives heat from the reference room due to temperature changes. No heat is accumulated, and the reference box room reaches an outside temperature of 13°C in the morning.

Temperatures and heat flow in PCM boxes operate differently and have more gradual heating and cooling processes. Starting with temperatures, in an air gap room Fresnel lens concentrates light and heats it up to 34°C . During solar simulation, the PCM box room is heated up to 23.3°C , and PCM has melted and reached a maximum temperature of 23°C . PCM box room heats up very gradually as when temperature raises PCM by

endothermic reaction changes its phase from solid to liquid when it reaches 21 °C and absorbs excessive heat. After lights are turned off opposite process happens, PCM cools down from 23 °C and starts to solidify at 21 °C, by exothermic reaction PCM starts to release heat, reaching a maximum value of 11.9 W/m² in the morning. This process is seen in heat flow measurement results, at the start heat flow in the solar facade model increases and has a direction from outside to the indoor room. In the 100th-minute inward heat flow growth rate decreases, in the 180th minute the heat flow direction from the indoor room to the outdoors. In the 380th minute heat flow reached its peak of -6.1 W/m² and PCM has maximally absorbed heat energy. In the 500th minute heat flow reaches an equilibrium of 0 W/m² and PCM starts to release heat and continues till reaching the peak of 11.9 W/m² in the 1100th minute.

It is observed that reference and PCM box heat flows have different cycles. The reference box does not have heat storage, while PCM accumulates heat by reducing overheating and undercooling processes. In the morning, PCM managed to ensure a gradual temperature drop and the room temperature was 16.8 °C, unlike the reference room that has the same temperature as outside of 13 °C.

Temperature and heat flux results of the second variation with air gap and PMMA acrylic glass are shown in Fig. 4. Reference box has similar values as in the first variation. Reference insulation is heated to 42.4 °C, reference room accordingly is overheated during the day to 28 °C and cools to outdoor temperature during the period of night. Temperatures in the PCM box are the following: temperatures in conus reach 35.4 °C, PCM room reaches 23.4 °C while PCM heats to 22.9 C on this day. PCM and PCM rooms are heated to the same temperature. Even though, PMMA acrylic glass managed to heat conus room at 1.5 °C higher temperature, heat fluxes are similar to the first variation and reach 11.8 W/m² in the morning and the PCM room has the same 16.8 °C.

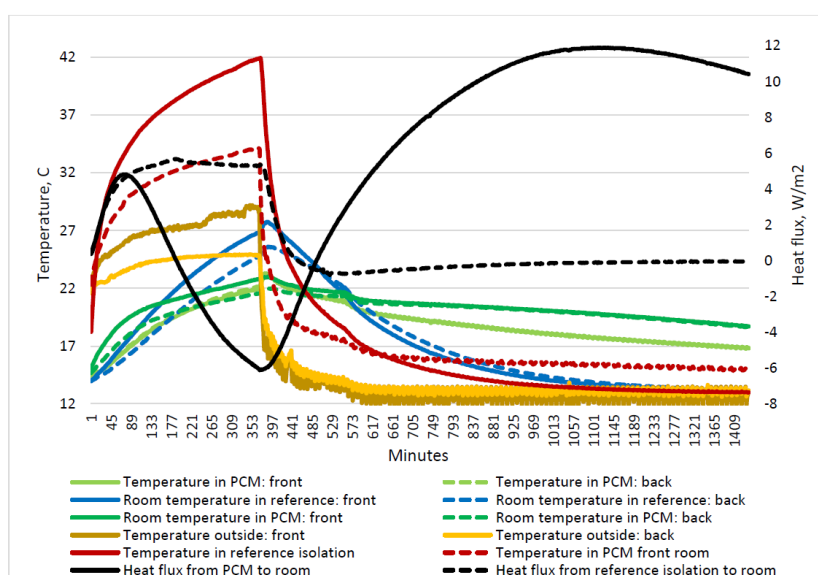


Fig. 3. Air gap and Fresnel lens temperature results

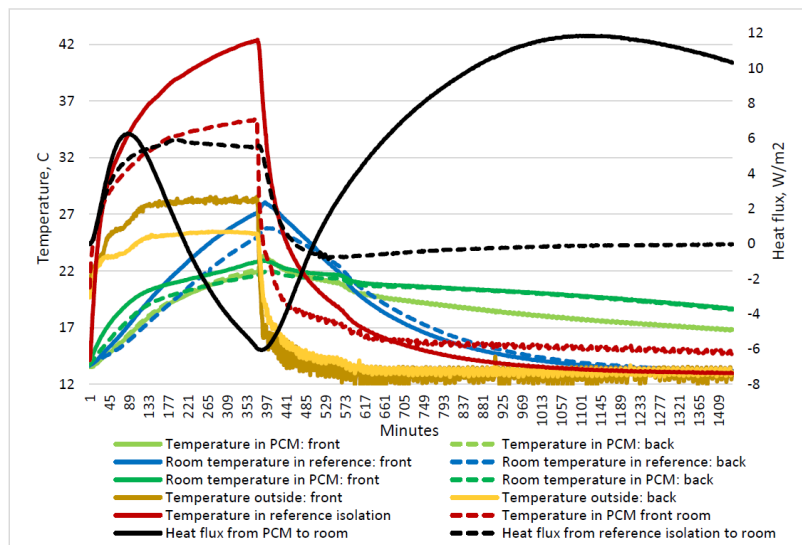


Fig. 4. Air gap and PMMA acrylic glass temperature results

Both conus shape front room variations results are described below, and graphs are illustrated in Fig 5. Of conus shape front room and Fresnel lens and Fig 6. of the shape front room and PMMA acrylic glass.

Temperature and heat flux results of the third variation with conus shape front room of the solar model and Fresnel lens are shown in Fig. 3.4. Reference insulation reaches 40.5 °C while conus room has been heated to 46 °C. The outside temperature of this test reached only 26.8°C, reference room was heated to 25.6 °C, on the contrary PCM room had a maximum temperature of 20.7 °C. The PCM room has optimal room temperature. The reasons why PCM room temperature has dropped is because of lower outside temperatures and PCM temperatures. In this test PCM did not heat to 21 °C, thermocouples measured a maximum temperature value of 20.6 °C in PCM front and 20.2 °C in PCM back. Of the low temperatures, PCM did not manage to melt; yet, heat flux reached 9.5 W/m² keeping the temperature in the PCM room in the morning at 16.4 °C which is only 0.4 °C less than for the previous test of air gap. Conus-shaped front room with aerogel managed to reduce heat loss.

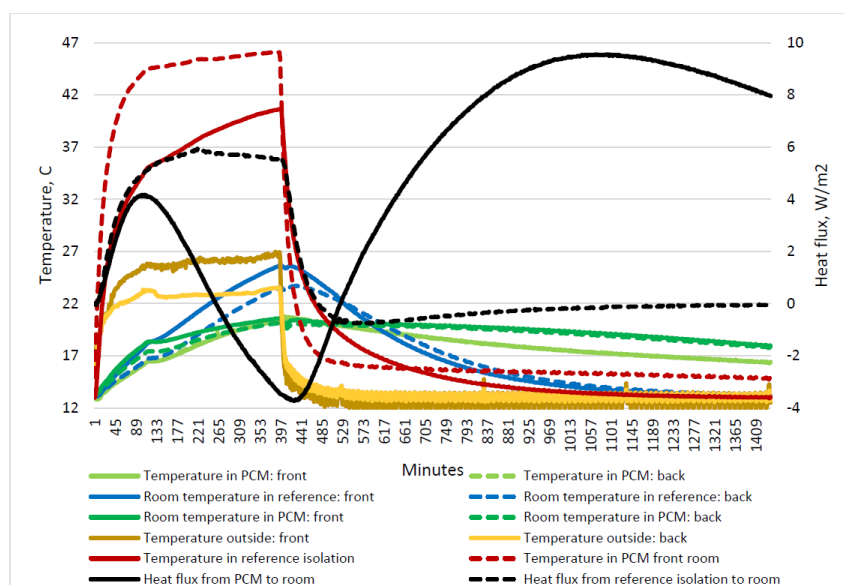


Fig. 5. Conus with aerogel and Fresnel lens temperature results

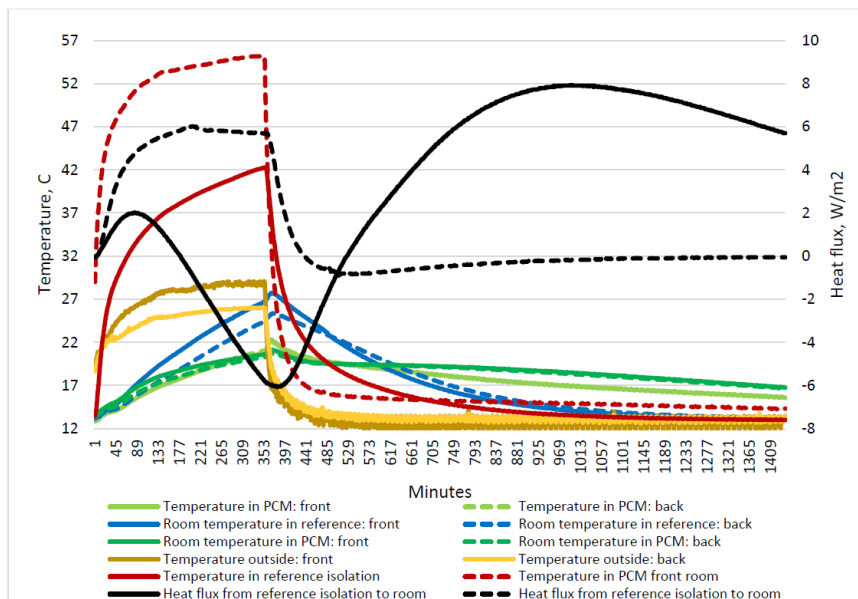


Fig. 6. Conus with aerogel and PMMA acrylic glass temperature results

Temperature and heat flux results of the fourth variation with conus shape front room of the solar model and PMMA acrylic glass are shown in Fig. 6. Reference insulation reaches 42.1 °C and conus room is heated to 55.2 °C. Outside temperatures of this test reached 29 °C, the reference room was heated to 27.7 °C, while the PCM room reached 22.3 °C. In this test PCM was heated to 21 °C, however, thermocouples measured 21 °C in the PCM front for only 20 minutes. Meanwhile, PCM back heated up to 20.7 °C. Due to insufficient and low temperatures, PCM did not manage to melt and heat flux reached only 7.9 W/m² keeping the temperature in the PCM room in the morning at the lowest value of 15.6 °C.

Both aerogel-filled variations results are described below, and graphs are illustrated in Fig 7. of aerogel fill and Fresnel lens and Fig 8. of aerogel fill and PMMA acrylic glass.

Temperature and heat flux results of the fifth variation with aerogel fill in the front room of the solar model and Fresnel lens are shown in Fig. 7. Reference insulation reaches 42.8 °C and aerogel room is being heated to 36 °C. The outside temperatures of this test reached 29.8 °C, the reference room was heated to 27.8 °C, while the PCM room reached 22.7 °C. This solar simulation also did not manage to heat PCM to 21 °C, however, thermocouples measured 20.9 °C in the PCM front for 50 minutes. Meanwhile, PCM back heated up to 20.5 °C. Of the low temperatures, PCM heat flow reached only 9.5 W/m² keeping the temperature in the PCM room in the morning value of 16.4 °C that are the same value as the variation with conus shape front room of the solar model and Fresnel lens.

Temperature and heat flux results of the sixth variation with aerogel fill in the front room of the solar model and PMMA acrylic glass are shown in Fig. 8. Reference insulation reaches 42.6 °C and aerogel room is heated to 71.9 °C. The outside temperatures of this test reached 29.3 °C, the reference room was heated to 27.1 °C, while the PCM room reached 21.6 °C. This solar simulation managed to heat PCM to 21 °C, however, thermocouples measured 21 °C in PCM front only for 30 minutes. Even though, the PCM back heated up to 20.8 °C, PCM heat flow reached 10.2 W/m² keeping the temperature in the PCM room in the morning value of 16.8 °C that are the same value as variation with conus shape front room of the solar model and Fresnel lens.

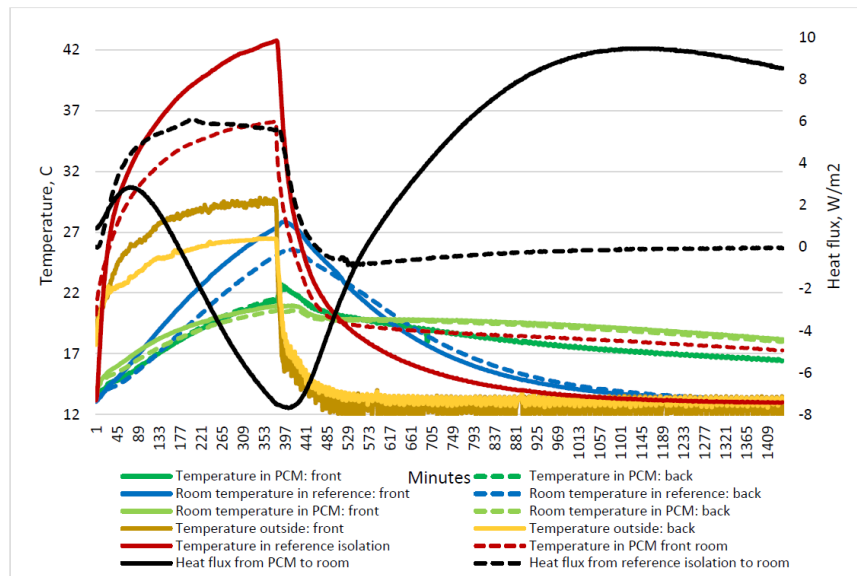


Fig. 7. Aerogel and Fresnel lens temperature results

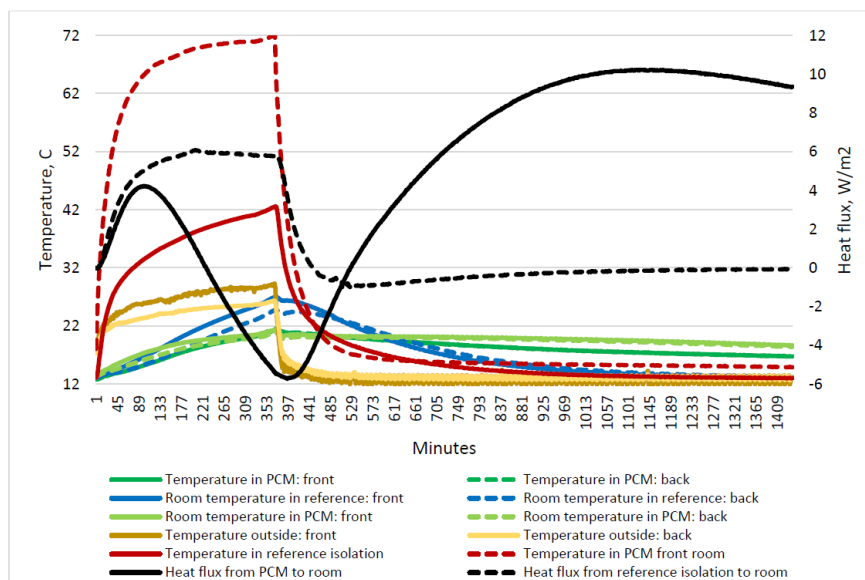


Fig. 8. Aerogel & poly-methyl methacrylate acrylic glass temperature results

Heat flux results of all six variations and reference boxes are illustrated in Fig. 8. At the beginning of solar simulation all boxes and variations experience heat flow growth rate in direction from outdoors to indoors. The reference box reached its peak heat flow of 5.5 W/m² in the 150th minute and stabilized till the 370th minute when the solar simulation is turned off. After 70 minutes in the 450th minute, the reference box flow reaches the equilibrium of 0 W/m². During solar simulation, heat flows in a direction from outdoors to indoors, after solar simulation is switched off, temperatures in reference box insulation and room drop by reducing heat flow towards the room and changing heat flow direction towards the outdoors. Four out of six test variations reach peak heat flow rate within the first 70 minutes those are air gap with Fresnel lens and PMMA acrylic glass, aerogel with Fresnel lens, and conus with PMMA acrylic glass. Conus with Fresnel lens and aerogel with PMMA acrylic glass reach heat flow peak at the 90th minute. Each of the test variations has different heat flux values.

Both air gap tests with Fresnel lens and PMMA acrylic glass in the solar simulation started reaching heat flux peaks of 4.8 and 6.2 W/m² and had 11.9 and 11.8 W/m² heat flow peaks at the time PCM released latent heat.

Both conus shape tests with Fresnel lens and PMMA acrylic glass had at the beginning heat flow of 2 and 4.1 W/m² and when PCM released heat it managed to have 7.9 and 9.5 W/m². Because of the low heat flow rate conus shape model with PMMA acrylic glass fails to accumulate heat in PCM and has the lowest room temperature. Aerogel fill model with Fresnel lens and PMMA acrylic glass had different heat flow rates at the start of 2.8 and 4.2 W/m². Even though the Fresnel lens test had a low heat flow rate, it managed to accumulate the appropriate amount of heat to release latent energy to 9.5 W/m² and maintain PCM room temperature to 16.4 °C. Aerogel with PMMA acrylic glass had a heat flow of 4.2 W/m² and released latent heat up to 10.2 W/m² to remain at room temperature to 16.8 °C.

Temperatures in PCM of all six variations and reference box insulation are illustrated in Fig. 9(a). This graph illustrates mineral wool and paraffin thermal properties. Reference box insulation experiences temperature changes that range from a peak of 42.8 °C to an outdoor temperature of 13 °C.

At the same time, in all six variations paraffin heats up to 20.6–23 °C and cools down to 16.6–18.7 °C. In both air gap models with Fresnel lens and with PMMA acrylic glass PCM is heated to 23 °C and paraffin manages to melt. In the air gap model with Fresnel lens thermocouples measured the PCM front is heated to 23 °C and the back of PCM to 22 °C, as a result, PCM cools down to only 18.7 °C and 18.6 °C. The air gap model with PMMA acrylic glass has similar results of 22.9 °C in the PCM front and 22 °C in the PCM back. In conus shape models PCM did not manage to melt properly and for that reason, PCM cools down at 1 °C compared to air gap models. In the conus shape model with Fresnel lens PCM reaches temperatures of 20.6 and 20.1 °C and cools down to 17.9 °C and 17.8 °C, While with PMMA acrylic glass PCM heats to 21 °C in front of PCM and 20.7 °C in back. However, this variation does not bring worthy results and PCM is cooled to the lowest values of 16.7 °C. In variations of aerogel fill paraffin also did not manage to melt, however, room temperatures are better than in cone-shaped variations. In aerogel with Fresnel lens front of PCM is heated to 21 °C, back to 20.6 °C and PCM cools to 18.2 °C and 18 °C. Aerogel with PMMA acrylic glass heats to 21.4 °C in front and 20.8 °C in back and paraffin cools down to 18.6 °C and 18.4 °C.

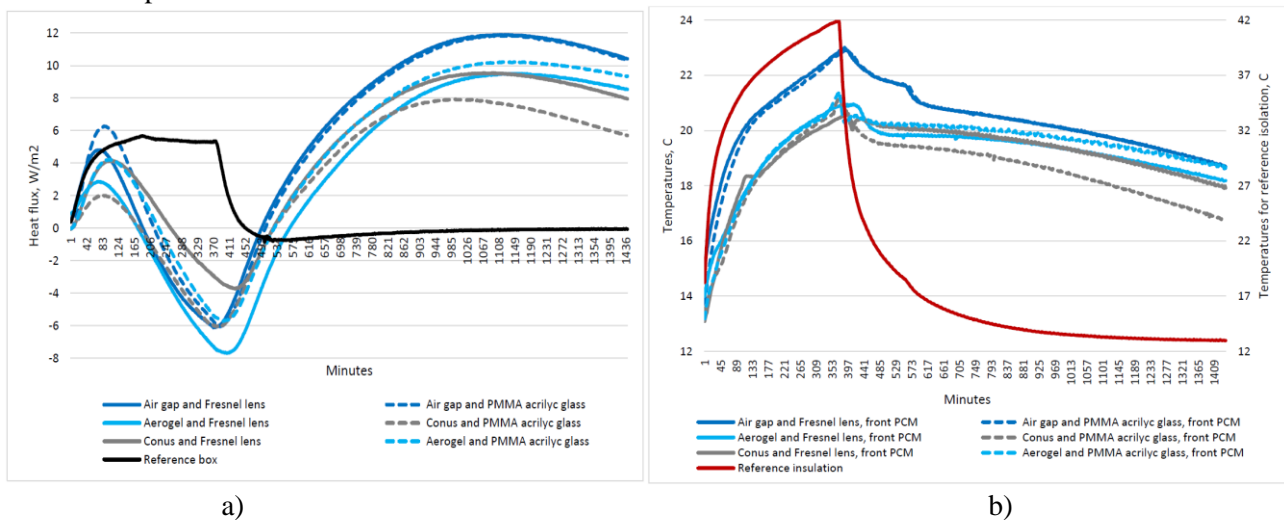


Fig. 9 (a) Heat flux and (b) temperature measurement in 6 variations and reference box results

Temperatures of all six variations of the PCM room and reference box room are illustrated in Fig. 9 (b). During tests reference box room was heated to 28 °C and in the climate chamber cooled to outdoor temperature to 13 °C, meanwhile PCM box room was cooled to temperatures in the range of 15.5 °C to 16.8 °C. As explained earlier, PCM melted only on test with an air gap, for this reason, PCM box room has both highest values within solar simulation and after reaching 23.3 °C and 23.4 °C and cooled to 16.8 °C for both Fresnel lens and PMMA acrylic glass. In variation of the conus shape model Fresnel lens PCM room was heated to only 20.7 °C, however, it managed to cool down on average as all other tests of 16.4 °C, unlike PMMA acrylic glass this variation also did not perform. Room temperature is heated to 22.7 °C. However, the room is cooled to the

lowest value of 15.5 °C. Aerogel filled with Fresnel lens heated up room is 22.7 °C and cooled to 16.4 °C, while aerogel filled with PMMA acrylic glass is heated only to 21.4 °C and cooled to 16.8 °C. °C

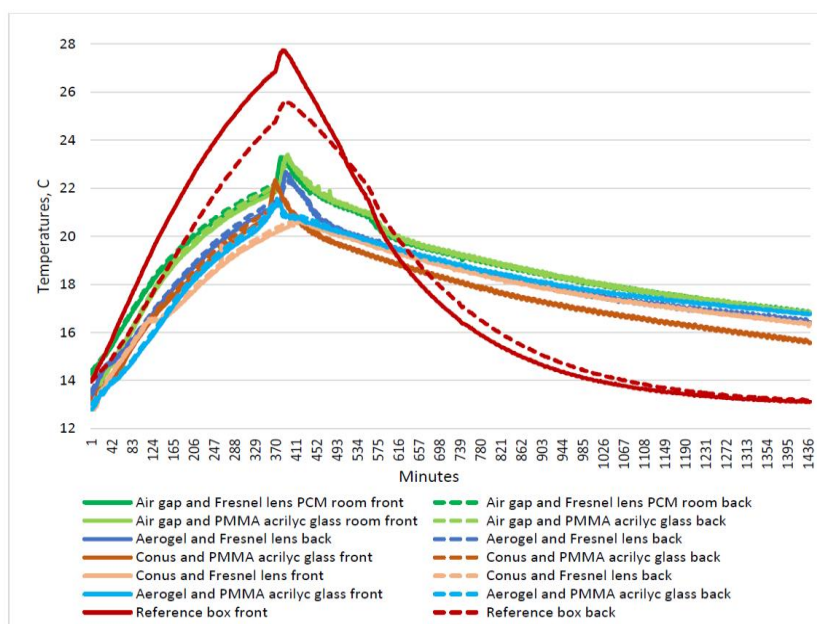


Fig. 10. Temperatures of PCM room in 6 variations and reference box

More detailed results of phase change during the solidification process of PCM are shown in Fig. 10. When the phase change process is over, the temperature continues to fall down at the previous rate which is higher. The green area is the melting temperature region and the purple area is the solidification temperature area given by the material producer (Noroozi et al. 2019).

All 6 variations compared to the reference box give certain level heat gains. As a result, this proves that solar façade systems with integrated PCM are energy-efficient solutions to incorporate in building facades. However, it was observed during the result analysis that paraffin should be heated at least to 21 °C to ensure the endothermic reaction that absorbs heat that is later released as latent heat. As PCM managed to melt only on the first 2 test days, not all six variations can be analyzed within each other. Air gap models can be compared with each other as for these tests PCM managed to melt. Another comparison is between the other four variations of conus shape and aerogel fill.

Conclusions

Aerogel is considered an essential material of this model. The four experiment variations that included aerogel as a component material, proved thermal and optical properties. It is concluded that thermal insulation as energy conservation and energy loss reduction are vital for this solar façade model. Thermal insulation applications in buildings maintain a comfortable indoor climate even at low ambient temperatures and reduce heat losses through thermal bridges. Aerogel is a reasonable choice to isolate thermal transfer. The basic principle applies to enclosing motionless air in material structure thermal insulation material. Heat is absorbed by aerogel and re-emitted back to the absorber, reducing radiation loss. Conduction loss through aerogel is very small due to the low solid thermal conductivity. Part of the heat is lost to the environment and conducted through the glass via radiation and convection.

Result analysis proves that using a Fresnel lens or poly-methyl methacrylate acrylic glass in solar energy concentration technology is an effective way to fully use sunlight. Results of the experimental study also uncover that the variations with Fresnel lens and poly-methyl methacrylate acrylic glass show similar results and light-gathering performance. It is concluded that the use of a Fresnel lens as a solar concentrator does not give any thermal improvements in this technical solution compared to poly-methyl methacrylate acrylic glass.

For this reason, the Fresnel lens as a solar concentrator can be substituted with poly-methyl methacrylate acrylic glass which would also reduce costs for material.

As mentioned in the literature, biomimicry is an innovative approach to adapting sustainable solutions by imitating nature's time-tested patterns and processes. Correspondingly, the natural process of heat absorbing is adapted to solar façade model design to manage heating. Basic natural processes and main heat transfer methods, radiation, conduction, and convection, are used in solar façade model solutions.

This research and solar model is an example that biology can be integrated with architecture via biomimicry principles and nature has countless multi-functional, complex, and highly responsive mechanisms, strategies, and solutions. Biomimicry in architecture remedies existing errors of efficient system design and products, by taking into the fact that outer shells in nature face the same weather conditions and have the same functions and tasks as reducing heat loss via thermal envelope (insulation, metabolism, hibernation), storing and generating energy, avoiding indoor from overheating.

Scientific novelty/practical value of the findings

Solar energy has great potential in all continents and locations in the world. The solar model proposed in this thesis is an effective way to collect solar energy with a concentrated lens and efficiently transfer heat via a building envelope. Materials used in the model are tested previously to suit the model and have compatible mechanical, chemical, electrical, optical, and thermal properties.

Results gained from the experiment show improvements in energy efficiency and reduction of heat losses, consequently, reducing CO₂ emissions. This model proves solar thermal façade system efficiency and suitability for domestic heating embedded in building envelopes.

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DETERMINATION OF IRON PROCUREMENT STRATEGY FOR MANUFACTURING COMPANIES

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Abstract. The objective of this paper is to evaluate the price development of iron (steel rebar and hot rolled coil steel) on commodity exchanges, to determine the dependence of the price of iron on prices of other major commodities (crude oil and natural gas), to forecast its future development and to propose a particular iron procurement strategy for manufacturing companies in the South Bohemian Region until the end of 2028. The content analysis method was selected to evaluate the price development. It was also used to assess the dependence of iron prices on other major commodities, which was considered using the correlation analysis method. The artificial neural network method, multilayer perceptron networks, was selected and used to forecast future price development. All calculations are performed using Statistica software (version 13). Linear regression is conducted using different functions, with 1,000 neural structures being generated each time, out of which 5 structures showing the best characteristics are selected. These are retained to forecast future prices for the 2023-2028 period in three experiments. Results are presented in tables and graphs processed in Microsoft Excel. Based on the selected variants of future steel price forecasting, a specific iron procurement strategy can be recommended for manufacturing companies in the South Bohemian Region until the end of 2028.

Keywords: price of steel; time series; future price forecasting; artificial neural networks; regression analysis

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JEL Classifications: C45, C22, Q02

Additional disciplines: construction engineering, strategic management, strategic planning

1. Introduction

Together with energy, iron and steel are the most critical raw materials needed to develop economies around the world (Rokicki, 2019). Historically, crude iron ore was traded based on long-term contracts. However, this changed in 2006 when the negotiation model between large producers and large consumers changed, and subsequently, trades were made on the spot market based on prices set mainly by independent benchmarking companies, which, however, have later seen frequent fluctuations in the price of crude iron ore (Kim et al., 2022; Behun et al., 2018). The main explanation for the collapse of the benchmarking system turned out to be the strengthening importance of the Chinese market (Olczyk et al., 2022). The current iron ore pricing system is based on several indices developed by benchmarking companies according to specific systematic procedures, which is also reported by

Wårell (2018). Iron ore is an essential mineral as it is used to produce steel. In 2020, iron ore became the 13th most traded product worldwide, with the value of these trades amounting to USD 141 billion. The largest exporters in 2020 were Australia (56 %, USD 80 billion) and Brazil (19 %, USD 26 billion), while the largest importers were mainly China (70 %, USD 99 billion), followed by Japan (6 %, USD 8 billion) and South Korea (4 %, USD 6 billion), which shows that the diversification of sellers and buyers is limited (OEC-Iron Ore, 2022).

Iron ore prices have been fluctuating widely since 2000, and there is a general belief that these price shifts may translate into inflation (Ahn et al., 2017). For instance, the price of iron ore increased extremely from USD 12/tonne in 2000 to USD 154/tonne in 2008, i.e. more than a 12fold increase, whilst the price of iron ore generally declined between 2011 and 2016. Chinese inflation has followed a similar trend to the international price of iron ore (Chen & Yang, 2021). The rise in the price of iron ore results from a combination of unprecedented macroeconomic expansion and intensive use of the commodity, especially from China. Given such circumstances, iron ore price changes are characterized by higher volatility, which directly affects the movement of the Australian dollar (AUD) exchange rate and indirectly affects Australia's economic prospects (Gomwe & Li, 2020).

Then, steel products are indispensable for machinery, construction of entire infrastructures and housing, and also essential for the automotive and engineering industries (Tkacova & Gavurova, 2023). With the significant development of machinery manufacturing, infrastructure construction, housing, and the automotive industry development, approximately 80 % of China's steel production is consumed by these enumerated industries (Ma, 2021). In the middle of 2021, various headlines were again piling up about skyrocketing prices of steel as well as depleted inventories of companies and long lead times for these steel products. All of this in turn can be unsettling for designers, builders, and steel workers at the end of the value chain of these steel structures. The construction cost of an entire steel building is complicated to determine mainly due to the volatile prices of materials and hence seems fraught with risk (Fischer, 2021).

The World Steel Association (WSA) defines steel as the most critical engineering and construction material in the world. The steel industry's contribution to social development and the far-reaching use of steel in its many forms in our daily lives determine its importance to our prosperity and well-being. The steel industry is often considered an indicator of economic progress, and several previous studies have focused on the close relationship between various aspects of the steel industry and the economy, particularly through GDP dynamics (Cerasa & Buscaglia, 2019). Given the wide use of steel products, their price changes play a crucial role in the development of related industries and even in the stable functioning of national economies (Qi et al., 2020; Simionescu & Gavurova, 2023).

Baláž & Bayer (2019) stated that the domestic industry is losing its former positions and is being pushed out of domestic and international markets. Development in the international steel market over the past year confirmed that the market is likely to experience significant changes as a result of safeguard measures, most of which will threaten the international competitiveness of the European steel industry with negative impacts on its overall economic growth (Simionescu et al. 2021, 2022; Bilan et al. 2017). Hančlová et al. (2020) pointed out that the iron and steel industry has had a very strong tradition in the Czech Republic since the nineteenth century and is extremely important for the Czech economy. According to data from the Czech Statistical Office, the share of sales of finished iron and steel products in GDP has been between 4 % and 5 % in recent years.

In 2020, there were, on average, 65 iron manufacturing companies in the South Bohemian Region (CZ-NACE 25, 28, 29, 30, and 33), which represents a 7 % share of the total number of such entities in the Czech Republic, with the companies generating sales of CZK 92 billion, which represents 54 % of the total sales of the industrial sector in the South Bohemian Region (CZSO.cz, 2021).

This paper aims to evaluate the development of iron prices on commodity exchanges, the impact of these prices on manufacturing companies in the South Bohemian Region, and to propose a strategy for procuring iron until the end

of 2028. The prices of iron ore, as well as many other raw materials and commodities, have been fluctuating significantly for several periods. Iron ore prices react quickly to the supply and demand situation in the world market (Chen & Yang, 2022). Iron ore has been the most expensive in the world in the last decade. Steel is the primary material that determines the price of other commodities and materials (Echo24.cz, 2021).

This issue leads to the formulation of the following research question (RQ1).

RQ1: What is the historical price development of iron in the 2010-2022 period?

Kim et al. (2022) reported that several academic studies have been conducted to understand the relationship between the price of iron ore and other economic indices or prices of other commodities as well. Ma & Wang (2019) examined the relationships between prices of crude oil, natural gas, thermal coal, and iron ore along with the Australian dollar and the exchange rate of the Chinese RMB.

About the above research conducted, the following research questions (RQ2, RQ3a) can be formulated:

RQ2: What is the relationship between the price of iron and other major commodities?

RQ3a: What price of iron can be estimated taking into account available price forecasts for other commodities in future years (2023-2028)?

If the relationship between the price of iron and other major commodities is not found, it will be necessary to formulate the following research question (RQ3b):

RQ3b: Given the historical price development of iron, what price can be estimated for future years (2023-2028)?

It is expected that steel production will again grow faster than consumption, resulting in renewed pressure on the price of steel. This adds to the fact that the historically high price of iron ore reduces the margins of companies unable to pass on cost increases to their clients (Credendo.com, 2021). Forecasting the iron ore price development is very important, considering that it significantly impacts company production costs and profitability (Lee et al., 2019).

These significant price changes and impacts on company production costs lead to the following research question (RQ4) formulation:

RQ4: What iron procurement strategy can be proposed for manufacturing companies in the South Bohemian Region until the end of 2028?

2. Literature Review

Iron is one of the most widely used metals in manufacturing worldwide. The development of demand and supply mainly determines the global price of iron ore. There are also many parameters (e.g. price of steel, steel production, price of crude oil, price of gold, interest rate, inflation rate, production of iron and price of aluminium) that affect the global price of iron (Li et al., 2020). Iron ore is an important and essential source of steel production, hence forecasting its price is strategically important, particularly for risk management in companies and related production projects (Tuo & Zhang, 2020; Gavurova et al. 2017). There are several methods for price forecasting, with some of the most appropriate methods being those that examine time series variables in a non-linear and dynamic way closer to reality, i.e. iron price fluctuations (Lv et al, 2022; Kolková, & Ključnikov, 2021; Kolkova & Rozehnal, 2022). A time series includes statistical data on various quantitative indicators of economic and social phenomena in a time sequence, and methods based on time series analysis comprise various estimation techniques (Landmesser, 2021; Fiszeder & Małecka, 2022), where the most important technique is the exponential smoothing estimation method

(Kahraman & Akay, 2022). Ten years time series analysis was used by Jeremić et al. (2022) in their research on agricultural development in Serbia, examining the relationship between crude oil and gold and the price of iron, concluding that changes in the price of steel cause a gradual increase in the price of agricultural machinery, which significantly increases the cost of agricultural production. Vochozka et al. (2021) collected research data from daily closing historical prices of copper converted into a time series, with the data then being processed with the use of artificial intelligence, recurrent neural networks including a Long short-term memory layer, as neural networks have great potential to forecast this type of time series. Carrasco et al., 2015 decided to look into the price of copper by analyzing the time series of prices of copper over the last 30 years and studying chaotic systems.

Su et al. (2017) examined whether there are multiple bubbles in the price development of iron ore by using the Dickey-Fuller test, considering this method suitable for the practical implementation of time series and recognition of the initiation and termination of multiple bubbles. The empirical results of their research indicated that there were four bubbles from January 1980 to December 2016 and that prices of iron ore differed from their intrinsic values based on market fundamentals to such an extent that they mainly explained the first three bubbles by excessive demand from China and attributed the last bubble mainly to the negative impact of the 2008 global financial crisis. An analysis of prices of iron was conducted by Wårell (2018) using time-series data related to the development of monthly prices between January 2003 and June 2017 and performing statistical tests of structural breaks as well as reduced-form price regressions of the most important factors for prices of iron over the given period. The overall results suggest that the price régime change does not have a significant impact on the prices of iron when the period is extended; rather, it was the end of the commodity boom in 2014. However, GDP growth in China had the strongest impact on the prices and still appears to be the most influential factor determining international prices of iron ore. A time series of steel price indices covering ten years from 15 June 2011 to 15 April 2021 was applied by Mir et al. (2021) for forecasting with the use of non-linear auto-regressive neural networks as a forecasting model. These simulations have proved to be relatively simple, generating forecasts of high accuracy and stability. To forecast commodity prices, Lasheras et al. (2022) used the methodology of using input value information from a time series of prices in previous months, while the research method itself is based on decomposing the time series into its trend, seasonal and random components, and using trend information as independent variables in a multivariate adaptive spline regression model.

Ma & Wang (2019) focused on examining dependency structures between prices of crude oil, natural gas, thermal coal, and iron ore, Australian dollar and Chinese RMB exchange rates based on dependencies analyzed and compared using copula models, resulting in the finding that the increase in commodity prices coincided with the rise in the Australian dollar and the decrease in the Chinese RMB. Kim et al. (2022) examined the relationship between monthly prices of iron ore and 12 other monthly commodity prices or indices in both bivariate and multivariate perspectives using the Augmented Dickey-Fuller (ADF) test and concluding that the price of iron ore has a bidirectional effect on the prices of oil, copper and Australian coal and vice versa, i.e. the price of iron ore is dependent on the price of other commodities. Looking into the long-run dependence and causality between prices of crude oil and precious metals (gold, silver, platinum, palladium, steel, and titanium), Shafiullah et al., 2021 used time series properties using new econometric techniques by testing each pair of variables for long-run equilibrium (cointegration) and Granger causality. The relationship between the main commodities was measured by Nicola et al., 2016 using correlation coefficients and studying the degree and time development of unconditional and conditional correlations by estimating and testing uniform spacing, multivariate dynamic conditional correlation models, and stepwise regression procedures. The relationship between foreign trade with iron in the European Union countries and the overall economic situation was researched by Rokicki (2019) with the use of the following methods: descriptive, graphical, and Pearson's linear correlation coefficient. To analyze the correlation between exchange rates and commodities, Tsiakas & Zhang (2021) selected an analysis based on a dynamic conditional correlation model with mixed data sampling, where this model separates high-frequency from low-frequency volatility and correlation dynamics and allows to relate long-run volatility and correlation.

Since steel is also included as a significant cost of construction projects, it is important to forecast its price accurately; to do so, Zhang (2015) first conducted a time series analysis of steel prices and used the autoregressive moving average (ARMA) model for the future price, with the forecast results being considered accurate and reliable based on the tests conducted. To develop three models that use artificial neural networks for forecasting future prices of steel rebar in the context of the Egyptian construction industry 6 months ahead, Shiha et al. (2020) used Microsoft Excel, NeuralTools software, and Python programming language in Spyder software to apply historical data on prices of steel and cement as well as macroeconomic indicators in Egypt from May 2008 to June 2018, where these proposed models can be potentially useful tools for forecasting and quantifying price fluctuations. In their price forecasting of hot rolled steel in Spain, Alcalde et al. (2023) applied artificial non-linear neural networks to several different input time series to identify whether any of the neural models outperformed the other models in forecasting steel prices. Lee et al. (2019) used a forecasting method based on multivariate time series analysis, with the forecasting target in their study being the price of iron ore, which was the largest contributor to the price of raw materials for steel products. They found that the proposed method was more than 2.3 times more accurate than past average values. Xu & Zhang (2022) regard the auto-regressive integrated moving average (ARIMA) model, vector auto-regressive (VAR) model, and vector error correction model (VECM) as the most popular and powerful approaches to solving numerous price forecasting problems. The ARIMA (or "autoregressive integrated moving average") model based on time series analysis provides a basic theory and good solution focusing on the steel price issue. It was used by Liu et al. (2015) to analyze and forecast the first ten periods of the Chinese thread steel price index, with the result showing that the short-term (four-phase) forecast is very effective and the ARIMA model is suitable for price forecasting. Concerning future steel price forecasting based on a time series of prices collected by anonymous weekly surveys among Italian steel operators, Zola & Carpita (2016) also used the ARIMA regression method. To forecast copper spot prices (from the New York Commodity Exchange), García-Gonzalo et al. (2022) used machine learning methods and support vector regression in conjunction with different modeling schemes (recursive, direct, and hybrid multi-step), and by using these techniques, they constructed three different time series analyses and compared their performance, showing that the hybrid direct-recursive model obtained the best results.

The vector error correction (VEC) model was identified by Faghieh & Kashani (2018) as reliable in forecasting short-term and long-term prices of asphalt, steel, and cement. Li et al. (2020) developed and presented a new model, namely the group method of data handling (GMDH), for price forecasting of iron ore. The study results showed that the GMDH forecasting model is significantly better than other forecasting models and that the GMDH technique can forecast the price of iron ore with a higher degree of accuracy than other techniques analyzed. Cetin et al. (2019) developed a steel price forecasting method using the long short-term memory (LSTM) network model, which is an adapted model of recurrent neural network architecture, and obtained the best forecasting result from the forward five-day forecasting model with high correlation coefficient R. For their forecast of iron sale price, Jian Ming et al. (2016) looked into different data analysis methods and used artificial neural networks and automatic regression moving average as forecasting models. They concluded that the combined forecasting model is effective and feasible, and the results of this forecast can provide effective support for companies in their strategic decision-making.

3. Methodological approach

3.1 Data

The primary data sources for RQ1, RQ2, and RQ3a will be data obtained from TradingEconomics.com (2023) and Investing.com (2023), containing current and historical data from commodity, equity, and currency markets. Specifically, the related data involve the price development of two types of steel (steel rebar and hot rolled coil steel) and two major commodities, i.e. crude oil and natural gas, selected with RQ2. The time interval for each commodity monitored will be set on a month-by-month basis for the 2010-2022 period. Prices of steel are in USD per tonne or CNY per tonne, with the CNY currency converted to USD using the exchange rate from Investing.com

(2023), prices of crude oil are in USD/barrel, and prices of natural gas are in USD/million British thermal units. The data source for RQ3a will be data on crude oil and natural gas forecast prices published on the European Central Bank website (ecb.europa.eu, 2023) in the European Central Bank Macroeconomic Forecast as of 15 December 2022.

3.2 Methods

In terms of addressing RQ1, the historical time series of prices of two types of steel will be analyzed, specifically by observing these values at certain time intervals (months and years). Subsequently, using the content analysis method, the historical price development of iron will be assessed, and the results will be presented, among other things, in a graph prepared in Microsoft Excel, where a linear trend line will be inserted, from which it can be deduced whether the price is increasing or decreasing.

To answer RQ2, correlation analysis, specifically the Pearson correlation coefficient method, will be used to determine possible dependence on the price of steel and selected major commodities (crude oil and natural gas). By calculating the Pearson correlation coefficient r , it will be determined whether there is a dependence between the price of steel and main commodities (i.e. prices of electricity, crude oil, and natural gas). If $r = 0$, there is no linear correlation between the variables. If the resulting $r < 0$, a negative relationship can be observed, whereas if the resulting $r > 0$, the correlation is positive. Therefore, the coefficient of r must be < 1 and > -1 .

The formula for calculating the Pearson correlation coefficient r is as follows:

$$r = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2} \sqrt{\sum_i (y_i - \bar{y})^2}} \quad (1)$$

where x and y are the mean values of the selection of AVERAGE (matrix1) and AVERAGE (matrix2).

The data will be processed using Microsoft Excel, whilst the CORREL statistical function will be used to calculate the coefficient r .

The strength will be interpreted by dividing the resulting coefficient r into the following three groups according to its correlation value: low (weak), medium, and very strong correlation. There will be a low (weak) correlation if the resulting r value ranges from 0.001 to 0.3 and from -0.001 to -0.3. A medium correlation will be represented by the resulting r value ranging from 0.3 to 0.9 and from -0.3 to -0.9. A very strong correlation will be the resulting r value between 0.9 and 1 and between -0.9 and -1.

If a very strong correlation between the price of steel and another commodity is established about RQ2, a particular forecast of the price of steel to answer RQ3a will be set concerning the future price of this commodity. However, provided that a very strong correlation between the price of steel and another commodity is not established about RQ2, the following procedure will ensure the answer to RQ3b.

The obtained data on prices of steel (steel price time series) will be processed in Microsoft Excel to import the data into the Statistica software (version 13) by Tibco Software Inc. A particular forecast of the future prices of steel will be determined using multilayer perceptron neural networks available in this software.

In the first stage, regression analyses will be performed for both types of steel using neural structures. The procedure will be the same, as neural networks will be generated for each type of steel, using so-called MLP – multilayer perceptron networks. An independent variable will always be the period, whereas a dependent variable will be the

price of each type of steel. The distribution of the steel price time series will be classified into three datasets, i.e. the training, the testing, and the validation. The first dataset will contain 70 % of the input information and will be used to train the neural structures, whilst the other 15 % of the input data will be used to test validation of the reliability of the found neural structures, or the found model. The time series delay will be 1 or 12.

There will be a total of 3 experiments (i.e. Experiment 1, Experiment 2, Experiment 3), and the software setup will be as follows:

- 1) The content of the hidden layer for MLP networks will always be formed in the first experiment and the second experiment: at least 2 neurons and a maximum of 8 neurons, or at least 3 neurons and a maximum of 11 neurons for the third experiment. A total of 1,000 neural networks will always be generated, and the five neural networks showing the best resulting characteristics will always be selected for the next forecast.
- 2) Activation functions: about the multilayer perceptron network of all experiments, the following activation functions will be valid in the hidden and output layer of neurons: Identity (linear), Logistics (logistics), Tanh (hyperbolic tangent), Exponential (exponential) and Sine (sine).
- 3) Other settings will be left as per the ANS (automated neural network) settings.

Regarding the first and second experiments, the monthly period will be selected as the independent variable, which will also apply to the third experiment, where the period will be further broken down into months, dates, and days of the week. Related results will then be processed and presented in tables and graphs prepared in Microsoft Excel. To forecast future prices for both types of steel, individual neural networks will be imported back into the Statistica software, with the future price time series being modeled over five years, namely 2023-2028 (by month). These forecasts will be made for all 3 experiments (always for all of the 5 neural networks with the best characteristics), hence there will be a total of 6 forecasts. The time series delay will be 12. Only time series showing meaningful forecast development will be selected for the presentation of the results, e.g. projections with negative or extreme values will not be presented. The selected results will also be subsequently processed and presented in tables and graphs prepared in Microsoft Excel.

4. Results and Discussion

RQ1: What is the historical price development of iron in the 2010-2022 period?

Figure 1 shows the development of the historical prices of steel rebar and hot rolled coil steel between 2010 and 2022.

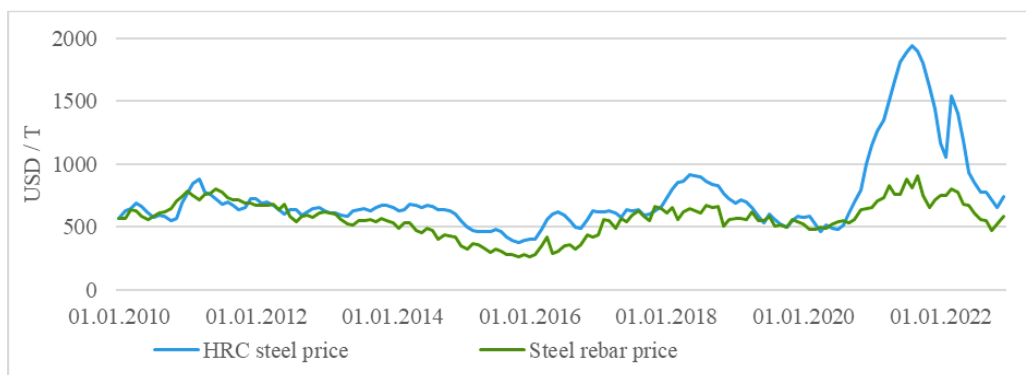


Figure 1. Historical price development of hot rolled coil steel and steel rebar

Source: Authors, based on data from TradingEconomics.com (2023)

In 2010, the price of both types of steel was at USD 570/t and gradually increased in the following years, reaching its peak in March 2011, after which the price gradually declined until February 2016, which, according to Csas.cz

(2020), was mainly related to the high growth of steel production in China in the previous years and the gradual decrease in demand. After 2016, the price started to rise again until around mid-2018, after which it started to fall again, with the price of both commodities hovering around USD 500/t during the year. Steep growth again followed, particularly for hot rolled coil steel, with an extremely high value in September 2021 trading at USD 1 900/t, which was almost four times the 2010 price. The price of steel rebar also rose significantly in the same month (up to USD 905/t), being less than double the original price in 2010. According to Credendo.com (2021), the main reason for this could be seen in limited growth in steel production on the one hand and significantly increased Chinese demand on the other, while the rise in prices of steel was also supported by an increase in the price of iron ore during this period. It then began to decline again but then rose sharply in early 2022, which was linked to the beginning of the Russian invasion of Ukraine and the fact that Russia and Ukraine account for 60 % of global iron ore exports and for some iron and steel products their share of global exports reaches 40 % (Csas.cz, 2022). From 2022 onwards, the price started to decline again to approximately average values of the other discussed commodities over the period under review.

RQ2: What is the relationship between the price of iron and other major commodities?

The correlation of historical prices was followed to determine the relationship between the prices of iron, or hot rolled coil steel and steel rebar, and two other important commodities (crude oil and natural gas). The correlation results of these prices showed a weak to moderate correlation of crude oil and natural gas with hot rolled coil steel and steel rebar prices. A summary of the correlation results is presented in Table 1 below. The strongest, but still only moderate, correlation is between the price of steel rebar and the price of crude oil.

Table 1. Correlation coefficients r

Commodity	Crude oil	Natural gas
Hot rolled coil steel	0.1723	0.3592
Steel rebar	0.5004	0.3431

Source: Authors

The results, therefore, show that it is not appropriate to base future steel price projections on available price forecasts of crude oil and natural gas, as the prices of these commodities are not strongly correlated. A similar conclusion regarding the correlation between the prices of major commodities and steel was also reached by Ma & Wang (2019) and Kim et al. (2022). The strongest correlation, but only at a medium level, between the price of steel rebar and crude oil is also visible in the graphical representation of the line graph in Figure 2.

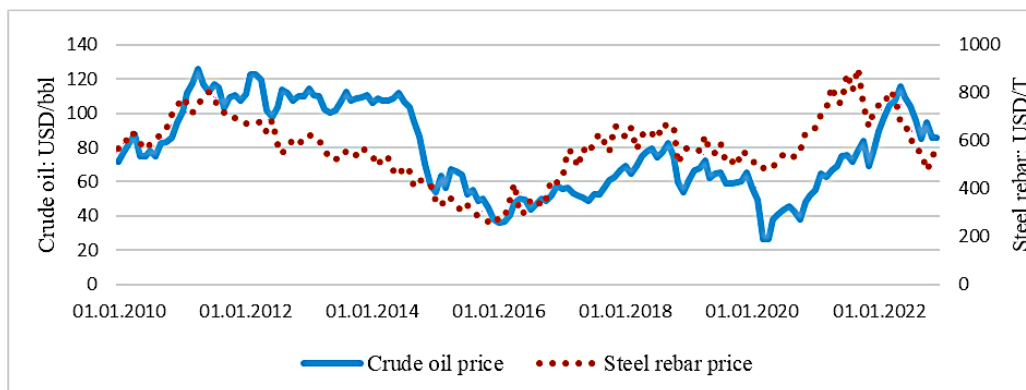


Figure 2. Historical price development of crude oil and steel rebar
Source: Authors, based on data from TradingEconomics.com (2023)

RQ3a: What price of iron can be estimated taking into account available price forecasts for other commodities in future years (2023-2028)?

As discussed in RQ2, a strong correlation has not been shown between the price of steel and the other major commodities. Thus, RQ3a was not addressed, but instead, it was proceeded directly to RQ3b.

RQ3b: Given the historical price development of iron, what price can be estimated for future years (2023-2028)?

Multilayer perceptron neural networks were used to project future prices. Neural networks have been successfully applied to project future commodity prices by e.g. Shiha et al. (2020), Mir et al. (2021), Vochozka et al., and Alcalde et al. (2023), with all of them particularly highlighting the high performance of neural networks in the applicability of individual future forecasts. The results were based on three experiments (Experiment 1, Experiment 2, Experiment 3), with the performance of individual neural networks varying across the experiments. The highest performance was achieved by the neural networks within Experiment 1, where the resulting correlations were greater than 0.95 for steel rebar and greater than 0.97 for coil steel. An overview of individual networks can be seen in Table 2 below.

Table 2. Correlation coefficients for Experiment 1

Steel rebar				Hot rolled coil steel			
Name of Network	Price (USD/T) Training	Price (USD/T) Testing	Price (USD/T) Validation	Name of Network	Price (USD/T) Training	Price (USD/T) Testing	Price (USD/T) Validation
1.MLP 12-7-1	0.962679	0.952103	0.956211	1.MLP 12-5-1	0.969318	0.967859	0.973020
2.MLP 12-8-1	0.965726	0.963630	0.953366	2.MLP 12-7-1	0.979258	0.978096	0.975766
3.MLP 12-7-1	0.959296	0.949821	0.955081	3.MLP 12-7-1	0.978651	0.973673	0.974446
4.MLP 12-8-1	0.967176	0.968927	0.953290	4.MLP 12-7-1	0.977503	0.975192	0.972309
5.MLP 12-5-1	0.963999	0.956093	0.955810	5.MLP 12-5-1	0.976032	0.979593	0.974582

Source: Authors

The second highest performance was achieved by the neural networks in Experiment 2, where the resulting correlations were higher than 0.92 for steel rebar and higher than 0.94 for coil steel. The lowest performance was achieved by the neural networks in Experiment 3, where the resulting correlations were higher than 0.83 for steel rebar and higher than 0.81 for coil steel, i.e. they least followed the historical price trend of each type of steel. However, in all experiments, the top 5 performing networks were always selected and used to project the future price of each type of steel.

When considering the forecast results of future prices of steel rebar by the individual neural networks in the experiments conducted, it is evident that the networks achieved very different results. It is also very interesting to note that the networks with the highest and second highest performance for the forecast steel rebar price predicted minima within the negative price levels, which can be considered a poor and unusable result for this future price forecast. A summary of the negative price minima is presented in Table 3 below.

Table 3. Statistics of networks with negative price forecast (forecast minima)

Future Forecast Statistics	Experiment 1				Experiment 2			
	1.MLP 12-7-1	2.MLP 12-8-1	3.MLP 12-7-1	5.MLP 12-5-1	1.MLP 5-8-1	3.MLP 5-11-1	4.MLP 5-9-1	5.MLP 5-4-1
Minimum forecast	-376.99	-376.63	-377.00	-372.90	-342.58	-368.70	-373.00	-377.00

Source: Authors

In Experiment 2 (see Figure 3 below), the 2.MLP 5-4-1 network forecasts future prices of steel rebar at very extreme volatility, with the price fluctuating widely between USD 500/t and USD 3 500/t over the 2025-2028 period, which seems highly unlikely given the historical price trend, and thus is not applicable for further conclusions.

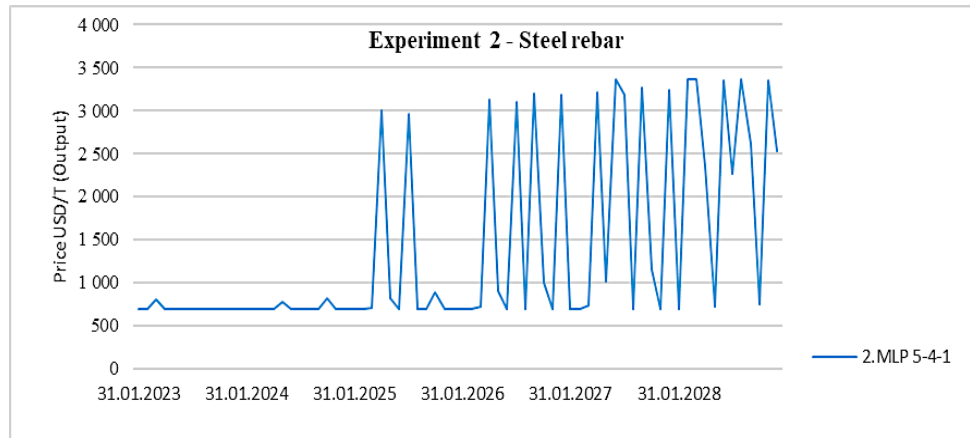


Figure 3. 2.MLP 5-4-1 network forecast

Source: Authors

Based on the historical price development and taking into account the performance of the individual networks (according to correlations), the best forecasts of the future price of steel rebar from the three conducted experiments are related to the results of the 4.MLP 12-8-1 network in Experiment 1, as well as the results of the forecasts of four neural networks, namely 1.MLP 60-6-1, 2.MLP 60-6-1, 4.MLP 60-6-1 and 5.MLP 60-3-1 in Experiment 3.

As regards the resulting forecasts of the future prices of hot rolled coil steel, the forecasts of each neural network also varied across the experiments conducted. The results of the forecasts within the second experiment can be seen as the least applicable, with the 2.MLP 5-3-1, 3.MLP 5-5-1, 4.MLP 5-6-1 and 5.MLP 5-3-1 networks forecasting a price of around USD 1 400/t at the beginning of 2023, which seems very unlikely given the price decreased to USD 700/t at the end of 2022.

The resulting forecasts according to Experiment 1, namely the forecasts of the 1.MLP 12-5-1, 2.MLP 12-7-1 and 3.MLP 12-7-1 networks, as well as the results according to Experiment 3, namely the forecasts of the 1.MLP 60-6-1, 2.MLP 60-6-1, 4.MLP 60-6-1 and 5.MLP 60-3-1 networks can be considered applicable given the historical price development of hot rolled coil steel and taking into account the performance of the individual networks (according to correlations).

However, even in these cases, there are some differences in the forecasts presented in a line graph in Figure 4. In Experiment 1, the neural networks forecast a price of hot rolled coil steel reading just under USD 700/t in early 2023, whilst in Experiment 3, the neural networks forecast a price of around USD 1 200/t. However, under both Experiments 1 and 3, the neural networks forecast a similar future downward price trend until the end of 2028 (see Figure 4 below).

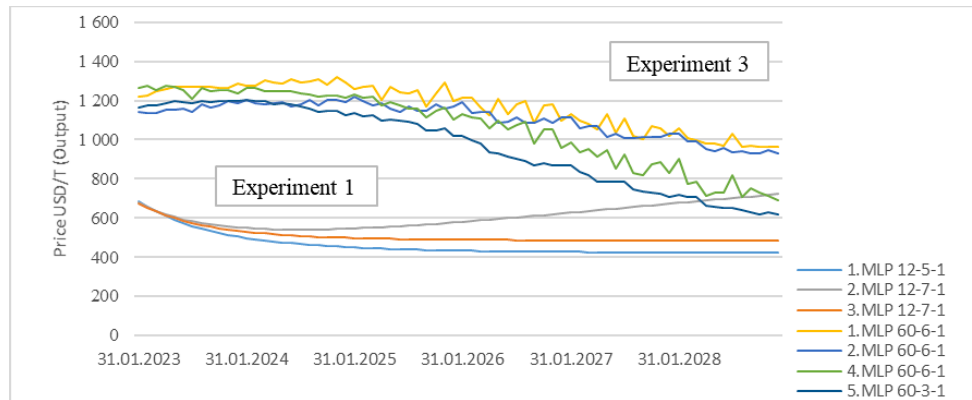


Figure 4. Forecast of future price of hot rolled coil steel according to Experiment 1 and Experiment 3

Source: Authors

Related discussion of the results shows that multilayer perceptron neural networks can be successfully used to forecast future prices of steel, and the conclusions of Shiha et al. (2020), Mir et al. (2021), Vochozka et al. (2021) and Alcalde et al. (2023) that neural networks achieve high performance can be confirmed.

RQ4: What iron procurement strategy can be proposed for manufacturing companies in the South Bohemian Region until the end of 2028?

To answer RQ4, it was necessary to select a suitable forecast variant of future prices of steel based on which it would be possible to recommend a specific iron procurement strategy for manufacturing companies in the South Bohemian Region for the 2023-2028 period. Within the processed results, forecasts of neural networks in the framework of Experiment 3 were selected for both analyzed types of steel, although within this experiment the networks achieved the lowest performance, expressed by the lowest level of correlation. As for the price projection of steel rebar, the projections of the 1. MLP 60-3-1, 4. MLP 60-11-1 and 5. MLP 60-10-1 networks in the third experiment seem to be the most appropriate, as shown in the following Figure 5. In all cases, these networks forecast a gradual stabilization of the steel rebar price level between USD 600-800 per tonne (in 2023-2026) and a subsequent decline in the future price to USD 500-600 per tonne in 2028.

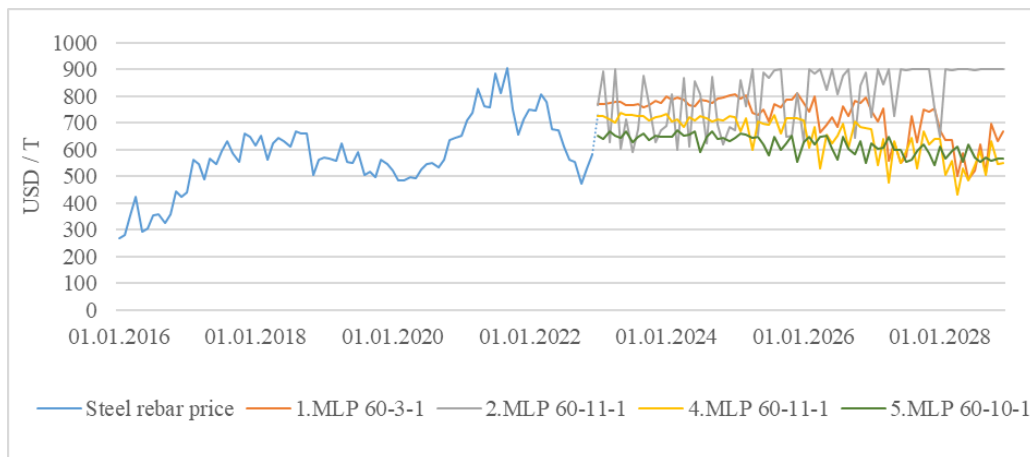


Figure 5. Real and forecast price development of steel rebar

Source: Authors

In Experiments 1 and 2, only the forecasts of two networks proved to be applicable, namely 4.MLP 12-8-1 in Experiment 1 and 2.MLP 5-4-1 in Experiment 2. The forecast related to 4. MLP 12-8-1 appears to be less applicable given the smooth and continuous decline in the price of steel in 2023 and 2024, whereas, in the following years, it is essentially constant at USD 280/t, which cannot be realistically predicted given the ongoing conflict in Ukraine. In this case, however, there is also a continuous decline and the overall trend is similar to the results of Experiment 3—the forecast of the only suitable network, i.e., 2.MLP 5-4-1 was found to be inapplicable in the discussion of the RQ3b results about the very extreme volatility, with the price fluctuating extremely between USD 500/t and USD 3 500/t over the 2025-2028 period.

In terms of price projection of hot rolled coil steel, using projections of neural networks in Experiment 3, namely 1. MLP 60-6-1, 2. MLP 60-6-1, 4. MLP 60-6-1 and 5. MLP 60-3-1, also seems to be the most appropriate, as shown in the following Figure 6.

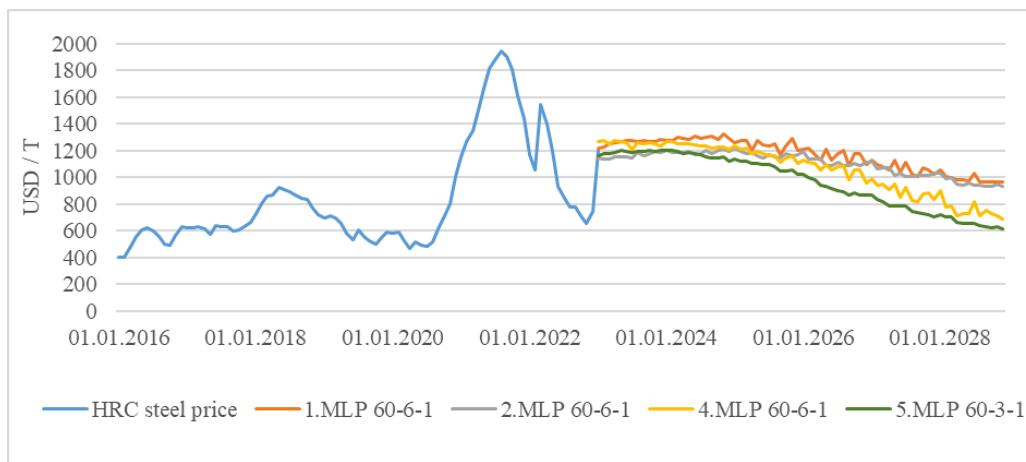


Figure 6. Real and forecast price development of hot rolled coil steel

Source: Authors

The individual forecasts assume a future gradual decline in the price of steel, except for the years 2023-2026, when the price tends to increase slightly and the price level is between USD 1 200-1 300 per tonne. However, a decline to a level between USD 600-900 per tonne is forecast in 2027-2028. The forecasts of the 1.MLP 12-5-1, 2.MLP 12-7-1, 3.MLP 12-7-1 and 4.MLP 12-8-1 networks in the first experiment appear less applicable given the smoothed and continuous decline in the price of steel in 2023 and 2024, except for 2. MLP 12-7-1, forecasting a subsequent increase, with an essentially constant price of USD 400-500/t being forecast in the following years, which cannot be realistically predicted due to the ongoing conflict in Ukraine. However, there is also a continuous decrease and the overall trend is similar to the results under Experiment 3, i.e. except for the forecast of 2.MLP 12-7-1, where the price increases to a level of USD 710/t by the end of 2028.

According to the discussion of the results related to RQ3b, the forecasts of the 2.MLP 5-3-1, 3.MLP 5-5-1, 4.MLP 5-6-1 and 5.MLP 5-3-1 networks in the second experiment proved to be the least applicable about the price forecasting that in all cases reaches a level of around USD 1 400/t in early 2023, which seems very unlikely given the price fell to USD 700/t at the end of 2022. However, even in the case of the second experiment, there is a gradual price decline and a future stabilization of the price in the last part of the forecast period, thus supporting the results of the third experiment.

The above discussion of the results confirmed the appropriateness of the forecasts selected according to RQ3b, and it can therefore be concluded that the manufacturing companies can be advised to gradually purchase iron on

a regular basis, as stated in this section of the paper. That is to say, the volume of stocks to be purchased will be set to cover the total consumption in a given year, particularly for the years 2023-2026, taking into account the selected results of the forecasts for these periods. Even for the next forecast period, i.e. 2027 and 2028, it cannot be recommended to the manufacturing companies that they pre-stock up with a larger volume of iron for a longer production period, again taking into account the forecast future decline in the price of both types of steel.

5. Conclusions

By observing the development of the prices of steel rebar and hot rolled coil steel in monthly time intervals for the years 2010-2022, the historical price development of iron was evaluated using the content analysis method. It was found that in January 2010, both types of steel were trading at approximately similar price levels represented by USD 570/t. However, it was further shown that in subsequent years, the price of each type of steel developed in different ways. In both cases, the highest price was in 2021, with the price of steel rebar rising to USD 905/t in September 2021, whereas the price of hot rolled coil steel was the highest in August 2021 trading at USD 1 950/t. It could be seen that the prices increased either slightly or more continuously over time but started to decline significantly again within the period under review, specifically at the end of the period (i.e., at the end of 2022). Regarding the aforementioned, the first research question was answered.

To answer RQ2, the content analysis method was also applied to collect data on historical prices of crude oil and natural gas, with the data obtained being evaluated with the use of the correlation analysis method, specifically the Pearson correlation coefficient method, where the CORREL function available in Microsoft Excel was used to process and produce the results. The correlation between crude oil and hot rolled coil steel was the weakest, with a correlation coefficient r of 0.19. On the other hand, the correlation between crude oil and prices of steel rebar was the highest, but the correlation strength was still only at a medium level, with a correlation coefficient r of 0.50. Thus, in all cases, the correlation reached very weak to medium values. This also completely answered this research question. Since a very strong correlation between the prices of the different types of steel and the prices of crude oil or natural gas failed to be determined in RQ2, RQ3a was not answered further.

About answering RQ3b, a prognosis of the future price of steel was determined with the use of multilayer perceptron networks. There were 3 experiments (Experiment 1, Experiment 2, Experiment 3) conducted with different software settings. The performance varied across individual experiments and networks, with the best performance at levels greater than 0.97 being achieved by the networks in the first experiment (for the price of hot rolled coil steel). On the contrary, the networks within the third experiment achieved the lowest performance, where the resulting correlations were greater than 0.83 for steel rebar and greater than 0.81 for rolled steel, thus least closely following the trend of historical price development for each type of steel. In all experiments, the top 5 performing networks were always selected and used to project the future price of each type of steel. It was evident from the resulting future price forecasts of steel rebar in the experiments conducted that the individual networks performed very differently, which was also true for the price forecasts of hot rolled coil steel. It also proved to be very interesting that the networks with the highest and second highest performance for the price forecasts of steel rebar predicted minima within the negative price levels, which was a poor and unusable result of these forecasts. The best future price forecasts of steel rebar from the three experiments conducted, considering the historical price development and the performance of each network, were the results of the 4.MLP 12-8-1 network under Experiment 1, as well as the forecast results of four neural networks, namely 1.MLP 60-6-1, 2.MLP 60-6-1, 4.MLP 60-6-1 and 5.MLP 60-3-1 under Experiment 3. Again, the resulting forecasts of neural networks under Experiment 1, namely the forecasts of the 1.MLP 12-5-1, 2.MLP 12-7-1 and 3.MLP 12-7-1 networks, as well as the results under Experiment 3, namely the forecasts of the 1.MLP 60-6-1, 2.MLP 60-6-1, 4.MLP 60-6-1 and 5.MLP 60-3-1 networks were considered to be usable results given the historical price development of hot rolled coil steel and taking into account the performance of each network (according to the correlations). Therefore, RQ3b was completely answered in this respect.

To answer the fourth (and final) research question (RQ4), suitable variants for forecasts of future prices of steel were selected. Based on these selected variants, it was possible to recommend a specific iron procurement strategy for manufacturing companies in the South Bohemian Region for the 2023-2028 period, with the neural network forecasts in Experiment 3 being selected for both analyzed types of steel, even though in that experiment the neural networks achieved the lowest performance expressed by the lowest level of correlation. Regarding the price projection of steel rebar, the projections of the 1. MLP 60-3-1, 4. MLP 60-11-1 and 5. MLP 60-10-1 networks were selected as the most suitable. It was found that in all cases these networks forecast a gradual stabilization of the steel rebar price level between 600-800 USD/t (in 2023-2026) and a subsequent decline of the future price to the level of 500-600 USD/t. In terms of the price projection of hot rolled coil steel, the use of projections of the neural networks in the third experiment, namely the 1. MLP 60-6-1, 2. MLP 60-6-1, 4. MLP 60-6-1 and also 5. MLP 60-3-1 networks also seemed to be the most appropriate. The individual forecasts assumed a future gradual decline in the price of steel, except for the years 2023-2026, when the price tended to increase slightly, and the price level was between USD 1 200-1 300/t. In 2027-2028, however, a decline to a level between USD 600-900/t was forecast.

Based on these findings, it was possible to recommend to the manufacturing companies concerned that they purchase iron on a gradual, regular basis, with the volume of stocks purchased being set to cover the total consumption each year, particularly for the years 2023-2026, considering the selected forecast results for these periods. Even for the next forecast period, i.e., 2027 and 2028, it was not possible to recommend to the companies pre-stocking more iron for a longer production period, again considering the forecast future price decrease for both types of steel. Thus, RQ4 was fully answered in the manner described above. However, given the different results of the forecasts, it is advisable to define the validity or set limitations of the conclusions presented on the condition that the results are to be confronted in the future with the actual prices of each commodity in the markets to verify that the neural networks forecast realistic projections of future prices. Thus, the conclusions of this paper are further applicable and usable for the iron procurement strategy of manufacturing companies in a given future time horizon.

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ORGANIZATIONAL DESIGN BASED ON HOLACRACY AS A SOURCE OF COMPETITIVE ADVANTAGE

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Abstract. This study aimed to investigate the extent to which an agile and flat organizational design based on Holacracy can bring a company a competitive advantage in the market. Holacracy design is considered to be a Dynamic Capability. The research was conducted as a case study of a flatly organized company operating in the field of designing and supplying technologies for industrial automation in the Czech Republic. Interviews with company executives and questionnaires were used to gather their opinions on the company's ability to have a competitive advantage. The questionnaire included a guiding question and four statements about their truthfulness on a 5-point Likert scale. The first group of statements assessed the extent of the company's ability to exploit market opportunities. This ability was rated as average to slightly above average. The second group of statements assessed the extent of the company's ability to neutralize competitive threats. Here, a rather average to slightly below-average level was found. This research found that the innovative Holacracy design may not be able to create a competitive advantage if a company operates in a highly competitive and price-sensitive industry. Companies' efforts to achieve above-average performance thus remain primarily a matter of appropriate pricing, well-managed costs, and the ability to differentiate more than dynamic or agile organizational capabilities. The limitations of this research were mainly the small number of similarly organized companies operating in the same industry and the small base of companies of similar size and structure.

Keywords: Holacracy; self-management; competitive advantage; dynamic capabilities; organization design

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JEL Classifications: A10, L10, L22

1. Introduction

The demands on businesses for rapid responses to external conditions and overall agility are constantly increasing. In this new environment, the main question facing business leaders worldwide is how to maintain competitiveness amid ongoing disruptions. The biggest problem is that every business that has made it past the start-up phase is optimized much more for efficiency than for strategic agility, as the ability to exploit opportunities and quickly and confidently avoid threats (Kotter, 2014). The ability of a company to respond rapidly and the need for continuous innovation make traditional organizational structures less flexible in decision-making, management, and organizational processes (Gavurova et al., 2020, 2022a; Szostek et al., 2023). One possibility for achieving higher corporate agility and flexibility is to redistribute and delegate decision-making processes to lower corporate levels and use individual self-managed teams or to apply an agile self-managed form to the entire organization, such as the Holacracy concept (Magpili & Pazos, 2018). In this

free organizational arrangement, where there are no traditional managers, individual employees take on all responsibilities and decision-making functions (Schwer & Hitz, 2018; Skare et al., 2023). Although efforts to disrupt traditional hierarchical organizational structures in the form of self-managed teams have been known since the 1980s, the first comprehensive concept of an entire self-managed organization, According to Robertson (2007), Holacracy was introduced in 2007 and has been actively developed and intensively supported since 2015 (Robertson, 2016).

Today, thousands of companies in the world have adopted this concept and are trying to apply it in various forms in practice. However, it is still a very new and unexplored organizational model, which is typically implemented in companies involved in the digital economy, software development, or service provision, and knowledge about it and empirical research are still very limited (Bernstein, Bunch, Canner, & Lee, 2016; Mehmood et al., 2023). The current experiences of Holacracy-organized companies are documented and published primarily as case studies, such as Zappos, Mercedes-Benz.io, Morning Star, and others (Bernstein et al., 2016; Ackermann et al., 2021; Gino et al., 2013). For the long-term success of an organization, it is essential to ensure that individual employees perform their work in a way that contributes to the organization's overall goals. This requires clear direction from the company, sharing and coordinating information, and ensuring that decision-making is aligned with the organization's objectives (Burton et al., 2017; Borisov & Vinogradov, 2022; Parmar et al., 2022).

The Holacracy structure is different from traditional hierarchical organizations in its internal behavior. Transitioning from a traditional hierarchical structure to Holacracy can be complicated (Schell & Bischof, 2022). The basic building blocks of Holacracy are roles, circles, tactical, governance, and strategic meetings. In general, Holacracy is a purpose-driven decentralized organizational system that eliminates decision-making at the managerial level and transfers it to self-managed units (circles) within the organization. The main advantage of this concept is a high degree of innovation and the ability to make rapid changes at the operational level without the need for lengthy approval processes. Another advantage is the higher responsibility and productivity of individual employees (Robertson, 2016). In the Holacracy structure, the main governing document is the Constitution, which provides a formal framework for the organization's operation. All responsibilities are delegated to self-managed decentralized circles where autonomous decision-making occurs (Farkhondeh & Müller, 2021). Even the company's CEO does not have decision-making authority or the ability to make directive interventions in self-managed teams (Robertson, 2016). The same way of organizing and delegating applies to strategic issues of the company as well (Lee & Edmondson, 2017). Strategic meetings are also organized at the lowest levels of circles. Still, they usually only address improvements in everyday work and deal primarily with operational inter-circle tensions or other obstacles (Robertson, 2016).

However, flat organizational structures, such as Holacracy, are a significant managerial approach to how companies could be organized. Research shows that traditional hierarchical managerial methods are insufficient for dealing with a hypercompetitive and rapidly changing environment (Rishipal, 2014). The main attributes of Holacracy that can be considered a competitive advantage are primarily innovative agility, distributed entrepreneurial decision-making, the ability to learn and adapt to change quickly, and transparent communication. It can be said that the most successful companies in the future will be those that discover and exploit new opportunities and turn them into management innovations and more efficient ways of organizing activities in companies (Velinov et al., 2018; Soltes & Gavurova, 2014).

The behavioral characteristics of Holacracy described above correspond in their nature to the theoretical concept of Dynamic Capabilities (DC), which in organizational theory represent the ability of a company to adapt its resource base quickly and purposefully. The idea of dynamic capabilities is partly like the previously existing concept of operational capabilities, which relates to the organization's current operations. However, dynamic capabilities relate more to the ability of the company to effectively and quickly change these operations and develop its resources (Helfat et al., 2009). Nelson and Winter (2004) associate the growth of the dynamic capabilities concept with the resource-based view of the firm and the concept of "routines" in evolutionary theories of organization. The resource-based view (RBV) mentioned here is a management framework used to identify strategic resources that a company can use to achieve sustainable competitive advantage. The resource-based and dynamic capabilities concepts are often linked and overlapping (Wernerfelt, 1984).

The initial Dynamic Capabilities concept organized the framework around processes, positions, and paths (Teece et al., 1997). This concept was revised and adapted by the same author after two decades and is conceived into three main groups of agile corporate capabilities: sensing, seizing, and transforming (Teece, 2007). Dynamic capabilities allow firms to identify profitable configurations of competencies and assets, gather and organize them, and use them in an innovative and agile organization (Schoemaker et al., 2018). The ability of flexible functions stands out here, which can be combined in one way and reconfigured into other combinations. The art of capturing and creating value in this way is necessary if an organization wants to develop and maintain a competitive advantage over its existing and potential rivals (Teece, 2023).

From the perspective of strategic management, then, the dynamic capabilities of a firm require that agility in rapid decision-making and strategy be very closely linked to make sense and be effective. Only when everything is well connected and mutually linked, value can be created and the concept of a sustainable business model may be implemented (Bocken & Geradts, 2020). Therefore, it can be assumed that in today's rapidly changing environment, an organizational design based on Holacracy can become a source of competitive advantage and could provide a company with higher efficiency in capturing and creating value.

The purpose of this article is primarily to expand theoretical knowledge about the organizational design of Holacracy, to understand and know it better, and to assess its benefits in practice. This study aims to clarify whether the Holacracy organizational structure can increase the competitiveness of a company and increase its ability to gain a more advantageous position in the market. Competitiveness as a comparative measure between companies is related to competitive advantage. Competitive advantage is thus a determining factor in strategic management, which shapes and forms a company's long-term success in the market.

RQ: Can the Holacracy concept bring a competitive advantage to a company?

2. Literature review

The Holacracy organizational structure is characterized by high agility, allowing it to react more quickly to changing conditions, higher operational efficiency, innovation, and higher employee engagement. This article explores Holacracy and its properties, which are linked to the theoretical framework of a company's Dynamic Capabilities. However, evaluating and comparing the effectiveness of dynamic capabilities between companies is very difficult, and therefore, assessing their effects is always very individual and multidimensional. It also essentially depends on the specific situation or certain specific conditions. For this reason, the literature review is focused primarily on a more holistic connection between dynamic capabilities and competitive advantage in the form of companies' organizational, innovative, and managerial abilities.

According to Bari et al. (2022) found a relationship between dynamic capabilities and sustainable competitive advantage. By examining the drivers of corporate sustainability, the study found that dynamic capabilities to sense opportunities, reconfigure, organizational flexibility, and technological flexibility lead to competitive advantage development. Ferreira et al. (2020) research shows that a firm's competitiveness is higher when creativity and innovation capabilities are supported by a higher level of entrepreneurial orientation, which supports critical firm interests in seeking new market opportunities and renewing existing areas of operation (Terán-Yépez et al., 2022). Other quantitative studies indicate that the innovative behavior of an organization and its environmental dynamism has a significant positive impact on competitive advantage (Fatoki, 2021; Ključnikov et al., 2021; Civelek et al., 2021). Qualitative comparative data analysis has shown that dynamic capabilities lead to competitive advantage in a dynamic and munificent environment, which allows for generic differentiation and low-cost strategies (Fainshmidt et al., 2019; Gavurova et al., 2022b).

In the context of business model innovations (BMI), the relationships between organizational design, dynamic capabilities, and sustainable BMI (SMBI) have been investigated. Bocken and Geradts (2020) explore how corporate design influences the dynamic capabilities needed for SMBI and analytically identify barriers and drivers as factors operating at institutional, strategic, and operational firm levels. Santoro et al. (2021) examine a quantitative method that the relationship between knowledge management, dynamic capabilities, and

ambidexterity in entrepreneurial intensity. The results show that knowledge orientation has a positive and significant impact on entrepreneurial passion when using both incremental and disruptive innovations and subsequently on the entire organization's performance.

Competitive strategy as a mediator between a firm's dynamic capabilities and the ability to create value in the environment was investigated in the SME segment (Rashidirad & Salimian, 2020). The study argues that the competitive strategy of SME firms significantly mediates their ability to derive value from their dynamic capabilities. A case study of a hierarchically managed manufacturing firm decomposed dynamic capabilities into two key elements: control and decision-making (Schulze & Brusoni, 2022). The firm developed its dynamic capabilities through a long-term transformation by focusing on processes and the ability of workers to switch attention between operational and adaptive tasks. A study of open innovation in firms confirms that dynamic capabilities can transform a firm's existing knowledge structure, enabling the firm to create and capture value from open innovation and ultimately achieve sustainable competitive advantage (Jia et al., 2023).

One of the critical features of bossless companies, which decentralizes decision-making and affects organizational performance, is self-selection, where each employee can initiate projects and participate in them. Ketkar & Workiewicz (2022) found that balancing resources and opportunities is essential in choosing between a self-selection regime and centralized resource allocation. While self-selection works better in an environment rich in opportunities relative to available resources, centralized distribution works better when opportunities are scarce relative to available resources. Semke & Tiberius (2020) attempt to connect the ability of firms to forecast and predict the future, explore possible future states of the business environment, and connect them with dynamic capabilities. The results show that firms must rely on more than static processes and rigid resource bases, but foresight and dynamic capabilities can ensure the flexible renewal of organizational competitiveness.

Three capabilities were investigated as drivers of organizational agility in the form of a test model. The input drivers of the model are formed by the ability to digitize, the ability to build relationships, and innovation capacity. The model's output comprises three components: financial performance, process innovation, and product innovation. The study showed a positive impact of organizational agility on higher firm performance (Troise et al., 2022). An empirical study in the services and manufacturing sectors, using the concepts of RBV and DC, confirmed the impact of shared managerial leadership on a firm's market-oriented culture and its subsequent impact on its innovation capacity and performance (Singh et al., 2022). Araújo et al. (2022) seek to demonstrate that strategic planning is the micro-foundation of a firm's dynamic capabilities. DC can more effectively guide decision-making in an organization and can be used effectively to improve firm performance.

Ojha et al. (2020) explored an empirical study of manufacturing firms in dynamic strategic planning, which led to improved financial performance through the mediator of a firm's operational capabilities. The study confirms that higher performance is associated with improved core processes and operational capabilities of a firm. Another combined study investigated the impact of strategic foresight on two distinct types of dynamic capabilities: strategic flexibility and strategic capabilities. The results show a significant positive effect of the studied dynamic capabilities, especially in periods of high environmental uncertainty (Haarhaus & Liening, 2020). A study of new firms in the market assessed the relationship between four variables: dynamic capabilities, competitive advantage, entrepreneurial creativity, and ambidextrous innovation. The authors found that more than strengthening dynamic capabilities is needed for new firms in the market to create a competitive advantage (Sijabat et al., 2021).

De Aro & Perez (2021) examine the relationship between capabilities related to open innovation and dynamic capabilities as a source of competitive advantage. The study reveals nine individual capabilities in the open innovation process related to dynamic capabilities and the strategic management of internal and external knowledge as a source of competitive advantage. Clauss et al. (2021) examine strategic agility in turbulent environments, the role of business model innovation (BMI), and the relationship to firm performance. The study finds that strategic agility, represented by strategic sensitivity, leadership unity, and resource flow, is positively correlated with the three dimensions of BMI, which are value proposition, value creation, and value innovation. A study highlighting the main features of strategic agility in the concept of multinational companies suggests

that strategic agility and sustainability of multinational companies are mutually contributing to their long-term success in the business environment (Shams et al., 2021).

Vu (2020) examines dynamic, innovative, and entrepreneurial capabilities and their relationships. She confirms the impact of these capabilities on a firm's extraordinary performance on an empirically verified model. Radical innovations, which directly affect firms' innovative and dynamic capabilities, have been studied in the context of a nearly threefold increase in literature in the last decade. The authors identify research clusters that affect organizational performance: radical innovation management, organizational learning and knowledge, financial aspects of radical innovation, adoption and diffusion of radical innovation, radical innovation in industry as a challenge for established firms, and radical innovation in specific industries (Tiberius et al., 2021). In the model of dynamic capability extension, the authors identify that investments in knowledge and educational processes, alliances, and resources increase the possibility of understanding new sources of competitive advantage, especially in unstable and turbulent conditions (Bitencourt et al., 2020)

The processes that support value creation through the precise orchestration of firm resources are studied by analyzing and combining the two constructs of dynamic managerial capabilities (DMC) and dynamic capabilities (DC). This utilizes the full spectrum of the firm's organizational capabilities (George et al., 2022). Miterev et al. (2020) found that different organizational designs can play a supporting or even hindering role depending on the nature of the value-creation process. Therefore, a successful corporate design must be adapted primarily to the conditions, disruptions, and interventions from the external environment. The ability to process and use information using an IT system is closely related to the issue of organizational design efficiency. The results of an empirical study show that a firm can gain a competitive advantage directly from developing a valuable, rare, and inimitable information processing ability and indirectly from improving the efficiency of decision-making processes (Cao et al., 2019). Research on SMEs confirmed a positive and significant influence between leadership and competitive advantage, where entrepreneurial orientation was a moderating factor. Entrepreneurial orientation can create a significant competitive advantage by providing the manager's or owner's perspective on management and the use of resources and capital (Tobing et al., 2021).

Feng et al. (2022) integrate both the Knowledge-Based View (KBV) and Dynamic Capability View (DC). The study confirmed that the ability to dynamically manage knowledge, including its absorption, transfer, and application, significantly contributes to the innovative and financial performance of firms. The authors use evolutionary theory based on the dynamic capabilities framework to connect and utilize the cognitive thinking of individuals and groups (Cristofaro & Lovallo, 2022). The view of the firm through dynamic capabilities clarifies the relationship between routine and innovation. It explains how strategic decisions of managers with dynamic capabilities are essential for the firm's success and the industry's dynamics. An empirical study of open innovation found a close relationship between the value of knowledge of top management, knowledge sharing, open innovation, and organizational performance. The study confirms that creating and sharing expertise in value-creation processes within a firm affects its competitiveness and performance (Singh et al., 2021).

3. Methods

Objective measurement and evaluation of the effects of competitive advantage and their mutual comparison between firms is complicated. Research in the field of competitive advantage is affected by its definitional ambiguity. Different authors use different definitions of competitive advantage in the literature, and thus, this concept needs explicit semantic content (Hamulczuk & Pawlak, 2022). The groundbreaking theory in the field of competition Porter (2004) introduced the concept of competitive advantage into business strategy but has not provided any explicit definition since its inception. The author only states that competitive advantage arises from the ability of a firm to create higher value for its buyers and that outstanding value results from offering lower prices than the competition for equivalent benefits or advantages.

Because it is difficult to identify and measure total created value, Grant (2022, p. 143) defines competitive advantage as: "a firm's potential to earn a higher rate of profit than its direct competition". Here, it is good to note that the word "potential" is crucial because exceptional value creation is naturally followed and measured by outstanding financial performance that company stakeholders, investment politics, or broader circumstances

can purposely influence. Even other authors do not focus on any explicit descriptive concept. Therefore, the concept of competitive advantage suffers from the so-called "definitional problem" and does not offer a unified semantic basis for more accurate scientific research (Sigalas & Pekka Economou, 2013). Despite the difficulty of identifying a conceptually robust stipulative definition of competitive advantage, Sigalas et al. (2013) have developed a definition of competitive advantage that incorporates all its latent characteristics. This definition deliberately separates competitive advantage from the two most common concepts, which are the performance-based concept and the resource-based concept. This results in a third concept that offers a suitable methodology and allows for the "measurement" and evaluation of competitive advantage. This measurement is focused on the firm's ability to exploit market opportunities above the industry average and neutralize competitive threats.

The methodology constructed a variable for measuring competitive advantage from the variable of firm competitiveness. For competitive advantage to be measured, it must be compared to the industry's competitiveness level. The firm's competitiveness variable contains four items crafted from the observable attributes of competitive advantage's operational definition, Figure 1.

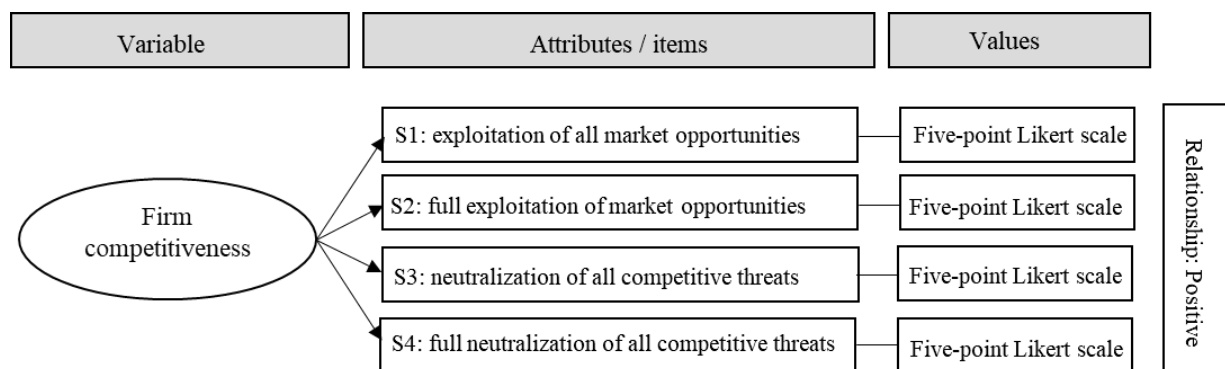


Figure 1. Methodology to measure competitiveness

Source: Sigalas et al. (2013)

In this article, the firm ICE Industrial Services, a.s., headquartered in the Czech Republic, which has been operating since 2014 as an engineering and supplier firm in industrial automation, is examined through a case study using the methodology mentioned above. Its specific business activity contains the architecture, design, manufacture, and supply of automated industrial production lines. The company is classified as an SME in terms of size. This company has been organized based on a flat organizational structure in the form of circles and self-managing teams since its inception, where decentralized decision-making is introduced, and the principles of Holacracy are used. The organization of internal activities is further adapted to the operational processes and internal needs of a private company.

Because the concept of Holacracy does not have a formal management structure, the research was conducted through personal interviews and questionnaires from five key representatives of the company, who either hold the position of statutory representative, specific top manager, or other important company role that could be identified for this research.

The questionnaire included the primary identification of the respondents, their function and position in the company, the date of response, guidance text, and four statements to which the respondents were to assign their opinions. The questionnaire was created based on a 5-point Likert scale. In the questionnaire, each respondent marked their opinion on a scale of: 1 strongly disagree, 2 disagree, 3 neutral, 4 agree, and 5 strongly agree.

The question and statements were formulated by the methodology used as follows:

“Over the last three years, your competitive strategy has allowed your firm to”:

Statement 1: exploit all market opportunities that have been presented to your industry.

Statement 2: fully exploit the market opportunities that have been presented to your industry.

Statement 3: neutralize all competitive threads from rival firms in your industry.

Statement 4: fully neutralize the competitive threads from rival firms in your industry.

Statement 1 and Statement 2 form the first thematically related group, while Statement 3 and Statement 4 form the second group.

For this study and by the proposed research methodology, the meaning of the terms competitive advantage and firm competitiveness was considered to be identical. The measured variable is then considered to be the degree of firm competitiveness.

4. Results

A small number of companies in the Czech Republic use Holacracy or other similar decentralized organizational designs, and they operate in different industries. Therefore, it would be challenging to compare them based on performance metrics. For this reason, a case study of the company ICE Industrial Services a.s. was used to conduct the research. The study's purpose, goal, and intent were explained to the respondents during a personal interview. Then, they completed a questionnaire that assessed the company's ability to exploit market opportunities and neutralize competitive threats above the industry average.

After completion, all questionnaires were submitted and grouped into Table I. Questionnaire evaluation, where the arithmetic mean, median, and variance of the obtained responses were calculated using basic statistical methods.

Table I. Questionnaire evaluation

	Attribute/Item	Mean	Median	Variance
S1	Exploit all market opportunities that have been presented to your industry	3.4	3	1.04
S2	Fully exploit the market opportunities that have been presented to your industry	2.8	3	0.56
S3	Neutralize all competitive threads from rival firms in your industry	2.8	2	0.96
S4	Fully neutralize the competitive threads from rival firms in your industry	2.4	2	0.64

Source: authors

The results of the first statement, S1, show that most respondents consider the company's ability to exploit all known market opportunities somewhat above average, with a value of 3.4 and a median value corresponding to the mean of 3. However, the relatively high value of the standard deviation of 1.04 indicates higher differences of opinion among respondents. This may indicate different perceptions among respondents regarding the amount and types of suitable market opportunities for the company.

The second statement, S2, which evaluates the company's relative ability to exploit more market opportunities than the competition, suggests the company's market position. This ability is classified as slightly below average, with a value of 2.8 and a median value of 3, which represents the mean. The low standard deviation of 0.56 then indicates greater consistency of opinion among respondents.

The third statement, S3, evaluates the company's ability to neutralize all known competitive threats in the industry. This ability is classified as slightly below average, with a value of 2.8 and a median of 2, which confirms the below-average trend. However, the standard deviation of 0.96 also indicates a certain degree of inconsistency of opinion among respondents. This may be due to respondents' different perceptions and perspectives on the competition.

The fourth statement, S4, deals with the ratio of the ability to neutralize competitive threats. This is at a below-average value of 2.4, which may indicate a highly competitive environment for the company and a low ability to respond. This is also reflected in the median of responses with a below-average value of 2. The relatively low standard deviation of 0.64 suggests a certain degree of consensus among respondents.

All the above results suggest that, on the one hand, the company under study is capable of slightly above-average utilization of market opportunities in the industry. Still, on the other hand, it operates in a highly competitive

market or cannot effectively neutralize competitive threats for different reasons. It can, therefore, be indicated that the company does not have an above-average level of competitiveness. This finding also supports previous research mentioned in the chosen methodology, which suggests links and correlations between the results of the used competitiveness measure and the company's financial performance itself. This link, in other words, means that the higher the company's competitiveness, the higher its performance. For the sake of completeness and, in this case, a more subjective assessment of this link, which was not the subject of the study, we provide a percentage expression of the value of EBITDA of ICE Industrial Services a.s. as determined from the Profit and Loss Statement obtained from the Commercial Register. This was 14.4% in 2019, 2.22% in 2020, and 2.28% in 2021.

5. Discussion

Global corporate, entrepreneurial, and market environments are highly variable and heterogeneous, and scientific research in the field of strategy and management should always consider both the conditions of the specific market and many other specific and exogenous factors that influence a given business in a given industry. In the current rapidly evolving, volatile, and heavily technologically influenced economic conditions, both new opportunities and new business models are emerging, as well as unique corporate structures and organizational arrangements.

In this sense, competitiveness and competitive advantage depend more on specific conditions and are context-specific. As Ma (2000) states, competitive advantage is a relationship between the focal firm and its rivals within a particular competition. Competitive advantage is not a universal, general, or summary characteristic of a firm or specific aspects of a firm. The research deals with the relationship between competitive advantage and the self-managing, flat organizational design of a company based on the principles of Holacracy in the form of a case study in the Czech Republic. The corporate structure of Holacracy is considered a Dynamic Capability that the company possesses in this case.

The results of the case study of a company in the field of industrial automation ICE Industrial Services a.s. show that although the company is very agile in its internal operation and in the established principles of self-management, where decentralized decision-making processes work well, and its dynamic capabilities are at a very advanced level, this arrangement has a negligible impact on competitive advantage. The company's ability to better exploit market opportunities is somewhat above-average, and the ability to neutralize competitive threats is slightly below-average.

These findings can be attributed to the very price-sensitive and saturated local market of the Czech Republic, where the company operates, with quite strong competition in industrial automation. A similar conclusion was reached by the study Sijabat et al. (2021), which investigated the impact and strengthening of dynamic capabilities primarily in new companies on the market. While these capabilities are positively related to competitive advantage, there is no evidence of their direct effect on firm performance.

In general, a firm's agile and unconventional organizational design is very closely linked to the value-creation process, through which the firm captures and creates value. The amount of this value created is represented on the one hand by the maximum price the customer is willing to pay and on the other hand by the firm's internal cost structure. According to Mitrev et al. (2020), long-term empirical research within a specific innovation program emphasizes the need to align value-creation processes and strengthen the organizational arrangements that influence them. From this, it can be inferred that only this alignment can help a company to create more value than the competition, and the company can thus achieve a competitive advantage in the sense of better performance. The ability of a company to take advantage of more market opportunities or neutralize competitive threats is, therefore, more subject to the external conditions of a price-sensitive and saturated market.

The significant impact of external conditions on the efficiency of self-managing companies and teams is also associated with the number of opportunities on the market. Self-managing teams work well in cases where there are enough opportunities in the industry on the market. Still, on the other hand, this increases the amount of organic competition. The study by Ketkar & Workiewicz (2022) confirms that decentralization of decision-

making and the use of self-managing teams is more suitable for an environment that is rich in market opportunities, while in an environment where there are few market opportunities, centralized decision-making, and centralized resource planning are more suitable. The ability of a company to exploit more opportunities or neutralize threats from competitors is, therefore, more dependent on external market conditions than its internal structure.

The findings suggest that a highly agile, self-managed organizational design may not create a competitive advantage if the company operates in a highly competitive and price-sensitive market. It is, therefore, more about the efficiency of the internal processes by which the company creates value rather than its dynamic capabilities. However, these can play a significant role in the company's long-term strategic direction, in a high degree of flexibility, and in the ability to identify and exploit new opportunities promptly. The recognized and discovered advantage of self-driving companies with decentralized decision-making is the relatively large freedom and individual time space at the level of the CEO, which is rarely needed for daily decision-making when the functionality of the entire Holacracy system is well set and maintained.

This case study shows that the Holacracy organizational design may have little impact on a company's competitiveness. Further research in Holacracy-organized companies or similar flat corporate designs should focus more on analyzing the external environment and individual industries and sectors where Holacracy could be more suitable and gain greater importance. With the availability of more empirical data, new research could better compare the effectiveness of traditional hierarchical and new organizational designs and their impact on a company's competitive advantage.

Conclusions

This study investigated whether an agile and flat organizational design based on Holacracy, with decentralized decision-making, can bring a company a competitive advantage in the market. In this sense, the company's corporate design is considered a Dynamic Capability of the company. Competitive advantage belongs to the multidimensional area of research in firm theory. Due to its ambiguous definition, it suffers from the so-called definition problem. For research purposes, competitive advantage is considered by conceptual streams, which are then categorized. These are currents focused on the company's economic performance, the resources of competitive advantage, and the company's ability to exploit market opportunities better and eliminate competitive threats. Competitive advantage often needs to be correctly understood and interpreted even in managerial and business practices (Sigalas, 2015).

This paper, in the form of a case study of a flat and agile company in the Czech Republic, ICE Industrial Services a.s., using the organizational principles of Holacracy, investigated to what extent such a corporate design can bring the company a competitive advantage. By surveying the company's leading representatives, their opinions on its disposition to have a competitive advantage were obtained. The questionnaire provided basic introductory text and four statements with the possibility of verifying the degree of their truthfulness according to a 5-point Likert scale. The first thematically related group of two statements assessed the degree of the company's ability to exploit market opportunities. This ability was evaluated as average to slightly above average. The second thematically related group of two statements then assessed the degree of the company's ability to neutralize competitive threats. Here, a rather average to slightly below-average level was found.

The main reason for Holacracy's low ability to create a competitive advantage is the influence of the highly competitive external environment, the structure of the industry, and industry standards in the field of industrial automation. A highly saturated and price-sensitive market becomes the primary determinant and measure of the value companies in the industry can create. In this competitive battle, the company's efforts to achieve above-average performance remain primarily a question of appropriate market pricing, carefully managed cost structures, and the need to differentiate rather than its dynamic or agile capabilities.

Due to the lack of empirical data for research on Holacracy, the limitations of this research were primarily the tiny number of flat-organized companies studied in the same industry in the Czech Republic. Another limitation is the small base of companies of similar size and structure, where it would be possible to carry out long-term

comparisons and evaluations of the economic efficiency of each of them about a traditional hierarchical or flat organizational structure.

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DESIGN AND IMPLEMENTATION OF A CRM SYSTEM TO OPTIMIZE BUSINESS PROCESSES OF A TRADING COMPANY

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Abstract. This paper aimed to formulate recommendations for implementing CRM systems for trading companies in the small and medium-sized enterprise segment. A content analysis of current documents was used to analyze the types and forms of CRM systems used in these companies. The essential functions a CRM system must contain were identified through structured interviews. The central part of the paper deals with the development and implementation of the CRM system. The current system was analyzed using the HOS 8 method, and its effectiveness was described. The results show that the system could be more efficient and balanced; based on these findings, it was decided to implement a new CRM system. The HOS 8 method was followed by a GAP analysis, which compares the current state of the CRM system with the expected (desired) state. Using the GAP analysis, the process of implementing the CRM system was carried out. The results of this work can be mainly used in trading companies with frequent and continuous contact with customers. However, the above analysis and procedures can also be applied to other types of firms. There are opportunities for further research in modern CRM systems such as automation, digitalization, and Artificial Intelligence. These areas will bring added value to firms and increase their competitiveness.

Keywords: Customer Relationship Management; CRM conceptual model; optimization of company processes; CRM system implementation; company performance; customer orientation

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1. Introduction

It is necessary to design and continuously improve business processes and communication channels in the business environment to maximize profits, increase business value, and ensure exceptional customer experience at all levels of communication. To maintain a competitive advantage, it is crucial to strengthen profitable relationships, increase customer loyalty, increase revenue, and improve sales performance. Business performance is the main objective of any business and is a top priority for managers (Gavurova et al. 2022; Dvorsky et al., 2021). Customer Relationship Management (CRM) capabilities are known in the literature as an important factor affecting business performance.

However, there are significant differences between companies, given the market environment in which they operate or the nature of the products they sell (Trif et al., 2019). Empirical tests show that the operational benefits of CRM are reflected in high corporate revenue per employee, which leads to high profitability; the strategic benefits of CRM are reflected in high customer satisfaction, which also leads to high profitability and market valuation (Li et al., 2019).

Not all approaches to implementing CRM systems are effective. Social CRM has a positive direct effect on innovation performance and customer engagement, but surprisingly, customer engagement does not directly affect corporate performance (Hakimi et al., 2023). The effectiveness of using social CRM varies depending on the size of the firm, its innovativeness, the industry, and the market in which it operates. CRM capabilities have only been proven to mediate the relationship between social CRM and firm performance indirectly (Foltean et al., 2019). In the future, social CRM is expected to become increasingly prevalent to achieve better performance and focus on a firm's ability to capture, generate, organize, and integrate information from customer engagement on social media to maintain and improve customer relationships and its financial results (Yasiukovich & Haddara, 2021). Kim, Hyun, and Zhan (2019) describe that most of the current literature on social CRM in small and medium-sized enterprises tends to focus on the use and maintenance phase, while issues related to adoption, acquisition, and implementation decisions are much less represented.

Powel et al. (2018) describe the characteristics of the micro and macro environments in which CRM is used in both customer engagement and overall corporate performance and discuss the human versus machine capability of CRM support. But as Pour et al. (2018) state in their study, although CRM has been at the top of management tools in recent years, they conclude their research by stating that the relationship between CRM and innovation, as well as the relationship between innovation and firm performance, has been confirmed, while the relationship between CRM and firm performance has not been verified. The interaction of these areas improves corporate performance, and despite the massive investment in CRM, its impact on business could be clearer. CRM affects the sales process (opportunity creation, opportunity management, and relationship management) and causes significant differences in sales processes. Companies with high efficiency and CRM help in opportunity creation and relationship management with the development of technologies such as Web 2.0 and cloud computing (Rodriguez et al., 2018). Suoniemi et al. (2022) describe the extent to which CRM consultants improve the quality of the CRM system, and, ultimately, the corporate performance depends mainly on the user interface, which acts as a key facilitating mechanism for dealing with complexity, application, and uncertainty of requirements. The user interface is also related to the possibility of using mobile devices to work with CRM systems: Markovets et al. (2021) describe the algorithms for mobile application development, in particular, the authorization/authentication algorithm and the algorithm for executing possible SQL queries on the back end of the CRM system. Mobile applications are related to the current concept – artificial intelligence that integrates with CRM systems and can analyze large volumes of customer data (Andronie et al., 2021; Dijmărescu et al., 2022; LazaroIU et al., 2022). From a CRM perspective, companies must store and analyze customer data to understand their needs (Chatterjee et al., 2021). Although CRM technology implementation initiatives often fail, most research focuses on user-related reasons for low success rates, but system quality also plays a significant role in mediating the effects of IT capabilities at the firm level (Suoniemi et al., 2021; Fedorko et al., 2018).

Business analytics (BA) is becoming increasingly important in a rapidly changing business environment, and the strong link between the IT environment and the use of business analytics is evident in the context of CRM (Nam et al., 2019). Boujena et al. (2018) state that customer relationship management is becoming a hot topic in both academic and business environments, and with the help of technology, predictive analytics in CRM is becoming an important tool in the marketer's toolbox. It is a process where vast volumes of historical customer data are used to predict future customer behavior, enabling marketers to make decisions based on their knowledge rather than what they think.

The paper aims to formulate recommendations for implementing CRM systems in trading companies operating in the segment of small and medium-sized enterprises in the Czech Republic. Sustainable customer relationship management combines business strategy, customer-oriented business processes, and computer systems that seek to integrate sustainability into customer relationship management (Ferrer-Estévez & Chalmeta, 2022).

The first research question focuses on identifying the systems that companies use:

RQ1: What forms (types) of CRM and what CRM systems do trading companies use in the SME segment?

To analyze the main functions and tools that firms use in CRM systems, the second research question is formulated:

RQ2: What are the key functions a CRM system should provide to successfully support business activities and improve customer experience?

In practice, CRM system implementation is slow or not meeting the company's expectations. Successful implementation depends on several factors, such as alignment between the firm's CRM strategy and programs and its broader marketing strategy and intra- and inter-organizational collaboration and coordination between those involved in the implementation. Management support for implementing CRM systems is also essential (Bohling et al., 2016). The above leads to the last research question, number three:

RQ3: What is the optimal procedure for implementing and deploying a CRM system?

2. Literature Review

In the era of e-commerce, the implementation of customer relationship management is a complex system process, which must be carried out by specific concepts and requirements and in steps suitable for society, customers, and enterprises (Bartók et al., 2021; Dabija et al., 2022). Companies should adhere to the “customer-oriented” business philosophy and use information technology to implement data analysis (Lv, 2021; Skare et al., 2023a). In the competitive environment of small and medium-sized companies, a smart approach to customer relationship management (CRM) is increasingly appreciated. However, it is difficult to select the appropriate CRM software, so one possible selection method is based on Multi-Criteria Decision Analysis (MCDM) and cost-benefit analysis (Cricelli et al., 2020). In the era of COVID–19, many business processes (customer communication and sales support) have moved to the online environment (Waliszewski & Warchlewska, 2021; Belas et al., 2022). Using descriptive and regression analysis, it was found that modern marketing communication tools have an impact on increasing the innovativeness of enterprises (Krchova & Hoesova, 2021; Skare et al., 2023b). According to Claybaugh et al. (2023), employees who work with a CRM system perceive the technology they use and evaluate the relational elements of the exchange relationship. The authors also propose a model that includes two technology components (positive prior experience and technology quality) and four relational constructs (reputation, trust, risk, and overall relational satisfaction) and analyze how these factors influence loyalty to the customer relationship management system provider.

According to Pohludka and Stverkova (2019), there has been an upward trend in recent years to focus on the customer and their needs. From this perspective, a fully functional CRM system can be considered a competitive advantage for both multinational and small and medium-sized enterprises. Melovic et al. (2022) discussed the factors influencing electronic customer relationship management (e-CRM). Based on a questionnaire survey, they explain the importance of technical, organizational, and environmental factors, whose assimilation depends on the successful use of CRM software. According to Whitaker et al. (2020), there is a gradual increase in the proportion of firms that use outsourcing for CRM solutions. The research was conducted between 2011 and 2022 on 150 North American small firms through a questionnaire survey. Similarly, Viana et al. (2020) report that outsourcing to SMEs in Germany is expanding due to the development of social CRM and its integration of social media data into CRM

tools to improve customer insight. The results show that German SMEs' outsourced services enhance customer satisfaction by focusing on core business, service quality, and cost reduction.

Since CRM tools are very expensive for small companies, Cruz et al. (2017) describe the possibility of using Open-Source CRM systems, which are without acquisition costs and are viable for small companies. The major Open-Source CRM systems include SugarCRM, Vtiger, Open CRX, and Odoo. Open-source software solutions are vital for SMEs as they allow easy access to reusable software. With the rapid increase in popularity of cloud technologies, public clouds also cost-effectively cater to the computing requirements of SMEs, as users can dynamically access on-demand resources according to their needs (Schork et al., 2019). Another advantage of using Open-Source is the ability to use existing CMS (Content Management System) such as WordPress, Joomla, or Drupal that are already used in companies and extend them with CRM modules. SMEs can use open-source software modules to cover more business areas with modern ICT solutions (Skulimowski, 2016).

The use of social media as a communication channel and source of data to understand customer needs is essential to keep companies alive in a constantly competitive market. The massive production of user-generated content is seen as a powerful resource of information about customer behavior, which enables the innovation of existing approaches. This has led to the emergence of a concept known as social CRM (Junior et al., 2020; Chovanová Supeková et al., 2023). Social customer relationship management is a new paradigm in the e-business environment. It enables businesses to collaboratively manage customer expectations through social technologies, combining social media capabilities with traditional CRM software to allow companies to engage their customers better (Pour & Hosseinzadeh, 2021). Another form of use is Mobile CRM. Research results show that Mobile CRM plays an important role in adopting traditional CRM and sales performance when sales process and collaboration capabilities are involved (Rodriguez & Boyer 2020). The basic marketing components include sales evaluation, customer satisfaction analysis, and segmentation (Langerová et al., 2021).

Marketing automation systems represent a type of management information systems (MIS) used in CRM. One of the tools is email marketing, whose basic function is to send emails. There is a correlation between the size of the database, email open rate, and email click-through rate. Research by Georgescu and Teiu (2021) showed a significant increase in the use of email marketing and strong correlations between the indicators used. Marketing automation is further enhanced using chatbots – a targeted online conversation with human end-users that influences user experience and satisfaction (Sohail et al., 2021). As also described by Brandtzaeg Folstad (2017), there is a growing interest in chatbots and machine agents that serve as a natural language user interface for data and service providers. In their questionnaire survey, they identified key motivating factors for using chatbots: productivity, effective help, or information. Web mining (an analytical methodology for extracting data from web portals), used to automatically collect information from clients' websites for customer relationship management systems, emerges as another suitable environment for customer data mining (Baumer & Buff, 2019).

Tazkarji and Stafford (2020) discuss the high failure rate of CRM system implementation, stating that many factors contribute to CRM implementation failure. According to the authors, the main categories of People and Technology are complicated and require organizational collaboration. In contrast, factors in the Processes category are more manageable because they can be addressed before CRM implementation. Therefore, when implementing a CRM system, successful management of the implementation project, perception of specific offerings, reliability and assurance, and services provided by CRM consultants are necessary (Gonzalez-Benito et al., 2017). Based on the study by Zhao and Li (2016), CRM implementation has 16 critical success factors. In the literature search, they develop relevant hypotheses. Their results show that the main success factor for CRM implementation is top management support and involvement. Some differences were found between consultants' and practitioners' responses for 4 critical success factors, specifically project manager's skills, education and training, project scope management, and staff attitude. In addition, the study's results suggest that some of the more important critical success factors of implementation do not belong to the CRM system's quality aspect but to the CRM project's scope

aspect and the organizational characteristics aspect. Habul et al. (2017) empirically analyzed successful CRM implementation. Based on the results of two online questionnaires, they concluded that an important requirement placed on CRM is the involvement of employees in CRM implementation and the involvement of external experts; this suggests that a lack of vision, leadership, and training of employees often leads to unsuccessful implementation.

As stated by Chromcakova and Starzyczna (2019), the components of CRM, barriers to implementation, and the use of customer relationship management by size are often discussed, as evidenced by their research conducted in 2014-2017 in the Czech Republic. The results show significant differences in the use of CRM depending on the size of the company and the business sector. Adamkovic (2015), in his study conducted in the Czech Republic, focused on small businesses and investigated the suppliers, time, and financial availability of the tools offered and flexibility to customer requirements. The study revealed a limited number of suppliers and limited required functionality of CRM systems. Sebjan et al. (2016) investigated how organizational orientation (process, innovation, and technology) as critical organizational factors influence attitudes towards using IS and CRM analytical tools. Their results show that all critical organizational factors, namely process, technology, and innovation orientation, have a positive influence on attitudes towards the use of IS and CRM analytical tools, with innovation orientation being of particular importance, having the strongest influence on attitudes towards the use of IS and CRM analytical tools. AlQershi et al. (2020), who examined the interaction of human capital and CRM on the performance of SMEs, found that key customer focus, technology-based CRM, and CRM knowledge management are effective factors influencing performance but not CRM organization tools. It was also found that human capital has no moderating effect on the relationships between key customer focus, knowledge management, and performance. However, it plays a role in moderating the relationship between performance and CRM organization.

Junior and Ramirez (2021) described the experience of defining a new customer relationship management system in an internal sales department where an outdated CRM system was being replaced using a Probe Methodology (PM) approach. The results showed that PM can help identify the specific software environment's main characteristics, usage patterns, and problems. In addition, it was possible to determine how users adapted to overcome the difficulties encountered when interacting with the system and provided valuable insights for CRM development. As reported by Khanh et al. (2022), who collected data based on a structured questionnaire survey with 241 valid responses, correlation analysis and structural equation modeling were used to investigate the causal relationships between organizational factors, customer, orientation, knowledge management, data quality, and CRM strategy. The result shows that organizational factors impact the success of e-CRM. However, more attention needs to be paid to other factors that influence customer orientation, followed by knowledge management and technology. Other factors, such as data quality and CRM strategy, indirectly affect the success of e-CRM.

3. Methodological approach

3.1 Data

The first research question will be answered using content analysis of documents from Web of Science and Scopus, which provide secondary data. In addition, current scholarly publications, such as "Customer Relationship Management - Concept and Technologies" (2019) and "Connected CRM - Implementing a Data-Driven, Customer-Centric Business Strategy" (2014) are considered. Data is also obtained from research by Gartner, a company focusing on CRM systems. The second and third research questions will be answered by conducting two interviews. The first interview is performed with the owner of MediLR s.r.o., the Czech Republic. The questions in the interview concern the strategy of building customer relationships, the evolution of customer communication, and the future expectations in the field of relationship management.

The second interview is conducted with the head of the consulting and development team of an ERP/CRM system supplier. This interview compares theoretical knowledge with practical experience and determines the current and

future status of CRM software in small and medium-sized companies. Data from the IS/CRM system of MediLR s.r.o. is analyzed as part of the research. Overall, this research aims to provide a deeper insight into the issues of building customer relationships and CRM software development in SMEs.

3.2 Methods

The content analysis of the documents to cover the first research question is based on identifying appropriate keywords to be searched on Web of Science, Scopus, Gartner (www.gartner.com), and G2 (www.g2.com) websites. Czech sources include, in particular, www.crm.cz, www.crmforum.cz, and www.systemonline.cz. The main keywords for the first research question are CRM Capability, CRM Software, Relationship Management, CRM Systems, Relationship Marketing, CRM Selection, Small and Medium Enterprises (SMEs), and their combinations. The second and third research questions are addressed in the form of a case study based on a questionnaire survey conducted with the owner of the business MediLR s.r.o. The purpose is to discover what key features a CRM program should have to support business activities and improve customer experience successfully. This investigation is followed by a structured interview with the head of the development department of a company that creates ERP/CRM systems. For the third research question regarding the optimal implementation and deployment of a CRM system, a content analysis of documents on Web of Science and Scopus portals is conducted at the theoretical level using the main keywords such as CRM System, CRM Implementation, Factors Affecting Successful Implementation, Small and Medium Enterprises (SMEs).

The HOS 8 method describes the environment and determines the effectiveness of the CRM software use. The basis for its processing is a questionnaire survey. The HOS 8 method comes from Koch (2010). The essence of this method is to get an overview of the surveyed program. The method aims to assess the existing CRM program and examine different areas' levels. The areas evaluated include Hardware (HW), Software (SW), Orgware (OW), Peopleware (PW), Dataware (DW), Customers (CU), Suppliers (SU), and Management Systems (MA). A questionnaire is created for each of the above areas (Appendix 4), containing 10 questions for each area. Answers will be a choice between yes, rather yes, partly yes, rather no, and no, with the following scores for each of the options: yes - 5, rather yes - 4, partly yes - 3, rather no - 2, and no - 1. A questionnaire (Annex 4) is created for each of the above areas, containing 10 questions for each area. Answers will be a choice between yes, rather yes, partly yes, rather no, and no, with the following scores: yes - 5, rather yes - 4, partly yes - 3, rather no - 2, and no - 1. For each area, the value of u_i is calculated using the equation (1):

$$u_i = \left[\frac{\sum_{j=1}^{10} u_{ij} - MAX_i - MIN_i}{8} + 0.5 \right] \quad (1)$$

The resulting value u_i can take the following values:

$u_i = 1$ – indicates a very low level of the area, $u_i = 2$ – indicates a low level of the area, $u_i = 3$ – indicates a medium level of the area, $u_i = 4$ – indicates a high level of the area and $u_i = 5$ – indicates a very high level of the area.

The aggregate state of the system is then found using the equation $u = \min(u_1, u_2, \dots, u_8)$.

We are looking for the smallest value of the region. This is followed by the determination of the balance of the system, which can take the following values: fully balanced program, balanced program, and unbalanced program. For a completely balanced model, $u_i = u$. A balanced program is the one where for all u_i : $(u_i - u) \leq 1$ and at the same time: $\sum_{i=1}^8 (u_i - u) \leq 3$. The last state, an unbalanced program, is the one for which $\sum_{i=1}^8 (u_i - u) \geq 4$. The balance of the system can take the following values: fully balanced program ($r = 1$), balanced program ($r = 0$), and unbalanced program ($r = -1$). The last area examined deals with the importance of the system for companies, which can again take three values (v). For $v = -1$, it means that the program is not important for the firm's operation, as there is no increase in production, profit, or labor savings. This means that the firm can work without the system program. For $v = 0$, the state means that the program is important to the firm's operation, but its short-term failure

will not affect the firm's operation, profit, or customer satisfaction. The last value, when $v = 1$, indicates that the program is critical to the firm's operation, and even a short-term failure will affect the firm's operation, profit, or customer satisfaction (Koch, 2010). After all areas have been evaluated, a graphical representation is made based on a table, where each area is described in the first column, the second column contains the final evaluation, and the third column contains the verbal evaluation. The graph consists of 8 semi-axes; each semi-axis is labeled with five points, i.e., the values that each area can take on, and then the points will be connected to form an octagon showing the values of all the areas examined. The graphical processing is carried out in Corel's program Corel Draw version 19.

The second method, which builds on the HOS 8 method and uses its results, is the GAP analysis. GAP analysis compares the current state with the expected (desired) state. The GAP analysis covers the following areas: identification of objectives and requirements, identification of a reference state, identification of the current state, comparison of the reference and current state, identification of actions to address the deficiencies, implementation planning, implementation, monitoring, maintenance, and training. Using GAP analysis, the third research question is addressed and answered.

4. Result and Discussion

RQ1: What forms (types) of CRM and what CRM systems do trading companies use in the SME segment?

The basic classification of CRM in the literature is divided into three main parts: analytical, operational, and strategic. Analytical CRM (Customer Relationship Management) is an approach to customer relationship management that focuses on collecting and analyzing customer data to understand their needs and behaviors better. Analytical CRM uses various methods and technologies, such as statistical modeling, data warehouses, and data visualization tools. Figure 1 describes basic data processing using analytical CRM.

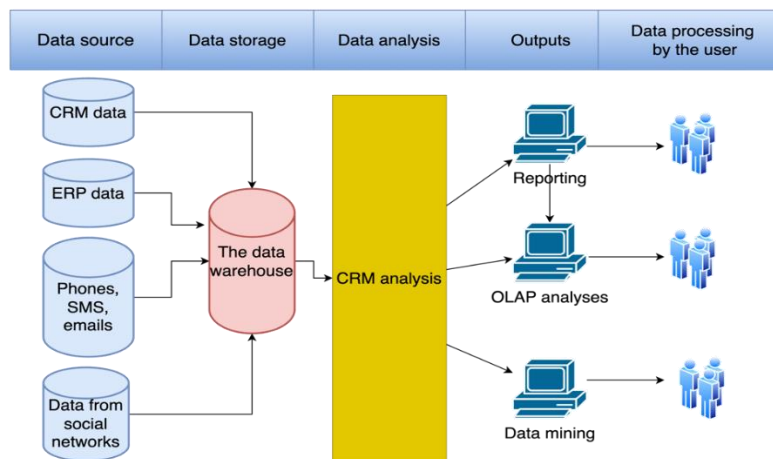


Figure 1. Basic data – analytical CRM

Source: Authors

Operational CRM (Customer Relationship Management) focuses on processing and analyzing customer data to maximize customer satisfaction and loyalty. Operational CRM primarily addresses issues related to using customer information to improve sales, marketing, and service delivery. Specifically, operational CRM deals with the collection, organization, and analysis of customer information, such as information about their purchases, previous inquiries, preferences, complaints, feedback, etc. This information is then used to provide personalized services,

offer products, and improve customer satisfaction. The main functions of operational CRM include customer contact management, marketing campaigns, sales management, and customer support management.

Strategic CRM is an approach to customer relationship management that focuses on planning and implementing long-term strategies to improve the customer experience and strengthen customer relationships. This approach is based on collecting and analyzing customer data to identify their needs and preferences and create personalized offers and services. Strategic CRM involves several phases, including data collection, data analysis, strategy planning and implementation, and follow-up monitoring of results.

In recent years, new CRM systems have emerged, namely Social CRM and Mobile CRM. Social CRM is focused on tracking and analyzing customer behavior on social media. This type of CRM helps companies create targeted advertising campaigns based on customer preferences and habits. Mobile CRM allows users to access customer information through mobile devices such as smartphones or tablets. This type of CRM is ideal for marketers who need to access customer information on the go.

CRM systems fall into three main categories based on where the data is stored: on-premises, cloud, and hybrid.

On-premises CRM systems reside directly in a company's facility and are run internally. This type of system allows companies complete control over data and storage but requires investment in infrastructure and technology to run the system. Cloud-based CRM systems are hosted on third-party servers and are accessible via the Internet. This type of system allows firms to deploy it easily and quickly without owning the infrastructure for data storage. Still, it also needs to be improved in terms of data control. The last group is hybrid systems, which combine the benefits of on-premises and cloud-based systems. Data is stored on an internal server in the company's environment. The use of CRM systems by small, medium-sized, and large companies is shown in Figure 2.

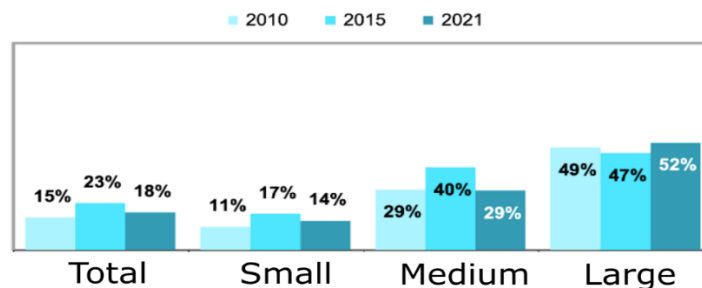


Figure 2. Using CRM systems to manage and use customer information.

Source: Czech Statistical Office (2021)

According to the results of the Gartner survey conducted in 2022, 84 % of respondents stated they use the Salesforce platform, with the majority of them (64 %) saying they use different CRM platforms for back-end master data management functions and customer engagement; when selecting a CRM platform, respondents consider “platform capabilities” as the most important factor (73 %), along with “product strategy and vision” (44 %) as the second most important factor (Gartner, 2022). What CRM systems companies use depends on their area, size, or B2B or B2C orientation. Gartner's research focuses mainly on the B2B market, but as the author states, the research results apply to B2C markets of all sizes. Gartner's latest study on CRM software from 2022 displays using the Magic Quadrant, where the quadrants are described as Challengers, Leaders, Niche Players, and Visionaries. The individual quadrants are defined as follows: Challengers - perform reasonably well or can dominate a large segment but do not have a roadmap that matches Gartner's view of how the market will evolve. Leaders - perform reasonably well today and are well positioned for tomorrow; Niche players - focus relatively successfully on a small segment

or are unfocused and do not innovate or outperform others; and Visionaries - understand where the market is going or have a vision for changing market rules but do not perform well or do so inconsistently. Figure 3 describes Gartner's magic quadrant.



Figure 3. Magic Quadrant
Source: Gartner (2022)

Table 1. Top 5 rated CRM systems by popularity

Position	Name of CRM SW	websites
1.	Salesforce Sales Cloud	https://www.salesforce.com
2.	HubSpot Sales Hub	https://www.hubspot.com/products/sales
3.	Zoho CRM	http://www.zoho.com/crm/
4.	Pipedrive	https://www.pipedrive.com/en/features
5.	Dynamics 365 Sales	https://dynamics.microsoft.com/en-us/sales/overview/

Source: Authors

RQ2: What key functions should a CRM system provide to support business activities and improve customer experience successfully?

Based on the structured interviews with the owner of the company and the head of the consulting and development team of the company selling ERP/CRM and comparing the features offered by the main CRM systems to the companies, the following key features have been identified: contact management, sales management, data analysis, automation, integration, mobile access, personalization, sales performance tracking, customer support, and data security. The most common CRM system features are shown in Figure 4.

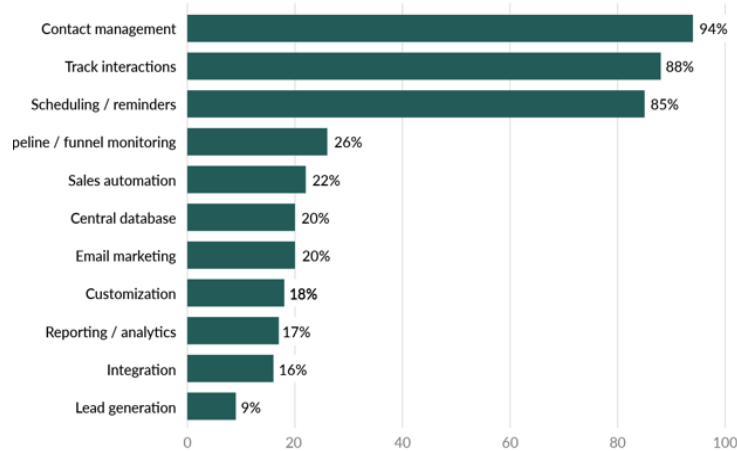


Figure 4. The most used functions of CRM systems

Source: <https://www.softwareadvice.com/resources/crm-trends-2019/>

Other features include task organization, business case management, intra-company (internal) communication, automatic notifications, or synchronization with calendars (e.g., Google Calendar, Outlook, deadline tracking).

RQ3: What is the optimal procedure for implementing and deploying a CRM system?

In the first part of this chapter, the HOS 8 method is proposed, which assesses the current system in eight areas and identifies the levels of each area. The HOS 8 method is followed by a GAP analysis that compares the current state with the expected (desired) state. The GAP analysis is used to implement the CRM system.

Evaluation of the HOS 8 method

The HOS 8 method is evaluated based on a questionnaire the company's CEO completed. The HOS 8 method uses the conversion of nominal values to ordinal values. The interviewee is not familiar with the principle of questionnaire evaluation. The questions for each area and the answers are given in Annex 3 – Questionnaire for the HOS 8 method by area. For each question, only one option can be selected. The individual options are scored as follows: Yes – 5, Somewhat Yes – 4, Partially Yes – 3, Somewhat No – 2, and No -1. The method of evaluation of the HOS 8 method is described in the Data and Methods chapter. For an illustrative example with specific data for calculating values, the first area HW - hardware was chosen. To calculate the value of u_i for each specific area, the formula $u_i = \left\lceil \frac{\sum_{j=1}^{10} u_{ij} - MAX_i - MIN_i}{8} + 0.5 \right\rceil$ is used. In this case, for the first region, $u_i = 4 + 4 + 4 + 3 + 4 + 4 + 1 + 2 + 4 + 5 = 35$, $MAX_i = 5$ and $MIN_i = 1$. After substituting its value to the above formula, the result is $u_{iHW} = \left(\frac{35-5-1}{8} \right) + 0.5$, i.e., 4 after rounding. If the calculation does not produce a whole number, the result will be rounded to a whole number. The following table shows the results for each area and the completed formula for the calculation u_i .

Table 2. Calculation of u_i for different areas of the HOS 8 method

Area	U_i area	Evaluation result
HW	$u_{iHW} = \left(\frac{35 - 5 - 1}{8}\right) + 0.5$	4
SW	$u_{iSW} = \left(\frac{15 - 3 - 1}{8}\right) + 0.5$	2
OW	$u_{iOW} = \left(\frac{28 - 5 - 1}{8}\right) + 0.5$	3
PW	$u_{iPW} = \left(\frac{24 - 4 - 1}{8}\right) + 0.5$	3
DW	$u_{iDW} = \left(\frac{25 - 5 - 1}{8}\right) + 0.5$	3
CU	$u_{iCU} = \left(\frac{25 - 4 - 1}{8}\right) + 0.5$	3
SU	$u_{iSU} = \left(\frac{22 - 4 - 1}{8}\right) + 0.5$	3
MA	$u_{iMA} = \left(\frac{36 - 5 - 2}{8}\right) + 0.5$	4

Source: Authors based on calculation

The above values suggest that the SW area has the lowest rating – 2, i.e., $u_i = 2$ means a low level of the area. The areas OW, PW, DW, CU, and SU have a rating $u_i = 3$, indicating a medium area level. The HW and MA areas have a rating of 4, i.e., high level.

After evaluating the individual areas, it is possible to express a detailed and comprehensive status of the CRM system under study. The detailed state can be expressed by the vector $m = (u_1, u_2 \dots u_8)$, where m describes the system's detailed state, consisting of an eight-membered vector and is denoted by u_1 to u_8 referring to each area. The formula can be broken down into the following form: $m = u_{HW}, u_{SW}, u_{OW}, u_{PW}, u_{DW}, u_{CU}, u_{SU}, u_{MA}$. The aggregate state of the system corresponds to the lowest region. This can be defined using the relation $u = \min(u_1, u_2 \dots u_8)$. Using a verbal expression, the aggregate state can be defined using Table 8. In this case, the aggregate system state corresponds to $u = 2$. The lowest value is in the SW – software domain.

The relevance and balance of the system is also evaluated. The HOS 8 method uses three categories: fully balanced system, balanced system, and unbalanced system. In a fully balanced system, all examined categories are equal. This condition is almost non-existent. An utterly balanced system can be described using the relation $u_i = u$. A balanced relation can be described using the formula $(u_i - u) \leq 1$ and $\sum_{i=1}^8 (u_i - u) \leq 3$. The last category, an unbalanced system, can be described as a system that is not balanced or completely balanced. It is a system where different values of (2,3,4) are obtained for at least three regions. The letter r is used to characterize the balance of a system and takes the following values: $r = 1$ – a completely balanced system, $r = 0$ a balanced system, and $r = -1$ an unbalanced system. In this case, it is an unbalanced system because according to the above formula $(u_i - u) \leq 1$ and $\sum_{i=1}^8 (u_i - u) \leq 3$, the above conditions are not met and it follows that $r = -1$.

Graphical representation of system states

The Data and Methods chapter described the values' graphical representation. The description is the basis for the graph in Figure 4. The graph contains eight semi-axes, each representing one studied area, i.e., HW, SW, OW, PW, DW, CU, SU, and MA. On each semi-axis, five levels (1-5) represent the values that can be taken. The resulting values are marked on the semi-axes and then connected by solid lines to form an octagon. This octagon is labeled with an arrow - Current State. The meaning of the system is represented by a circle with radius 2 corresponding to the importance of the system. The circle is marked in dashed red. The recommended state of the system is an octagon of radius 2 marked in green. The graph shows the values $m = (4, 2, 3, 3, 3, 3, 3, 4)$, $u=2$ and $v=-1$.

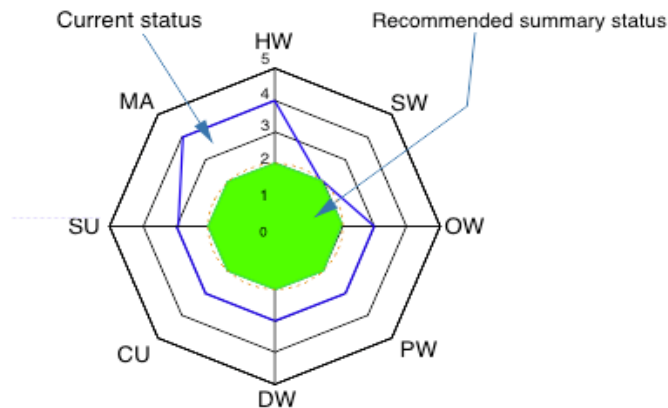


Figure 4. Graphical representation of system states and values

Source: Authors based on calculated values

CRM system implementation

The CRM system will be implemented using the GAP analysis described in the Data and Methods chapter. The GAP analysis aims to compare the current state of the CRM system with the expected state (desired) state, i.e., a system that meets all the requirements for a modern CRM system. The implementation of the new CRM system will be carried out based on an implementation study.

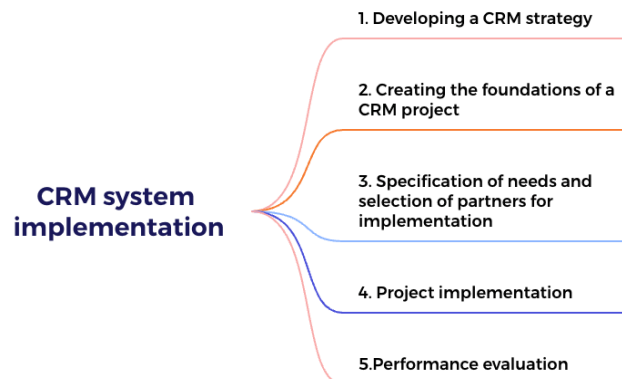


Figure 5. CRM system implementation phase

Source: Authors according to Customer Relationship Management - Concepts and Technologies (2019)

Figure 5 describes the 5 main processes of CRM system implementation (creating a strategy, creating a project foundation, specification of needs and selection of partners, project implementation, and performance evaluation).

Conclusions

The analysis and identification of forms and types of CRM systems used in small and medium-sized enterprises firms was carried out using literary research mainly from online sources, such as Web of Science, Scopus, and other professional publications dealing with CRM systems. After analyzing keywords (CRM Capability, CRM Software, Relationship Management, CRM Systems, Relationship Marketing, CRM Selection, Small and Medium-sized Enterprises (SMEs) related to CRM systems, 15 sources were searched and, on their basis, all forms and types of CRM systems used by trading firms in the SME segment were described. The analysis showed that the main classification of CRM systems is as follows: analytical, operational, and strategic CRM systems. In addition to this classification cited in the literature, new forms of CRM, such as collaborative, social, and mobile CRM, emerged. Using content analysis, it was possible to answer the first research question: Which forms (types) of CRM systems and which CRM systems do trading companies use in the SME segment?

When using CRM systems, it is important to know and understand the main features that a CRM system should contain. Through structured interviews with the business owner and the head of the consulting and development team of the company supplying the ERP/CRM systems, all the key functions of a modern CRM system were identified and confirmed. The key features include contact management, sales management, data analysis, automation, integration, mobile access, personalization, sales performance tracking, customer support, and data security. In addition, the respondents also mentioned modern CRM system trends such as Social CRM or automation of routine tasks and activities. Based on the structured interviews, it was possible to answer the second research question: What key features should a CRM system provide to support business activities and improve customer experience successfully?

After identifying the types of CRM systems and the requirements for each function of the CRM system, the company can decide to implement such a system. The process of implementing a CRM system is divided into two parts: the identification of the current state and the implementation of a new CRM system. The HOS 8 method was chosen to describe the environment and determine the effectiveness of using the given CRM system. The method includes 8 areas, and 10 questions were created for each area. To evaluate the questionnaire, it was necessary to convert the verbal answers into ordinal values to assign a specific value for each of the 8 areas. In the SW – Software domain, a value of 2 was found, which corresponds to a verbal assessment as a low-level domain. Based on other results of the HOS 8 method, it was determined that the current CRM system can be described as inefficient and unbalanced, i.e., using the HOS 8 method, it was identified as ineffective. This was also in line with the responses from the interview with the business owner, who stated that the CRM system no longer meets their requirements. Therefore, it was decided to implement a new CRM system. The implementation of the CRM system was described using a GAP analysis that compared the current state of the CRM system with the expected or desired state. If all the above points of the GAP analysis are followed, the CRM system should provide the company with a modern system that will meet the objectives set for the CRM system. The third research question was addressed and answered based on the case study.

Based on the above, trading firms should benefit from the CRM system to improve two-way communication between the customer and the firm. Firms should be interested in new forms of communication with customers and be able to use new forms to communicate. The research has a limited validity of approximately five years. The online environment in which companies create and use CRM systems is very dynamic. Therefore, companies should also keep their own CRM systems up-to-date, regularly evaluate their functionality and effectiveness, and if necessary, adjust the objectives that the CRM system should address.

Continuous and further research into CRM systems and their implementations should focus on small and medium-sized enterprises, as the use of CRM systems in this category is low compared to other EU countries and can bring benefits, new customers, and ultimately higher profits to these entities.

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MORAL DILEMMA IN DECIDING ON THE AMOUNT OF EXCISE TAX ON TOBACCO PRODUCTS IN THE CZECH REPUBLIC

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Abstract. The goal of the paper is to identify the relationship between the amount of excise tax (ET) on tobacco products in the Czech Republic and the collection of excise tax on tobacco products into the state budget of the Czech Republic between 2013 and 2021. The development of the tax rate and the method of determining the amount of excise tax on tobacco products in the CR is illustrated using the comparison method. The relationship between the revenue for the state budget from tobacco products and the amount of excise tax on tobacco products in the CR is expressed using a regression model. Development trends of illegal tobacco products in the territory of the CR are represented using time series regression. The net revenues from the excise tax on tobacco products are calculated using the difference-in-difference method. The amount of costs incurred by the state associated with smoking is defined based on an in-depth analysis of literary resources on the Web of Science portal, where a calculation based on a percentage share of the GDP is used. The results indicate that the excise tax rates in individual years show a growing trend except for one year where there was no change in the excise tax rate. On the other hand, the results show that an increased excise tax does not automatically result in higher revenue for the state budget. Other factors influence the collection of the excise tax on tobacco products, such as illicit trade in tobacco products. It is possible to use other research methods and data sources to determine the development of illegal trade in tobacco products to calculate the amount of smoking-related costs to the state.

Keywords: Excise tax on tobacco products; Customs Administration of the Czech Republic; illegal tobacco products; Gross Domestic Product; smoking-related costs to the state

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1. Introduction

The harmful effects of cigarettes have been long known and pose a particular threat to people suffering from asthma. Exposure to passive inhalation of tobacco smoke, as well as active smoking, can lead to disease exacerbation, wheezing, cough, and shortness of breath (Bednářová et al. 2023; Nowak, Pawliczak, 2021). Tobacco products contain thousands of chemicals, including additives and toxic ones. It is believed that more than 1,200 chemicals are identified in tobacco products with mutagenic potential, with 900 potential mutagens being contained in tobacco smoke (Goel, Valerio, 2020). Cigarette butts are the most common form of litter in the world, and their impact on

the environment is related to both persistence and potential toxic effects on chemical composition (Caridi et al., 2020).

Cross-sectional, longitudinal, and experimental studies have identified a relationship between the exposure of young people to cigarette marketing and their initiation of smoking (Illésová et al. 2023; Dobrovolná et al. 2022). These research findings have led to the regulation of cigarette marketing targeted at young people, including bans on radio or TV commercials, bans on cartoons, transit or billboard advertisements, and bans on sponsoring sporting events or concerts by tobacco brands (Biglau, Van Ryzin, Westling, 2019). According to the EU's Tobacco Products Directive (2014/40/EU/TPD), manufacturers and importers of tobacco products are obliged to report information on products intended to be placed on the market to the European Commission and Member States (Carnicer-Pont et al., 2022). Tobacco products show rapid development. Since 2005, when the WHO Framework Convention on Tobacco Control (WHO FCTC) came into force, the parties to this convention have focused on tobacco use control. Moreover, the social norm of smoking has changed as well (Lee, Kim, 2020). These changes have prompted the tobacco industry to change their products and business model.

Based on a KPMG study in 2021, it was concluded that in countries with a high excise tax on cigarettes, there is an increase in the consumption of illegal tobacco products instead of a decrease in the number of smokers. Given the rising prices of staple products, there is a high risk that lower-income smokers will turn to illegal products (Echo24.cz, 2022). The illicit tobacco market is a significant socioeconomic and criminal-fiscal problem every modern state and its institutions need to deal with. High taxes, duties, and excise taxes that affect the price of legal tobacco and tobacco products are the main motivations for consumers to purchase illegal and cheaper tobacco products and tobacco (Kojic, Orlovic, 2016). Taxes effectively curb tobacco consumption (Freitas–Lemos, Keith, Tegge et al., 2021). Tobacco tax avoidance and evasion undermine the effectiveness of tobacco tax policies, which leads to lower prices and increased tobacco consumption (Papadaki et al., 2022; McDonell, McCansland et al., 2021). Tobacco tax evasion undermines the goal of tobacco taxes as a measure of tobacco consumption control concerning lower affordability of tobacco products increased health risks for smokers, and reduced government revenue (Vladislavjevic, Zubovic, Jovanovic, et al., 2022). Koch (2018) argues that tobacco taxes reduce tobacco consumption and are regressive.

The policy of tobacco control can thus have a preserve effect and harm the poor. However, if tobacco consumption decreases faster amongst the poor rather than the rich, the policy of tobacco control can have a progressive effect. Nargis, Hussain et al. (2020) state that the effectiveness of increasing taxes in reducing tobacco consumption depends on the extent to which the industry passes the tax on the consumers. Evidence suggests that the tobacco industry can absorb or increase prices more than a tax increase depending on the price segment of tobacco products. Based on the conducted study, Maldonado, Llorente et al. (2022) argue that tobacco tax increases reduce the number of smokers and intensity of smoking, which results in a decline in the number of cigarettes smoked. This decline is expected to decrease premature mortality, costs of health care, and poverty, improve health, increase income, and strengthen gender equality and mobilization of domestic resources for people who have to face catastrophic health care costs as well as in the case of illegal tobacco products (Soltes, Gavurova, 2015; Gavurova, Megyesiova, 2022). Tobacco taxes are an effective public health intervention and a powerful tool for advancing the 2030 Agenda for Sustainable Development. One of the most significant barriers to tax reform and increased tax rates is the threat of illicit trade promoted by the tobacco industry. The tobacco industry argues that higher taxes will encourage smuggling, undermining tax policy objectives and disrupting domestic tobacco production (Nguyen, 2020). Multinational tobacco companies intensively promote their argument that standardized tobacco packaging will increase illicit tobacco trade (Evans-Reeves, Hatchard et al., 2020).

The goal of the paper is to identify the relationship between determining the amount of the excise tax on tobacco products (cigarettes, cigars/cigarillos, and smoking tobacco) in the Czech Republic between 2013 – 2021 and the

collection of the excise tax on tobacco products (cigarettes, cigars/cigarillos, smoking tobacco) into the state budget of the CR in the period 2013-2021.

An appropriate increase in taxes and tobacco prices is an essential component of complex tobacco control strategies (Golestan, Kalan, Ben Taleb, et al., 2021). This leads to the formulation of research questions 1, 2, and 3 presented below:

RQ1: What was the development of the tax rate and the method of setting excise tax on tobacco products in the CR between 2013 and 2021?

RQ2: What is the relationship between the volume of excise tax collected on tobacco products in the CR and the tax rate in the period 2013-2021?

RQ3: What is the trend of illegal tobacco products in the CR between 2013 and 2021?

An increase in the excise tax on cigarettes can help some people stop smoking, but some can avoid the higher tax by buying cigarettes in another country (Bishop, 2018). Lower affordability of legal products, accessibility of cheaper cigarettes, higher national income inequality, higher population density, and the number of illegal cigarettes in neighboring regions are associated with higher illegal consumption (Aziani, Calderoni, Dugato, 2021). This leads to the formulation of research question 4 below:

RQ4: What is the net tax revenue from the excise tax on tobacco products in the CR?

2. Literature Review

Unlike a value-added tax, excise tax is limited to excisable goods. The list of excisable goods is compiled and taxed on, or, in the case of resale, using tax deductions, which meets the requirements of indirect taxation (Mamrukova, Bloshkina, 2020). Increasing the price of tobacco products via higher taxation is considered the most efficient tool to control tobacco consumption and its negative externalities (Putri, Murwendah, 2019). Increasing tobacco taxes is one of the most cost-effective interventions in the area of public health; however, many opponents often mention regressivity as an argument against tobacco taxation (Postolovska et al., 2018). Linegar, Van Walbeek (2018) state that the effectiveness of excise tax increases to reduce tobacco consumption largely depends on how the increased tax influences the retail price. The degree of excise tax pass-through and the effect of a discretionary increase in cigarette prices are largely determined by the competition in the cigarette market. According to Adenijj (2019), tobacco consumption remains a global threat to the population and public health. Increasing tobacco taxation is an efficient tool for its control. However, only 13 % of the global population lives in countries that impose adequate taxation on tobacco (Felsing, Groman, 2022). Olesinski, Rozkrut, Toroj (2020) state that the differences between the actual and optimal tax policy in the case of tobacco products were marginal in the Polish market in the period 2014-2018. Valek (2019) states that excise taxes on tobacco products are highly harmonized in the EU, as there are the same types of products, regimes in intra-communitarian trading, and the same bans are applied in terms of selling these products to minors, advertising in media, or sponsorship.

Tax bases for excise tax on cigarettes are interrelated; any modification thus influences the collection of other taxes (Gonzalez-Rozada, 2020). Excessive consumption of tobacco products contributes to higher costs of health care and reduction of productivity. In the past, tobacco product taxation was motivated by generating revenue. Governments are increasingly using taxation to reduce unhealthy consumption of tobacco products (Chaloupka, Powell, Warner, 2019). Tobacco product consumption is associated with adverse health effects on consumers, often leading to premature deaths, which, in turn, impose additional costs and reduce a country's productivity (Valek,

2019; Gavurova et al. 2021b). Although excise tax is primarily levied on products that negatively affect our health and environment, the tax burden must be increased with caution by governments. For most of these products, it is impossible to find suitable substitutes, which makes the elasticity of demand very low (Hajdikova, Janak, Oberreiterova, 2019). Kukalova et al. (2018) state that excise tax is an important source of revenue for state budgets globally, and excise tax revenues from tobacco products do not reach the level of costs of health care for tobacco-related diseases for most of the analyzed period; this gap grows with the length of consumption, which can be interpreted e.g. as current excise tax revenues potentially implying public health expenditures that cumulatively exceed the revenues from relevant excise taxes. David (2018) also argues that the average tax rate imposed on tobacco products in the EU is insufficient compared to the social costs of smoking, as confirmed by previous research. Zhang and Zheng (2020) conclude that an increase in the excise tax on cigarettes hurt the likelihood of regular alcohol consumption among smokers, and the excise tax on cigarettes thus reduced smokers' average daily consumption of cigarettes.

Gibson and Kim (2019) argue that higher taxes shift demand to lower-quality tobacco products. The existence of an illicit tobacco market negatively affects public health and revenues from cigarette taxes by making cheaper, untaxed cigarettes more available (Gavurova et al. 2021a; Lavares et al., 2021). The illicit tobacco trade undermines the effectiveness of tax increases as a measure to control public health and a fiscal measure by introducing cheaper alternatives to full-priced legal cigarettes (Rigelsky et al., 2020; Vallios, van Walbeek, Ross, 2020). Cigarette packs are considered illegal if there is evidence that the tax has not been paid. This is inferred from the absence of an excise stamp (glue residue) (Ross et al., 2020). Smoking is considered a cause of one in five deaths worldwide. Therefore, governments try to reduce the number of active smokers by increasing taxes on tobacco products, which increases the consumption of illegal cigarettes, which are often seized and analyzed by police forces (Jurisch, de Paula, Augusti, 2020). According to Schafferer et al. (2018), illicit trade with cigarettes increases both the demand and affordability of tobacco products. Verguet, Kearns, Rees (2021) challenge the doctrine that in terms of standard accounting revenue share, tobacco taxes are uniformly regressive and point to the importance of the specific features of tax policy for shaping a progressive approach to tobacco taxes. In addition, the authors state that the threat of tax evasion and avoidance is the most frequently mentioned argument against increasing tax on tobacco products. The tobacco industry commonly overestimates the size of the illicit market to reinforce the idea of its direct relationship to the efforts of increasing taxes by the Internal Revenue Administration (Szklo, Iglesias, 2020). Sheikh, Branston, Gilmore (2021) concluded that although there is limited evidence to fully ascertain the response of the tobacco industry to the excise tax increase, the tobacco industry widely uses many sophisticated pricing strategies across various environments in the world to undermine the tax policy, hereby increasing tobacco consumption and maximizing their profits. The main pricing strategies include differentially shifting taxes between products, the introduction of new brands or products as ways for downtrading, product promotion and different prices of the same products for different customers, smoothing of prices, and changes in product attributes such as length or size of cigarettes or production processes. Balwicki et al. (2020) mention that farmers and intermediaries can only trade tobacco products if registered with the government. Farmers are obliged to report the size of their fields and the weight of the crop to the government authorities; any purchase within the supply chain is reported by a seller and a buyer for cross-validation to prevent manipulation within the system. Spivak, Givel, Monnat (2018) conclude that smokers consider their pocketbooks but both current and former smokers are ideologically motivated to oppose health initiatives; therefore, public health policymakers should emphasize the importance of public education and social norms in gaining support for tobacco control policies. Illegal cigarettes cause governments a significant revenue loss (Kasri et al., 2021). Moldonado et al. (2020) state that illegal cigarettes account for 3.5 % of overall cigarette consumption in five Colombian towns, which is a much lower estimate than the data provided by the industry. Aziani, Calderoni, Dugato (2021) believe that both price and non-price factors influence the consumption of illegal cigarettes. There is no empirical evidence on the role of two usual factors that are believed to have a significant impact, specifically corruption, and the shadow economy. Both supply and demand shape the illicit cigarette market. Priege, Kulick (2018) state that there are differences in the estimates of the global illicit tobacco trade scale, but in general, estimates in the order of USD 40 billion in annual tax losses are cited. The illicit trade

in tobacco products accounts for approx. 10 % of the global retail market, with shares varying widely across countries.

The main input resources for comparing the development of the excise tax on tobacco products, the amount of collected excise tax from tobacco products, the volume of illegal tobacco products, and revenues from the tobacco product excise tax in the CR are data obtained from relevant official resources, especially data provided by the Ministry of Health of the Czech Republic, the Institute of Health, the Customs Administration of the Czech Republic, the Ministry of Finance of the Czech Republic, and the Czech Statistical Office (Kukalova et al., 2021). Linegar, Van Walbeek (2018) used data on excise tax on tobacco products from the Ministry of Finance and disaggregated data on cigarette prices used to calculate the consumer price index provided by the Czech Statistical Office. Olesinski, Rozkrut, Toroj (2020) used data on retail sales volumes and weighted average retail prices of cigarettes in two market segments: low-price (LOW) and high-price (HIGH) segments defined based on information obtained from BAT on the price position of each brand. Another source of retail price data is Nielsen. The Euromonitor International Passport database was a source of data on legal and total cigarette use and legal cigarette prices in the monitored period. World Bank data (the Atlas method) were used for the calculation of gross national income (GNI) per capita for each country (Schafferer et al., 2018). Data on cigarette consumption (i.e., smoking prevalence and average daily consumption of cigarettes) were obtained from published reports of the Ministry of Health (e.g., Basic Health Surveys and the Global Adult Tobacco Survey) and statistics (e.g., the National Socioeconomic Survey). Data on cigarette production (i.e., orders of cigarette industry stamps) were obtained from the Ministry of Finance (Office of Fiscal Policy). The assumption is that the market absorbed all cigarettes in the year of their production. Data on population estimates were based on population estimates provided by the Bureau of Statistics (Kasri et al., 2021).

The statistical methods for hypothesis testing were the most suitable methods for assessing the importance of tax rates. The main tool was the Gretl software (Kukalova et al., 2018). According to Dunbar, Nicosia, Kilmar (2021), logistic and Poisson regression analysis show the cross-sectional associations between the excise tax on cigarettes and smoking behaviors, specifically current cigarette smoking, smoking frequency, the intensity of consumption, and cigarette cessation among individuals smoking at the current installation. Olesinski, Rozkrut, Toroj (2020) developed a methodological framework for estimating time-varying elasticities of demand in a state model estimated using a maximum likelihood based on the Kalman filter. Schafferer et al. (2018) used panel data for legal and illegal cigarette consumption and fixed-effect regression models for different income groups. Kasri et al. (2021) estimate the illicit cigarette trade in terms of its volume and revenue loss. Illicit trade was estimated as a difference between legal cigarette sales and domestic consumption recorded by national representative surveys.

3. Methodological approach

3.1. Data

The source of the data is the information published by the Customs Administration of the Czech Republic, specifically the Overview of excise tax rates for tobacco products according to the Act No. 353 / 2003 Coll. (effective from 1 January 2004), Determination of the weighted average price of cigarettes for the years 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, the Calculation of the amount of excise tax on tobacco products, as well as data published by the Ministry of Finance of the Czech Republic in the Report on the activities of the Financial Administration of the Czech Republic, and the Customs Administration of the Czech Republic for the years 2017 and 2021, Tax and Customs Revenue as of 31 December 2021. Other sources of information include data published by the Ministry of Health of the Czech Republic, data published by the World Health Organization (WHO), data published by the Zdravotnický deník and Sociální politika. Another data source is data published by the Czech Statistical Office, specifically data on gross domestic product (GDP) for the years 2013-2021 from the main macroeconomic indicators. Other data sources include data published in a study by the Consultancy KPMG, which

estimates the extent and the development of the illicit cigarette market in the EU. This report was prepared for the multinational tobacco manufacturer, Philip Morris International. The input data are also obtained from available literary resources on the Web of Science, with the selection parameter being the last five years, i.e., the years 2018, 2019, 2020, 2021, and 2022.

3.2. Methods

The calculation of the excise duty on tobacco products: the amount of tax on cigarettes while using a fixed amount and a percentage share of the tax rate is calculated as a sum of the following items:

The product of the percentage share of the tax rate and the price for the final consumer of these cigarettes divided by 100, and The product of the fixed amount of the tax rate and the number of pieces. The tax base for the percentage share is the price for the final consumer, while the base for the fixed amount is the quantity given in pieces. A tobacco string of up to 80 mm is considered 1 cigarette. A tobacco string longer than 80 mm but shorter than 110 mm is considered 2 cigarettes. A tobacco string longer than 110 mm but shorter than 140 mm is considered 3 cigarettes. Each additional 30 mm of tobacco string (even a part of it) is considered another cigarette. If the amount of tax on cigarettes calculated using the fixed and percentage share of the tax rate is lower than the amount of tax calculated using the minimum tax rate, the amount of tax calculated using the minimum tax rate shall be used. The amount of tax on cigars, cigarillos, and smoking tobacco is calculated as a product of the tax base and the fixed tax rate, where the weight of smoking tobacco at the time of the tax is due and payable is decisive for calculating the tax on smoking tobacco. The tax base for cigars and cigarillos is the quantity expressed in pieces; in the case of smoking tobacco, it is the quantity expressed in kilograms (Celní správa ČR, 2022).

The development of the tax rate and the method for setting the excise tax on tobacco products in the CR between 2013 and 2021 is described using the method of difference. Data provided by the Customs Authority of the CR are used to compile tables in Microsoft Excel, which represent the amount of excise tax rate for a given year, consisting of the tax rate – fixed amount, tax rate – percentage share, and the minimum tax rate. If the sum of the fixed amount of the tax rate and the percentage share is lower than the minimum tax rate, the tax rate at the amount of the minimum tax is used. A grouped bar chart in Microsoft Excel is used to describe the development of the minimum excise tax on cigarettes, cigars, cigarillos, smoking tobacco, and heated tobacco products for individual years in the period 2013-2021. These methods are used to answer the first research question. To describe the relationship between the state budget revenues from the excise tax on tobacco products and the amount of the excise tax on tobacco products in the CR between 2013 and 2021 in terms of the linear dependence of the two variables, the regression model is used, which examines the effect of the amount of the excise tax on the state budget revenue from the excise tax on tobacco products in the CR in the monitored period 2013-2021. The amount of excise tax collected and the excise tax rate in individual years are tabulated in Microsoft Excel.

Regression analysis was used to examine the relationship between two variables – the so-called independent (explanatory) variable (the amount of excise tax on cigarettes) and the dependent (response) variable (the amount of the collected excise tax on tobacco products) with the help of statistical function Regression in Microsoft Excel. Using regression, the following values can be obtained: Multiple R (correlation coefficient R), R Square (coefficient of determination R^2), Adjusted R Squared (the value of reliability, adjusted coefficient of determination R^2), Observations (the number of observations), p-value, and other values. To be applicable in practice, regression analysis needs to meet the requirements of serial independence, data normality, and homoskedasticity. The assumption of data normality is verified using the Shapiro-Wilk test of data normality. The null hypothesis is not rejected if the p-value is greater than the level of significance α . To verify the assumption of serial independence, the Durbin-Watson test was used. The null hypothesis is not rejected if the p-value is greater than the level of significance α . These assumptions are verified using the statistical program R.

The equation of the regression line in the graph is expressed using a dot chart in Microsoft Excel. The basis of the simple linear regression is an equation in the following form: $y = b_0 + b_1 \cdot x$, where y is a dependent (response) variable, which is, in this case, the amount of the collected excise tax on tobacco products, and x is an independent (explanatory) variable, i.e., the amount of the excise tax rate on cigarettes, b_0 is a constant, b_1 indicates how the amount of excise tax on cigarettes affects the excise tax revenue from tobacco products in the state budget of the CR. The regression equation supplemented by values shows how much CZK on average the excise tax revenue from tobacco products will increase by increasing the excise tax on a 20-cigarette pack by CZK 1. The graph also presents a linear trend line.

The correlation analysis is used to illustrate the relationship between individual variables, i.e., how the amount of the excise tax on tobacco products changes with the change in the amount of the excise tax on cigarettes. The correlation analysis is performed using the statistical correlation function (CORREL) in Microsoft Excel. Based on the calculated correlation coefficient, it was possible to determine the relationship between the collected excise tax on tobacco products and the amount of the excise tax on cigarettes. The correlation coefficient takes the values between -1 and +1. These steps will lead to answering research question 2.

The development trend of illegal tobacco products in the CR between 2013 and 2021 is illustrated using time series regression. Data on the number of illegal tobacco products in the CR within the monitored period are obtained from the KPMG consultancy study conducted for the multinational tobacco producer Philip Morris International. The methodology used to estimate the size of the illicit cigarette market in the context of previous annual studies and the reports of Project Stella was used consistently in this study, with the underlying data sources remaining the same. The methodology is based on the combination of hard data, such as the sales of legal cigarettes in the EU, publicly available data, such as smoking prevalence and average prices of cigarettes, and surveys on empty packs ordered by many tobacco producers, which are conducted by independent market research agencies. It should be noted that external factors, such as the COVID-19 pandemic, influenced the results for the years 2020 and 2021. Using Microsoft Excel, the data obtained are shown in a dot plot, and a trend line is created. The X-axis shows the time (period), while the Y-axis shows the quantity of illegal tobacco products in the CR (in billions of cigarettes). These methods are used to answer research question 3.

The difference-in-difference method is used to calculate the net revenues from the excise tax on tobacco products in the CR. From the collected excise tax on tobacco products for each year in the reference period 2013 - 2021, the costs incurred by the state about smoking for each year of the monitored period were deducted. From an economic perspective, if the difference between the collected excise tax and the costs incurred by smoking was positive, smoking would be economically advantageous for the state. In contrast, if the difference between the collected revenue and the costs incurred from smoking was negative, it would mean that smoking is economically disadvantageous for the state. Given the fact that smokers do not die instantly from smoking but represent a gradual burden of costs for the health system and their life expectancy varies, it is very difficult to calculate the exact costs of smoking. For this reason, in-depth research of scholarly papers dealing with the costs incurred by the state about smoking is available on the Web of Science. Suitable data sources were searched using the following keywords: costs of smoking, and costs of the state with smoking. In addition, a time filter of the date of the publication of scholarly papers was set for the last five years, i.e., for the period 2018 – 2022. Subsequently, an analysis of papers related to the costs of smoking was conducted using other available resources: the World Health Organization, the Government of the Czech Republic, the Ministry of Health of the Czech Republic, Nemocnice Strakonice, a.s., Zdravotnický deník, Tobacconomics. Based on the content analysis, a suitable procedure for calculating smoking-related costs was selected. The data were tabulated using Microsoft Excel, while the net tax revenue/cost for each year was presented in a Microsoft Excel chart. These methods were used to answer research question 4.

4. Results and Discussion

The application part includes the introduction, evaluation of the data obtained, and answering the research questions.

RQ1 Method of setting the excise tax on tobacco products in the CR between 2013 and 2021

The calculation of the excise tax on tobacco products in the CR differs according to the type of the product. The amount of the excise tax on individual tobacco products each year is defined by the Customs Administration of the Czech Republic in the document Tobacco Products – Overview of the excise tax rates for tobacco products under Act No. 353/2003 Coll. (effective since 1 January 2004).

Based on the Overview of the excise tax rates for tobacco products by Act No. 353 / 2003 Coll. (effective since 1 January 2004) published by the Customs Administration of the CR, an overview of the excise tax rates for tobacco products in the CR between 2013 and 2021. The excise tax on cigarettes consists of a fixed amount, a percentage share, and the minimum tax rate. If the sum of the fixed amount and the percentage share is lower than the minimum tax rate, the minimum tax rate applies.

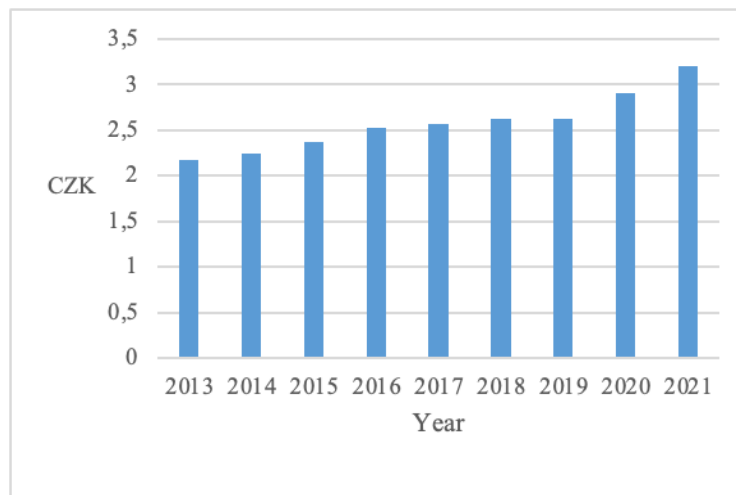


Figure 1. The amount of the minimum excise tax rate on cigarettes in 2013-2021 (CZK/1 piece)

Source: Authors based on data from the Customs Administration of the CR

In Figure 1, there is a clear upward trend of the amount of the minimum excise tax on cigarettes in the monitored period 2013-2021 except the year 2019, where there was no change in the minimum excise tax rate on cigarettes.

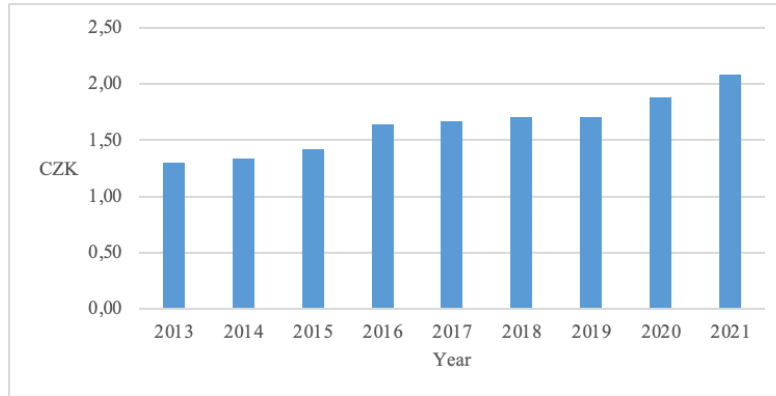


Figure 2. The excise tax rate on cigars and cigarillos in the years 2013-2021 (CZK/1 piece)

Source: Authors based the data from the Customs Administration of the CR

Figure 2 shows a clear upward trend of the fixed amount of the excise tax on cigars and cigarillos in the monitored period 2013-2021. The year 2019 is an exception, as there was no change in the fixed amount of the excise tax rate on cigars and cigarillos.

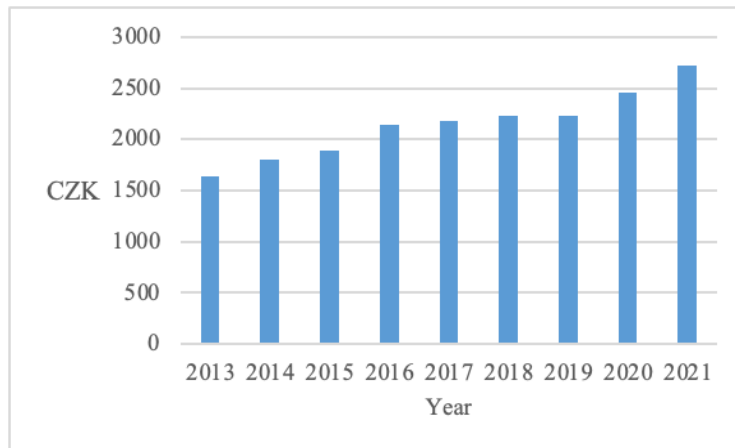


Figure 3. The excise tax rate on smoking tobacco in the years 2013-2021 (CZK/1 kg)

Source: Authors based on the data from the Customs Administration of the CR

Figure 3, there can be seen an upward trend of the excise tax rate on smoking tobacco in the monitored years 2013-2021, except the year 2019, when no change in the excise tax rate on smoking tobacco was recorded.

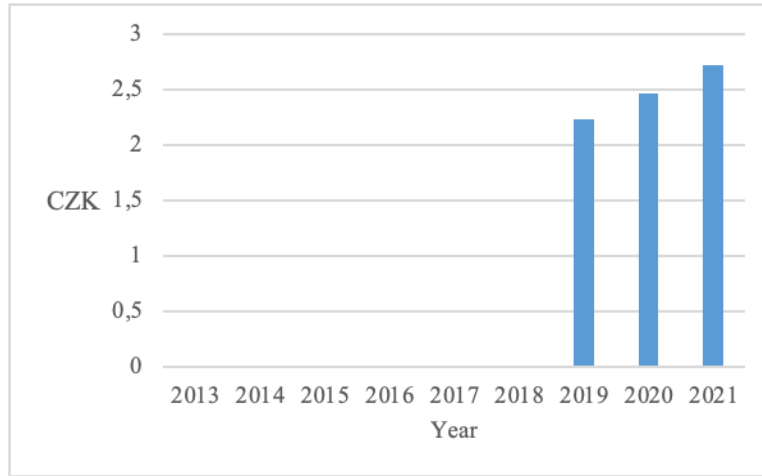


Figure 4. The excise tax rate on heated tobacco products in the years 2013-2021
Source: Authors based on the data from the Customs Administration of the CR

Figure 4 shows an upward trend in the excise tax rate on heated tobacco products in the monitored period. Heated tobacco products are currently the last type of tobacco products on which the excise tax was imposed on 1 April 2019. The fixed amount of the tax on heated tobacco products shows a continuous year-on-year growth.

RQ2 Relationship between the amount of the collected excise tax on tobacco products and the amount of the excise tax rate on tobacco products in the CR in the years 2013-2021.

Table 1. Excise tax rate applied to a 20-cigarette pack.

Excise duty rates on cigarettes in the year	Tax rate fixed part (CZK/1 cigarette)	Tax rate percentage (%)	Minimum tax rate (but at least CZK/1 cigarette in total)	Weighted price average for cigarettes (packs of 20 cigarettes)	Tax rate fixed part + percentage (pack of 20 cigarettes)	Minimum tax rate per 20 pack of cigarettes	The tax rate applied to 20 packs of cigarettes	Excise duty collected on tobacco products (CZK billion)
2013	1.16	27	2.18	69.71	42.02	43.60	43.60	46.8
2014	1.19	27	2.25	73.74	43.71	45.00	45.00	44.7
2015	1.29	27	2.37	76.48	46.45	47.40	47.40	50.9
2016	1.39	27	2.52	80.14	49.44	50.40	50.40	54.4
2017	1.42	27	2.57	83.96	51.07	51.40	51.40	56.2
2018	1.46	27	2.63	86.00	52.42	52.60	52.60	58.8
2019	1.46	27	2.63	89.72	53.42	52.60	53.42	55.9
2020	1.61	30	2.90	91.12	59.54	58.00	59.54	59.5
2021	1.79	30	3.20	102.38	66.51	64.00	66.51	56.2

Source: Authors based on the data from the Customs Administration of the CR and the Ministry of Finance of the CR

The time series presented in Table 1 indicates that except for three years, the minimum tax rate is applied. The exception concerns the years 2019, 2020, and 2021.

Due to the possible application of regression analysis in practice, the assumption of serial independence, data normality, and heteroskedasticity are verified using the statistical program R. The assumption of data normality is

verified using the Shapiro-Wilk test of data normality. The resulting p-value is 0.3816 (38.16 %). $0.3816 > 0.05$, i.e., the p-value is greater than the level of significance α . In this case, the significance level is set at 5 %. The assumption of data normality is thus confirmed, the null hypothesis is thus not rejected. The verification of the data normality is carried out using the statistical software program R. Breusch-Pagan test is used to verify the assumption of homoskedasticity. The resulting p-value is 0.6467 (64.67 %). $0.6467 > 0.05$, i.e., the p-value is greater than the level of significance α . In this case, the significance level is set at 5 %. The assumption of homoskedasticity is confirmed; the null hypothesis is thus not rejected. The assumption of serial independence is verified using the Durbin-Watson test. The resulting p-value is 0.02717 (2.717 %). $0.02717 > 0.01$, i.e., the p-value is greater than the significance level α . In this case, the significance level is set at 1%. The assumption of serial independence is thus confirmed, and the null hypothesis is not rejected. Based on the above data, when the null hypotheses are not rejected, it can be stated that all the assumptions for regression analysis are met.

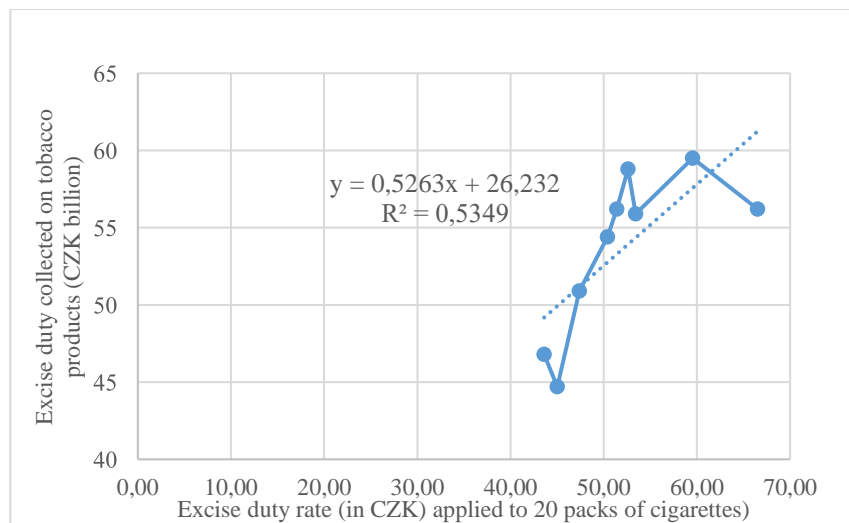


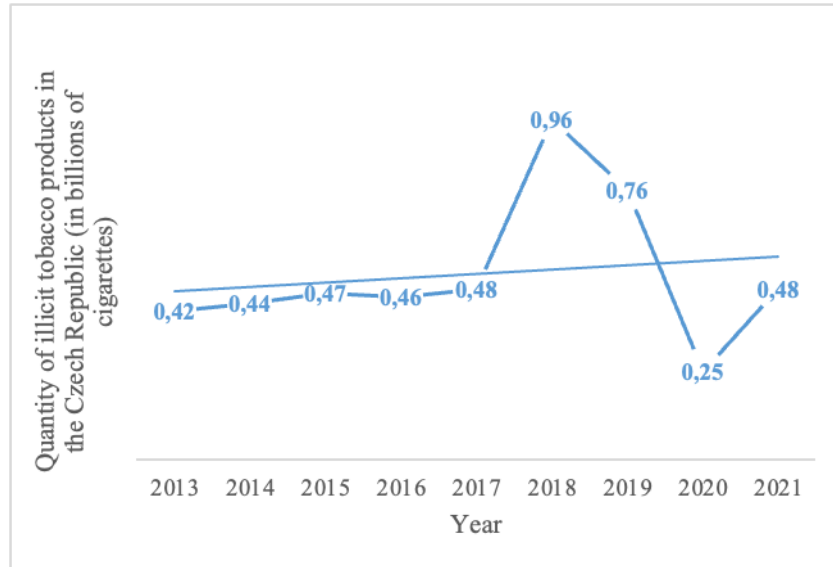
Figure 5. The relationship between the amount of the collected excise tax and the excise tax rate in the years 2013-2021 in the CR

Source: Authors based on data from the Customs Administration of the CR and the Ministry of Finance of the CR

The equation of the regression line is as follows: $y = 0.5263x + 26.232$. Y is a dependent (response) variable, which is the amount of the collected excise tax on tobacco products; x is an independent (explanatory) variable, i.e., the excise tax rate on cigarettes. 26.232 is a constant, and $0.5263x$ indicates how the amount of the excise tax on cigarettes influences the revenue from the excise tax on tobacco products to the state budget of the CR. The regression equation supplemented with values shows how much the revenue from the excise tax on tobacco products will increase on average if the excise tax on a 20-cigarette pack is increased by CZK 1. The graph also shows the linear trend line and the R^2 value.

RQ3 Development trend of illegal tobacco products in the CR in the years 2013-2021

Figure 6. Quantity of illegal tobacco products in the CR in the years 2013-2021



Source: Authors based on KPMG data

As seen in Figure 6, the highest volume of illegal tobacco products in the CR was recorded in the year 2018. Here, it should be noted that the results for the years 2020 and 2021 are influenced by the COVID-19 pandemic.

RQ 4 Net revenue from excise tax on tobacco products in the years 2013-2021

The net tax revenues from the excise tax on tobacco products in the CR were calculated using the difference-in-difference method. The incurred costs were deducted from the amount of the collected excise tax on tobacco products in the CR for each year in the reference period 2013-2021. Given the fact that smokers do not die instantly from the effects of smoking, they represent a burden for the health system and their life expectancy varies, it is very difficult to calculate the exact costs associated with smoking. For this reason, in-depth literary research of available scholarly papers dealing with costs incurred by the state about smoking on the Web of Science was carried out. Suitable data sources were searched using the following keywords: costs of smoking, and costs of the state with smoking. The time filter for the date of the scholarly papers' publication was set to the last five years, i.e., the period 2018-2022. In addition, an analysis of papers related to the costs of smoking was conducted using other available web sources: the World Health Organization, the Government of the Czech Republic, the Ministry of Health of the CR, Nemocnice Strakonice, a.s., Zdravotnický deník, Tobacconomics.

Tobacco tax is the most cost-effective measure to reduce tobacco consumption and costs of health care, especially among young people and low-income groups of people, as well as to increase the state income in many countries. Tax increases must be high enough to push prices above revenue growth. Rising tobacco prices by 10 % reduces its consumption by about 4 % in high-income countries and by about 5 % in low- and middle-income countries (Tobacco, Key Facts, WHO, 2022).

Based on the results of the content analysis, a method for the calculation of the costs of smoking was selected. For this reason, to calculate the costs of smoking in the CR, the highest and the lowest % value of the GDP stated in research and the % value of GDP for the CR. The lowest cost of smoking cited in the literature was 0.65 % of the

GDP (Komonpaisarn, 2021), while the highest cost represented 3 % of the GDP (Ministerstvo zdravotnictví ČR, 2021). 2 % of the GDP was cited for the CR (Schillerová et al., 2019).

Table 2. Costs of smoking in the CR calculated based on the GDP.

Year	Excise duty collected on tobacco products in the year (CZK billion)	GDP in the Czech Republic in CZK billion	Smoking-related expenditure in the Czech Republic, calculation 0.65% of Czech GDP (CZK billion)	Smoking-related expenditure in the Czech Republic, calculated as 3% of Czech GDP (CZK billion)	Smoking-related expenditure in the Czech Republic, calculated as 2% of Czech GDP (CZK billion)	Difference between excise duty collected on tobacco products and smoking-related expenditure of 0.65% of Czech GDP (CZK billion)	Difference between excise duty collected on tobacco products and smoking-related expenditure of 3% of Czech GDP (CZK billion)	Difference between excise duty collected on tobacco products and smoking-related expenditure of 2% of Czech GDP (CZK billion)
2013	46.8	4142.8	26.9	124.3	82.9	19.9	-77.5	-36.1
2014	44.7	4345.8	28.2	130.4	86.9	16.5	-85.7	-42.2
2015	50.9	4625.4	30.1	138.8	92.5	20.8	-87.9	-41.6
2016	54.4	4796.9	31.2	143.9	95.9	23.2	-89.5	-41.5
2017	56.2	5110.7	33.2	153.3	102.2	23.0	-97.1	-46.0
2018	58.8	5410.8	35.2	162.3	108.2	23.6	-103.5	-49.4
2019	55.9	5791.5	37.6	173.7	115.8	18.3	-117.8	-59.9
2020	59.5	5709.1	37.1	171.3	114.2	22.4	-111.8	-54.7
2021	56.2	6108.4	39.7	183.3	122.2	16.5	-127.1	-66.0

Source: Authors

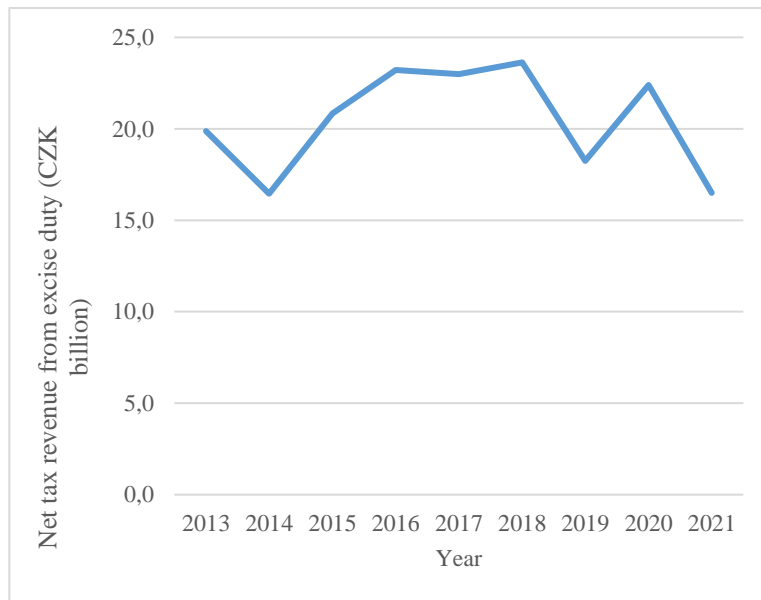


Figure 7. Difference between the collected excise tax on tobacco products and costs of smoking of 0.65 % of GDP in the CR (in CZK billion)

Source: Authors based on the calculated data

As seen in Figure 7, when calculating the costs of smoking of 0.65 % of the GDP in the CR, the difference between the amount of the collected excise tax on tobacco products and the costs of smoking takes positive values, which means that the state budget of the CR received a higher amount than it incurred to cover costs of smoking.

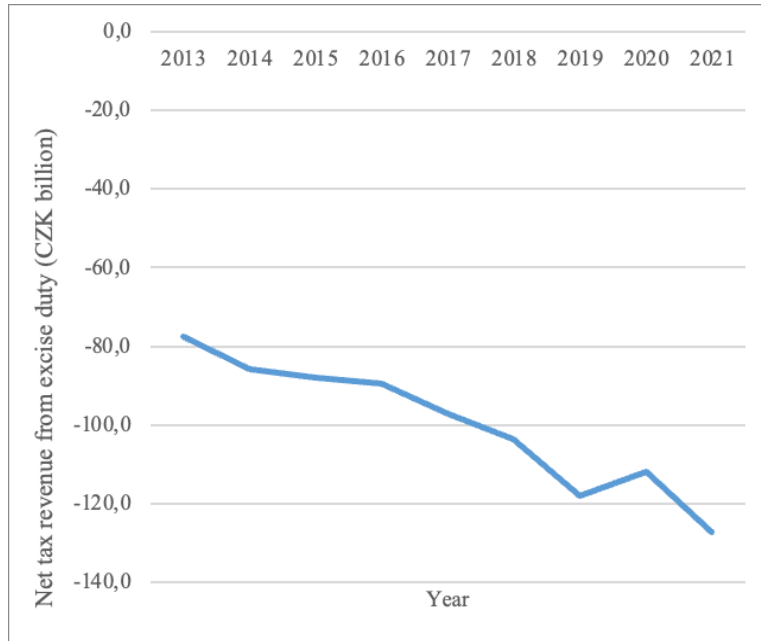


Figure 8. Difference between the collected excise tax on tobacco products and costs of smoking of 3 % of the GDP in the CR (in CZK billion)

Source: Authors

Based on Figure 8, it can be stated that when calculating the costs of smoking of 3% share of the GDP in the CR, the difference between the amount of the collected excise tax on tobacco products and the costs of smoking takes negative values, which means that the amount the state budget of the CR receives is lower than the amount of the collected excise tax from tobacco products.

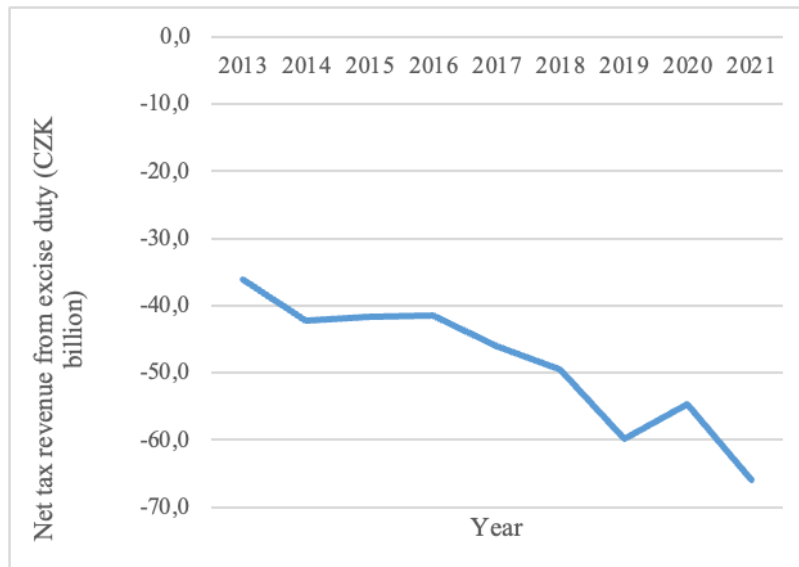


Figure 9. Difference between the collected excise tax on tobacco products and costs of smoking of 2% share of GDP in the CR (in CZK billion)

Source: Authors

As seen in Figure 9, when calculating the costs of smoking of 2% share of the GDP in the CR, the difference between the amount of the collected excise tax on tobacco products and the costs of smoking achieves negative values, which means that the state budget of the CR receives a lower amount than the amount of the collected excise tax on tobacco products.

5. Conclusions

The objective of the paper was to identify the relationship between the amount of the excise tax on tobacco products (cigarettes, cigars/cigarillos, and smoking tobacco) in the CR in the period 2013–2021 and the collected excise tax on tobacco products in the state budget of the CR between 2013 and 2021.

Excise tax on tobacco products is part of the state budget of the CR. Setting the amount of the excise tax and the mechanism for its calculation is one of the factors influencing the amount of the collected excise tax on tobacco products in the state budget. It is not an automatic rule that the higher the excise duty rates on tobacco products, the higher the revenue to the state budget, which is confirmed by the results presented in this paper. Another factor affecting the amount of the collected excise tax on tobacco products in the CR is the number of illegal tobacco products in the CR in the reference period, as the state does not receive any revenue from them. Here, the direct proportionality applies, as the greater the amount of illegal tobacco products in the CR, the greater the tax leakage and the amount the state budget loses. The development trend of illegal tobacco products in the CR in 2020 was partly influenced by the COVID-19 pandemic, especially the restriction of the movement of people between countries and thus the flow of illegal tobacco products.

The state collects excise tax for the state budget from tobacco products. On the other hand, the state has to cover the costs of smoking, which include, e.g., the costs related to smoking treatment or the costs related to the reduction of smoking. Smoking is associated with adverse health effects on smokers, often resulting in premature death, thus depriving the state of income tax, reducing the productivity of the Czech Republic, and causing further economic losses to the state. The costs of smoking cannot be precisely determined, as many factors cannot be clearly quantified and attributed to smoking. The amount of the incurred costs related to the consumption of tobacco products in the CR may vary significantly depending on the chosen percentage of the gross domestic product of the CR since the percentage of the GDP varies as well, as confirmed by the content analysis performed on WoS sources.

It should be noted that on the revenue side of the state, there are excise taxes on tobacco products as well as taxes on the profits of tobacco companies, which employ many people and generate additional income taxes paid to the state budget. The tobacco companies are linked to other companies dealing with the purchase, sale, storage, distribution, logistics, and transport of tobacco products, which pay other taxes on their profits to the state budget and generate additional taxes on the income of their employees.

Further research could deal with the moral decision-making concerning the amount of excise tax on tobacco products, specifically on the development of sales and the effects of the imposed excise tax on other alternatives to tobacco products. These are primarily nicotine pouches and disposable flavoured e-cigarettes, which are currently not subject to any excise tax and thus the regulation by the state. Consumers of these products often include very young people who in some cases, do not meet the age limit for purchasing these products. Due to this fact, the state loses part of its revenue to the state budget; moreover, the legislation does not fulfil the function of reducing the demand for these products.

In addition, further research could also focus on the amount of excise tax on heated tobacco products, as there is a large disproportion in setting the amount of excise tax compared to conventional cigarettes.

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IMPROVING HR MANAGEMENT IN INNOVATIVE BUSINESS ORGANIZATIONS THROUGH DIGITALIZATION AND ICT*

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Abstract. Today`s business organizations face enormous challenges: an unpredictable, unsecured and complex business environment, strong competitiveness, substitute products, spoiled customers with growing needs and demands, pandemic restrictions and social isolation, post-pandemic situation and recovery, economy crisis, military conflicts etc. On this background the rapid development of information and communication technologies offers very logical and convenient way to secure company`s existence and growth. Recent past years proved that the usage of ICT in HR management opens new horizon both for the employees and their managers. On the other hand, the implementation of Artificial Intelligence and digitalization in HR management is not an unambiguous process. Still there are many open questions concerning ethics, personal freedom of employees etc. The aim of the present article is to understand the opinion of young people as future employees on the usage of ICT and AI in companies and on this base to propose some workable solutions for improving HR management in innovative business organizations. Our findings indicate that young people are not yet ready to accept the decision made only by AI without any interference from the managers. At the same time our responders admit that the most serious advantage of AI is in collection and analysis of large amounts of data, while the most serious limitation is the heavy reliance on the technology, which is the logical result in digital era.

Keywords: HR Management; digitalization; Artificial Intelligence; ICT

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1. Introduction

To be successful business organization nowadays requires “gold” combination between visionary management, dedicated employees, well selected counteragents and strategic policy for continuous development and innovations. In this algorithm each element has its important role for the final equilibrium, although it could be assumed that the human factor is the based for the all the rest. The dedication of employees could be supported and developed through many different policies and tools, but recent years information and communication technologies (ICT), digitalization and Artificial Intelligence (AI) has become an integral part of innovation policy in Human Resource Management (HR Management). Parallel with the huge development and incursion of digitalization and AI, there is a public discussion regarding, based on the reasonable conferences on the level of usage AI especially specially for the purpose of HR Management. Questions such as how to se-

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cure and guarantee personal freedom of employees, or how to prevent AI and digitalized processes from the occurrence of some kind of discrimination models remain unrevealed at this moment. At the same time there is another big discussion from the legal point of view – for instance who will be liable, including legal liability, when decisions such as demotions, punishments and dismissals of employees are made directly by AI. At the middle of the 2023 the European Commission has launched initiative for adoption a specific regulation on the use of AI which is a part of overall digital strategy of the European Union. In such time of preparation of big changes which will reflect and impact all of European citizens, the opinion of young people who are the next employees and managers, becomes very important and has to be taken into consideration in the current discourse. In fact, it will be the young people whose entire working life will pass along with the use and development of AI. At the same time, the fact that young people accept innovations and changes much more easily is not unimportant. Therefore, their opinion can be decisive in the public discussion about the level of intervention of AI in HR management work processes and digitalization of organization.

The aim of the present article is to understand the opinion of young people as future employees on the usage of ICT and AI in companies and on this base to propose some workable solutions for improving HR management in innovative business organizations.

2. Theoretical background

It could be claimed that the discourse on the implementation of AI and high level of digitalization in the modern business organizations does not reach yet its peak, but even now is vivid and on the agenda both in politicians, managers, employees, and scientists. In this specific aspect the subject for AI-Augmented HRM could be considered as central and in the top focus of the scientific research. Prikshat et al. (2023) propose multi-level framework, outlining the role of the AI-Augmented HRM for the competitiveness of company and its outcomes. At the same line is the research of Malik, Budhwar and Kazmi (2023), who also develop and propose strategic framework for adoption and implementation of AI in HRM. Chowdhury et al. (2023) elaborate AI capability framework, which is designed to assist and facilitate HR managers in AI adoption in the company. Radonjić, Duarte and Pereira (2022) explore the potential of AI in decision making process in HRM. Scholars admit that one of the major roles of AI and therefore, its central potential is on the collection and fast analysis of big data massive which could be used in the decision-making process, especially when it concerns HRM decisions. Another advantage of using AI in HRM is discussed by Malik, De Silva, Budhwar and Srikanth (2021) and refers to the management and retention of talent in the organization. Scholars explore the experience of a multinational company operating in IT sectors and focus on the impact that knowledge sharing mediated by AI has on the development of talent. Allal-Chérif, Aránega and Sánchez reveal the benefits of using AI in recruitment process of talents, claiming that AI drastically improves level of their identification, selection and retention (2021). Arslan et al. (2021) explore the interaction between AI and employees, but on team level and propose different strategies for their team management. At the same time scholars admit that AI has positive impact on building good infrastructure (including facilitating environment as well as improved training opportunities for employees and securing technological competence of the employees) even before the formation of the different teams. Mikalef and Gupta (2021) prove empirically that AI integration for different processes in the business organization impacts positively and increases the level of creativity of organization as well as company's performance.

One of the major concerns when it comes to digitalization in more general context, and particularly – the adoption of AI for the HRM purpose, is the relevance with the existing principles of ethics and culture of diversity. On this base is dedicated the research of Rodgers et al. (2023) who admit that one of the possible solutions is the usage of algorithmic positions which are also ethical ones. According to their opinion, this will help and improve the decision-making process, generated by AI. For the duality of using AI in HRM process is dedicated the study, developed by Meijerink and Bondarouk (2023). Authors develop and analyze the relationship on the axis HRM algorithms, its reflection on the autonomy of employees and their human rights as well as added value for the employees who are the subject of such algorithmic management. Recruitment of the employees executed with the help of AI could be considered as one of the sensitive topics where ethics and equality are somewhat at odds with the way algorithmic management and decision-making works. This

specific question is the focus of a study, developed by Horodyski (2023). He has executed an empirical survey with 238 participants, who are human resource managers practitioners in attempt to understand their attitude on the usage of AI tools in the process of recruitment of new employees. His findings reveal that one of the biggest weaknesses in such recruitment is the lack of human judgment while time saving and automation are considered as the more important benefits. Almost the same opinion is shared by Pereira, Hadjielias, Christofi, and Vrontis (2023), who also admit that datamining in the process of recruitment of new staff could help HR managers to find the most appropriate candidate for the concrete job position which could lead to the improving of the effectiveness and efficiency in this specific selection process, very important part of HR activities in the company. Interesting findings in this line of consideration – relation between datamining and talent identification is proposed by Nijs, Dries, Vlasselaer and Sels (2021). On the other hand, Esch, Black and Ferolie (2019) claim that potential job candidates who experience anxiety about being evaluated by artificial intelligence in the recruitment process, do not give up on their decision to apply for a job in this same company, which uses AI. They directly admit that company should not spend time, efforts and financial resources as well for overcoming the level of anxiety of the potential candidates, generated by the implementation of AI in recruitment process. Instead, authors advise company management to focus on candidates who have a positive attitude toward using AI at workplace, including in HRM processes. Khan et al. (2023), exploring the possibilities for achievement the technological innovation trough AI specifically in conservative industries claim that service reliability has to be considered as necessary prerequisite which could guarantee the sustainability of AI in these industries. Exploring the relation between AI and business models for achieving the sustainable development goals, Di Vaio, Palladino, Hassan and Escobar (2020) affirm that innovation challenges related to the usage and adoption of AI in business organizations requires combination of varies of efforts in different aspects, such as ethics, social relations, economic and legal issues. Langer and König (2023) develop strategies to reduce opacity in algorithm-based HRM, revealing that there are three reasons for occurring opacity: first one is called system-based, second one is based on the illiteracy and the third one is intentional. Arias, Rivero and Márquez (2023) propose interesting research studying the impact between AI, bullying and harassment in the workplace. They conducted an empirical survey with 329 participants and based on the data, collected by the survey, they outline different interactions. Many researchers focus attention on the working conditions in different sectors of economy and outline the direct relation and impact between working conditions and results of their work (for instance Anguelov, 2019; Parteka, Wolszczak-Derlacz, Nikulin; 2024).

Some very specific aspects of adoption and implementation of AI in HRM are explored by Sienkiewicz-Małyjurek (2023), Anguelov (2021), Bhupathi, Prabu and Goh (2023), Dabić, Maley, Švarc and Poček (2023), Rebelo et al. (2023), Lee and Ahn (2020) etc.

Industry digitalization is one of the major important trends in changing economy. In this base Ammirato at al. (2023) identify the need for relevant theorizing the relationship and complex interactions between humans and digitalization processes in the business organizations.

All above mentioned give the needed grounds for scholars to conclude that digitalization and AI has great prerequisites to change in depth the HRM in the next years (Pan, Froese; 2023) and to put the existing relationship between manager and employees on completely new foundations. In this same line the research of Giudice, Scuotto, Orlando and Mustilli (2023) reveals interesting findings connected to the personal attitude of employees and their level of willingness to accept the adoption of AI in the company. Scholars conclude after a comprehensive analysis that the technology is the key element that defines the personal attitude of employees on the adoption of AI in HRM of the company. At the same time, they admit that this individual attitude is based and impact on the pure personal traits which they define as rational, emotional and cognitive ones (ibid). According to Zirar, Ali and Islam (2023), many of employees are suspicious to AI due to the fact that they consider AI as a threat for their jobs. At the same time, Kong, Yin, Baruch and Yuan (2023) reveal that there is a strong connection between AI trust and sustainability of career development. Scholars outline that once there is a solid collaboration between AI and employee, this will secure the sustainability of the career development of this employee.

In summary of all that has been said so far regarding the review of the existing literature, it could be concluded that the new trends in human resource management related to digitalization, the use of ICT and the increasing penetration of AI are yet to be subject to many scientific discussions and studies. This is a still insufficiently well-researched area, which is also due to its rapid development. However, the future is invariably associated with the increasing use of AI in various processes in business organizations, including human resource management, which is why each new study, such as the present one, will contribute to enriching this discourse.

3. Methodology of the research

Our major objective is to propose a workable solution for improvement of HRM in innovative business organization using the opportunities and benefits offering by digitalization, information and communication technologies and more specifically – Artificial Intelligence. Having this major goal in mind, our scientific team has decided to explore at first step the attitudes of employees and their sincere opinion on the adoption of AI for the HRM purpose in innovative organizations. Once we have the opinion and point of view of the employees, on this basis we will be able to develop and offer a good mix of solutions, guaranteeing on the one hand the improvement and efficiency of the HR processes at organizational level, and on the other hand - the opportunities for self-expression, affirmation, motivation, creativity of the employees themselves. We decided for the purpose of the research to collect opinion of students (in regular, correspondence courses and distance forms of education) in leading Bulgarian universities and there are four major reasons for this decision as follows:

- The students are our future logical workers. The majority of students in correspondence and distance forms of educations are at the same time workers in different companies and have very clear attitude to the overall process of digitalization, ICT and AI in HRM;
- The students accept easily change and innovations, including at work; therefore, their opinion will frame the trends in HRM for the short-term period;
- The opinion of young people is important in attempt to achieve sustainable human resource management with high level of loyalty, satisfaction, motivation and responsibility of the employees;
- usually, young people do not conform to authorities, they freely express their opinion in the way they perceive things, which would lead to better credibility of the information collected.

After we determined the specific characteristics of our sample, our next methodological steps became clear. In order to prepare our questionnaire in relevance to our responders, as well as to formulate appropriate questions, we decided on preparational phase to use semi-structured interview. For this purpose, we formed 2 focus groups (2x20 students each) of representatives of our responders (both of these groups were composed by students in different forms of education). We had 6 initial open questions for discussion with each of the focus groups:

- In your personal opinion, what are the new challenges that cutting edge HRM has to offer in innovative business organizations to the employees?
- In your personal opinion, how does digitization affect HRM and employees?
- In what aspects do you think digitization helps HR managers?
- In what aspects do you think digitization helps or hinders employees in a concrete company?
- How do you think the increased use of artificial intelligence in recruiting will be perceived?
- How do you think the increased use of artificial intelligence in employee control will be perceived?

The discussions were helpful to formulate relevant questions for our main research. With the help of analysis, the information received in these two focus groups, our initial observation was proven – that young people easily change the roles – they have sound opinion both as employees but also could enter as a role of HR managers and to foresee the advantages and limitations in adoption of AI tools for HRM needs of the company. At the same time the responses from the participants in the focus groups help us to formulate the different options of answers in the final questionnaire.

We developed our questionnaire using google forms and released the link between our students. At the same time, we share the link of the questionnaire to our colleagues from other Bulgarian universities in attempt to spread information for the survey among representatives of different universities. We have to outline that the participation in the survey was absolutely voluntary and based on the guaranteed anonymity of the responders. All participants were informed that the results of the survey and collected information will be used only for educational and scientific needs. The methodology of the research is graphically presented on fig. 1.

As a result of our efforts, we received 184 responses in total from the 7 leading universities in Bulgaria, namely: University of National and World Economy, Sofia University St. Kliment Ohridski, Technical University of Sofia, New Bulgarian University, Medical University of Sofia, University of Telecommunication and Posts and University of Chemical Technology and Metallurgy. We are pleased to conclude that in our survey we have reached more than 30% representation of the universities in Sofia (in total 22). This fact will eligible in more appropriate manner the achieved results and based on this analysis of data.

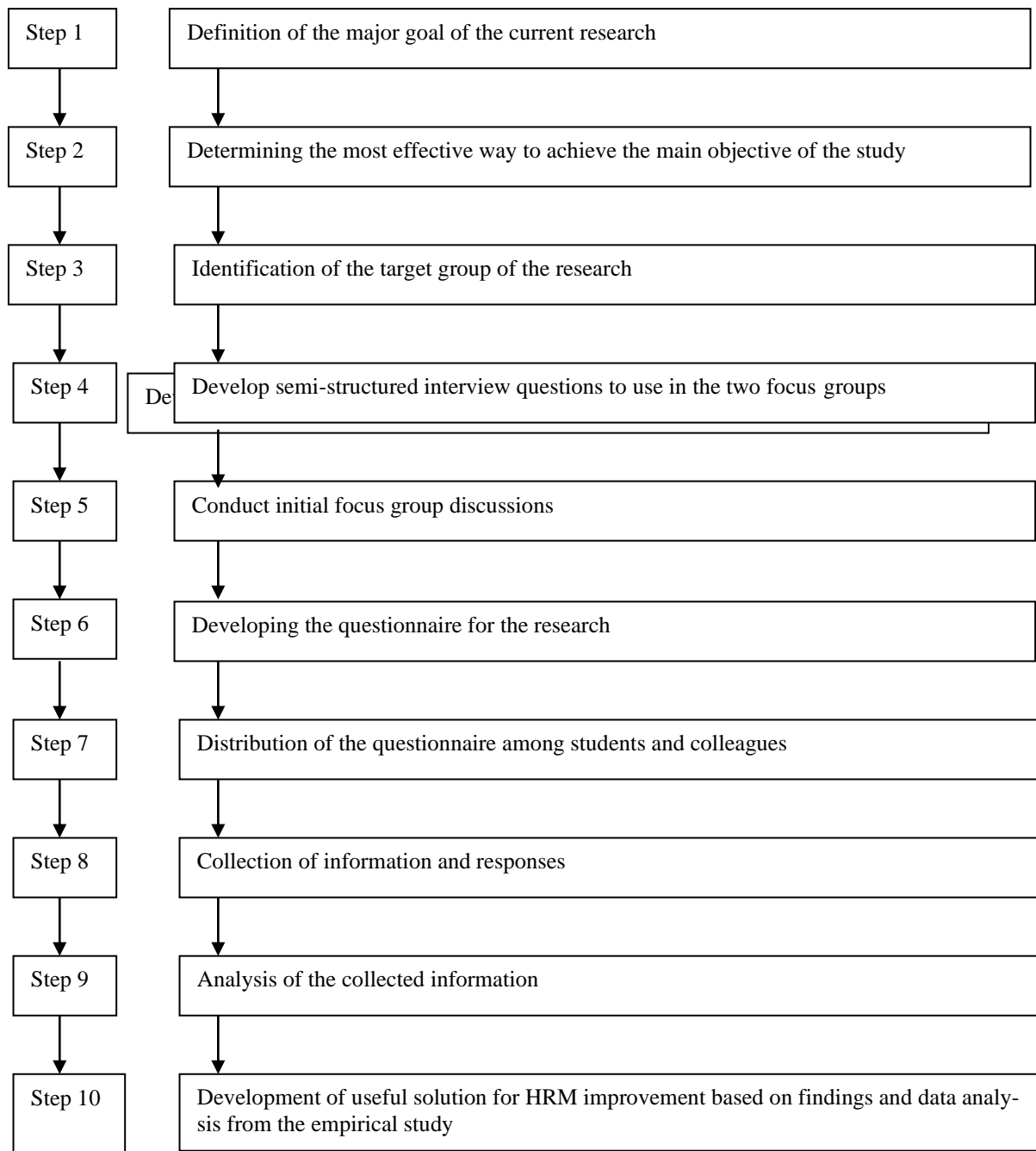


Fig. 1. Methodological steps for the research implementation

One of our specific aims of the present article is to understand the opinion of young people as future employees on the usage of ICT and AI in companies and on this base to propose some workable solutions for improving HR management in innovative business organizations.

On this line we develop the following hypothesis:

Hypothesis 1: The majority of young people consider digitalization and AI in HRM as a natural part of the development of the modern business company.

Hypothesis 2: The majority of young people accept using AI in HRM, including in recruitment activities and control.

4. Survey results, analysis, and observations

4.1. Profile of the responders

We had 3 options as a response to this question: Male, Female and the third option was “I don’t want to answer”. None of the students surveyed chose the last answer option, which fact contributes to the clarity on the gender of our respondents which is the following: from total 184 responses, we have exact 100 females’ responders and 84 males. This fact gives slight advantage of the female point of view on the disputed subject (54% versus 46%), but on the other hand, considering the idea that usually females are more sensitive than men, this could benefit the final results of our survey (Table 1).

Table 1. Gender and Age of responders

Gender of responders (%)		Age of responders (%)		
Male	Female	18-23 years old	24-29 years old	Over 30 years old
46	54	57	34	9

In terms of responders age, the major part of students participating in the research are in the between 18-23 years old, followed by the group between 24-29 and the smallest group is formed by the representatives of students over 30 years (fig. 3).

This picture of the age of our responders in fact is logical, having in mind that in Bulgaria tertiary educational level begins usually right after the school graduation, when the students are 18 years old and lasts (again usually) 5 years – 4 years in bachelor degree and 1 or 1, 5 years for master educational programme.

The next question gives an idea for the place of birth of our responders. This information could help us to understand better the level of relation between place of birth and the level of acceptance of changes and innovations, including digitalization and AI in the workplace (fig. 2).

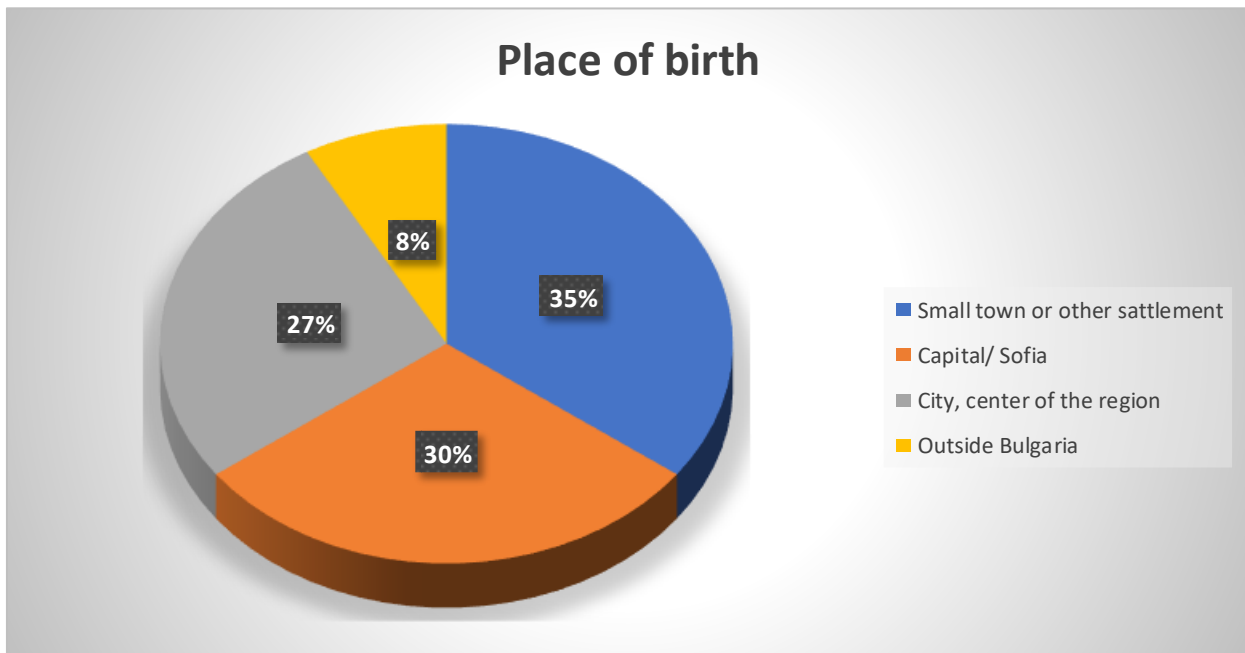


Fig. 2. Place of birth of responders

Here the smallest group is formed by the responders with place of birth outside Bulgaria. Despite the fact, that the questionnaire was distributed only in Bulgarian language, we have 8% of responders, who claim to be borne outside Bulgaria. According our observations during the years, usually these are students, coming from neighboring countries in Bulgaria who study in Bulgarian languages Bachelor or Master programmes (Citizens of Republic of North Macedonia, Serbia) or students, coming from historical formed Bulgarian community abroad – such as Bessarabian Bulgarians. Here it could be also assumed that there are representatives of Ukrainian refugees. Interesting finding is that the major group of responders claims for birthplace small town or other settlement (35% or 64 of responders). This fact is curious considering the demographic statistic of the countries, where we have a clear concentration of population in the capital of Bulgaria and in big cities (such are the regional city centers).

The last question about the profile of the responders justifies the working experience of the students (fig. 3). Almost the half of the responders combines studying at the university with work. This statement is often practice for Bulgarian students, who try to be financial independent from their parents. On the other hand, our survey was distributed also among students in correspondence and distant form of education, who usually choose these of education precisely because of the opportunity to work full-time. Another almost 40% of participants stated that they did not work at the time of the survey but had work experience mainly related to seasonal work. The rest of responders are focused on the study as priority. This picture provides us with a very good level at students who have some job experience – 88% of responders, which is important for the purpose of our survey.



Fig. 3. Working experience of respondents

4.2. Attitude of young people towards digitalization and using AI for HRM in business

This section of the questionnaire includes 11 closed questions. Here the responders have to choose between different ratings (according to a five-point Likert scale) or between different types of predefined answers. First one of these questions is the following: Would you apply for a job at a company that uses Artificial Intelligence in recruiting? As it can be seen from the results (fig. 4), the major part of our responders is willing to apply in company which uses AI for candidate selection (in total 93 responders are positive, which makes exactly the half of responders). The group of people with negative answers to this question is 55 in total, which makes almost 30% of responders. Here the number of people who claim that cannot decide is not negligibly small. One of the possible explanations on this fact is that perhaps they do not perceive themselves as people well-versed in this topic and therefore cannot make their choice.

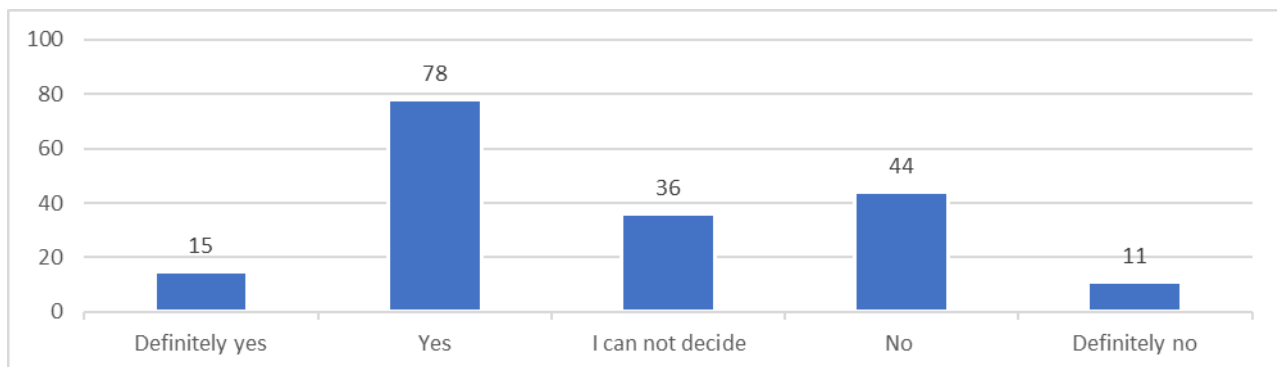


Fig. 4. Results obtained in response to the question "Would you apply for a job at a company that uses Artificial Intelligence in recruiting?"

The next question is "Would you work for a company that uses Artificial Intelligence to control work processes?". The results are more than curious – we have almost equal number of answers with "Yes" and "No" (with a minimum margin of 1 vote for respondents who chose the answer „No") and almost the same results for the two very opposite opinions, this time with slight predominance of students, who choose definitely "yes". Here the number of persons who cannot decide is visibly less, compared to the previous answer. Therefore, when it comes to workplace control, the picture becomes clearer.

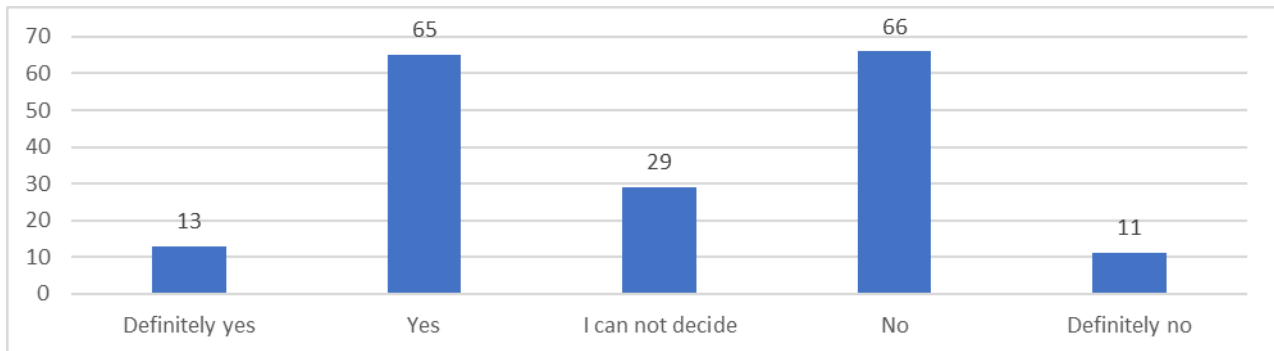


Fig. 5. Results obtained in response to the question “Would you work for a company that uses Artificial Intelligence to control work processes?”

Motivation is in the center of the following question, which is the following: “Would you feel motivated as an employee if the company you work for uses Artificial Intelligence to evaluate your work?” (fig. 6). Here the results could be considered rather surprising – the number of people with negative answers is significantly bigger than the groups with positive answers – 97 versus 52 – almost twice. This fact is interesting having in mind that AI tools could secure unbiased assessment, lack of subjective personal opinion and equal criteria for evaluation to all employees.

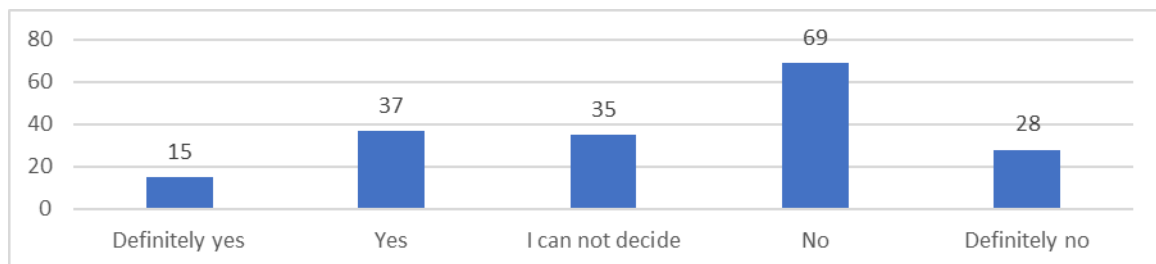


Fig. 6. Results obtained in response to the question: “Would you feel motivated as an employee if the company you work for uses Artificial Intelligence to evaluate your work?”

In the line of motivation is the question for commitment: „Would you feel committed to meeting organizational goals (i.e. would you give your full effort) if the company you work for uses Artificial Intelligence to evaluate your work?“. Here the majority of responders claim the positive answer, perhaps driven by the presumption that they will always put in a sufficient amount of effort as employees, regardless of how management provides control over their work (99 positive answers in total, which makes 54% of responders).

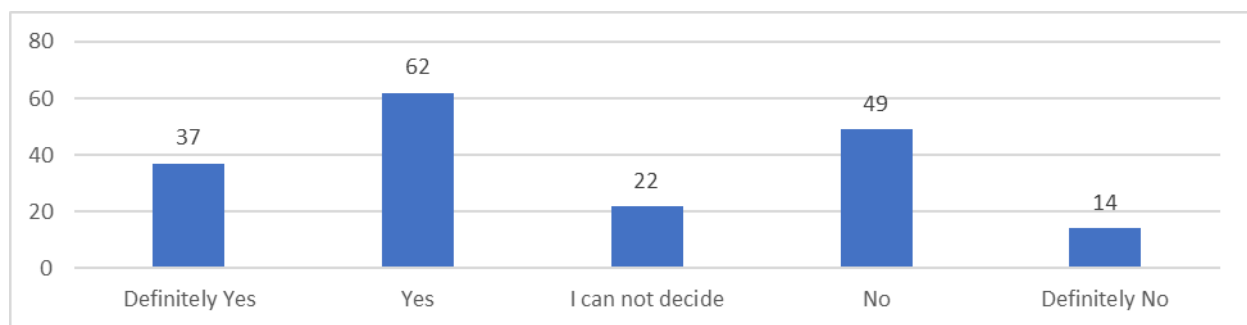


Fig. 7. Results obtained in response to the question: “Would you feel committed to meeting organizational goals if the company you work for uses Artificial Intelligence to evaluate your work?”

The next two questions are content related and cover the assessment of level of acceptance of responders in first case – the incentive, and in the second case – the punishment is decided directly by AI. The questions are as follows: “Would you accept it if the incentive you receive for a job well done was determined directly by Artificial Intelligence rather than your direct manager?” and “Would you accept it if the punishment you receive for not doing a good job was determined directly by Artificial Intelligence rather than your direct manager?”.

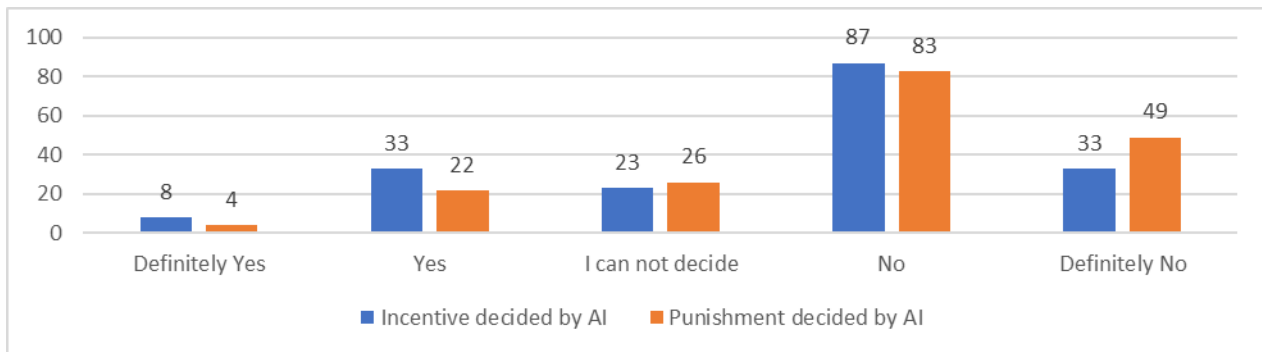


Fig. 8. Results obtained in response to the questions for level of acceptance incentive and punishment decided by AI

Despite slight differences between the responses of these two questions, the trend remains the same – definitely positive answers are minority, and the majority of responders choose “no” as an answer of both questions. At the same time, the number of people who choose definitely “no” as response to the second question increases from 33 to 49. Therefore, students are not willing to accept both incentive and punishment at work, if this decision is made only by AI. However, the level of negative definiteness increases when it comes to the punishment.

For the next two questions the responders are asked to rate what they think are the indisputable benefits for the employees themselves in using Artificial Intelligence and digitalization of human resources (with 5 being the most beneficial and 1 being the least beneficial). The same rate is used for the assessment on the undeniable limitations for employees in digitization and artificial intelligence for human resource management? (with 5 being the most restrictive and 1 being the least). The final results after additional calculations of the achieved average score in each of the indicators are presented on the fig. 9 and fig. 10.

As it can be seen on fig. 9, the top three indicators for the real benefits from the adoption of AI in HRM from the employees’ point of view are the following: Facilitates the collection and analysis of large amounts of data on productivity, employee’s satisfaction etc. with the highest average score of 4,39. The second place is for the indicator: Facilitates administrative tasks such as payroll processing, attendance tracking, etc. with the average score of 4,22, followed by easy access to educational resources for employees (4,17). The lower score is for the indicator “facilitates employees career development processes” with average score 3,05.



Fig. 9. Average score by indicators of the benefits for the employees in the process of usage AI in HRM

According to the assessment of our responders, there is only one limitation which has high impact on the limitations for the employees in the process of usage AI in HRM and this indicator is the heavy reliance on the technology, which could be considered as major concern, with average score of 4,15 (in maximum 5,00 scale). This is the only one indicator which passes the 4,00 score. The rest of predefined indicators for limitations are with almost similar results with slight differences. However, the second place among them is the indicator for increasing the fear of substitution by new technologies (with average score of 3,94) closely followed by the indicator for lack of social contact and interaction with colleagues.

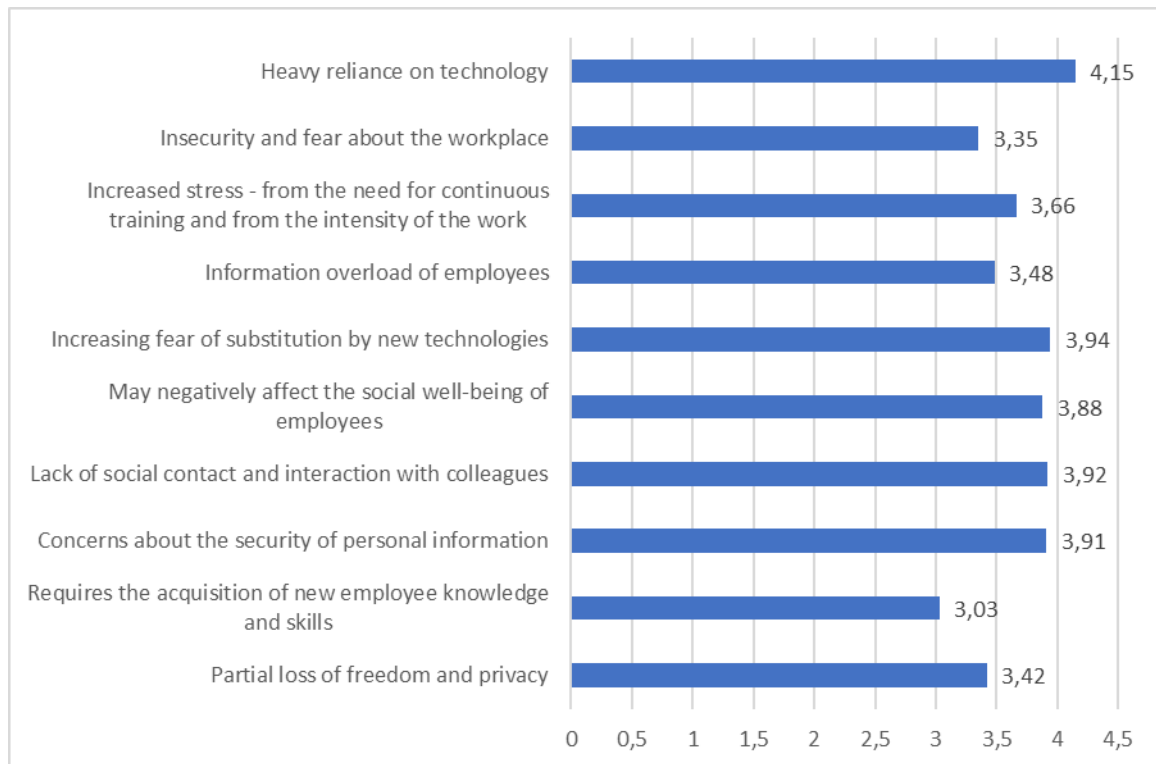


Fig. 10. Average score by indicators of the main limitations for the employees in the process of usage AI in HRM

The last question again contains the assessment on the relation between usage of AI at work and its impact on different elements of the business organizations. The responders were asked to assess the impact in 5-point Likert scale, where 1 is very negative and 5 is very positive. Final results from this assessment, after additional calculation for the average score in each element, are presented on fir. 11.

Evident from the results, it can be concluded that the students have a very sober view when it comes to the impact that AI has on the various elements of the business organization. According to our respondents, the three elements from the business organization that AI most positively impacts are: the image of the company (with average score of 3,93 in maximum 5,00), followed by organizational culture (3,39) and ethics in organization (3,15). At the same time, it has to be noticed that these average scores are almost in the middle of the rating scale rather than towards the visible positive rating. The top three elements of the company with negative impact on AI are as follows: level of professionalism (2,22), employee relations (2,36) and relationship between managers and employees (2,52).



Fig. 11. Average score from the assessment on the impact between AI and different company's elements

The obtained results on the attitude of young people could be considered as rather interesting and partly surprising due to the fact and usually young people are open to innovations, easily accept changes and are willing to explore new horizon. At the same time these results are indicators for the challenges and additional future work that has to be done in order to achieve balance between employee's expectation and level of digitalization and usage of AI.

5. Conclusion and recommendations

We usually perceive young people as carriers of change, with an eye towards new horizons. In this article, we investigated the attitude of students from seven leading Bulgarian universities to digitalization and, more specifically, to the use of artificial intelligence in human resource management. The results of our research indicate that students are still skeptical and would not generally trust only AI-based career development solutions. As representatives of the future generation of employees and managers, their opinion is important and innovative companies should take it into account when developing effective strategies to ensure on the one hand the use of AI and digitalization, on the other hand - data protection and the possibility of development and creativity of the individual employee. Constructed in this way, a human resource management strategy of an innovative business organization will be able to generate sustainability of results in a strategic plan.

Obtained results from the empirical research give us solid information, that in fact confirm our initial hypothesis that the majority of young people consider digitalization and AI in HRM as a natural part of the development of the modern business company. On the other hand, however, this initial support that young people demonstrate towards new technologies and their use for HRM purposes is not automatically generated. Young people who have grown up in a digital environment have a very clear idea and a very clear understanding of the limitations and to some extent the real threats that can arise in a work environment. As employees, they largely accept the possibility of being hired by AI-assisted selection, but on the other hand, they would find it difficult to accept any career development decisions based solely on AI without human intervention. This fact partly confirms and partly rejects our second hypothesis, namely: The majority of young people accept using AI in HRM, including in recruitment activities and control.

Based on the findings of our research, we developed and propose several useful solutions that could be used in the development of HRM strategy which adopted AI, as follows:

- to strengthen the role of the line manager in the integration of HRM tools using AI. This should be reflected in several directions: a stronger opportunity for direct communication between manager and employee; to enable a final manager decision based on the information collected and analyzed by AI, especially regarding decisions related to career development, training opportunities, etc.;
- to strengthen the internal organizational culture development policy by building a supportive environment for employees. Currently, young people believe that the use of AI brings more public image to the company than to support and develop the organizational culture, which can be considered an insufficiently and under-developed so far opportunity;
- parallel to the process of adoption of AI for the purposes of HRM, to conduct a targeted internal information campaign for employees, in which the benefits that each employee will have from their introduction are very clearly explained. For example, training opportunities, opportunities for impartial and somewhat transparent evaluation of work should also be very clearly highlighted, as they are one of the undeniable advantages of digitization in general.

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EMPIRICAL ANALYSIS OF THE IMPACT OF ECONOMIC FREEDOM ON ECONOMIC GROWTH IN THE SLOVAK REPUBLIC, THE CZECH REPUBLIC AND SINGAPORE

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Abstract. A quality business environment is considered a key factor that affects the competitiveness and growth of the market economy. The article provides an evaluation of the development of the business environment in the Slovak Republic and its comparison with selected countries using the Index of Economic Freedom from the Heritage Foundation. The aim is to verify the influence of individual sub-indexes of the Index of Economic Freedom on the economic growth of the Slovak Republic, the Czech Republic and Singapore, measured by the GDP per capita growth (%), through a panel analysis. By choosing these three countries over a period of 20 years, the article brings new knowledge that appropriately complements already conducted empirical studies in the researched area. As a result, two of the twelve sub-indexes of the economic freedom index, namely the labor freedom sub-index and the monetary freedom sub-index, demonstrated an impact on the economic growth of the surveyed countries. In addition to them, the dependent variable is also influenced by the control variables foreign direct investment and gross capital formation. However, economic freedom is a complex indicator, so importance should also be attributed to other sub-indexes of the Index of Economic Freedom as a manifestation of the synergy of all its basic elements in the creation of macroeconomic policy.

Keywords: Index of Economic Freedom; GDP per capita growth; business environment

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JEL Classifications: A13, O11, O43, O47, P48

1. Introduction

Nowadays we live in difficult times. The coronavirus crisis, which was the main risk for the economy and the financial sector for two years, was replaced by new challenges – high inflation and rising interest rates, a war in a neighboring country and deteriorating economic prospects. These facts are also the reason why the creation of a favorable business environment, which is considered a significant condition for healthy economic growth, is gaining more and more importance today. One of the characteristic features of a quality business environment is a high degree of economic freedom in the country.

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Already in 1776, Adam Smith concluded that a free institutional environment, i.e. without excessive control by governments, is a determinant of economic growth. In contrast, there have been periods in the history when the hand of salvation of the state, instead of invisible, was demanded. In professional circles, there is still a debate about whether economic freedom is the reason not only of economic growth, but also of economic crises, or whether crises did not arise as a result of insufficient liberalization in all areas of the economy. There have also been many empirical studies investigating the relationship between economic freedom and the economic growth of the country, respectively, groups of countries, realized, but even these could not unequivocally confirm this relationship as significant.

In most of these studies, a holistic approach to economic growth was applied, and the authors used the GDP growth rate, or GDP per capita (p.c.) as a measure of economic performance.

To determine the impact of economic freedom on economic growth, economic freedom is also required to be a measurable category. However, economic freedom is more qualitative than quantitative in its nature. As a result, some degree of subjectivity and imprecision is an inseparable element in any attempt to measure it (Hanke and Walters, 1997).

In this regard, the so-called competitiveness rankings, which are compiled on the basis of indexes, can be useful. The most sophisticated indexes of economic freedom that have been designed and used in scientific circles are: 1. The Freedom House Index 2. The Index of Scully and Slottje (1991) 3. The Index of Economic Freedom from the Fraser Institute 4. The Index of Economic Freedom from the Heritage Foundation. Of these four indexes of economic freedom, which are applied by scientists, policy makers, as well as international organizations, the last two named are the most important.

The article compares the quality of the business environment of selected countries through the Index of Economic Freedom (IEF) from the Heritage Foundation. The authors decided to apply this index mainly due to its annual periodicity and the availability of data for individual sub-indexes for the period under study. Cebula et al., 2013; Kovačević and Borović, 2014; Brkić, 2020 and others followed a similar approach.

The Heritage Foundation was founded in February 1973 and is headquartered in Washington, D.C., USA. Together with The Wall Street Journal, since 1995, they have compiled and published an analytical study called the Index of Economic Freedom every year. In Slovakia, the partner of this study is the F. A. Hayek Foundation, which is based in Bratislava.

The Heritage Foundation measures economic freedom based on twelve qualitative and quantitative factors, which are divided into 4 broad pillars of economic freedom: rule of law, government size, regulatory efficiency, and open markets (the IEF factors are stated in Table 2). Each of the economic freedoms is assigned a rating from 0 to 100, with 100 being the best possible rating representing maximum freedom. Averaging these twelve freedoms, which are assigned equal weight, the country's total point score is obtained.

The Czech Republic (CR), a neighboring country with similar starting conditions, and Singapore as one of the best rated countries were chosen as a benchmark in the comparison. The Slovak Republic (SR) and the Czech Republic have achieved scores above the world and European average in this assessment for several years. Singapore is an exemplary country in this regard and has held the first place in the ranking for several years. By choosing these countries, the authors also respect the recommendation that when comparing countries, city states, such as Singapore, should not be included in the regression along with large countries because city-states can gain economic freedom at a lower cost (Cebula et al., 2013).

According to the creators of the Index, the IEF refers to the connection between the prosperity of economies and the degree of their economic freedom. All of the measured aspects of economic freedom have a significant impact on the country's economic growth. The freer a country is, the more it tries to stimulate its growth. Economic growth has a significant impact on the emergence of new opportunities and economic progress, thereby contributing to permanent prosperity and reducing poverty in the country (The Heritage Foundation, 2023).

The aim of the article is to verify the impact of individual sub-indexes of the Index of Economic Freedom on the economic growth of the Slovak Republic, the Czech Republic and Singapore, measured by the GDP per capita growth (annual %), through a panel analysis. According to the findings, two of the twelve sub-indexes of the IEF, namely the labor freedom sub-index and the monetary freedom sub-index, showed an impact on the economic growth of countries. In addition to them, the dependent variable is also influenced by the control variables foreign direct investment and gross capital formation.

The results of the panel analysis are valid for a selected sample of countries and they are connected with a defined time period. In this regard, they cannot be expected to be consistent with the findings of other authors, nor with the general scientific view. From the comparison, a conclusion can be made what aspects of economic freedom equally influence the surveyed countries and what are their characteristic features.

The rest of the article is structured as follows. The following part summarizes the empirical literature that discusses the relationship between economic freedom and economic growth. Section 3 states research objective, methodology and data. Section 4 provides the results of the research divided into two parts: a comparative analysis of the quality of the business environment of selected countries through the IEF and results from panel analysis. The last part presents the conclusions.

2. Theoretical background

Surveying the determination of economic growth by economic freedom is a relatively new field. Economic freedom has only gained significant attention in recent decades. As already the founders of modern economics recommended to release economic flows from government intervention, this is a little bit surprising.

Nevertheless, by 2011, a total of 402 scientific papers had been published in 211 renowned international journals on economic freedom (Hall and Lawson, 2014).

Empirical studies surveyed the relationship between economic freedom and economic growth of the country, measured by the GDP growth rate, resp. GDP per capita through simple correlation and regression analysis to more sophisticated dynamic panel data analysis, or using causality à la Granger.

Erdal (2004) states that economic freedom has a positive impact on economic growth, but some aspects affect economies differently. N'Zue (2011) concluded that economic freedom has positive, but not significant impact on GDP p.c. On the other hand, Bayar and Aytemez (2015) argue that economic freedom has positive, statistically significant impact on GDP p.c. growth. According to Cebula and Mixon (2012) fiscal freedom, decrease of government spending, trade freedom, personal rights protection have positive and statistically significant impact on GDP per capita growth (annual %). Kovačević and Borović (2014) tested 11 European countries and found out that the IEF is positive, but not statistically significant.

As documented, various, sometimes contradictory or inconsistent conclusions about the relationship between economic freedom and economic growth have come from the realized empirical studies conducted so far. Some of them state there is no robust link, while others show a connection between economic growth and selected aspects of economic freedom. Therefore, it is very difficult to determine the quality and credibility of each study.

Consequently, Doucouliagos and Ulubasoglu (2006) sought to prove the hypothesis of a link between economic growth and economic freedom using meta-analysis as a quantitative synthesis of empirical research based on the available literature. Their results confirm a positive direct connection between economic freedom and economic growth.

Latest studies concentrated mainly on selected region (i.e. Dia, and Ondo, 2023; Henri and Mveng, 2023; Ahmed et al., 2023; Cloyne et al., 2023 and many others) or specific group of countries (i.e. Yang et al., 2023;

Lach and Malaga, 2023; Murphy, 2023; Espich et al., 2023), resp. they surveyed certain aspect of economic freedom on economic growth (e.g. Ang and Patalinghung, 2021; Sirbu et al., 2023; Khyareh and Zamani, 2023).

Inspirational for this research is the work of Brkić, 2020, which tried to demonstrate the relationship between economic freedom and economic growth in EU countries. The results showed a positive, but statistically insignificant effect, and therefore the alternative hypothesis that economic freedom has no effect on economic growth in EU countries was accepted. She also examined the impact of individual IEF sub-indexes and demonstrated that two of them (monetary and investment freedom) have an impact on the economic growth of EU countries, while monetary freedom has a positive effect and investment freedom has a negative effect.

Following this study, as well as according to the opinions of many authors (e.g. Kovačević and Borović, 2014; Heckelman and Stroup, 2000) that the aggregate IEF may not be an accurate indicator of the economic growth of certain countries, the authors decided to analyze the relationship between the individual components of economic freedom and economic growth.

3. Research objective, methodology and data

In accordance with the objective of the empirical study, i.e. to determine the impact of sub-indexes of economic freedom on the economic growth measured by GDP per capita growth (annual %), specific and individual hypotheses were defined:

Specific hypotheses:

1. H0: Some aspects of economic freedom have a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Some aspects of economic freedom have a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

Individual hypotheses:

1.1 H0: Property rights have a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Property rights have a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.2 H0: Judicial effectiveness has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Judicial effectiveness has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.3 H0: Government integrity has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: The integrity of the government has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.4 H0: Government spending has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Government spending has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.5 H0: Tax burden has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Tax burden has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.6 H0: Fiscal health has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Fiscal health has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.7 H0: Business freedom has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Business freedom has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.8 H0: Labor freedom has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Labor freedom has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.9 H0: Monetary freedom has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Monetary freedom has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.10 H0: Trade freedom has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Market freedom has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.11 H0: Investment freedom has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Investment freedom has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

1.12 H0: Financial freedom has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

H1: Financial freedom has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

The influence of individual sub-indexes of the economic freedom index on economic growth in the selected countries (SR, CR, Singapore) was surveyed in the Gretl statistical computer system using the OLS model. Like other authors (N'Zue, 2010; Cebula and Mixon, 2012, 2013; Kovačević and Borović, 2014; Bayar and Aytemiz, 2015; Brkić, 2020 and others), the GDP per capita growth (annual %) as the dependent variable (GROWTH) of individual countries for the entire examined period (20 years) was used. Individual sub-indexes of the economic freedom index as independent (explanatory) variables were chosen.

Data on sub-indexes of economic freedom were obtained from The Heritage Foundation/Wall Street Journal Annual Index of Economic Freedom, which is available for download on their website <http://www.heritage.org/index/explore>. Data on economic performance come from the World Bank database <http://data.worldbank.org/>. The control variables in the analysis were selected based on the results of the influence of various variables on economic growth from already conducted empirical studies.

4. Results and discussion

4.1 Comparison of the quality of the business environment through the Index of Economic Freedom from the Heritage Foundation

There were 176 countries of the world evaluated in the latest edition of the Index of Economic Freedom 2023 (IEF 2023). The global economic score reached 59.3, which is a decrease of 0.7 points compared to the previous year (the IEF 2022). Out of the total number of 176 evaluated countries, 4 countries achieved a rating of 80 or more, thus ranking them among free countries. 23 countries scored between 70-79.9, ranking them among the freer countries. 56 countries were included among moderately free countries with a score of 60-69.9. Approximately half (79) of the evaluated countries are thus classified in the IEF 2023 as a country in which individuals and businesses have at least a moderate degree of economic freedom. On the contrary, 93 countries were included in the evaluation among countries with a score of less than 60. Specifically, 65 economies belonged to the rather unfree category, and the remaining 28 evaluated countries were classified as repressive. Table 1 shows the position of selected countries in the IEF 2023 and 2022 rankings.

Table 1. The IEF 2023 and 2022 rankings of selected countries

Country	The IEF 2023		The IEF 2022		Performance change
	Performance relative to EU in 2023	Ranking	Performance relative to EU in 2022	Ranking	
Singapore	83.9	1	84.4	1	-0.5
Switzerland	83.8	2	84.2	2	-0.4
Ireland	82	3	82	3	0.0
Taiwan	80.7	4	80.1	6	0.6
New Zealand	78.9	5	80.6	4	-1.7
The Czech Republic	71.9	21	74.4	21	-2.5
The Slovak Republic	69.0	33	69.7	36	-0.7
Venezuela	25.8	174	24.8	176	1.0
Cuba	24.3	175	29.5	175	-5.2
North Korea	2.9	176	3.0	177	-0.1

Source: own processing according to the Heritage Foundation

Singapore has become the freest economy in the world for the fourth year in a row with a score of 83.9, which has worsened by 0.5 points compared to the previous year. Although the Czech Republic recorded a drop in the IEF by 2.5 points, it still retained 21st place. In the IEF 2023, the Slovak Republic reached the 33rd position with a score of 69.0. This achieved score is above the regional (68.2) and world average (59.3). In the evaluation of forty-four European countries, the Slovak Republic reached 20th place.

Figure 1 shows the development of the IEF values of the Slovak Republic, the Czech Republic, and Singapore for the period 2004 – 2023.

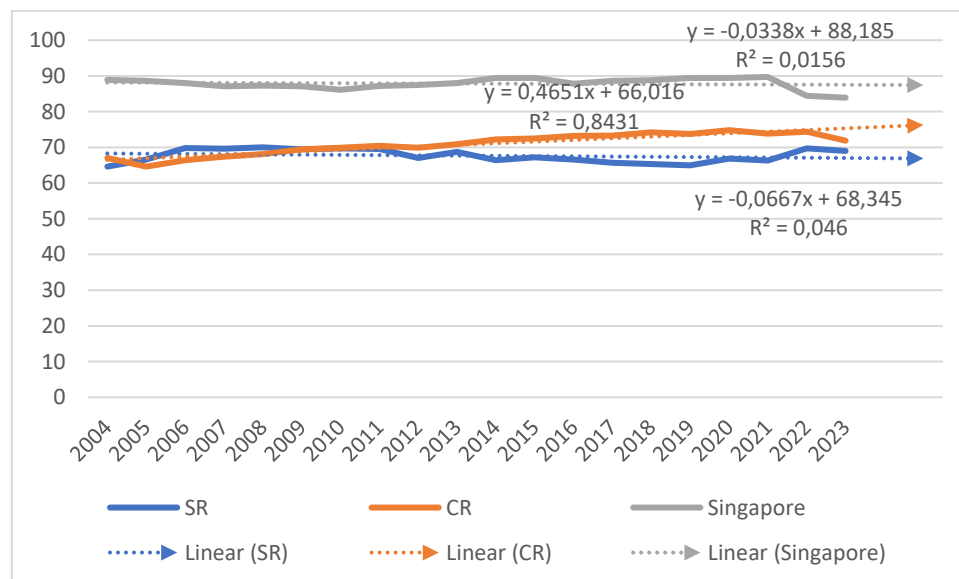


Figure 1. Development of the IEF values of the Slovak Republic, the Czech Republic, and Singapore for the period 2004 – 2023.

Source: own processing according to the Heritage Foundation

According to the IEF, the Slovak economy has been among the moderately free economies of the world for the last 20 years. The exception was 2008, when it reached the lower limit of the rather free countries category. The Czech Republic ranks among the rather free countries for the eleventh year in a row. Previously, it achieved the rating of a moderately free country with values comparable to the Slovak Republic. Singapore has been among the free countries for the past 20 years.

A simple linear trend estimate was created based on historical data. For observations of the results of economic freedom for the Czech Republic and Singapore, the linear model assumes a growing trend for the next 2 years. For the Slovak Republic, the model predicts a decline in the development of economic freedom. However, this assumption is limited by the ceteris paribus condition.

Table 2 analyzes the achieved scores of the Slovak Republic, the Czech Republic and Singapore in individual IEF 2023 categories.

Table 2. Achieved scores in individual categories of IEF 2023 of the countries Singapore, the Czech Republic and the Slovak Republic.

Pillars of economic freedom	Category	Singapore	CR	SR
Rule of Law	Property rights	94.0	88.5	84.2
	Judicial effectiveness	58.3	81.9	70.6
	Government integrity	91.2	60.3	56.8
Government Size	Government spending	90.6	79.3	77.3
	Tax burden	89.0	39.5	41.2
	Fiscal health	78.0	73.5	62.4
Regulatory Efficiency	Business freedom	86.9	76.9	72.2
	Labor freedom	77.3	56.1	64.7
	Monetary freedom	81.9	78.0	74.8
Open Markets	Trade freedom	95.0	78.6	78.6
	Investment freedom	85.0	70.0	75.0
	Financial freedom	80.0	80.0	70.5

Source: own processing according to the Heritage Foundation

As documented by the data in Table 2, the Slovak Republic achieved worse values for most sub-indexes, compared to the two selected countries in the IEF 2023. Compared to the Czech Republic, it had better values for the tax burden, labor freedom and investment freedom sub-indexes. The Judicial effectiveness subindex had a higher value in both the Slovak Republic and the Czech Republic compared to Singapore.

Figure 2 shows the development of the GDP per capita growth (annual %) and the IEF in the analyzed period for the Slovak Republic (% annual change). As can be seen, positive or negative changes in IEF are not parallel to growth, or by a decrease in GDP p.c (%). This fact may also be an indication that improvements in IEF may not have a positive effect on economic growth.

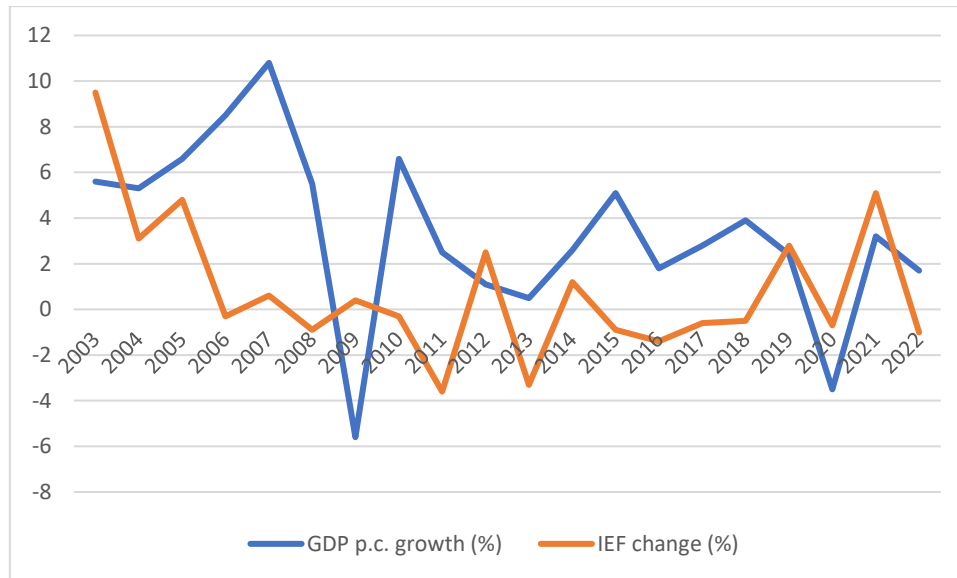


Figure 2. Development of the growth rate of GDP per capita and the IEF (%).

Source: own processing according to the Heritage Foundation and the WB database

4.2 Panel analysis

The basic characteristics of the dependent, independent and control variables using descriptive statistics are presented in Table 3.

Table 3. Descriptive statistics of dependent, independent and control variables

Variable	Average	Median
GROWTH	3,1362	3,0566
P_rights	73,667	70,9
J_effectiveness	63,261	57,35
G_integrity	61,67	50,5
T_burden	82,945	82,75
G_spending	61,67	52,3
F_health	87,344	86,05
B_freedom	77,358	70,4
L_freedom	76,563	77,05
M_freedom	82,082	81,5
T_freedom	86,133	86,95
I_freedom	76,75	75
F_freedom	75,167	80
FD_investment	9,49	5,3985
GC_formation	26,055	26,366
M_openness	220,48	168,25

Source: own processing

Figure 3 is an output from the Gretl program.

File Edit Tests Save Graphs Analysis LaTeX					
Model 1: Pooled OLS, using 60 observations					
Included 3 cross-sectional units					
Time-series length = 20					
Dependent variable: GROWTH					
	coefficient	std. error	t-ratio	p-value	
const	-43,6306	20,8935	-2,088	0,0426	**
P_rights	-0,0656231	0,0791399	-0,8292	0,4115	
J_effectiveness	-0,669220	1,10692	-0,6046	0,5486	
G_integrity	-0,0779702	0,102419	-0,7613	0,4505	
T_burden	0,181817	0,152597	1,191	0,2398	
G_spending	-0,108291	0,0799179	-1,355	0,1823	
F_health	0,812961	1,19637	0,6795	0,5004	
B_freedom	-0,112564	0,119020	-0,9458	0,3494	
L_freedom	-0,148848	0,0631676	-2,356	0,0230	**
M_freedom	0,316905	0,141302	2,243	0,0300	**
T_freedom	0,000797113	0,220528	0,003615	0,9971	
I_freedom	0,141619	0,128548	1,102	0,2766	
F_freedom	-0,00738165	0,0803260	-0,09190	0,9272	
FD_investment	0,311447	0,106423	2,927	0,0054	***
GC_formation	0,493284	0,192472	2,563	0,0139	**
M_openness	0,0334871	0,0211523	1,583	0,1206	
Mean dependent var	3,136215	S.D. dependent var	3,811098		
Sum squared resid	455,2314	S.E. of regression	3,216546		
R-squared	0,468773	Adjusted R-squared	0,287673		
F(15, 44)	2,588478	P-value(F)	0,007266		
Log-likelihood	-145,9301	Akaike criterion	323,8603		
Schwarz criterion	357,3698	Hannan-Quinn	336,9677		
rho	-0,151610	Durbin-Watson	2,005702		

Figure 3. Gretl output

Source: own processing in Gretl

The model explains 46.88% of the variability of the dependent variable (GDP growth p.c., %) and the model as a whole is statistically significant at the $\alpha = 5\%$ significance level.

Based on the results of the t-statistics, it can be concluded that the constant and the other four explanatory variables included in the model (labor freedom, monetary freedom, foreign direct investment, gross capital formation) are statistically significant at the $\alpha = 5\%$ significance level. The other sub-indexes of the economic freedom index together with the market openness indicator proved to be statistically insignificant in the model, and therefore have no effect on the economic growth of the observed countries (the Slovak Republic, the Czech Republic, Singapore).

The constant turned out to be negative (-43.6), i.e. assuming ceteris paribus, GROWTH will decrease by 43.6 units.

Labor freedom has a negative impact on GROWTH, which can be explained by the inclusion of only three countries in the model.

Monetary freedom is the only one of the IEF sub-indexes to have a positive impact on GROWTH in the countries that have been analyzed. When monetary freedom increases by one unit, assuming ceteris paribus, GROWTH increases by 0.317 units.

Foreign direct investments also affect GROWTH positively. If foreign direct investment increases by one unit, ceteris paribus, GROWTH increases by 0.311 units.

In the same way, the creation of gross capital has a positive impact on the growth of the economy according in the model. If gross capital formation increases by one unit, *ceteris paribus*, GROWTH will increase by 0.493 units.

The obtained results indicate that "certain aspects of economic freedom have a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore", therefore the special hypothesis 1 (H0) is accepted.

With the help of individual hypotheses, it will be clearly defined which aspects of economic freedom have a positive impact and which ones have a negative impact, i.e. which have no (statistically significant) impact on economic growth.

Property rights did not show a statistically significant effect on the dependent variable economic growth; therefore, Individual Hypothesis 1.1 (H0) - Property rights have a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore is rejected, and the alternative hypothesis (H1) - Property rights have a negative or no effect on economic growth in the surveyed countries is accepted.

The panel analysis did not show a positive, statistically significant relationship between the **judicial effectiveness** aspect of the Heritage Foundation's Index of Economic Freedom and economic growth in the sample of the Slovak Republic, the Czech Republic and Singapore, therefore Individual Hypothesis 1.2 Judicial efficiency has a positive effect on economic growth in the surveyed countries is rejected, while the alternative hypothesis (H1) – Judicial efficiency has a negative or no effect on economic growth in the countries under study is accepted.

Government integrity did not show a statistically significant relationship with the dependent variable economic growth in the selected countries, therefore Individual hypothesis 1.3 Government integrity has a positive effect on economic growth in the studied countries - is rejected, while the alternative hypothesis (H1) is accepted - Government integrity has a negative or no effect on economic growth in the Slovak Republic, the Czech Republic and Singapore.

Government spending did not show a statistically significant impact on the dependent variable, therefore Individual Hypothesis 1.4 (H0) – Government spending has a positive impact on economic growth in the Slovak Republic, the Czech Republic and Singapore – is rejected, and the alternative hypothesis (H1) – Government spending has a negative or no impact on economic growth in the surveyed countries – is accepted.

Likewise, another aspect of economic freedom, **the tax burden**, did not show a statistically significant effect on the dependent variable, therefore the Individual Hypothesis 1.5 (H0) – The tax burden has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore – is rejected, and the alternative hypothesis (H1) – The tax burden has a negative or no effect on economic growth in the surveyed countries – is accepted.

The panel analysis did not show a positive, statistically significant relationship between the aspect of **fiscal health** of the Heritage Foundation's Index of Economic Freedom and economic growth in the sample of the Slovak Republic, the Czech Republic and Singapore, therefore the Individual Hypothesis 1.6 Fiscal health has a positive effect on economic growth in the surveyed countries is rejected, while the alternative hypothesis (H1) – Fiscal health has a negative or no effect on economic growth in the countries under study is accepted.

The aspect of **business freedom** did not prove to be statistically significant either. Individual hypothesis 1.7 Business freedom has a positive effect on economic growth in the countries under study is rejected, while the alternative hypothesis (H1) is accepted – Business freedom has a negative or no effect on economic growth in the countries under study.

The aspect of economic freedom devoted to the liberalization of the labor market – **labor freedom** has a negative statistically significant effect on economic growth, therefore Individual Hypothesis 1.8 Labor freedom

has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore – is rejected. Since this aspect of economic freedom was formed in the Heritage Foundation's Index of Economic Freedom only in later years, it is possible that the lack of the required amount of data contributed to this result, or by including only three countries in the model.

Within the analysis, **monetary freedom** showed a POSITIVE, STATISTICALLY SIGNIFICANT impact on economic growth, i.e. Individual Hypothesis 1.9 Monetary freedom has a positive impact on economic growth in EU countries - is CONFIRMED.

The research did not show a statistically significant relationship between the aspect of **trade freedom** and economic growth in the Slovak Republic, the Czech Republic and Singapore, so Individual Hypothesis 1.10 Market freedom has a positive effect on economic growth in EU countries - is rejected.

Individual hypothesis 1.11 **Investment freedom** has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore is rejected, because the analysis did not reveal a statistically significant effect of the subindex of economic freedom – investment freedom on the variable GROWTH.

Similarly, in the case of the last examined sub-index of economic freedom, Individual Hypothesis 1.12 **Financial freedom** has a positive effect on economic growth in the Slovak Republic, the Czech Republic and Singapore is rejected, because the analysis did not reveal a statistically significant effect of the sub-index of economic freedom - Financial Freedom on the variable GROWTH.

Conclusions

The business environment in its broadest sense reflects the quality of the economic conditions and prerequisites for the economic activity of business entities. A high-quality business environment creating conditions for achieving long-term sustainable economic growth is a basic condition for business development and increasing the competitiveness of the country's economy on an international scale.

Several competitiveness rankings are available to assess the quality of the business environment. The article compares the quality of the business environment of selected countries through the Index of Economic Freedom from The Heritage Foundation.

According to the compilers of the Index of Economic Freedom as long as institutions protect the freedom of the individual, this has a positive effect on the growth of the prosperity of the entire society.

Since according to many authors (e.g. Kovačević and Borović, 2014; Brkić, 2020, Heckelman and Stroup, 2000 and others) the aggregate index of economic freedom may not be an accurate indicator of the economic growth of certain countries, the authors of the article verify this assumption through an empirical analysis of the impact of individual sub-indexes on economic growth. As a result, two of the twelve sub-indexes of the economic freedom index, namely the labor freedom sub-index and the monetary freedom sub-index, showed an impact on the economic growth of countries. Foreign direct investment and gross capital formation, which were also included in the model, also confirmed the impact on GDP growth in the surveyed countries. The positive impact of the subindex of monetary freedom is recorded, for example, in Ahmadi et al., 2013; Alexandrakis and Livanis, 2013; Cebula et al., 2013; Akin et al., 2014; Brkić, 2020. The negative impact of labor freedom on economic growth is the result of a study by Kovačević and Borović (2014).

Regardless of the model specification, the control variables showed the expected results in that gross capital formation as well as foreign direct investment have a positive, statistically significant effect on economic growth. The trade aspect did not show importance for growth in our sample of countries.

Although the panel model identified the element of economic freedom that contributes the most to economic growth (element of monetary freedom), economic freedom is a complex indicator, therefore, as a manifestation

of the synergy of all its basic elements in the creation of macroeconomic policy, importance should also be attributed to other sub-indexes of the IEF.

By choosing the Slovak Republic, the Czech Republic, Singapore and the observed period of 20 years, the authors bring new results to the studies carried out so far. Looking to the future, it would be appropriate to test, for example, the impact of economic freedom on other indicators such as for investments, which would indirectly demonstrate the impact on economic growth. The conducted empirical study examines the impact of individual sub-indexes of the index of economic freedom on the performance of the economy as a whole. It would be interesting to find out the impact on individual sectors of the economy, i.e. industry, agriculture and services. It could identify which sector is affected by which sub-index and how to transfer potential positives to other sectors.

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MEASURING THE SUSTAINABILITY OF ECONOMIC DEVELOPMENT IN THE EU COUNTRIES: A COMPARATIVE ANALYSIS OF THE EXISTING TOOLS*

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Abstract. This article aims to analyze and compare the existing tools for measuring the sustainability of economic development in EU countries. The primary method of empirical data processing in the framework of this study is a comparative analysis of the ranks of EU countries by new measurement tools in relation to the traditional ones, GDP and HDI). Sources of empirical data are analytical reports of international organizations, international statistical information from various institutions, open-access databases, and individual researchers' publications. The results of a comparison of the ranks of EU countries by GDP, HDI, Green GDP, Sustainable Development Goals Index (SDG Index), Green Economy Index (GEI), Green Growth Index (GGI), Sustainable Development Green Index (SDGI) show that basically, the ranks of each specific country within all ratings analyzed in this study are similar. Still, there are some exceptions (for example, Luxembourg). Given these results, developing multiple 'green' indices instead of one traditional GDP from a practical point of view seems completely unjustified and unnecessary. However, the author believes that the main driving force behind individual researchers and entire organizations' search for new tools is the real need for more comprehensive and multidimensional approaches to measuring economic progress and sustainable development. The many proposed tools for measuring the sustainability of territorial development provide a broader picture. It is unlikely that one instrument is most suitable for measuring the sustainability of economic development of the EU countries since each of them allows evaluating the sustainability of development (both economic and general) from its unique discourse.

Keywords: sustainability of economic development; sustainability of territorial development; measurement tools; comparative analysis; green economy; circular economy; the European Union countries.

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JEL Classifications: Q56, O44, R11

1. Introduction

The sustainability of economic development of any territory is based on the so-called 'Hartwick rule' (Hartwick, 1990), which refers to the sustainable use of natural resources in the economy and is a key element in the context of long-term development (Hamilton, 1995). The 'Hartwick rule' states that if an economy compensates for the depletion of natural resources (e.g., oil, gas, minerals) by adequate investment in produced capital (e.g., machinery, buildings, infrastructure, technology), then the level of consumption can be

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maintained at a constant level almost indefinitely (Hartwick, 1990). This means that income from exhaustible resources must be reinvested in other forms of capital (including human capital) to compensate for declining natural resource supplies (Hartwick, 1990; Hamilton, 1995). Sustainability of economic development, therefore aims to ensure that the economic benefits from using these resources extend to future generations.

In the international scientific space, there is a complete agreement that the traditional measurement tools of a country's achieved level of economic development, such as Gross Domestic Product (GDP) or Gross National Product (GNP), fail to account for the environmental issues and cannot measure whether the economy is developing towards a sustainable path (Hartwick, 1990; Hamilton, 1994, 1995; Costanza et al., 2014a, 2014b; Pokharel & Bhandari, 2017; Stjepanović et al., 2019; Ma et al., 2020; Wang et al., 2021 and many others). Instead, many other tools are proposed and used to assess the sustainability of economic development of the world's countries and their internal regions – for example, Green GDP, Gross Ecosystem Product (GEP), Gross Economic-Ecological Product (GEEP), Sustainable Development Goals Index (SDG Index), Green Economy Index (GEI), Green Growth Index (GGI), Global Green Economy Index (GGEI), Sustainable Development Green Index (SDGI), System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA-EA) (Hamilton, 1994; Li & Lang, 2010; Rauch & Chi, 2010; Ryszawska, 2013, 2015; Pokharel & Bhandari, 2017; Vimochana, 2017; Stjepanović et al., 2019, 2022; Ouyang et al., 2020; Ma et al., 2020; Niu et al., 2021; Wang et al., 2021; Wang et al., 2022; Lange et al., 2022; Sustainable Development Solutions Network, 2022; Zhao et al., 2023; Rybalkin, 2022, 2023; Global Green Growth Institute, 2023; Dual Citizen, 2023; United Nations, 2023a, 2023b).

Measurement of the sustainability of economic development, considering the impact of the economy on the environment, is also crucial for the EU countries, since, firstly, EU countries strive to reduce their carbon footprint and combat climate change (Rybalkin, 2020; Cifuentes-Faura, 2022; European Commission, 2023a). Secondly, the EU is actively implementing environmental standards and legislation (for example, the Paris Agreement, the European Green Deal). Thirdly, the EU emphasizes the importance of social responsibility and equity in economic growth (European Committee for Social Cohesion, 2004; Mikušová, 2017; Gkorezis & Petridou, 2017; MacGregor Pelikánová, 2019). Fourthly, the EU strives to be a world leader in environmentally sustainable development (Sustainable Development Solutions Network, 2022; European Parliament, 2023; Mentis, 2023), and then evaluating the impact of the economy on the environment emphasizes its role in promoting global environmental standards and cooperation with other countries and regions. Thus, integrating environmental aspects into the evaluation of sustainability of economic development is essential for the long-term prosperity and health of society, the economy and the environment in EU countries.

This article aims to analyze and compare the existing tools for measuring the sustainability of economic development in EU countries. The result of such a comparative analysis should be a conclusion about which of the existing tools is more suitable for measuring the sustainability of economic development in the EU countries, as well as the answer to the question of why so many new measurement tools have replaced one GDP. In the next section of the article, the author will review the literature on the sustainability of economic development of territories and existing measurement tools for evaluating the sustainability of economic development of territories. The research methodology will then be presented, followed by the study results and discussion. In the article's final section, the author will highlight the main findings of the study, as well as the limitations, and possible directions for future research in the relevant area.

2. Literature review

The transition from the conception of quantitative economic growth (Kuznets, 1949) to the idea of sustainable economic development (based on the conceptions of green economy and circular economy – Ryszawska, 2013; Kasztelan, 2017; Razminienė et al., 2021; Rybalkin, 2023) began in the second half of the 20th century (Barbier, 1987; Wang, 1996), mainly in developed countries, including Western Europe, North America and also some Asian countries such as Japan. This process was determined by several key factors: (1) in Western Europe and North America, where industrialization began earlier, environmental problems such as air and water pollution became apparent by the 1970s, leading to increased public and political attention to

environmental issues; (2) significant economic development has been achieved in these regions, which has brought attention to issues related to the sustainability of the economic growth, including natural resource depletion and inequality; (3) developed countries played a key role in international efforts to promote sustainable development, including signing international treaties and participating in global conferences; (4) in these countries, there was significant academic and research interest in the environmental and social aspects of economic development, which contributed to the formation and dissemination of the conception of sustainable development; (5) the active participation of non-governmental organizations, environmental movements and the public in these countries also contributed to the rethinking of traditional approaches to economic development. Subsequently, the idea of economic development focused on sustainability, social justice and environmental responsibility, and not just traditional economic growth, gained widespread acceptance and began to permeate economic development policies and practices around the world, including in developing countries, where it was adapted to local conditions and challenges (Huambachano, 2011; Markard et al., 2012; Boronenko & Drezgic, 2014; Boronenko et al., 2015; Lonska & Boronenko, 2015; Komarova, 2016; Komarova & Drezgic, 2016; Carbonnier et al., 2017; Kasztelan, 2017; Sánchez García & Díez Sanz, 2018; Okunevičiūtė Neverauskienė et al., 2020; Beirne & Fernandez, 2022; Focardi & Fabozzi, 2023).

In the 1970s, studies emerged, such as the report “The Limits to Growth” published by the Club of Rome, which emphasized that unlimited economic growth was impossible due to limited natural resources and the environmental impact of human industrial activities (Meadows et al., 1972). This message has been noted as an effective antecedent to the conception of ‘post-growth economy’ – an economic system in which the emphasis is not so much on quantitative economic growth, measured by traditional indicators such as GDP, but on sustainable qualitative development and social well-being, environmental sustainability and equitable distribution of resources (D’Alessandro et al., 2018), as well as to the ‘degrowth’ movement – a radical economic theory born in the 1970s, which broadly means shrinking rather than growing economies, to use less of the world’s dwindling resources, or a planned reduction of energy and resource use designed to bring the economy back into balance with the living world in a way that reduces inequality and improves human well-being (Hickel, 2019, 2021).

In 1972, the first UN Conference on the Human Environment took place in Stockholm, which became a turning point in the discussion of global environmental problems. One of the major results of the Stockholm conference was the creation of the United Nations Environment Program (UNEP) (United Nations, 2023c). In 1987, the report “Our Common Future” (also known as the Brundtland report) introduced the notion of sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 1987). The growing global connectivity and interdependence of countries (especially since the collapse of the socialist bloc in the 1990s) has shown that many environmental and social problems are global and require coordinated efforts (Wu et al., 2022; Xia et al., 2022; Zhang et al., 2022). Furthermore, growing awareness of global inequality and social issues has led to the understanding that economic development must be inclusive (Rauniyar & Kanbur, 2010; Zhu, 2022) and should involve a combination of mutually reinforcing measures including (Rauniyar & Kanbur, 2010): (1) promoting efficient and sustainable economic growth, (2) ensuring a level political playing field and (3) strengthening capacities and providing for social safety nets. Thus, the conception of sustainable economic development is the result of a profound revision of traditional approaches to economic growth, including the consideration of environmental and social issues in the planning and implementation of development policies (Pearce & Atkinson, 1993).

Recognizing the vital need for sustainable economic development, however, the question of how to measure the achievements of different countries of the world on the path to sustainable economic development in a situation where traditional GDP is unanimously rejected by the international scientific community remains unclear. What is proposed instead as measuring tools for the sustainability of economic development? In the international scientific literature, the author was able to find many relevant measurement tools – for example, such as Green GDP (Li & Lang, 2010; Pokharel & Bhandari, 2017; Vimochana, 2017; Stjepanović et al., 2019, 2022; United Nations, 2023a), Gross Ecosystem Product (GEP) (Ouyang et al., 2020; Wang L et al., 2022; Zhao et al., 2023), Gross Economic-Ecological Product (GEEP) (Ma et al., 2020; Niu et al., 2021; Wang et al., 2021), Sustainable Development Goals Index (SDG Index) (Sustainable Development Solutions

Network, 2022); Green Economy Index (GEI) (Ryszawska, 2013, 2015), Green Growth Index (GGI) (Global Green Growth Institute, 2023), Global Green Economy Index (GGEI) (Dual Citizen, 2023), Sustainable Development Green Index (SDGI) (Rybalkin, 2022, 2023), System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA-EA) (Lange et al., 2022; United Nations. 2023b).

First of them, Green GDP (GGDP) (or environmentally adjusted GDP) derived from Net Domestic Product (NDP) is an alternative indicator of economic activity that considers the impact of economic activity on the natural environment and resources (Hamilton, 1994; Li & Lang, 2010; Rauch & Chi, 2010; Pokharel & Bhandari, 2017; Vimochana, 2017; Stjepanović et al., 2019, 2022). The conception of Green GDP emerged in the late 1980s as a response to growing concerns about environmental sustainability and the shortcomings of traditional GDP in measuring economic well-being (Hamilton, 1994). Green GDP has been supported and used by international organizations such as the UN and the World Bank (United Nations, 2023b). Unlike traditional GDP, Green GDP includes adjustments for losses from pollution, natural resource depletion, and other environmental variables. Despite significant efforts, the application of the Green GDP in practice has encountered a number of problems related to methodology, data accuracy and political will (Jiang, 2007; Rauch & Chi, 2010; Vimochana, 2017). This has meant that Green GDP has not been widely adopted as a standard indicator of economic well-being, but has contributed to developing other sustainable economic development measurement tools. However, there is an open access database containing Green GDP values versus traditional GDP values for 160 countries from 1970 to 2019 (Škare et al., 2021).

In the 2000s, the conception of Gross Ecosystem Product (GEP) began to be developed in China, which, like Green GDP, was a response to the growing awareness that traditional tools for measuring economic development (such as GDP) do not take into account the full cost of depreciation of ecosystems and used natural resources. One of the pioneers in this field is Chinese ecologist Ouyang, who played a key role in developing and implementing GEP in China. "GDP fails to fully capture nature's contributions to economic activity and human well-being. To address this critical omission, we develop a measure of GEP that summarizes the value of ecosystem services in a single monetary metric" (Ouyang et al., 2020). China was one of the first countries to (and continues to this day) actively use GEP as a tool for evaluating environmental achievements and the impact of environmental policies at the national and regional levels, especially in regions rich in natural resources (Ouyang et al., 2020; Wang et al., 2022; Zhao et al., 2023). At the same time, Chinese researchers do not claim that GEP can completely replace GDP in measuring the economic development of a territory. Rather, they emphasize that GEP is an important complement to traditional economic development measurement tools (such as GDP) (Wang et al., 2022; Zhao et al., 2023).

Another conception for evaluating economic activity considering its impact on the environment is Gross Economic-Ecological Product (GEEP), developed and tested by scientists from the Chinese Academy of Environmental Planning in order to obtain a more complete picture of economic progress in China, including its environmental impacts and sustainability (Ma et al., 2020; Niu et al., 2021; Wang et al., 2021). According to the creators of the GEEP, this tool can help governments and organizations make more evidence-based decisions, striving for a balance between economic growth and environmental safety. "The development of this new accounting system is an important step toward a more accurate measure to capture the change of ecosystem services in national accounts and a policy instrument to grow the economy within the means of the environment" (Wang et al., 2021). For the authors of the GEEP, the ultimate goal of this tool is to become a satellite national account parallel with GDP to measure sustainable economic development. "Many improvements are needed to achieve that goal. Notably, considerable uncertainties exist in the GEEP accounting, especially in various aspects of the valuation of ecosystem services and environmental degradation" (Wang et al., 2021).

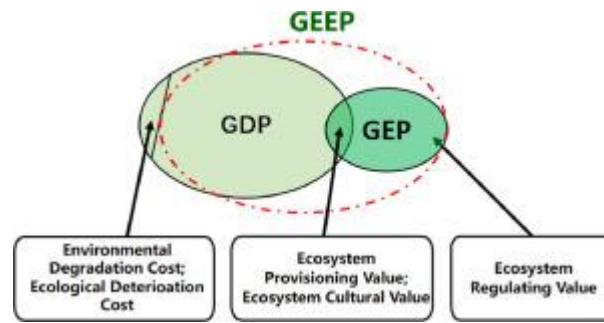


Fig. 1. Conceptual framework of the Gross Economic-Ecological Product (GEEP)

Source: Wang et al., 2021.

Unlike Green GDP, which always adjusts the territory's GDP downward (Škare et al., 2021), the GEEP value exceeds the territory's GDP, since it also includes the value of services provided by ecosystems. For example, in 2016, China's GEEP was 126.6 trillion RMB, 1.6 times of GDP (Ma et al., 2020). Currently, in China, the conceptions of GEP and GEEP are to a certain extent competitors in the field of measuring the sustainability of economic development of the country's regions and are used in parallel (Ma et al., 2020; Ouyang et al., 2020; Niu et al., 2021; Wang et al., 2021; Wang et al., 2022; Zhao et al., 2023). Although GEP and GEEP have overlapping goals of integrating environmental considerations into economic accounting, they serve different functions and are not interchangeable. GEP focuses on accounting for the value of ecosystem services, while GEEP is a broader accounting tool that incorporates and adjusts traditional GDP to add an environmental dimension.

GEP and GEEP are the result of China's efforts to integrate environmental factors into traditional measurement tools of the economic development and the pursuit of more sustainable development, and are not used in other countries and regions of the world to evaluate the sustainability of economic development of territories. However, there is significant global interest in integrating environmental indicators and ecosystem services into economic planning and policy development (Sustainable Development Solutions Network, 2022). This includes the development and use of various tools and approaches aimed at evaluating environmental sustainability and environmental impact of an economy. In the EU, efforts to develop and use different tools for measuring the sustainability of economic development are often carried out within the framework of broad strategies (Mentes, 2023), such as the European Green Deal, which aim to promote sustainable development and a green economy (Ryszawska, 2013, 2015).

One of the newest tools for measuring sustainability of development of the European countries is the Sustainable Development Goals (SDG) Index, first issued in 2016. SDG Index is an initiative of the UN Sustainable Development Solutions Network (SDSN) in collaboration with SDSN Europe and Bertelsmann Stiftung. It aims to measure human welfare beyond the traditional GDP metric by incorporating 110 indicators that cover social and economic prosperity, as well as environmental sustainability. This index also penalizes countries for negative social and environmental impacts caused by unsustainable supply chains, consumption, profit shifting, and tax evasion (Sustainable Development Solutions Network, 2022). The SDG Index differs from traditional GDP in several ways. While GDP focuses on economic activity, the SDG Index provides a more comprehensive assessment of a country's performance in achieving sustainable development. This includes social and environmental factors, thus offering a broader perspective on national well-being and progress (Our World in Data team, 2023).

The next measurement tool, Green Economy Index (GEI), created by Ryszawska, was developed through an iterative process that began with an overview of the definitions of a green economy presented in selected strategic documents. The approach involved outlining and specifying areas and objectives of the green economy, distinguishing specific objectives and variables for measuring the implementation of these individual objectives (Ryszawska, 2013). The GEI was proposed in response to the growing need to measure

the actual implementation of green economy policies. It was developed amidst various approaches by international organizations like OECD, UNEP, World Bank, and Global Green Growth Institute, and consulting companies like Dual Citizen (Ryszawska, 2015). According to its creator, GEI is a critical tool for understanding and evaluating the implementation of green economy practices globally, providing insights into how nations are transitioning towards more sustainable economic practices. This includes analysis of aspects such as green economy leadership, domestic policies, investments in green technologies and green tourism (Ryszawska, 2013, 2015; Rybalkin, 2023).

Another measurement tool, the Green Growth Index (GGI) was developed as a collaborative effort among several international organizations, namely the Global Green Growth Institute (GGGI), Organisation for Economic Cooperation and Development (OECD), United Nations Environment Programme (UNEP) and the World Bank. This initiative was aimed at standardizing and integrating the measurement of green economy and green growth, reflecting the collective effort to develop a comprehensive framework for assessing such policies and practices (Global Green Growth Institute, 2023). GGI includes four dimensions, one of which is directly related to economic development, and the others to territorial development in a broader sense: (1) efficient and sustainable resource use; (2) natural capital protection; (3) green economic opportunities; (4) social inclusion. GGI and the previously reviewed Green Economy Index (GEI) are related in their focus on sustainable development and green economy, but they were developed independently by different authors and organizations (Ryszawska, 2013, 2015; Global Green Growth Institute, 2023), with their own unique methodologies and objectives. Moreover, we have also the Global Green Economy Index (GGEI) developed by Dual Citizen LLC, a consulting firm. It is an analytical tool that measures the green economic performance, focusing on aspects like leadership and climate change, environmental sectors, and green tourism. This index was first calculated in 2010 and is designed to evaluate the green economy performance of various countries (although it is not an open access tool) (Dual Citizen, 2023).

One more tool for measuring the sustainability of economic development and development in a broader sense, Sustainable Development Green Index (SDGI), was created by Rybalkin within the Ph.D. thesis at Daugavpils University (Latvia) (Rybalkin, 2023). SDGI is based on the Quintuple Helix Model, which consists of five subsystems: educational, economic, political, societal and environmental. Particular attention is paid to the educational subsystem, since its inclusion is methodologically innovative as compared to other similar indexes and allows to perform interdisciplinary analysis of green economy in the context of sustainable development (Rybalkin, 2022, 2023). Based on his analysis for the EU countries, Rybalkin concluded that the economic subsystem of SDGI does not possess a high differentiating significance dividing the EU countries by the performance of green economy in the context of sustainable development. This conclusion makes it impossible for some countries to appeal to so-called split between Central-Eastern and Western Europe, as well as to a pronounced North-South divide, according to which the new EU members supposedly do not have necessary resources to develop green economy because of lower level of economic development. Just the reverse: the results of analysis with the help of SDGI show that countries can improve the sustainability of economic development by focusing on educational (primarily), social and political factors (Rybalkin, 2023).

The last tool for measuring the sustainability of economic development of territories reviewed within this study is the System of Environmental-Economic Accounting (SEEA) (Lange et al., 2022; United Nations, 2023b). The System of Environmental Economic Accounting (SEEA) is the international statistical standard for natural capital accounting, organizing environmental data and linking them to economic data. The SEEA provides a statistical framework from which aggregated 'green' economic indicators can be calculated (United Nations, 2023b). In March 2021, the UN Statistical Commission adopted the revised ecosystem accounting framework (System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA-EA)) (UN 2021).

This new framework builds on an earlier adopted experimental approach (SEEA-EEA), UN, 2012, UN, 2017) and forms the foundation for a transformation in the national accounting and economic reporting aiming for a better recognition of our natural capital (Lange et al., 2022). In combination with the growing relevance and increasing awareness of ecosystem accounting in policy- and decision-making in the countries and within supranational bodies like the UN and the EU, it is expected a significant increase in completed ecosystem accounts in the foreseeable future (Lange et al., 2022).

In the scientific literature there are quite rare attempts to compare many relevant tools for measuring the sustainability of economic development - for example, Stjepanović and his colleagues compared alternative tools for measuring socio-economic well-being (20 in total, including such as Index of Sustainable Economic Welfare, Genuine Progress Indicator, Environmentally-Adjusted Net Domestic Product and many others) in relation to traditional GDP and concluded about each of them in terms of whether a particular alternative measurement tool complements, replaces or corrects traditional GDP (Stjepanović et al., 2022). In turn, Rybalkin in his Ph.D. thesis “Green Economy in the Context of the European Union's Sustainable Development in 2017–2020” (2023) compared tools for measuring sustainable development in a broader sense than just the economic one, and came to the need to create a new index consisting of five subsystems (economic, environmental, political, societal and educational) and further expanding the meaning of sustainable development of territories (Rybalkin, 2023). However, none of the above-mentioned and other authors, who compared current tools for measuring the sustainability of economic development and territorial development in a broader sense, compared the positions of countries (in particular, the EU countries) on all these indices and did not conclude about the real practical need to create such a variety of tools for measuring sustainability of development instead of one traditional GDP. With this study, the author hopes to fill this research gap.

3. Research methodology

To achieve the aim of this study to analyze and compare the existing tools for measuring the sustainability of economic development in the EU countries, the author uses data from various sources to assess and compare the positions of the EU countries according to various tools for measuring the sustainability of development. Despite the fact that the subject of this study is measuring the sustainability of economic development specifically, the author also touches on the topic of measuring the sustainability of territorial development in a broader sense (traditionally it is measured using the Human Development Index (HDI), which evaluates the quality of human capital in a certain territory). This makes it possible to create a broader and more realistic context for a comparative analysis of existing measurement tools, which are sometimes most suitable for measuring the sustainability of economic development specifically, and sometimes for measuring the sustainability of territorial development in a broader sense. The following figure presents those specific tools for measuring the sustainability of territorial development (both economic and more general), which were analyzed by the author in the previous section of the article during the literature review and for which ratings of EU countries are available.

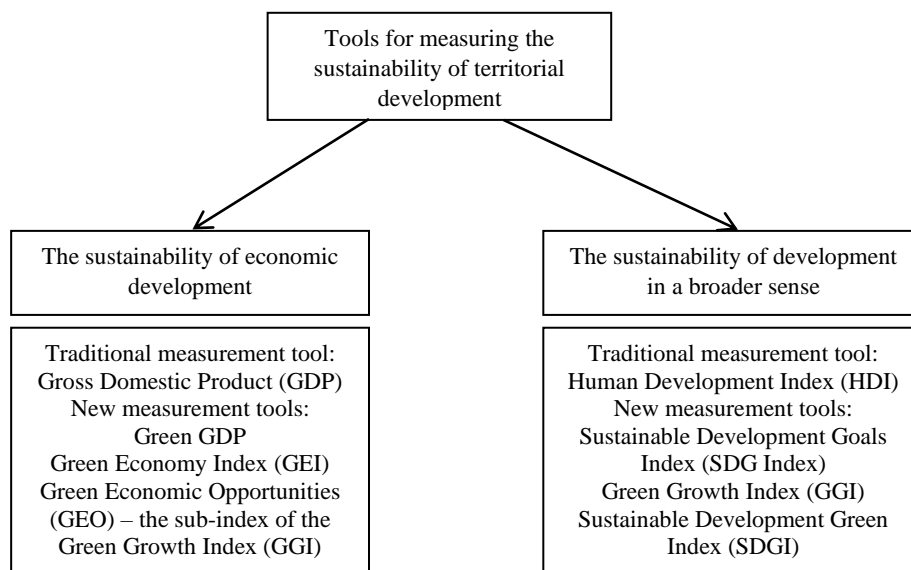


Fig. 2. Specific tools for measuring the sustainability of territorial development available for the EU countries

Source: elaborated by the author based on literature review

The main method of empirical data processing in the framework of this study is a comparative analysis of the positions of EU countries in the ratings of existing new measurement tools of the sustainability of economic development and the sustainability of development in a broader sense, in relation to the traditional measurement tools (GDP and HDI). Sources of empirical data are analytical reports of international organizations (for example, Human Development Report 2021/2022 (Human Development Report Office, 2022)), international statistical information from various institutions (for example, European Commission, Eurostat, United Nations Economic Commission for Europe (UNECE), open access databases (for example, International Database on Green GDP 1970-2019 (Škare et al., 2021)), as well as publications by individual researchers (for example, Ryszawska, 2015; Stjepanović et al., 2019; Rybalkin, 2023).

4. Study results and discussion

The main result of this study is a comparison of the tools proposed in the international scientific literature (and reviewed in the Section 2 of this article) for measuring the sustainability of economic development (as well as development in a broader sense) of a territory and their relationship with such a traditional tool for measuring the economic development of a territory as GDP (and in some cases with HDI). The author will begin presenting the research results with a comparative analysis of Green GDP and traditional GDP in the EU countries.

Table 1. Ranking EU countries by Green GDP in comparison with traditional GDP, n = 26 countries,* 2019

EU country**	Difference between GDP and Green GDP, %	GDP per capita (current US\$)	Rank by GDP per capita	Green GDP per capita	Rank by Green GDP per capita
Luxembourg	0,2	115826	1	115631	1
Ireland	0,2	79258	2	79111	2
Denmark	0,5	59951	3	59622	3
Netherlands	0,5	52602	4	52335	4
Sweden	0,2	51889	5	51761	5
Austria	0,3	50381	6	50252	6
Finland	0,4	48707	7	48529	7
Germany	0,2	46322	8	46213	8
Belgium	0,2	46232	9	46125	9
United Kingdom	0,6	42419	10	42175	10
France	0,2	40355	11	40290	11
Italy	0,3	33456	12	33370	12
Spain	0,3	29702	13	29621	13
Cyprus	0,4	28045	14	27940	14
Slovenia	0,3	25826	15	25746	15
Estonia	0,9	23691	16	23485	16
Portugal	0,4	23129	18	23040	17
Czechia	0,6	23145	17	22996	18
Greece	0,4	19567	19	19484	19
Lithuania	0,4	19404	20	19335	20
Slovakia	0,4	19342	21	19263	21
Hungary	0,5	16471	22	16388	22
Poland	1,0	15594	23	15441	23
Croatia	0,8	14821	24	14702	24
Romania	0,7	12881	25	12788	25
Bulgaria	1,4	9704	26	9565	26

* Latvia and Malta are not included in the database on Green GDP (Škare et al., 2021).

** EU countries are listed by the Green GDP rank.

Source: calculated and compiled by the author based on the data from Škare et al., 2021; European Commission, 2023b.

As the data in Table 1 shows, the values of Green GDP in most EU countries differ by only tenths of a percent, and the rankings of EU countries in terms of traditional GDP and Green GDP are almost completely identical (with one minor exception for Portugal and Czechia). Even though Green GDP is an improved modified version of traditional GDP, countries with a comparatively high GDP also have a comparatively

high Green GDP, and vice versa. Thus, in the empirical practice of measuring the sustainability of economic development in the EU countries, additional efforts to calculate Green GDP are methodologically sound and meet the requirements of the time, but say little new about the economic development of countries (except, perhaps, that the Bulgarian economy is the most unfriendly in relation to the environment).

Table 2. Ranking EU countries by the Sustainable Development Goals (SDG) Index in comparison with traditional GDP and HDI, n = 27 countries, 2022

EU country*	GDP per capita, %, EU=100	Rank by GDP per capita	HDI,** score 0–1	Rank by HDI	SDG Index, score 0–100	Rank by SDG Index
Finland	109	9	0.940	6	81.7	1
Sweden	120	6–7	0.947	2	80.6	2
Denmark	137	3	0.948	1	79.2	3
Austria	125	4	0.916	11	78.2	4
Germany	117	8	0.942	4	74.8	5
Czechia	91	15	0.889	17	74.2	6
Slovenia	92	13–14	0.918	9–10	74.0	7
Estonia	87	17	0.890	16	73.2	8
France	102	10–11	0.903	13	73.1	9
Poland	80	19	0.876	19	72.4	10
Ireland	233	2	0.945	3	72.2	11
Belgium	120	6–7	0.937	7	71.7	12
Netherlands	129	4	0.941	5	71.6	13
Croatia	73	24	0.858	23	70.7	14
Portugal	77	20–22	0.866	21	70.6	15–16
Italy	96	12	0.895	15	70.6	15–16
Slovakia	68	25–26	0.848	24	70.2	17
Spain	85	18	0.905	12	70.1	18
Hungary	77	20–22	0.846	25	69.9	19
Latvia	74	23	0.863	22	69.5	20
Luxembourg	261	1	0.930	8	68.7	21
Lithuania	89	16	0.875	20	66.1	22
Greece	68	25–26	0.887	18	65.7	23
Malta	102	10–11	0.918	9–10	64.9	24
Romania	77	20–22	0.821	26	63.4	25
Cyprus	92	13–14	0.896	14	60.7	26–27
Bulgaria	59	27	0.795	27	60.7	26–27

* EU countries are listed by SDG Index rank.

** Human Development Index (HDI) values 2021 (Human Development Report Office, 2022).

Source: compiled by the author based on the data from Sustainable Development Solutions Network, 2022; Human Development Report Office, 2022; Eurostat Statistics Explained, 2023.

As the data in Table 2 shows, the 2022 SDG Index for the EU countries is topped by Northern European countries. Finland ranks first, followed by Sweden and Denmark, which all have scores close to or above 80 (out of 100). Yet the SDG dashboards show that even these countries face major challenges in achieving at least two goals (Sustainable Development Solutions Network, 2022): (1) unsustainable diets and food systems (for example, typical diets are to a large extent composed of meat, fish or dairy products, with a low consumption of vegetables); (2) inequalities within countries (there are persisting gaps in access to and quality of services and opportunities across population groups). The last positions in the ranking of SDG Index are already usually occupied by Romania and Bulgaria (which occupy the last positions in almost all rankings for the EU countries), but in this case Cyprus is also ‘squeezed’ between them. As for the ranking of traditional GDP, according to Table 2 you can see that it does not coincide with SDG Index ranking, as was the case with Green GDP, although here Bulgaria usually ranks last, and Northern and Western European countries are usually in the first ten.

Since SDG Index measures the sustainability of development in a broader sense rather than sustainability of economic development, its ranking can be expected to be more similar to the ranking of countries by traditional tool for measuring the sustainability of development of a territory in a broader sense, namely the Human Development Index (HDI). The results of correlation analysis using Spearman's rank correlation

coefficient show that the relationship between the ranks of EU countries by SDG Index and GDP is quite strong and statistically significant ($p = 0.532$, $r = 0.004$, probability 99%), but is slightly weaker than the relationship between the ranks EU countries by SDG Index and HDI ($p = 0.603$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 2), although this difference (0.532/0.603) in the strength of the relationship between the ranks of EU countries by SDG Index and GDP and between the ranks of EU countries by SDG Index and HDI cannot be considered significant. Interestingly, the ranks of EU countries by traditional instruments for measuring economic development (GDP) and development in a broader sense (HDI) are very strongly correlated with each other ($p = 0.899$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 2). Thus, we can say that the ranking of EU countries by SDG Index, much more than by Green GDP, differs from the ranking by traditional tools for measuring territorial development – GDP and HDI. For example, Latvia has a higher rank by SDG Index than by GDP and HDI, and Lithuania – vice versa (Table 2).

Table 3. Ranking EU countries by the Green Economy Index (GEI) in comparison with traditional GDP and HDI, n = 27 countries,* 2013

EU country**	GDP per capita, USD adjusted by PPP	Rank by GDP per capita	Standardized GEI, score 0–1	GEI, score 0–1	Rank by GEI
Sweden	46312.4	6	1.00	0.66	1
Netherlands	49242.5	2	1.00	0.66	2
Denmark	46742.9	5	0.96	0.65	3
Austria	47936.8	3	0.96	0.65	4
Germany	44993.9	7	0.88	0.62	5
United Kingdom	39989.2	10	0.81	0.60	6
Belgium	43670.9	8	0.69	0.56	7
Ireland	47836.1	4	0.68	0.56	8
France	39528.6	11	0.66	0.55	9
Finland	41492.8	9	0.66	0.55	10
Slovenia	29979.4	17	0.53	0.52	11
Luxembourg	100927.3	1	0.52	0.51	12
Latvia	22637.3	25	0.52	0.51	13
Malta	32297.3	14	0.50	0.51	14
Italy	36267.9	12	0.48	0.50	15
Lithuania	26721.4	21	0.43	0.48	16
Hungary	24548.0	23	0.40	0.48	17
Estonia	27418.9	20	0.40	0.47	18
Czechia	30828.5	15	0.37	0.47	19
Poland	24028.1	24	0.36	0.47	20
Slovakia	28021.3	18	0.34	0.46	21
Spain	32463.1	13	0.34	0.46	22
Romania	19678.0	26	0.21	0.42	23
Cyprus	30460.7	16	0.20	0.41	24
Portugal	27935.9	19	0.16	0.40	25
Bulgaria	16654.2	27	0.03	0.36	26
Greece	25986.5	22	0.00	0.36	27

* Croatia is not included in the 2013 list of countries because it was a member of the EU for only an incomplete year – from 1 July 2013.

** EU countries are listed by GEI rank.

Source: compiled by the author based on the data from Ryszawska, 2015; [United Nations Economic Commission for Europe \(UNECE\)](#), 2023.

As the data in Table 3 shows, in the ranking of EU countries according to the Green Economy Index (GEI) the countries of Northern and Western Europe are still in the lead, and Bulgaria usually closes the ranking, but this time together with Greece and Portugal, i.e. countries of Southern Europe. The results of the correlation analysis using the Spearman rank correlation coefficient show that the relationship between the ranks of EU countries by GEI and GDP is strong and statistically significant ($p = 0.785$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 3). At the same time, in the ranking of EU countries by GEI, the top three are the countries of Northern Europe, and in the ranking by traditional GDP – the countries of Western Europe. In turn, in the last three of the ranking of EU countries by GEI are only the countries of Southern Europe (Portugal, Bulgaria and Greece), and in the ranking of EU

countries by traditional GDP in the last three are the countries of Southern Europe (Romania and Bulgaria), as well as Latvia. The position of some EU countries in these two ratings is radically different – for example, Luxembourg and Latvia occupy, respectively, 12th and 13th positions in the ranking of EU countries by GEI, although in terms of traditional GDP, Luxembourg is the leader in the ranking, and Latvia is in the last three countries. Thus, despite the strong and statistically significant correlation between the rankings of EU countries by GEI and GDP, the positions of some countries in these rankings are very different from each other and require additional study (considering, for example, the fact that in Luxembourg the difference between traditional GDP and Green GDP is minimal, and it is the leader in the ranking of EU countries by Green GDP – Table 1).

Table 4. Ranking EU countries by the Green Growth Index (GGI) and Green Economic Opportunities (GEO)* in comparison with traditional GDP and HDI, n = 26 countries, ** 2022

EU country***	GDP per capita, %, EU=100	Rank by GDP per capita	HDI, **** score 0–1	Rank by HDI	GEO, score 0–100	Rank by GEO	GGI, score 0–100	Rank by GGI
Denmark	137	3	0.948	1	63.84	1	75.32	1
Sweden	120	6–7	0.947	2	57.96	6	75.09	2
Austria	125	4	0.916	11	52.27	11	72.32	3
Finland	109	9	0.940	6	58.86	5	71.69	4
Czechia	91	14	0.889	16	61.85	2	71.29	5
Italy	96	12	0.895	14	57.63	7	70.22	6
Germany	117	8	0.942	4	60.55	3	70.04	7
Estonia	87	16	0.890	15	59.12	4	68.50	8
Latvia	74	22	0.863	21	49.40	13	68.24	9
Slovakia	68	24–25	0.848	23	49.51	12	67.60	10
Portugal	77	19–21	0.866	20	47.25	15	66.32	11
Belgium	120	6–7	0.937	7	55.88	8	64.94	12
Hungary	77	19–21	0.846	24	55.10	9	64.82	13
France	102	10–11	0.903	13	45.39	18	64.66	14
Croatia	73	23	0.858	22	44.29	20	64.49	15
Slovenia	92	13	0.918	9–10	41.78	21	64.00	16
Spain	85	17	0.905	12	47.61	14	63.67	17
Lithuania	89	15	0.875	19	46.47	17	63.65	18
Netherlands	129	4	0.941	5	46.76	16	63.38	19
Poland	80	18	0.876	18	52.48	10	62.00	20
Romania	77	19–21	0.821	25	44.56	19	59.00	21
Ireland	233	2	0.945	3	38.15	23	59.00	22
Luxembourg	261	1	0.930	8	33.19	24	59.00	23
Greece	68	24–25	0.887	17	30.95	25	57.00	24
Bulgaria	59	26	0.795	26	40.67	22	57.00	25
Malta	102	10–11	0.918	9–10	2.45	26	28.00	26

* Green Economic Opportunities (GEO) is an economic dimension of the green growth, sub-index of GGI (Global Green Growth Institute, 2023).

** Cyprus is not included in the database on GGI (Global Green Growth Institute, 2023).

*** EU countries are listed by GGI rank.

**** Human Development Index (HDI) values 2021 (Human Development Report Office, 2022).

Source: compiled by the author based on the data from Global Green Growth Institute, 2023; Human Development Report Office, 2022; Eurostat Statistics Explained, 2023.

As the data in Table 4 shows, the ranks of EU countries in the Green Growth Index (GGI) and its most economic sub-index, Green Economic Opportunities (GEO), are already quite different from their ranks in the ratings of traditional instruments for measuring territorial development (GDP and HDI), although the opposition between the leading North and the lagging South remains here too. The results of correlation analysis using Spearman's rank correlation coefficient show that there is no statistically significant relationship between the ranks of EU countries by GGI / GEO and GDP ($p = 0.263 / 0.205$, $r = 0.194 / 0.315$), and there is also no relationship between the ranks of EU countries by GGI / GEO and HDI ($p = 0.288 / 0.243$, $r = 0.154 / 0.231$) (the author's calculations with the IBM SPSS Statistics based on the data from Table 4).

The case of Latvia: in contrast to the relatively low level of economic development and development in a broader sense (22nd rank by GDP and 21st rank by HDI), Latvia occupies a relatively high 9th rank by GGI and 13th rank by its economic sub-index (GEO), which shows the opportunities for a green economy. In turn, Luxembourg, which has a high level of economic development and development in a broader sense (1st rank by GDP and 8th rank by HDI), occupies a very low 23rd rank by GGI and 24th rank by its economic sub-index (GEO).

Table 5. Ranking EU countries by the Sustainable Development Green Index (SDGI) in comparison with traditional GDP and HDI, n = 27 countries, 2020

EU country*	GDP per capita, USD adjusted by PPP	Rank by GDP per capita	HDI, score 0–1	Rank by HDI	SDGI, score 0–100	Rank by SDGI
Sweden	55631.0	6	0.942	4	58.97	1
Denmark	60020.7	3	0.947	1	57.75	2
Germany	55433.6	7	0.944	2	56.42	3
Finland	50935.4	9	0.938	6	56.02	4
France	46864.1	10	0.898	13	54.69	5
Netherlands	59001.0	4	0.939	5	54.38	6
Austria	55916.3	5	0.913	9–10	52.22	7
Luxembourg	118401.8	1	0.924	8	52.14	8
Spain	37663.8	19	0.899	12	51.37	9
Estonia	38497.7	18	0.892	15–16	51.07	10
Italy	42103.5	12	0.889	17	50.82	11
Belgium	53536.2	8	0.928	7	50.55	12
Ireland	94046.5	2	0.943	3	50.08	13
Slovenia	39825.7	15	0.913	9–10	48.59	14–15
Czechia	41706.8	13	0.892	15–16	48.59	14–15
Portugal	34250.9	20	0.863	22	48.47	16
Latvia	32114.1	24	0.871	21	48.29	17
Lithuania	39167.7	16	0.879	19	47.82	18
Greece	27901.2	26	0.886	18	47.60	19
Slovakia	31811.6	25	0.857	23	45.95	20
Croatia	38720.6	17	0.855	24	45.53	21
Malta	44600.1	11	0.911	11	45.46	22
Romania	32628.7	23	0.824	26	45.25	23
Hungary	33377.1	22	0.849	25	44.95	24
Cyprus	40967.5	14	0.894	14	43.50	25
Bulgaria	24786.4	27	0.802	27	43.46	26
Poland	34040.7	21	0.876	20	43.21	27

* EU countries are listed by SDGI rank.

Source: compiled by the author based on the data from Rybalkin, 2023; Human Development Report Office, 2022; United Nations Economic Commission for Europe (UNECE). 2023.

As the data in Table 5 shows, in general, in the SDGI ranking, the countries of Northern and Western Europe expectedly occupy leading positions, and Bulgaria, as usual, is at the bottom of the list of the EU countries. But there are also surprises in the SDGI rating – for example, Poland has the lowest rank, which has not happened to it in any other ranking. According to the calculations of the creator of the SDGI, Poland got the lowest rank in the ranking mainly due to the relatively low level of development of the political subsystem of the SDGI (37.50 points in comparison even with Bulgaria, which was ahead of it with 42.14 points in the political subsystem) (Rybalkin, 2023). The results of correlation analysis using Spearman's rank correlation coefficient show that the relationship between the ranks of EU countries by SDGI and GDP is strong and statistically significant ($p = 0.726$, $r < 0.001$, probability 99%), but is slightly weaker than the relationship between the ranks EU countries by SDGI and HDI ($p = 0.795$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 5), although this difference (0.726/0.795) in the strength of the relationship between the ranks of EU countries by SDGI and GDP and between the ranks of EU countries by SDGI and HDI cannot be considered significant.

Table 6. Comparison of new measurement tools of the sustainability of economic development and the sustainability of development with traditional measurement tools – Gross Domestic Product (GDP) and Human Development Index (HDI)

Measurement tools	Sustainable economic development	Sustainable development
Traditional measurement tools	Gross Domestic Product (GDP)	Human Development Index (HDI)
New measurement tools in relation to traditional ones		
Green GDP	The rankings of EU countries in terms of traditional GDP and Green GDP are almost completely identical (with one minor exception) (Table 1).	-
Sustainable Development Goals Index (SDG Index)	The relationship between the ranks of EU countries by SDG Index and GDP is quite strong and statistically significant ($p = 0.532$, $r = 0.004$, probability 99%) – a slightly weaker than the relationship between the ranks EU countries by SDG Index and HDI (the author's calculations with the IBM SPSS Statistics based on the data from Table 2).	The relationship between the ranks of EU countries by SDG Index and HDI is quite strong and statistically significant ($p = 0.603$, $r < 0.001$, probability 99%) – a slightly stronger than the relationship between the ranks EU countries by SDG Index and GDP (the author's calculations with the IBM SPSS Statistics based on the data from Table 2).
	The difference (0.532/0.603) in the strength of the relationship between the ranks of EU countries by SDG Index and GDP and between the ranks of EU countries by SDG Index and HDI cannot be considered significant; the ranks of EU countries in traditional instruments for measuring economic development (GDP) and development in a broader sense (HDI) are very strongly correlated with each other ($p = 0.899$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 2).	
Green Economy Index (GEI)	The relationship between the ranks of EU countries by GEI and GDP is strong and statistically significant ($p = 0.785$, $r < 0.001$, probability 99%) (the author's calculations with the IBM SPSS Statistics based on the data from Table 3). At the same time, the position of some EU countries (for example, Luxembourg and Latvia) in these two ratings is radically different, which requires additional case study.	-
Green Growth Index (GGI) and its sub-index – Green Economic Opportunities (GEO)	There is no statistically significant relationship between the ranks of EU countries by GGI/GEO and GDP ($p = 0.263/0.205$, $r = 0.194/0.315$) (the author's calculations with the IBM SPSS Statistics based on the data from Table 4).	There is no statistically significant relationship between the ranks of EU countries by GGI/GEO and HDI ($p = 0.288/0.243$, $r = 0.154/0.231$) (the author's calculations with the IBM SPSS Statistics based on the data from Table 4).
Sustainable Development Green Index (SDGI)	The relationship between the ranks of EU countries by SDGI and GDP is quite strong and statistically significant ($p = 0.726$, $r < 0.001$, probability 99%) – a slightly weaker than the relationship between the ranks EU countries by SDGI and HDI (the author's calculations with the IBM SPSS Statistics based on the data from Table 5).	The relationship between the ranks of EU countries by SDGI and HDI is quite strong and statistically significant ($p = 0.795$, $r < 0.001$, probability 99%) – a slightly stronger than the relationship between the ranks EU countries by SDGI and GDP (the author's calculations with the IBM SPSS Statistics based on the data from Table 5).
	The difference (0.726/0.795) in the strength of the relationship between the ranks of EU countries by SDGI and GDP and between the ranks of EU countries by SDGI and HDI cannot be considered significant	

Source: elaborated by the author based on the data from Tables 1–5.

As the data in summarizing Table 6 shows, the ranks of EU countries by continuously developing new tools for measuring the sustainability of economic development of territories (as well as tools for measuring the sustainability of their development in a broader sense) generally correlate quite strongly with the ranks of these countries by traditional measurement tools – GDP and HDI, which, in turn, are strongly correlated with each other. But the author also managed to find those tools for measuring the sustainability of economic development of territories (such as the Green Growth Index (GGI) and its sub-index - Green Economic Opportunities (GEO)), according to which the ranks of EU countries are completely different from their ranks by traditional tools for measuring the sustainability of territorial development. For example, Luxembourg traditionally has a leading rank among the EU countries by GDP and Green GDP, is in the top ten according to HDI and Sustainable Development Green Index (SDGI), but is at the bottom of the ranking in Green

Growth Index (GGI) and its sub-index – Green Economic Opportunities (GEO) (Table 7). According to Rybalkin, key challenges of the indicator approach, which also included data availability, right balance between different indicator selection criteria, systemic understanding of the relationships between indicators and the context of their use could lead to different results (Rybalkin, 2023).

Table 7. Comparison of ranks of the selected EU countries (as an example) according to the new and traditional measurement tools of sustainability of economic development and sustainability of development in a broader sense

Measurement tools	Finland	Austria	Bulgaria	Latvia	Lithuania	Poland	Luxembourg
Gross Domestic Product (GDP)							
- 2013	9	3	27	25	21	23	1
- 2019	7	6	26	-	20	23	1
- 2020	9	5	27	24	16	21	1
- 2022	9	4	27	23	16	19	1
Human Development Index (HDI)							
- 2020	6	9–10	27	21	19	20	8
- 2021	6	11	27	22	20	19	8
Green GDP 2019	7	6	26	-	20	23	1
Sustainable Development Goals Index (SDG Index) 2022	1	4	26–27	21	22	10	21
Green Economy Index (GEI) 2013	10	4	26	13	16	20	12
Green Growth Index (GGI) / its sub-index – Green Economic Opportunities (GEO) 2022	4 / 5	3 / 11	25 / 22	9 / 13	18 / 17	20 / 10	23 / 24
Sustainable Development Green Index (SDGI) 2020	4	7	26	17	18	27	8

Source: elaborated by the author based on the data from Tables 1–5.

As shown by the results of a comparison of the ranks of the seven EU countries representing Northern, Eastern, Central, Western and Southern Europe, basically the ranks of each specific country for all ratings analyzed in this study are similar. For example, Finland, according to any instrument for measuring the sustainability of economic development and development in a broader sense, is in the top ten among the EU countries, and Bulgaria ranks last also according to any measurement instrument (Table 7). Given these results, the development of multiple ‘green’ indices instead of one traditional GDP (conditioned by a number of important factors reflecting changing priorities and understanding of economic development) from a practical point of view seems completely unjustified and unnecessary. However, the author believes that the main driving force behind the activity of individual researchers and entire organizations in the search for new tools is the real need for more comprehensive and multidimensional approaches to measuring economic progress and sustainable development. The many proposed tools for measuring the sustainability of territorial development provide a broader picture, helping to shape policies and development strategies for both individual countries and their internal regions, and regions of the world (for example, the EU). The author agrees with Pearce and Atkinson that “the measurement of sustainable development is not without considerable difficulties, yet this should not detract from the positive advances that can be made in this direction” (Pearce & Atkinson, 1993). Thus, it is unlikely that one instrument is most suitable for measuring the sustainability of economic development of the EU countries, since each of them allows assessing the sustainability of economic development from its own unique perspective.

5. Conclusions

Currently, most scientists agree that traditional tools for measuring the economic development of territories, as well as the development of territories in a broader ‘human’ sense (namely, GDP and HDI) are not suitable for evaluating the sustainability of development (economic and more general) of the world’s countries. Instead, many other tools for measuring the sustainability of territorial development are being developed and tested, including environmental and political, educational, and cultural components. Their creators argue that new measurement tools correspond to the modern need to evaluate territorial development from the point of view of quantitative economic growth and long-term qualitative development or inclusive growth.

Having carried out a comparative analysis of the ranks of EU countries by both traditional and some of the new tools for measuring the sustainability of territorial development, the author concludes that, despite the versatility and smarter structure of the newly created indices, the ranks of EU countries in these rankings mostly similar. Thus, the countries of Northern and Western Europe have leading ranks both by traditional GDP and HDI, and by new tools for measuring sustainable development - such as Green GDP, Sustainable Development Goals Index (SDG Index), Green Economy Index (GEI), Green Growth Index (GGI), Sustainable Development Green Index (SDGI). In turn, the countries of Southern Europe (especially Bulgaria) are at the bottom of the rankings for almost all instruments for measuring the sustainability of development of the EU countries. But there are exceptions, the most striking of which is Luxembourg, which has a leading rank by traditional measurement tools of the territorial development (GDP and HDI) and is close to the last ranks in 'green' ratings.

The main limitation of this study is the incomplete list of analyzed tools for measuring the sustainability of economic development and territorial development in a broader sense. Furthermore, some measurement tools do not have open access data (e.g. Global Green Economy Index (GGEI) and the System of Environmental Economic Accounting (SEEA)) or are not used in Europe (e.g. Gross Ecosystem Product (GEP) and Gross Economic-Ecological Product (GEEP)). The latter circumstance may become a direction for further research in this area, namely, testing the GEP and GEEP developed by Chinese scientists as tools for measuring the sustainability of economic development of the EU countries and their internal regions.

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HDI INDEX DIMENSIONS IN THE CONTEXT OF HYBRID THREATS*

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Abstract. The Human Development Index (HDI index) is considered a summary index of the perception of human well-being in a selected economy. It consists of 3 sub-dimensions: the population's education, health and income. It is considered a vital indicator of the perception of the state of human development, and based on it, countries are compared in the mentioned areas. Our contribution aims to analyze the position of European countries in the context of the HDI index and, at the same time, to apply expanded indicators of education and health. Subsequently, we apply these new, supplemented dimensions in comparing the selected countries and in the context of hybrid h. Within the methodology, we use the methods of agglomerative cluster analysis and paired T-test.

Keywords: HDI index; education; income; health; Europe

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JEL Classifications: J24, O15, J10

1. Introduction

Scientific literature that discusses human capital often focuses on its definition in relation to economic growth and development. However, little attention has been paid to studies on the relationship between human capital and life expectancy, education, health, or the impact of hybrid threats on social development (Sentürk et al., 2023)

When studying Human Development, one must orient oneself to a broader concept, sustainable development. This includes environmental, economic and sociodemographic elements. A standard definition of the term is "meeting the needs of the current population in a way that does not prevent the meeting of the needs of future generations" (UN. Report of the World Commission on Environment and Development, 1987).

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According to Dao & Khuc (2023), sustainable growth, the common goal of every country, is only possible with human capital development. This represents the workforce's knowledge, skills and competencies (Mathur 1999).

The Human Development Index (HDI) is an index that measures key dimensions of human development. The access to education dimension is essential. This dimension is measured by the expected years of schooling of children of school age and the average years of schooling of the adult population. Another dimension is Long and Healthy Life, measured by average life expectancy. The last is the standard of living, measured by the gross national income per capita adjusted according to the country's price level. (Ranis et al., 2006)

The HDI index, which is the result of the work of the UN, has become an essential alternative to the traditional one-dimensional measurement of development (e.g., GDP, GNP). Many blame this "modern" indicator for the absence of an environmental dimension. (Sagar & Najam, 1998)

Several modifications were also achieved as part of the approach to the HDI index. It is primarily a general index that allows for calculating the percentage of individual dimensions on the overall success, thus identifying the attributes that are susceptible to achievement. This model also takes into account factors of the political environment of the analyzed country. (Chakravarty, 2003)

Several authors (Cahill, 2005; Sihite et al., 2021; Alijanzadeh et al., 2016) state that using the income dimension in the index is inappropriate, and the results are irrelevant due to the lack of year-to-year comparability. They also believe that the index is robust to measurement error and that the evaluation of the countryside based on other measures of the economy is significantly different. One of the first steps for evaluating the countries was to summarize the European Union's human development index data. It was then analyzed for the period 1980-2013 using general estimating equations to see if there was a trend over the years. (Aktaş & Karagöz, 2015)

Two categories of technical problems related to the 1995 HDI that affected the model's predictive power were also discussed. (Norbakhsh, 1998) While criticizing the nature of the Human Development Index, he proposes a different way of constructing the HDI to capture the net flow of human development in terms of material well-being, health and education. (Bagolin & Comim, 2008)

2. Research carried out in the conditions of Slovakia and other countries

The author's research (Michálek, 2002) confirmed the different levels of human development in the regions using the human development index based on social, demographic and economic statistical data. The results clearly show the differences between parts of the country - specifically between the regions of the northwestern and south-eastern parts of Slovakia. The HDI index's favourable values were recorded in western Slovakia's urban areas. Conversely, lower rates were observed in south-eastern Slovakia. The following study focussed on the correlation analysis of gross domestic product per capita and the human development index in the Vyšehrad Four and some Balkan countries. In most regions, the correlation was high, above 0.9. The author emphasizes the GDP performance indicator, which, according to her, is one of the best ways to compare different economies. (Hudáková, 2017)

GDP per capita is a primary measure of economic development and prosperity worldwide. However, it is a limited measure of living standards aimed at capturing changes in economic output per person and neglecting many things necessary for quality of life. For this reason, the HDI model was proposed, which, in addition to GDP, also includes the education and health of citizens. (Broček & Lalinský, 2017)

Based on world HDI research, Europe has the highest HDI with a significant advantage over the world average. On the other hand, African countries have acquired low HDI values and, therefore, should focus on increasing the

dimensions of the HDI indicator for all their citizens, which will also lead to peace and overall well-being. Asia, North America, South America and Oceania do not differ significantly in their HDI. (Kpolovie et al., 2017)

The results of the author's study (Sarabia et al., 2020) show a high correlation between the human development index and the level of corruption. This was due to the impact of the 2008 financial crisis on EU citizens. The research of the collective around the authors Cieřlik et al. (2016) presents the role of summary indicators of human development, such as the Human Development Index and its components over the standard set of variables of the international trade model. The author notes that aggregated and disaggregated human development indicators affect the volume of international trade flows.

The results of research in the area of the HDI index also serve as a proposal for health policymakers, which will be aimed at solving the increasing morbidity and mortality, especially among women over 65 years of age, in regions with poorer access to prevention and treatment services. Increased values were observed in Latvia, Bulgaria and Poland. (Mohammadian et al., 2017) As measured by the Human Development Index, the prevalence of coronary heart disease is growing in developing countries while decreasing in developed countries. For this reason, future research must pay more attention to the appropriate allocation of medical resources and the control of risk factors for coronary heart disease in world regions. (Zhu et al., 2016) In the field of health issues, the importance of HDI is very high, as confirmed by research that points to the disproportionate current and future burden of ovarian cancer in countries with lower HDI levels and calls for global action to reduce the burden and inequality of ovarian cancer in access to quality oncological care and treatment. (Cabasag et al., 2022)

Analysis and comparison of HDI information with indicators from other countries and their publication can promote positive societal changes. Many researchers suggest combining the HDI with other indicators and dimensions. For this reason, researchers have introduced a sustainable HDI based on a multidimensional synthesis of other indicators and developed new classification methods and clustering methodologies that can be used to monitor sustainable human development. (Shek & Wu, 2018; Myers et al., 2018; Berman, 2021)

The research also improved the version of the Education Index based on the data available from the PISA assessment. This new index considers the social impact of school years and the results of education systems in each country. As a result of this finding, it is necessary to change the construction of the HDI index, according to the authors. (Grisolia et al., 2022a, 2022b) We can also monitor the development of the HDI indicator with respect to environmental and energy indicators. (Lima et al., 2022; Zhang & Wu, 2022; Hwang et al., 2023, Conigliani et al., 2023)

The behavior of citizens in the country in the area of paying taxes is an essential factor in human development. The tax system is one of the main instruments by which the state exercises sovereignty through collecting, allocating and redistributing income in a given territory. The research pointed to the characteristics of tax systems and the effectiveness of government measures in relation to human development in the member states of the European Union. (Dronca, 2016)

The HDI index is also important when analyzing the behavior of citizens in the field of waste management. The authors used data from ten European countries to investigate the impact of gross domestic product, human development index, unemployment rate, and CO₂ emissions on the generation rate of thirteen solid waste streams. Regression modelling was performed between the rate of waste production and each of the four indices, and significant correlations were calculated. (Namlis & Komilis, 2019)

The results of the cluster research show that European countries are grouped into four clusters according to the values of the HDI Index. Based on the results of the research analysis, European social policies should be better

designed and implemented with increased public spending to increase the population's living standards and reduce the differences between European citizens. (Androniceanu, 2022)

3. Methodology of the paper

In the research section, we will analyze selected factors that are part of the Human Development Index indicator. We will look closer at the construction of the formula and its development over the last 5 years. Subsequently, we will compare the results for the areas of education and health with other variables in relation to the GDP of selected European countries. We will also perform a clustering analysis using the data included in the

HDI index and compare them with the results of clustering our selected factors.

As part of the scientific contribution, we set three scientific questions to which we will direct our research:

1. *Are there significant differences in clusters according to the HDI index and its dimension?*
2. *Are there significant differences in the clustering of countries according to the COFOG budget classification of education and health indicators compared to the HDI index?*
3. *Is there statistical significance between the births of the HDI index and its dimensions (health, education, income) before and after the spread of the COVID-19 disease?*

We used agglomerative cluster analysis with Euclidean distance and Ward's method as part of the methodology. Subsequently, we also performed descriptive statistics and paired t-testing of variables for individual analyzed variables.

Data for the values of the HDI index and its components were analyzed for 2017 to 2021 (as the last available year is 2021) and represents 5 years. We obtained the data through the Human Development Report portal (<https://hdr.undp.org/>).

The Human Development Index (hereinafter referred to as "HDI") is a tool that compares the factors of education, health, poverty and other factors of life developed by the United Nations. It represents a means of comparing critical dimensions of human development. The resulting calculation of the indicator consists of a combination of three dimensions and looks as follows:

$$HDI = \sqrt[3]{Health\ index * Education\ index * Income\ index} \quad (1)$$

HDI indicates the standard of living and expresses the geometric mean of indices that express health, income and education. The HDI index takes on values from 0 to 1, which places countries in one of four levels of development: above 0.80 - very high human development; between 0.70 and 0.80 - high human development; between 0.55 and 0.70 - medium human development and below 0.55 - low human development. If the value of the index is low, it declares a low level of human development in the state and vice versa. The following graph shows the achieved values of the HDI index for the year 2021 together with the individual partial parameters of the formula.

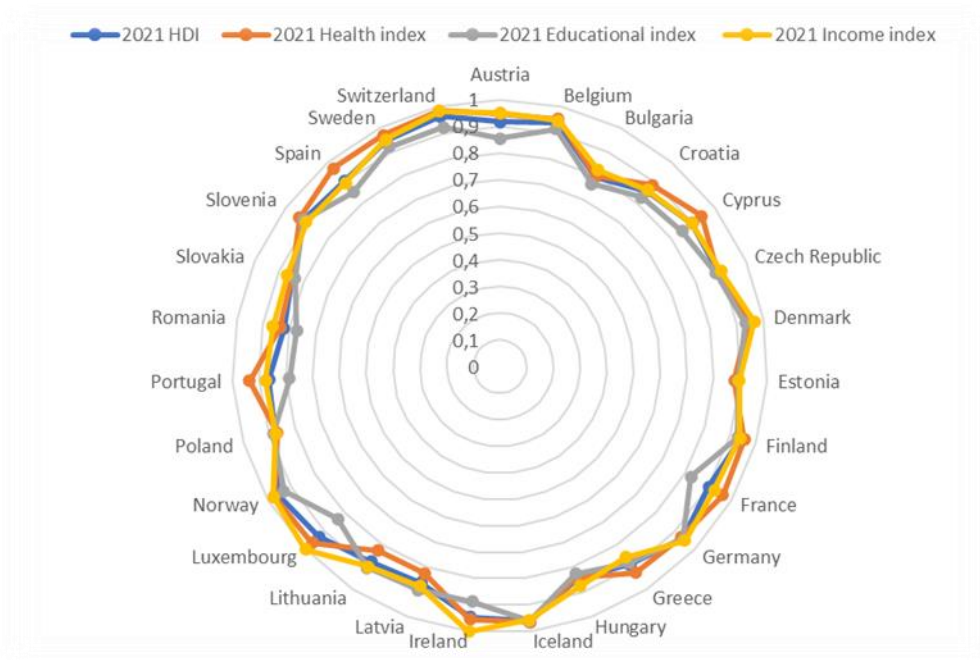


Figure 1. Development of the HDI indicator and its components in the analyzed countries
Source: own processing

4. Results

We will monitor the HDI index for 5 years (specifically, 2017-2021), as the year 2022 is not evaluated in the statistics. We analyzed part of the results of the share of healthcare and health in the countries' GDP for the last year when data were available. As a statistical tool for processing the results, we used the R-studio and JASP programs. In our case study, we will focus on 27 European countries. In the following section, we can present the descriptive statistics of the analyzed variables.

Table 1. Descriptive statistics of the analyzed variables

	Valid	Median	Mean	Std. Deviation	Variance	Skewness	Kurtosis
% of GDP Health 2021	27	7.344	7.210	1.693	2.865	-0.366	0.120
% of expenditure Health 2021	27	15.533	15.40	2.841	8.072	-0.247	1.358
% of expenditure Education 2021	27	10.864	11.07	2.124	4.509	0.486	0.046
% of GDP Education 2021	27	5.013	5.121	0.978	0.957	0.225	1.293
2017 HDI	27	0.897	0.898	0.042	0.002	-0.327	-0.741
2018 HDI	27	0.901	0.901	0.042	0.002	-0.351	-0.624
2019 HDI	27	0.905	0.904	0.041	0.002	-0.428	-0.507
2020 HDI	27	0.898	0.900	0.042	0.002	-0.436	-0.405
2021 HDI	27	0.903	0.901	0.045	0.002	-0.493	-0.414

Source: own processing

In addition to the HDI index and its components, we also analyzed the descriptive statistics of another 4 indicators (the share of budget expenditures on health and education and the share of these categories in the country's GDP). In the next part, we will perform a statistical analysis, which we call clustering, by which we mean a set of statistical and mathematical techniques through which we can identify clusters.

A cluster represents a set of identifiable countries that are close to each other and similar, when, however, countries belonging to other clusters are different and distant in terms of characteristics - in our case, different - the basics of the HDI indicator for the years 2017-2021 and its components. We thus used 20 indicators to use this analysis.

Different groups of object similarity measures can measure the similarity between countries. The selection of individual similarity measures also depends on the observed characteristics, the values of which characterize the countries under study.

Country clustering aims to find groups of similar countries in our data. In our work, we will use a hierarchical approach, the essence of which is that the number of clusters of countries is not known at the beginning of the analysis. This approach allows analysis for smaller selections of research objects.

We correlated the input variables at a significance level of 5% ($\alpha = 0.05$), where we observed the variables' dependencies. However, a high degree of dependence between variables can be a problem, which can affect the classification results. Decomposition of the problem can be achieved through the method of principal components, in which the input indicators are transformed into new variables. These new variables, called principal components, are already mutually independent.

We only need to use 2 principal components to explain more than 82% of the variability of the original ensemble. So, we have met the rule that the number of principal components explains at least 70% of the total variance of the data.

Subsequently, we plotted the clusters in a hierarchical tree, where individual clusters are marked. We can see that 4 clusters have been created, which are heterogeneous from each other, but the companies within their cluster are homogeneous. We chose a heuristic approach to count the clusters.

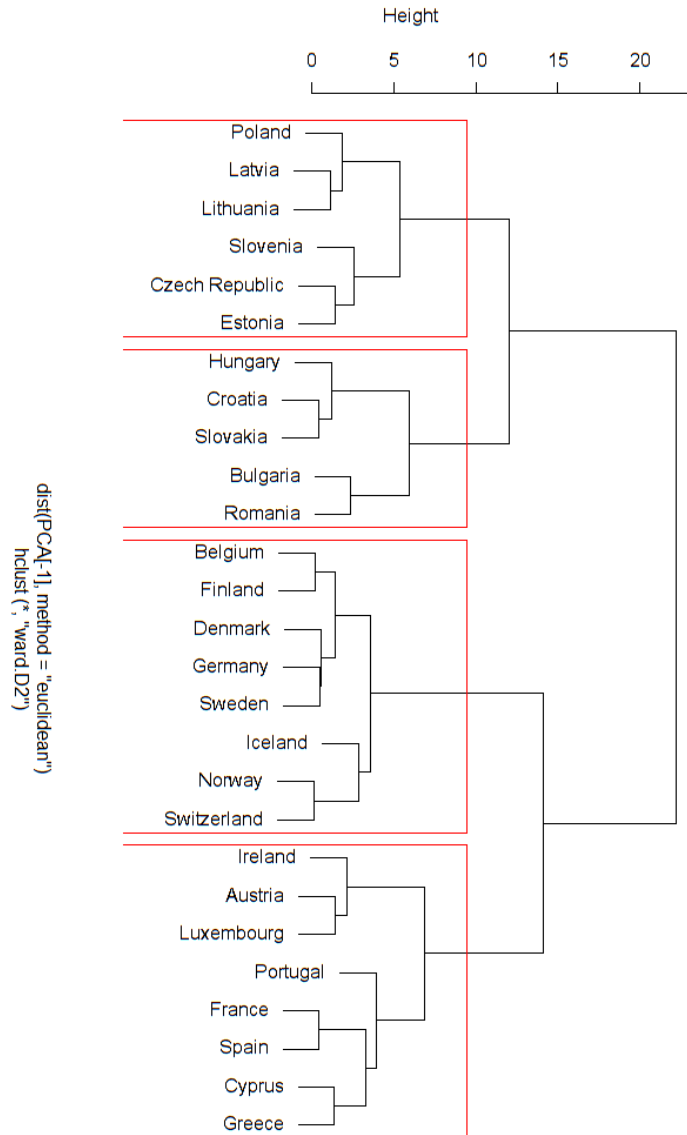


Figure 2. Clustering dendrogram
Source: own processing according to JASP

We can see that within our 4 clusters, these clusters are evenly distributed and we do not record any extreme fluctuations between countries. Slovakia is found in a group with Hungary, Croatia, Bulgaria and Romania, which shows that compared to the achieved numerical results of the HDI index, it places us in a group with a higher HDI index. Still, compared to European countries, we achieved worse results. On the contrary, the cluster that we can consider the best - because it achieves the best results - is the cluster of Belgium, Switzerland, Scandinavian countries and Germany. Here, the index HDI reaches the number 1, i.e. the best result.

In the previous part, we presented the results of the clustering of countries through the HDI index and its sub-parameters - health, education and income. Essential to our research is whether other variables can change the results of the classification of countries into clusters.

We are based on the share of individual health and education variables on the countries' GDP. For the field of education, these were the following indicators: Pre-primary and primary education, Secondary education, Tertiary education Education not definable by level, Subsidiary services to education, R&D Education, Education n.e.c.

We note that it was a share of GDP from the point of view of the COFOG budget classification within the national accounts of individual countries. For the area of health, we again used indicators that reflect their share in the country's GDP. These are the following indicators: Medical products, appliances and equipment, Outpatient services, Hospital services, Public health services, R&D Health and Health n.e.c.

In this case, we again analyzed the same countries but with different indicators. As in the scanning method, we will use Euclidean distance and Ward's method.

The method of principal components, which excludes the negative influence of the inter-correlation of the input variables, concluded that it is necessary to use 7 principal components that explain more than 80% of the variability of the original data. Based on the heuristic principle, we then determined five clusters. The following graph reflects the results.

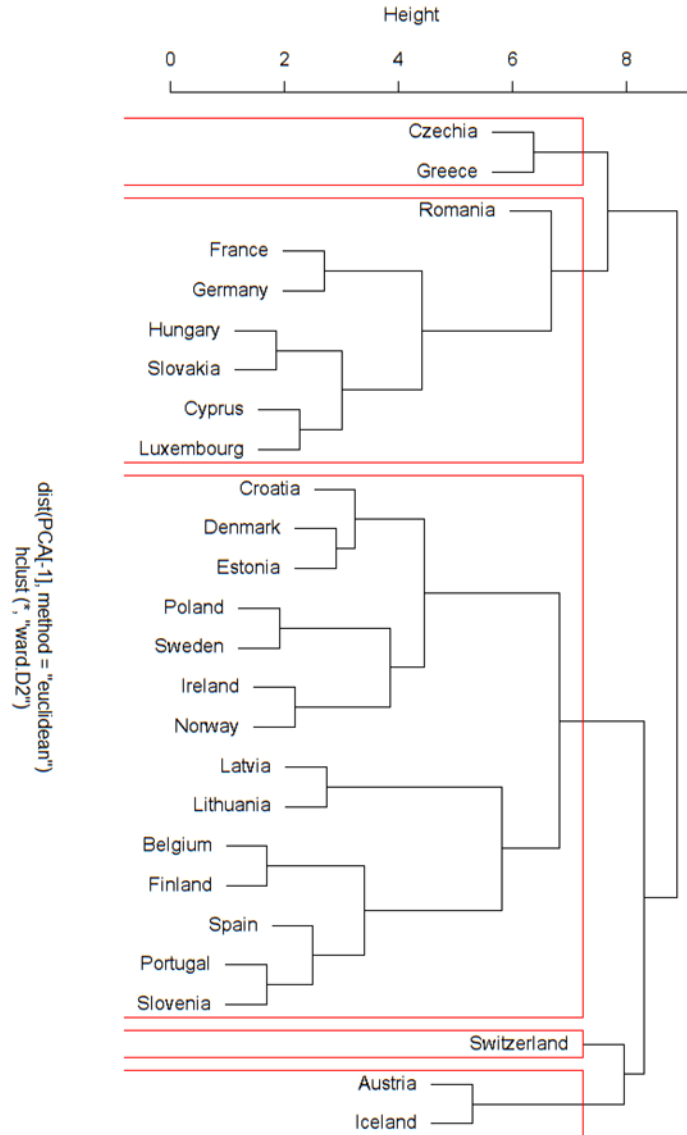


Figure 3. Clustering dendrogram

Source: own processing according to JASP

From the dendrogram (hierarchical tree), we can conclude that the countries of Switzerland, the Czech Republic, Greece, Austria and Iceland reached values that set them apart and thus created separate clusters. The reason is, for example, in the case of Switzerland, a higher representation of the country's expenditures on selected areas of education and health than in other countries. Slovakia is among the countries with Romania, Hungary, France, Germany, Cyprus and Luxembourg. However, if we were to create an even larger number of clusters, we would find that Slovakia can be compared with neighboring Hungary in terms of its expenditure on healthcare and education.

Thus, the comparison of the HDI index and its components and selected COFOG budget classifications in the area of health and education yielded different results for the countries achieved by the clustering method.

We also tried to answer the research question regarding the change in values before and after COVID-19. Performing a t-test will give us a closer answer. A paired t-test is used to compare the values of a variable for the same country in two different experimental conditions (before and after the crisis caused by COVID-19).

Table 2. Paired Samples T-Test

Measure 1	Measure 2	Test	Statistic	z	df	p
2017 HDI	- 2021 HDI	Student	-2.584		26	0.016
		Wilcoxon	80.000	-2.426		0.016
2017 Health index	- 2021 Health index	Student	2.619		26	0.015
		Wilcoxon	273.500	2.030		0.043
2017 Educational index	- 2021 Educational index	Student	-3.553		26	0.001
		Wilcoxon	38.000	-3.200		0.001
2017 Income index	- 2021 Income index	Student	-5.022		26	< .001
		Wilcoxon	17.000	-3.915		< .001

Source: own processing

For statistical testing, we used two performed tests: students and Wilcoxon test. We performed the test at an alpha level of 0.05. The difference between the first and second assessments is statistically significant for all analyzed variables, as the p-value is lower than 0.05. The results could be predicted depending on the conditions we observed in connection with the pandemic in European countries. Expenditures on education and healthcare were increased, and citizens' incomes were adjusted and increased in connection with the problems of the economy.

During the analysis of the HDI index, characteristics suitable in the field of security, stability, resilience, technological development and the creation of national strategies implementing joint activities carried out by the government or other organizations or institutions were arrived at. These bodies aim to ensure the solution of security problems. (Valdivia-Granda, 2021) Social indicators that affect the long-term viability of hybrid systems modeling in society were analyzed by Sawle et al. (2018). From his point of view, these are important parameters that need to be considered. Several authors have taken into account the inclusion of social variables, primarily the HDI index or its partial parts.

The impact of the HDI index has been analyzed by several authors in connection with hybrid threats and hybrid wars among security communities around the world since 2000. It has increased exponentially after the conflict in Russia's Ukraine in 2014. Several research studies confirm the importance of the social impact of the HDI index, and this social context is intended to serve as a tool for changing the strategy of the attitude towards the hybrid threat. (Bingöl et al., 2017)

5. Discussions and conclusion

In the results of the study by the authors Salman Iqbal et al. (2023), it is stated that the competitiveness of each country depends on the quality of the business environment, institutions, science and research, innovations, but especially on the development of human capital.

HDI index represents a tool based on which we can measure the human development of a given region. From the point of view of several authors, it represents one of the noisy indicators we can use for international comparisons of education, income and health care. In our scientific paper, we analyzed not only the HDI index, but also other variables related to it. In our case study, we tried to solve the following questions.

Are there significant differences in clusters according to the HDI index and its dimension? The countries we analyzed in our research achieved an average HDI index of 0.90 in 2017-2021, which means that the values are at

a very good level and have a growing character. Of course, there are slight differences between the analyzed countries, which we attributed to the different values of the dimensions of education, health, and income within the framework of the country's ranking. The Slovak Republic found itself in a cluster with countries at the bottom of the analyzed countries within the HDI index, even though the value of the index increased year-on-year.

Are there significant differences in the clustering of countries according to the COFOG budget classification of education and health indicators compared to the HDI index? The clustering of selected parameters of education and health confirmed our assumptions, and we achieved statistically different results. The reason was the more detailed inclusion of health and education components and their share of GDP in the cluster analysis. The results revealed that the Slovak Republic was included in a cluster with countries that can be considered the core of Europe. Still, when looking more closely at the results of the hierarchical clustering tree, we must state that we are at a very similar level to Hungary. On the other hand, Switzerland became independent, spending rapidly more on education and health than other countries. The results of clustering using the factors of the HDI index and its dimension and clustering using the factors of the share of GDP for education and health yielded different results.

Is there statistical significance between the births of the HDI index and its dimensions (health, education, income) before and after the spread of the COVID-19 disease? In this area, we had come to interesting results where we can state that the values, especially in the income area from before and after the crown period, achieved statistically significant changes. We also recorded changes in education and health, probably the most related to the coronavirus period. In these areas, there was not only an increase in interest but, above all, an increase in the expenses of the state budgets of individual countries.

A new index has been introduced to quantify, measure and monitor progress towards the goals of the Europe 2020 strategy. It consists of relevant, accepted and reliable indicators presented by the European Commission. The new index shows that it can be a valid measure to assess the overall competitiveness of countries and that the most critical factors for the success of this strategy are good governance and social capital. It also includes the dimension of human development. (Pasimeni, 2013)

In the future, we will undoubtedly supplement the mentioned study with the effects of education (Grisolia 2022; Vergara et al., 2022), which plays an essential role in the HDI index.

We also want to focus on analyzing the relationship between the hybrid threat and the results of the HDI indicator. Above all, it will identify factors that can influence the applicability of the HDI index.

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HYBRID THREATS AND THEIR IMPACT ON THE PERFORMANCE OF THE BUSINESS ENVIRONMENT*

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Abstract. The paper aims to assess the impact of hybrid threats on the performance of the business environment of the European Union countries. Hybrid threats were represented by six threats and their consequences, namely unavailability of ICT services due to hardware or software failure, unavailability of ICT services due to external attack, destruction or corruption of data due to malware infection or unauthorised intrusion, disclosure of confidential data due to intrusion, phishing, phishing attack or deliberate action of own employees, disclosure of confidential data due to negligent action of own employees. The performance of the business environment was assessed through the Country Competitiveness Index. The results showed that our selected threats and their consequences had a statistically significant impact on the performance of the business environment. We observed an adverse effect for unavailability of ICT services due to hardware or software failure, destruction, or corruption of data due to malware infection or unauthorised intrusion, and disclosure of confidential data due to intrusion, phishing, phishing attack, or deliberate actions of own employees. Positive impacts on business environment performance were observed for unavailability of ICT services (insider attack), unavailability of ICT services due to external attacks and disclosure of confidential data due to negligent actions of own employees.

Keywords: business environment; cyber-attacks; cybersecurity; performance

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JEL Classifications: H55, O35, Z13

1. Introduction

In an era characterised by rapid technological advances and geopolitical complexity, the traditional boundaries that once defined security threats are blurred. The current global space creates possibilities for the emergence of the application of hybrid threats, a multifaceted and dynamic challenge that goes beyond the conventional categorisation of security risks. These hybrid threats represent a fusion of conventional, unconventional, and

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cyber threats, often organised by state and non-state actors, with the potential to disrupt national security and the stability and vitality of the global business environment.

This scientific article discusses the field of hybrid threats and their profound consequences for the performance of the business environment. The term "hybrid threats" encompasses various activities, from disinformation campaigns and cyber-attacks to economic coercion and proxy warfare. As these threats continue to evolve, their impact on businesses worldwide is becoming more significant.

This article aims to comprehensively examine the nature of hybrid threats, their *modus operandi*, and the complex web of connections between these threats and the business world. Through empirical research, implemented case studies and critical analysis, we clarify the multifaceted dimensions of this complex challenge and its consequences for businesses operating in a globalised economy.

The vulnerabilities to hybrid threats are exacerbated as the business environment becomes more interconnected and reliant on digital infrastructure. Companies are at risk of financial losses and face reputational damage, operational disruption, and regulatory scrutiny. Understanding the dynamics of hybrid threats is imperative for businesses to develop effective risk management strategies, enhance resilience, and ensure the continuity of operations in an increasingly uncertain world.

In our article, we will outline the various manifestations of hybrid threats, their effects on the economic and business environment, and the strategies organisations can use to mitigate these risks. We will contribute to the knowledge base that informs the decision-making processes of politicians, business leaders and security professionals in ensuring the integrity and performance of the modern business environment.

The use of information technology gives organisations a competitive advantage. Widespread access to the Internet has changed the way businesses manage their processes. With the rise of new devices, doing business has become easier. (Biclesanu et al. 2021) Information and technology services also pose a security risk to the enterprise in the form of leakage of sensitive information, unavailability of information and communication technologies, or data corruption due to attacks. Organisations, therefore, need to implement comprehensive security strategies to protect them from this risk. (Mosteanu, 2020; Ghelani, 2022; Gombár et al. 2022)

Many enterprises use antivirus software, firewalls, antispyware software, virtual private networks (VPNs), and the like to protect themselves from threats and secure their data. However, using these protections is often ineffective, hence the need for a comprehensive security strategy. (Mosteanu, 2020) In addition to protection systems, the focus should be on detection systems that help gather information about threats and attacks. Detecting malicious actions is one of the most critical cybersecurity issues. Intrusion detection refers to the detection of specific patterns or observations of anomalies. Nowadays, it is necessary to pre-emptively anticipate incoming malicious activities so that we can react to them and prevent an attack in time before it causes any damage. (Pivarníková, Sokol, Bajtoš, 2020)

Early detection of security incidents and correct prediction of the evolution of an attack is the basis for an effective and timely response to cyber threats. The evolution of an attack depends on the next steps available to the attackers, their goals, and motivations. (Dovnikova et al., 2020; Vagaska et al. 2022)

While technology plays a critical role in addressing cybersecurity issues, the human aspects have recently gained serious attention. (David et al., 2020) Data loss or corruption can also occur in the event of intentional or unintentional actions by employees, hence the need to emphasise employee training in cybersecurity.

Human capital is considered the most essential resource in any organisation. However, most companies pay more attention to the external environment and pay little attention to their employees. Technological developments have changed our lives and habits. (Fernandes et al., 2023) Weritz (2022) emphasised in her work that organisations should monitor the skills of their employees and offer opportunities for individuals to develop their skills. She pointed out that entrepreneurial mindset, digital responsibility, digital literacy, transformational

skills, personal development, communication, community management, data analytics, and web application development skills are critical in the digital workplace.

These threats are not only a danger to businesses themselves but equally dangerous to countries as well. A country needs consistent protection against these threats to avoid becoming unattractive to businesses, which will impact its business environment.

2. Business environment

The term business environment refers to all factors that impact business. This includes internal and external factors. Each of these factors somehow affects the business environment and the companies within it. Technological development has recently moved the business environment, its quality and development. The business environment, characterised by high instability and uncertainty, is much more precarious for enterprises because they need access to significant resources. Still, effective innovation depends, above all, on the quality and quantity of the resources that the enterprise controls. Managers are therefore called upon to consider innovation as a central factor in building the competitiveness and performance of their enterprises. They must, therefore, invest heavily in innovation, employee training and research and development. Otherwise, they are exposed to the destructive effects of a highly volatile environment, and their performance will decline as the business environment remains unstable. (Ruba et al., 2023; Mihalčová et al., 2021)

On the other hand, a healthy business environment can create a fairer market, facilitate flexibility in business operations and encourage technological innovation in enterprises. A good business environment has a more significant impact on large enterprises than on small enterprises. (Han et al., 2023; Straková et al., 2021)

The evolution of the business environment varies from country to country; therefore, the business environment gives some countries a competitive advantage. In their paper, Rusu and Dornean (2019) noted that a country must outperform its competitors in research and innovation, entrepreneurship, competition, and education. They investigated the impact of factors measuring the quality of entrepreneurial activities on national competitiveness in 28 European Union member states. Their research showed that innovation rate and job creation significantly influence the level of economic development of countries and their national competitiveness.

Technology has become an integral part of everyday and working life. However, with the development of information technology comes new risks, namely security risks. The business environment generates vast complex data that provides decision support through information processing and insight generation. (Lu, 2022) As most business processes and data-driven operations in today's business environment have moved into cyberspace, securing, protecting, and defending organisational information has become more critical. (Rawat et al., 2019)

According to Gamidullaeva & Gamagomedova (2023) and Šimberová et al. (2022), different business environments may have other impacts. Improvements in the institutional environment and greater certainty about the future significantly impact entrepreneurial activity and business performance.

In 2021, 22.2% of enterprises (with 10 or more employees and self-employed) in the EU corporate economy (excluding the mining and quarrying sector and the financial sector) experienced ICT security incidents resulting in different types of consequences, such as unavailability of ICT services, destruction or corruption of data, or disclosure of confidential data (Euostat, 2023).

Countries and supranational organisations such as the European Union are reshaping their traditional economic environments by promoting the use of broadband connectivity and the Internet, providing online services to citizens, facilitating investment in the spectrum of the digital economy, and introducing new business models suitable for the development of the digital economy. (Laitsou et al., 2020)

Eurostat (2023) also reported that, among EU countries, the highest proportion of enterprises that experienced ICT security incidents leading to unavailability of ICT services, destruction or corruption of data or disclosure of confidential data was in Finland, at more than two-fifths (43.8%), followed by the Netherlands and Poland (30.1% and 29.7%), the Czech Republic (29.3%) and Denmark (26.4%). At the other end of the scale, Bulgaria (11.0%), Portugal (11.5%), Slovakia (12.3%), Hungary (13.4%) and Cyprus (14.3%) had the lowest shares.

We see the impact of hybrid threats on the business environment in areas other than information. Examples include:

Economic impact - they create uncertainty and instability in a country, which can scare away foreign investors and cause a drop in economic confidence. This can harm business growth and investment.

Political destabilisation - creates political uncertainty and instability, which can result in changes in government policies, regulations, and legislation. This can affect businesses' strategic decisions and ability to plan long-term investments.

Information warfare - often involving disinformation campaigns and propaganda that can influence public opinion and perceptions of specific businesses and industries. Fake news can cause loss of customer and investor confidence. In a rapidly changing world, economies and companies must reshape their traditional models to adapt to a rapidly evolving digital environment. Information and communication technologies (ICT) have become more than a normal use. ICT has gradually become a critical operational component for individuals, businesses, and national economies. (Laitsou et al., 2020)

Social unrest - caused by hybrid threats can lead to riots and demonstrations that can disrupt normal business activities and even lead to loss of property and lives.

Corruption risk - in countries affected by hybrid threats, corruption and bribery may increase, resulting in an unsafe business environment for companies that seek to comply with ethical standards and legislation.

Therefore, businesses must be aware of hybrid threats and develop strategies to manage and protect against them. This may include improving cyber security, monitoring political and economic events, proactively managing risks, and working with local and international authorities to address these threats.

3. Hybrid threats

Hybrid threats represent one of the growing security challenges for the safe and effective management of critical infrastructure, digital systems and social domains worldwide. The deliberate misuse or disruption of these domains and digital technologies has widespread implications in various aspects of life, including daily activities, civil and military operations, transportation and aviation, communications, finance, and the interconnection of water, food and energy, medical treatments, and social media. (Vaseashta, 2022) Security is a serious issue that we all face. Every day, skilled hackers breach security and exploit vulnerabilities to gain access to top-secret and confidential data. (Fatima et al., 2023)

Vulnerabilities identified in Latin American countries include low cybersecurity awareness, lack of sufficiently implemented standards and regulations, use of updated software, security gaps in critical infrastructure, lack of training and specialisation, and the prevalence of advanced persistent threats (ATP). Investing and paying attention to cyber security in crucial public organisations and banking sectors is essential. (Flor-Unda et al., 2023)

One of the main aspects of hybrid threats to enterprises is cyber vulnerability. Cyber-attacks can cause service outages, steal sensitive data or damage confidential information assets. These attacks can be more complex and sophisticated, meaning businesses must invest in robust cyber security measures and keep up with the latest technology trends to protect their digital assets.

In addition, hybrid threats are often associated with manipulating public opinion and misinformation, which can affect business decisions and customer confidence. Businesses must also address the risk of economic destabilisation due to political conflicts and sanctions. It is crucial for businesses to be prepared for these hybrid threats and have rapid response and recovery strategies in place to minimise potential damage and maintain their resilience to these complex threats.

In their article, Mityakov et al. (2023) suggest 12 main "quick" indicators that can be used for operational monitoring of a country's economic security, grouped into four spheres. The choice of indicators was dictated by sufficient coverage of certain areas of economic security. In addition, the proposed indicators were used based on the availability of information from official sources and the required frequency of receiving information.

Another vital aspect of hybrid threats to businesses is their ability to interfere with global supply chains. In today's world, companies are often involved in large and complex chains involving suppliers and customers from different parts of the world. Hybrid threats such as trade blockades, cyber-attacks, or political manipulation can seriously affect these chains, with the potential to cause supply disruptions and increase logistics costs and business risks.

Therefore, businesses need to have comprehensive risk management and business continuity plans that consider hybrid threats. They need to actively monitor the geopolitical situation and cyber security trends to respond quickly to potential threats and minimise their impact. Collaboration with other businesses, government agencies, and security experts can also be critical to effectively defending against hybrid threats and maintaining stability in corporate operations.

Despite these risks, several strategies have emerged in the market that effectively combat hybrid threats. One of them is artificial intelligence, which helps improve the state of cybersecurity. (Rawal, 2022) In addition to protecting sensitive data and combating hybrid threats, these strategies help organisations prevent breaches and facilitate recovery and adaptation after such breaches. (Vaseashta, 2022)

There are several hybrid threat tools. Common ones encountered in practice are propaganda, disinformation, sabotage, economic warfare, or cyber-attacks. The sophistication of cyber-attack techniques poses a danger to businesses and can disrupt operations, destroy critical data, and damage reputations. The current wave of attacks surpasses and outpaces humans and even includes artificial intelligence (AI). (Guembe et al., 2022) Artificial intelligence, according to Rawal (2022), helps improve the state of cybersecurity. Still, on the other hand, cybercriminals are also using it to launch more targeted and sophisticated attacks.

Given the cyclical increase in security incidents, cybersecurity is a significant concern for all industries involved in digital activities. As more and more Internet of Things (IoT) devices are used in homes, offices, transport, healthcare and other locations, malicious attacks are becoming more frequent. Due to the vast amount of data IoT devices produce, Machine Learning (ML) is commonly used to detect attacks. (Prabakar et al., 2023)

Today's cyber-attacks on businesses have become an integral part of the digital age and pose a persistent threat to organisations of all sizes and sectors. One of the most common types of attack is ransomware, which encrypts an organisation's sensitive data and a subsequent ransom demand from the attackers. These attacks not only cause financial losses but also severely disrupt the operations and reputation of companies.

To prevent these attacks, businesses must strive to raise their employees' cyber security awareness and implement robust security measures, including firewalls, antivirus programs and network monitoring. In addition, it is essential to have a cyber-attack recovery plan in place to minimise losses and restore normal operations quickly. Cybersecurity has become a priority for businesses in today's digital era and requires constant investment and attention to protect against everchanging threats.

With the increasing severity and frequency of cyber-attacks, the rapid proliferation of smart objects is intensifying cybersecurity threats. Extensive data on communication traffic between Internet of Things (IoT)

devices poses a significant challenge in protecting these devices from potential security breaches exacerbated by unbalanced network traffic data. Artificial intelligence technologies, particularly machine and deep learning, have shown promise in detecting and addressing these security threats targeting IoT networks. (Alkhudaydi et al., 2023)

Cyber-attack detection detects and responds to malicious or unauthorised activity on networks, computer systems and digital environments. The goal is to identify these attacks early, protect sensitive data and minimise potential damage. (Albakri et al., 2023)

Effective detection and prevention of cyber-attacks contribute to minimising economic losses, maintaining trust, promoting responsible digital transformation, ensuring supply chain resilience, and preventing potential damage. Detecting cyber-attacks involves proactive risk management, ethical responsibility, resilience and the well-being of individuals, organisations, and the planet. In addition, businesses prioritise long-term viability, and cyber-attack detection is essential in maintaining business continuity. By integrating robust cybersecurity practices into the fabric, society can move towards a safer, more secure, and responsible future. Organisations can avoid costly disruptions, financial losses and reputational damage by preventing and responding quickly to cyber threats. (Doynikova et al., 2020; Albakri et al., 2023)

As information technology has become an integral part of everyday as well as working life. They play a significant role in global communication. Tan et al. (2021) state that innovations and low cost in information technology have significantly increased the availability, use and performance of information technology.

According to Aghajani and Ghadimi (2018), most economic, business, cultural, and social interactions of countries at all levels, from individuals to NGOs and government institutions, occur in cyberspace. Moving these activities to cyberspace has brought with it several risks. A certain degree of instability, uncertainty or problems in this space can affect various aspects of life. (Li et al., 2020)

Duo et al. (2022) state that cyber-attacks can be divided into three classes: attacks on availability, integrity, and confidentiality. Availability attack is one of the most common cyber-attacks. It aims to block a communication network by making data and information inaccessible to the user. Typical availability attacks include DoS attacks, distributed DoS attacks and jamming attacks. An integrity attack is a compromise of integrity through falsifying data or control commands. There are many types of integrity attacks, e.g., false data injection, middlemen, sparse and replay attacks. Integrity attacks can occur in any part of the system because the attacker's target can be any system information. Attack methods include eavesdropping and a combination of DoS and integrity attacks.

Due to cyber-attacks, cybersecurity has become an essential part of any organisation's infrastructure. Cybersecurity involves practical measures to protect information, networks, and data from internal or external attacks. Cybersecurity experts safeguard networks, servers, intranets, and computer systems so that only authorised individuals can access this information (Jamal et al., 2021).

Safitra et al. (2023) describe in their work an evolutionary approach and its application to cyber-attack prevention through a methodological approach involving an evolutionary model. This model illustrates how modern cyber-physical systems can face attacks and evolve based on the experience of past security incidents. An evolutionary approach to cybersecurity thus allows organisations to evolve and adapt to new threats continuously, increasing their resilience to cyber-attacks. These efforts include developing the ability to anticipate threats, prepare responses to attacks, and quickly restore operations after incidents. In addition, an evolutionary approach enables organisations to improve their proactive cybersecurity capabilities continuously. This includes developing employee security training programs, raising security awareness throughout the organisation, and fostering a strong security culture. Therefore, an evolutionary approach helps organisations respond to cyberattacks but also helps prevent them from occurring in the first place.

Sensuse et al. (2022) recommend using big data, blockchain, biometrics, machine learning, cryptography, network security, artificial intelligence, and intrusion detection to achieve cybersecurity goals. Cybersecurity

also needs risk assessment, management, and awareness so that the selected security technology can achieve the expected goals.

Cybersecurity solutions for information technology (IT) have been developed and refined for some time. The availability of sensitive data is highly valued, but in IT, the security of that data is of paramount importance. (Alzahrani & Aldhyan, 2023)

4. Methodology

In this paper, we focus on the impact of hybrid threats on the performance of the business environment in the European Union countries in 2022. The total sample consists of 26 countries belonging to the European Union. We excluded Malta from the assessment because no published data on the country's competitiveness existed. We determined the performance of the business environment based on the World Competitiveness Ranking (WCR) determined by IMD.

The World Competitiveness Ranking is based on 335 criteria selected based on comprehensive research. These criteria are regularly reviewed and updated in light of new research, data, and developments in the global economy. (IMD World Competitiveness Ranking, 2023) We consider WCR as a dependent variable in our study.

Six threats and consequences obtained from Eurostat databases represented hybrid threats as independent variables. We divided these threats into two groups, namely:

1. No harmful consequences.
2. With harmful consequences caused from inside or outside the company.

We included in the first group the unavailability of ICT services due to hardware or software failure, unavailability of ICT services (e.g., denial of service attacks, ransomware, hardware, or software failure).

The second group consists of the unavailability of ICT services due to an external attack (e.g., ransomware attacks, Denial of Service attacks), destruction or corruption of data due to malware infection or unauthorised intrusion, disclosure of confidential data due to intrusion, pharming, phishing attack or deliberate action by own employees, disclosure of confidential data due to inadvertent action by own employees.

We chose these factors based on data from Eurostat, which states that the most common consequence of security threats was the unavailability of ICT services due to hardware or software failure (18.7%). The unavailability of ICT services due to external attacks (e.g., ransomware attacks, denial of service attacks) was much less frequent (3.5%). EU businesses also reported data destruction or corruption caused by two types of incidents: hardware or software failure (3.9%) or malware infection or unauthorised intrusion (2.1%). The least frequent consequence of ICT security incidents was the disclosure of confidential data, which was related to two different reasons: intrusion, pharming, phishing attack, deliberate action by own employees (1.1%) and inadvertent action by own employees (1.0%) (Eurostat, 2023).

5. Results

At the beginning of the investigation, we assumed that hybrid threats represented by our selected variables negatively impact the performance of the business environment in the European Union countries.

The first step in analysing the data was to test what distribution it came from. Based on the Shapiro-Wilk test, we found that the data met the assumptions of a normal distribution.

Table 1. ANOVA regression

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2675.721	6	445.953	3.002	.031 ^b
	Residual	2822.819	19	148.569		
	Total	5498.540	25			

a. Dependent Variable: World Competitiveness Ranking

b. Predictors: (Constant), Disclosure of confidential data due to unintentional actions by own employees, Destruction or corruption of data due to infection of malicious software or unauthorised intrusion, Unavailability of ICT services due to hardware or software failures, Unavailability of ICT services due to attack from outside (e.g. Ransomware attacks, Denial of Service attacks), disclosure of confidential data due to intrusion, pharming, phishing attack, intentional actions by own employees, Unavailability of ICT services (e.g. Denial of Service attacks, ransomware attacks, hardware or software failures)

Source: own processing

The regression model presented in Table 1 shows statistical significance as the p-value (Sig.) is less than the set significance level of 0.05. This indicates that there is a statistically significant relationship between the dependent variable and the independent variables.

Table 2. Coefficients

Country	Non-malicious causes		Malicious causes caused by attack from inside or outside				World Competitiveness Ranking (Constant)	Ranking
	Unavailability of ICT services due to hardware or software failures	Unavailability of ICT services (e.g., Denial of Service attacks, ransomware attacks, hardware, or software failures)	Unavailability of ICT services due to attacks from outside (e.g., Ransomware attacks, Denial of Service attacks)	Destruction or corruption of data due to infection of malicious software or unauthorised intrusion	Disclosure of confidential data due to intrusion, pharming, phishing attacks, intentional actions by own employees	Disclosure of confidential data due to unintentional actions by own employees		
Austria	-0.79	1.01	0.02	-0.07	-0.07	0.07	46.18	8
Belgium	-1.33	1.60	0.03	-0.08	-0.15	0.19	45.87	9
Bulgaria	-0.55	0.65	0.01	-0.07	-0.09	0.05	29.49	26
Croatia	-0.84	1.00	0.01	-0.09	-0.19	0.20	32.91	21
Cyprus	-0.69	0.86	0.03	-0.13	-0.23	0.30	37.51	18
Czech Republic	-1.69	1.94	0.03	-0.14	-0.15	0.12	43.54	11
Denmark	-1.56	1.82	0.03	-0.07	-0.18	0.27	57.43	1
Estonia	-1.55	1.75	0.02	-0.07	-0.15	0.21	45.36	10
Finland	-2.66	2.99	0.03	-0.06	-0.21	0.37	53.43	4
France	-1.51	1.70	0.01	-0.06	-0.11	0.08	42.69	12
Germany	-1.58	1.81	0.02	-0.07	-0.11	0.15	49.20	7
Greece	-0.80	1.14	0.03	-0.06	-0.19	0.08	32.88	22
Hungary	-0.50	0.64	0.02	-0.07	-0.10	0.16	37.83	17
Ireland	-0.81	0.99	0.01	-0.02	-0.04	0.07	51.41	5
Italy	-0.88	1.06	0.02	-0.06	-0.06	0.06	37.34	19
Latvia	-1.03	1.17	0.02	-0.07	-0.19	0.21	38.14	14
Lithuania	-0.92	1.01	0.00	-0.07	-0.07	0.09	42.18	13
Luxembourg	-0.82	1.01	0.02	-0.10	-0.12	0.16	50.40	6
Netherlands	-1.63	2.00	0.04	-0.09	-0.30	0.29	54.15	3
Poland	-1.86	2.05	0.02	-0.11	-0.07	0.10	30.65	24
Portugal	-0.56	0.71	0.01	-0.08	-0.05	0.05	37.04	20
Romania	-1.13	1.27	0.02	-0.10	-0.07	0.08	30.55	25
Slovakia	-0.65	0.75	0.01	-0.04	-0.05	0.08	30.74	23
Slovenia	-0.78	0.90	0.01	-0.06	-0.15	0.08	37.88	16
Spain	-0.86	1.04	0.02	-0.10	-0.13	0.07	38.01	15
Sweden	-1.17	1.40	0.02	-0.07	-0.15	0.16	56.11	2

Dependent Variable: World Competitiveness Ranking

Source: own processing

Based on the analysis, we assessed the impact of our chosen independent variables (threats and consequences) on the dependent variable (competitiveness index) and then determined the ranking of the countries.

The analysis results showed that 3 out of the 6 selected threats and their consequences negatively impact the performance of the business environment in all countries. We consider the unavailability of ICT services due to hardware or software failure as a threat without harmful causes. However, we have seen the most significant negative impact on the business environment for this threat. The values ranged from -2.66 to -0.50. We also observed a negative effect when confidential data was disclosed because of employee intrusion, phishing, phishing attacks, or deliberate actions, where the values ranged from - 0.30 to - 0.04. The last threat with a negative impact was the destruction or corruption of data due to malware infection or unauthorised intrusion; for this threat, the values ranged from - 0.14 to - 0.02.

A surprising finding was that some of the threats and their consequences positively impacted the performance of the business environment. Specifically, these were unavailability of ICT services (e.g., Denial of Service attacks, ransomware, hardware, or software failure) (0.64 - 2.99), unavailability of ICT services due to external attack (e.g., ransomware, Denial of Service attacks) (0.00 - 0.04), and disclosure of confidential data due to inadvertent actions of own employees (0.05 - 0.37).

We hypothesise that the positive impact of these factors is due to increased attention from enterprises and security engineers. Enterprises and technicians try to prevent these threats by improving the security protocols used in enterprises.

Table 3. Cyber Safety

Ranking	Country	National Cyber Security Index (NCSI)	Global Cybersecurity Index (GCI)	Cybersecurity Exposure Index (CEI) 2020	Cyber-Safety Score (Mean Average of NCSI, GCI, and CEI)
1	Belgium	94.81	96.25	81.00	90.69
2	Finland	85.71	95.78	89.00	90.16
3	Spain	88.31	98.52	79.00	88.61
4	Denmark	84.42	92.60	88.30	88.44
5	Germany	90.91	97.41	75.90	88.07
6	Lithuania	93.51	97.93	70.30	87.25
7	France	84.42	97.60	77.20	86.41
8	Sweden	84.42	94.55	79.00	85.99
10	Portugal	89.61	97.32	69.70	85.54
11	Netherlands	83.12	97.05	73.80	84.66
12	Poland	87.01	93.86	71.40	84.09
13	Luxembourg	66.23	97.41	87.60	83.75
17	Croatia	83.12	92.53	74.50	83.38
18	Greece	96.10	93.98	60.00	83.36
19	Slovakia	83.12	92.36	73.80	83.09
20	Italy	79.22	96.13	73.10	82.82
26	Latvia	75.32	97.28	64.80	79.13
27	Ireland	75.32	85.86	74.50	78.56
28	Czech Republic	92.21	74.37	66.60	77.73
29	Hungary	67.53	91.28	71.40	76.74
33	Cyprus	66.23	88.82	66.60	73.88
35	Romania	89.61	76.29	53.80	73.23
40	Slovenia	59.74	74.93	71.70	68.79
51	Bulgaria	74.03	67.38	51.70	64.37

*Missing countries: Austria, Estonia, Malta

Source: own processing

In addition to analysing the impact of the independent variables on the dependent variable, we have also reported the results of the cybersecurity scores of the European Union countries. SEON.IO compiled this global ranking by combining data from three central cybersecurity authorities, namely the National Cybersecurity Index (NCSI), the Global Cybersecurity Index (GCI) (2020) and the Cybersecurity Exposure Index (CEI) (2020) (SEON.IO, 2023).

From the above rankings, we have selected the countries of the European Union. The ranking of the countries corresponds to the ranking from the overall ranking. The index values and the overall scores of Austria, Estonia and Malta were not included in the given ranking; therefore, these countries are considered missing.

Table 4. Correlation

			World Competitiveness Ranking	Cyber-Safety Score (Mean Average of NCSI, GCI, and CEI)
Spearman's rho	World Competitiveness Ranking	Correlation Coefficient	1.000	0.540**
		Sig. (2-tailed)	.	0.006
	Cyber-Safety Score (Mean Average of NCSI, GCI, and CEI)	N	24	24
		Correlation Coefficient	0.540**	1.000
		Sig. (2-tailed)	0.006	.
		N	24	24

****.** Correlation is significant at the 0.01 level (2-tailed).

Missing countries: Austria, Estonia, Malta

Source: own processing

In the end, we examined the relationship between a country's business environment's performance and cybersecurity. The correlation results indicate a moderate to moderately strong relationship between the variables. The value of the correlation coefficient between business environment performance represented by the variable global competitiveness ranking and cybersecurity represented by the variable cybersecurity score was equal to 0.540.

Conclusions

Examining hybrid threats and their impact on the business environment reveals a complex and evolving range of challenges and opportunities. As the global community grapples with the multifaceted nature of these threats, businesses are on the front lines of this fight and face significant risks and responsibilities.

Hybrid threats, combined with traditional and non-traditional elements, have demonstrated the ability to disrupt the digital realm and the physical and economic foundations of business. Many published case studies and analyses highlight the importance of recognising the interconnectedness of these threats and their potential to undermine corporate stability.

Faced with these challenges, businesses must adopt a proactive and multifaceted approach to risk management. This approach should include cyber defence and strategies to combat disinformation, manage economic pressures, and increase supply chain resilience. Cooperation between the public and private sectors is essential as it supports exchanging information on threats, the development of regulatory frameworks, and the implementing of best practices.

Furthermore, resilience is a crucial theme in mitigating the impact of hybrid threats on the business environment. Resilient organisations could adapt, recover, and continue operating despite negative influences from the external environment. By embedding resilience into corporate culture and strategies, businesses can increase their ability to withstand and recover from hybrid threats.

In conclusion, hybrid threats are a dynamic and ongoing challenge that requires vigilance, adaptability, and cooperation. As a vital part of modern society, the business environment must remain vigilant in identifying and mitigating these threats to ensure the stability and prosperity of global trade. As technological advances and geopolitical complexity continue, the study and understanding of hybrid threats will continue to evolve, and businesses must evolve with them to thrive in this everchanging environment. By comprehensively solving these threats and cooperating, we can work on a safer and more resilient business environment for the future.

The results of the analyses showed that our chosen independent variables have a statistically significant effect on the dependent variable. Thus, we can conclude that when the number of recorded threats and their consequences increases, changes in the business environment of a given country occur. We find that hybrid threats do not only affect the performance of a country's business environment in a negative sense, but some of them can also have a positive impact.

Ultimately, we compared the relationship between the performance of a country's business environment and cybersecurity. From this, we found that if a country has a better cybersecurity rating, the business environment performance scores higher and vice versa.

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DETERMINANTS OF THE GROWTH OF SMALL AND MEDIUM ENTERPRISES*

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Abstract. SMEs (Small and Medium Enterprises) play a vital role in the economic and social life of the country. Existing studies mostly use proxy performance indicators and relatively general determinants of the performance of SMEs. The goal of the research is to contribute to the deepening and expansion of knowledge about the determinants of performance and growth of SMEs, while the growth and performance of SMEs are expressed by monetary indicators of actual performance, and the determinants of performance are ascertained in specific enterprises based on personal observation of the researcher. The research was conducted on a sample of 146 SMEs. Descriptive statistics, correlation and regression analysis were used to analyze the research sample. The results of the research are the positive determinants, which are the ambitions of the founder, the number of employees, the excellence of the product, the diversity of the level of education and work experience of the employees, the level of education of the employees and the managerial experience of the founder. Negative determinants are the company's age, proof of product excellence, and explicit formulation of financial goals. The originality of the research lies in the use of audited performance indicators of specific SMEs, which are influenced by the determinants identified in these SMEs' field research. Determinants are divided into positive and negative, including the intensity of their influence, further into long-term and short-term, and according to the range of influence on various performance indicators.

Keywords: SMEs, business growth; performance indicators; positive and negative determinants; short-term and long-term influence

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JEL Classifications: L25, L26, M10

1. Introduction

Small and medium enterprises have become a recognized economic and social phenomenon of economic and social life (Malki, 2023). Their role in the economy and society cannot be overlooked. In the era of economic globalization, SMEs are recognized as the engine of sustainable economic development in developed and developing countries (Prasanna et al., 2019), (Khorshid et al., 2023). Even in developed countries, there are lofty expectations for SMEs' growth as the country's economic growth depends on them (Heilmann et al., 2018). Small and medium-sized enterprises are still an exciting topic to study because they play a significant role in employment (Simbaña-Taípe et al., 2019), (Eklund, 2020), and in the generation of gross domestic product (Sarwoko and Frisdiántara, 2016). Small and medium-sized enterprises are key to local economic development, contributing to job creation, poverty reduction, and economic growth. They help stimulate competition (Kessler, 2007) and economic renewal, especially in transitioning from a command to a market economy. They show

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more creativity, innovation, and flexibility than large firms (Ha et al. 2018). Cicea et al. (2019) believe that studying the performance of SMEs is necessary for three reasons: their significant impact on gross domestic product and unemployment, their ability to adapt to a rapidly changing environment, and the cultivation of free entrepreneurial initiative. In addition, SMEs contribute significantly to technological progress in society and innovation in the economy (Zygmunt, 2017).

The arguments in favour of the existence and role of SMEs in the economy, business and society are favourable, but they do not lead to smooth business success. For example, the survival rate of new SMEs in Slovakia after five years of existence is 46.8%, which is in line with the European Union average (SBA, 2022, p. 44). In a competitive environment, SMEs look for small gaps to avoid direct pressure from large companies. Compared to large companies, their resources are quantitatively smaller and structurally limited. The existence of SMEs can be solved in several ways, but the healthiest way is to achieve sustainable growth (Yoo et al., 2018). Therefore, the fundamental question is what causes, influences, or promotes SMEs' business performance and growth. The answer to this question is the purpose and goal of the research, the results of which are presented in this article.

2. Analysis of the Literature on the Growth of Small and Medium-sized Enterprises

A company's growth is a manifestation of its viability, customer acceptance, and ability to seize opportunities and avoid threats. Pursuing growth is crucial for companies regardless of industry, age, or size (Kindström et al. 2022). The ability to sustain growth is a prerequisite for survival and prosperity (Dobbs and Hamilton, 2007). Explosive growth is essential for superior financial performance (Pearce and Pearce, 2020). From a family business perspective, growth is seen as a sign of success, particularly as a source of continuity and generational wealth creation (Stenholm et al., 2016). Business growth is not the result of chance but is linked to specific factors and attributes (Vaz, 2021). Small business growth is a multidimensional concept that is not easy to grasp, and researchers have not found agreement on a single measure (Cesinger et al., 2018). Understanding the reasons influencing small business growth can help ensure growth is regulated, thoughtful, and sustainable.

Standard or proxy performance indicators are used to measure the growth and success of SMEs. In both cases, they measure business performance, which is expressed in different quantifiers and described from different perspectives because of its multiple meanings. Standard indicators measure financial performance, such as profit growth, sales growth, return on sales, return on assets, return on equity, financial performance (composite) (Ahinful et al., 2023), profitability (Grau and Reig, 2021), return on sales (Fiorentino et al., 2021). Business performance can be profit-oriented and focus on sales returns, cost efficiency, or operational activities, or market-oriented and then on market share, sales growth, or unit cost economy (Zhou, Park, & Ungson, 2013). Standard performance indicators do not only measure immediate performance, for example, for one year. Performance is also expressed over a more extended period, e.g., revenue growth (Kindström et al., 2022), sales growth (Eklund, 2020), (Dalgıç and Fazlıoğlu, 2021), increase in total assets (Ergün and Doruk, 2020).

Proxy performance indicators express performance indirectly, e.g., competitiveness (Dvouletý and Blažková, 2021), SME productivity (Owalla et al., 2022), export performance (Zuchella et al., 2019; Safari and Saleh, 2020), access to sufficient financing (Batrancea et al., 2022), value added (Cicea et al., 2019). Another form of proxy performance indicators is represented by complex indicators, such as entrepreneurial success (Kozielski, 2019) and the replacement of actual data with point scales (Ahinful et al., 2021), Maaji et al. (2023), which compare indicators such as profit growth, revenue/sales growth with indicators of similar companies in the industry. However, according to Fiorentino et al. (2021), employee growth is the most widely used non-financial alternative measure of start-up growth. The most commonly used measures of small business growth (Wiklund and Shepherd, 2003; Gilbert et al., 2006; Wiklund et al., 2009) are firm size growth and sales growth. With the advent of the digital era, the performance of SMEs is measured not only by financial but also by technical indicators (Kim, 2021).

Little is known about which capabilities are more or less critical for achieving a particular dimension of performance, such as growth (Barbero et al., 2011). Internal and external determinants and their combinations influence business performance and its growth. The performance of SMEs is greatly influenced by the

experience, skills, values, and knowledge of employees (Malki, 2023) and their competencies (Eklund, 2020). Another study found that four factors, namely the owner's education level, the owner's marketing skills, customer complaints, and the firm's age, are important in determining the success or failure of SMEs (Maaji et al., 2023). Nazaro and Maltano (2023) also emphasize the owner's key role and predisposition to run the business; Rafiki (2020) reports the experience of the senior manager. The motivations of new entrepreneurs, such as the desire for success, financial reward, social recognition, and the desire for independence, are positively and significantly related to the growth of SMEs (Ismail, 2022), including the self-actualization of the founder (Ekinci et al., 2020). Kozielski (2019) writes that the knowledge of the market, the learning organization, and the marketing orientation of the founder and the employees make it possible to achieve better performance in the market; similar results were also obtained by Putra et al. (2019). However, in the background of personal determinants of growth, the intention to grow stands out, which is promoted by the ambition of the founder of the SME (Cesinger, et al., 2018).

Innovation is a frequently cited internal growth factor for SMEs. Research shows that innovation is crucial to the growth of new firms (Arcuri et al., 2023). Innovation fundamentally increases the likelihood that a firm will grow rapidly (Dalgic and Fazlioglu, 2021). Differences in growth can be explained by different levels of innovativeness in new firms (Fiorentino et al., 2021). Family-owned SMEs benefit from an innovative orientation directly and indirectly related to firm growth through entrepreneurial activity (Stenholm et al., 2016). Zuchella et al. (2019) argue that entrepreneurial and innovative capabilities are the most influential antecedents of objective and subjective international performance measures. Innovation, in combination with an SME's leverage, size, and reputation, influences its profitability (Grau and Reig, 2021). Restrepo-Morales et al. (2019) write that the performance of SMEs depends on their internal innovation efforts, which focus on product development. Furthermore, their findings suggest that imitators perform almost as well as innovators.

In addition to owners, employees, and innovation, the internal factors of SME growth include strategic flexibility (Brozović et al., 2023), firm age (Coad and Karlsson, 2022), (Ur Rehman, et al., 2019), management, technology, and technical competence in marketing and innovation (Kim, 2021), and type of business ownership (Ahinful et al., 2023). According to Kindström et al. (2022), the specific challenges for the growth of SMEs are three central themes, namely, business model, leadership, and people.

External factors do not receive as much publicity and scholarly interest as internal growth factors. This does not diminish their importance, but external determinants affect all sizes of firms, although not to the same extent. Most studies have focused on internal factors (Eggink, 2021). Ur Rehman et al. (2019) examined business environment factors mainly as barriers to SME growth: availability of finance, infrastructure, regulations, corruption, competition, and insufficiently educated labour force. Eggink (2021) conducted a comprehensive analysis of external influences, from which it is clear that their use in favour of the growth of SMEs is beyond the strengths and possibilities of this category of enterprises. A similar study was carried out by Cicea et al. (2019). From their conclusions, it can be deduced that they are intended more for the creators and regulators of the business environment than for the SMEs themselves. SMEs from the external environment can make the most of this information and resources, such as interest rates, business angels, bank support and public support (Batrancea et al., 2022), financial constraints in the region (Nizaeva and Coskun 2019), influence of industry concentration (Bartoloni et al., 2020).

However, the company's sustainable growth is not the result of a single particular factor. Rather, it is a mixture of business strategy, organization and procedures that are interrelated or mutually influential (Malki, 2023). A study by Runtuk et al. (2023) shows that internal factors that are interrelated and strongly influence SME growth are MS (managerial skills), EO (entrepreneurial orientation) and OwS (ownership structure). In addition, external factors such as CIL (Customer Involvement and Location) (customer involvement and location) and GS (government support) also play an important role in reinforcing the impact of other SME growth factors. The concept of combined determinants of SME growth has also been explored to varying degrees in studies by Salder et al. (2020), Dvouletý and Blažková (2021), Vaz (2021), Owalla et al. (2022). From these studies, the relationships between the size of the firm and its competitive ability (Dvouletý and Blažková, 2021) and the idiosyncratic characteristics of the entrepreneur (Vaz, 2021) come to the fore. The results of a quantitative and

qualitative analysis by Pearce and Pearce (2020) show that high-growth firms rely on different combinations of attributes related to advanced technology, market aggressiveness, and functional excellence.

The literature analysis shows that both standard and proxy indicators of SME performance and growth are predominantly expressed in scoring scales that capture respondents' subjective assessments. There are relatively few studies that work with specific data on the performance and growth of SMEs. In many countries, individual data on the performance and growth of a particular SME are not publicly available or are available only in some detail for a fee. Very few studies describe in more detail the nature of the internal factors that influence firm performance and growth. Most studies are based on publicly available data and, therefore do not go deep enough inside the company, and broadly constructed determinants are much more prevalent. Among the internal determinants, the person of the owner and founder, the internal characteristics of the company, whose bearers are the employees, and motives for growth and innovation come to the fore. It can be assumed that research using individual data on the growth and performance of specific SMEs from audited sources and identifying growth determinants through field research in these SMEs will contribute to deepening and broadening knowledge about the internal determinants of SME growth and performance.

3. Aim, Research Sample, and Research Methods

The research aims to identify the internal determinants of growth and performance of small and medium-sized enterprises. The growth and performance of SMEs are expressed by actual economic results, substitute or proxy indicators measured in rating scales are not used. Internal determinants of performance are identified in specific companies based on personal observation of the researcher.

The analysis of the literature shows that essential determinants of the performance and growth of SMEs are the founder/owner/leading person of the firm (by leading person we mean the most senior employee, who can be the founder, owner and at the same time e.g., the director of the company or a hired professional manager), employees, growth ambitions, and innovations that have an internal (intra-firm) origin. Most of the literature analyzed these determinants have a declarative and hypothetical character without empirical verification. The decision to focus on internal factors is also supported by a study on SME growth (Salder et al., 2020), which found that out of 208 citations on this topic, 33% were devoted to company characteristics, 30% to the external environment, 23% to strategy, and 14% of citations belonged to assets. The company's leading person and employees are an essential part of the company's characteristics, and growth ambitions significantly influence the company's strategy.

3.1 Research Sample and Field Research

The research was conducted in 146 small and medium-sized enterprises on the territory of the Slovak Republic between October and November 2022. The only condition for selecting a company for the sample was its size. The branch of business was not a requirement, although it was recorded. The selection of companies was deliberately random to avoid emphasizing or favoring any other characteristic, apart from the size of the company, which could influence its performance and growth. The research was conducted in the form of a structured interview based on a questionnaire in direct contact between the respondent and the researcher. Sectoral classification of the SMEs studied according to SK NACE (Nomenclature statistique des économies économiques dans la Communauté européenne):

C - Industrial production: 27

E - Water supply; Sewerage, waste management, and remediation activities: 3

F - Other building completion and finishing work: 12

G - Wholesale and retail trade: 40

H - Transport and storage: 2

I - Accommodation and food services: 5

J - Information and communication: 17

K - Financial and insurance activities: 6

L - Real estate activities: 1

M - Professional, scientific, and technical activities: 12

N - Administrative and support service activities: 12

P - Education: 1

Q - Human health and social work activities: 5

R - Arts, entertainment, and recreation: 3

3.2 Application of Statistical Methods

Business performance is expressed by indicators of revenue, sales and economic results achieved in 2021, and performance growth is expressed by indicators of ln revenue avg, ln sales avg and economic results avg for the period 2016 to 2021. The data on company performance comes from the Finstat database (<https://www.finstat.sk>), which uses, processes, and displays data from the Register of Financial Statements database (<https://www.registeruz.sk>). This database contains primary and audited accounting data of the surveyed SMEs. Performance and growth indicators are dependent variables in regression models.

The dependent variables, revenue and sales, were transformed using a logarithm before building the regression models because the distribution of the values of these variables is highly skewed, which can cause bias in the estimates obtained through statistical analyses. In this case, logarithmic transformation is the most common data transformation type in econometric models. In this study, it helped to arrange the variable values symmetrically and alleviate the problem of extreme values. Logarithmic transformation was not used for the dependent variable, economic result, because this variable also acquires negative and zero values. The distribution of values is relatively symmetrical, so transformation is unnecessary.

The regression model was built using backward or stepwise methods, which search for independent variables that significantly influence the dependent variable based on the statistical significance of the variables in the regression model. In the backward method, variables are gradually eliminated from the complete model containing all the selected explanatory variables, based on tests of statistical significance, until the step at which all the remaining variables are statistically significant. The stepwise method is based on gradually including variables with the highest correlation with the dependent variable. At the same time, the statistical significance of variables previously included in the model is also tested at each step. If a variable is found insignificant during the step, it is removed from the model. A regression model is built for each dependent variable using both procedures, and the resulting model is selected based on actual significance and interpretability. The quality of the regression model is assessed using the coefficient of determination (R^2) and the adjusted coefficient of determination (adjusted R^2). The significance of the overall model is tested using the ANOVA test.

Potential determinants of performance and growth (Figure 1) are the product and its innovativeness, the leading person of the company, the employees, and the interest in the growth of the company (growth ambitions). The detailed content of the verified determinants and their measurement scales are given in the Appendix. The data on determinants come from field research on SMEs. Determinants of performance and growth represent independent variables in regression models.

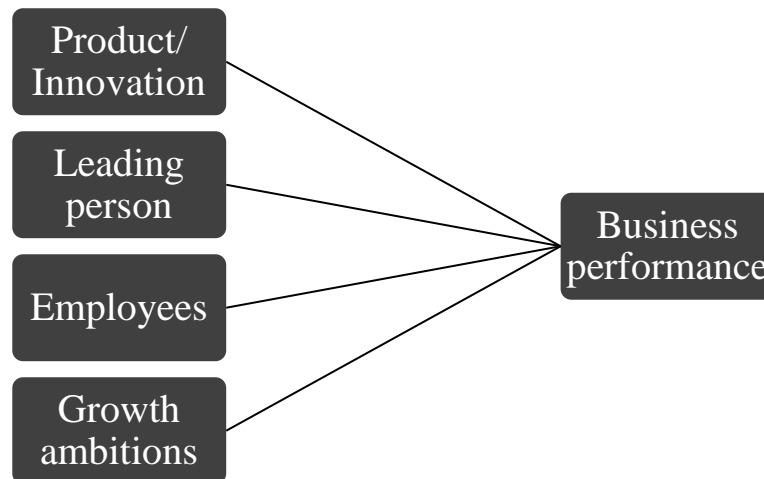


Figure 1. Model of determinants of business performance and growth.

4. Results of the Analysis of the Research Sample

The results of the analysis of the research sample are divided into five groups A, B, C, D and E. Group A (Table 1) shows the determinants divided by individual dependent variables, which are revenues, sales and economic results in 2021 and revenues, sales and economic results for the period 2016 - 2021, which serve to express the growth of business performance. Group B (Table 2) shows the determinants sorted by the magnitude of their impact on the performance indicators, the basic distinction being between positive and negative impact. Group C (Table 3) distinguishes between short-term results, which record the impact of the determinants on performance in 2021, and long-term results, which record the impact of the determinants on performance growth for the period 2016 - 2021. Group D shows the range, or the extent of the influence of the determinants on several performance indicators. Group E shows the sensitivity of performance indicators to influential determinants.

Table 1. Group A: Results of regression analysis – influence of determinants on revenues/sales/economic result

Dependent variable	Independent variable statistically significant	Influence	regress. coef. B
ln revenues 2021	number of employees	positive ↑	0,025
ln revenues avg	age of company	negative ↓	- 0,043
ln revenues avg	financial goals*	negative ↓	- 0,368
ln revenues avg	ambitions*	positive ↑	0,405
ln sales 2021	number of employees	positive ↑	0,023
ln sales 2021	reasons for starting a business *	negative ↓	-0,406
ln sales avg	age of company	negative ↓	- 0,042
ln sales avg	evidence of product excellence*	negative ↓	- 0,481
ln sales avg	homogeneity vs. heterogeneity of education level*	positive ↑	0,364
ln sales avg	homogeneity vs. heterogeneity of working experience*	positive ↑	0,352
econ. result 2021	level of education of employees	positive ↑	**
econ. result 2021	NACE M (Professional, scientific, and technical activities)	negative ↓	***
econ. result 2021	evidence of product excellence *	negative ↓	- 0,340
econ. result 2021	number of employees*	positive ↑	0,397
econ. result 2021	ambitions*	positive ↑	0,358
econ. result avg	excellence of product	positive ↑	10,568
econ. result avg	management experience of the founder*	positive ↑	0,329
econ. result avg	ambitions*	positive ↑	0,347

independent variables statistically significant at the 0.05 level

*independent variables statistically significant at the 0.1 level

Beta = 518 053,29; *Beta = -1 024 713,6; **, *** (it is not appropriate to use a log. transformation)

4.1 Model for ln Returns 2021, Stepwise Method

Dependent variable: ln returns 2021

* statistically significant independent variable is the number of employees, $B = 0.025$, sig. 0.015

Interpretation: if the number of employees increases by 1 in 2021, revenues will increase by 2.5%; if the number of employees increases, revenues also increase in the last monitored year;

the model explains 37.6% of the variability of the dependent variable

the model is statistically significant at the 0.05 level, sig. 0.015

4.2 Model for ln Returns avg for the Monitored Period, Stepwise Method

Dependent variable: ln returns avg for the monitored period

* a statistically significant independent variable is the age of the company, $B = -0.043$, sig. 0.005;

Interpretation: If the age of the enterprise increases by 1, the average returns decrease by 4.3%; as the company's age increases, its average revenues for the monitored period decrease.

The model explains 46.2% of the variability of the dependent variable.

The model is statistically significant at the 0.05 level.

Independent variables statistically significant at the 0.1 level:

* financial goals, Beta ln = -0.368, sig. 0.067;

Interpretation: If the financial goals are explicitly formulated, then the performance of the company decreases; however, companies that explicitly set financial goals have a share of 21% in the research sample, while 81% of companies, i.e., four times more, do not formulate financial goals.

* ambition, Beta ln = 0.405, sig. 0.072;

Interpretation: if ambitions increase by one degree/point, average returns will rise; as the company's ambitions grow, its average revenues for the monitored period increase.

4.3 Model for ln Sales 2021, Stepwise Method

Dependent variable: ln sales 2021

* Only the number of employees is a statistically significant variable, $B = 0.023$, sig. 0.026;

Interpretation: If the number of employees increases by 1, sales will increase by 2.3% in 2021; if the number of employees increases, sales increase in the last observed year.

The model explains 35.1% of the variability of the dependent variable.

The model is statistically significant at the 0.05 level, sig. 0.026.

Independent variables statistically significant at the 0.1 level:

* reasons for starting a business, Beta ln = -0.406, sig. 0.086;

Interpretation: If the share of psychological reasons for starting a business increase, sales will decrease in 2021; if the share of situational reasons for starting a business increase, then in the last observed year sales decrease.

4.4 Model for ln Sales avg for the Monitored Period, Stepwise Method

Dependent variable: ln sales avg for the monitored period

* a statistically significant variable is the age of the company, $B = -0.042$, sig. 0.013;

Interpretation: If the age of the enterprise increases by 1 year, the average returns will decrease by 4.2%; if the age of the company increases, its average revenues for the monitored period decrease.

The model explains 38.7% of the variability of the dependent variable.

The model is statistically significant at the 0.05 level, sig. 0.013.

Independent variables statistically significant at the 0.1 level:

* proof of exceptionality, Beta ln = -0.481, sig. 0.099;

Interpretation: If the evidence of product excellence is increasing, then the average returns for the observed period are decreasing.

* homogeneity of level/degree of education of employees, Beta ln = 0.364, sig. 0.098;

Interpretation: If the homogeneity of the level of education decreases, or heterogeneity increases, the average returns for the observed period increase.

* homogeneity of employees' work experience, Beta ln = 0.352, sig. 0.10;

Interpretation: If the homogeneity of work experience decreases, or heterogeneity increases, then the average returns for the observed period increase.

4.5 Model for Economic Result 2021, Stepwise Method

Dependent variable: economic result 2021

Statistically significant variables are:

* predominant education of employees, Beta = 518,053.3, sig. 0.000;

Interpretations: If the prevailing education of employees increases by 1 degree, the hosp. result in 2021 by 518053 units; as employees' education level increases, the economic result increases in the last observed year.

The model explains 45.7% of the variability of the dependent variable.

The model is statistically significant at the 0.05 level, sig. 0.006.

* NACE M (Professional, scientific, and technical activities), Beta = -1,024,713.6, sig. 0.000;

Interpretation: Enterprises in the NACE M category have (ceteris paribus) an economic result in 2021 of 1.026 mil. units lower than enterprises in other NACE categories, which were, however, statistically insignificant.

The model explains 86.9% of the variability of the dependent variable.

The model is statistically significant at the 0.05 level, sig. 0.001.

Independent variables statistically significant at the 0.1 level:

* proof of exceptionality, Beta ln = -0.340, sig. 0.097;

Interpretation: If the evidence of product excellence is increasing, then the economic result in the last monitored year is decreasing.

* number of employees, Beta ln = 0.397, sig. 0.081;

Interpretation: If the number of employees increases, so does the economic result in the last monitored year.

* ambition, Beta ln = 0.358, sig. 0.079;

Interpretation: If ambitions grow, the economic result also grows in the last observed year.

4.6 Model for Economic Result Average for the Monitored Period, Stepwise Method

Dependent variable: economic result average for the monitored period

* only product/service excellence is a statistically significant variable, B = 10.568, sig. 0.001;

Interpretation: If product/service excellence increases by 1 degree, the average economic result of the company will increase by 10,568 units; if the exceptionality of the product/service increases, the average economic result of the company increases in the monitored period.

The model explains 59.7% of the variability of the dependent variable.

The model is statistically significant at the 0.05 level, sig. 0.001

Independent variables statistically significant at the 0.1 level:

* managerial experience of the founder before starting the business, B = 0.329, sig. 0.063;

Interpretation: Longer managerial experience of the founder before starting the business has a favourable effect on the growth of the average economic result in the monitored period.

* ambition, B = 0.347, sig. 0.051;

Interpretation: If ambitions grow, the average economic result also grows in the monitored period.

Table 2. Group B: Results of regression analysis – the size of influence of significant factors.

Dependent variable	Independent variable statistically significant	Influence	regress. coef. B
econ. result avg	excellence of product	positive ↑	10,568
ln revenues avg	ambitions*	positive ↑	0,405
econ. result 2021	number of employees	positive ↑	0,397
ln sales avg	homogeneity vs. heterogeneity of education level*	positive ↑	0,364
econ. result 2021	ambitions*	positive ↑	0,358
ln sales avg	homogeneity vs. heterogeneity of working experience*	positive ↑	0,352
econ. result avg	ambitions*	positive ↑	0,347
econ. result avg	management experience of the founder*	positive ↑	0,329
ln revenues 2021	number of employees	positive ↑	0,025
ln sales 2021	number of employees	positive ↑	0,023
econ. result 2021	level of education of employees	positive ↑	**
ln sales avg	age of company	negative ↓	- 0,042
ln revenues avg	age of company	negative ↓	- 0,043
econ. result 2021	evidence of product excellence *	negative ↓	- 0,340
ln revenues avg	financial goals *	negative ↓	- 0,368
ln sales 2021	reasons for starting a business *	negative ↓	- 0,406
ln sales avg	evidence of product excellence *	negative ↓	- 0,481
econ. result 2021	NACE M (Professional, scientific, and technical activities)	negative ↓	***

independent variables statistically significant at the 0.05 level

*independent variables statistically significant at the 0.1 level

Beta = 518 053,29; *Beta = -1 024 713,6; **, *** (it is not appropriate to use a log. transformation)

Positive factors:

- the number of employees is recorded three times as a relevant independent variable or influential positive factor,
- ambition as a characteristic of the leading person of the business is recorded three times as a relevant independent variable, once the managerial experience of the founder before starting the business is recorded, these are influential positive factors,
- the level of education and the work experience of the employees in terms of their diversity are recorded as two relevant independent variables, which have a positive effect on the performance of the company with increasing diversity,
- the level of education of the employees is recorded once as a relevant independent variable or an influential positive factor,
- the excellence of the product is recorded once as a relevant independent variable or an influential positive factor.

Negative factors:

- the age of the firm is recorded twice as a relevant independent variable or influencing factor, but with a negative effect,
- reasons for starting a business are recorded once as a relevant independent variable or influencing factor, but with a negative impact (as the share of psychological reasons increases, the firm's performance decreases),
- evidence of product excellence is recorded twice as a relevant independent variable or influencing factor, but with a negative impact,
- the explicit formulation of financial goals appears once as an influential determinant, but with a negative effect,
- NACE M companies are the only type of companies that determine their own performance from this point of view, but with a negative impact.

Strength of the influence of factors:

Strong factors for performance and growth are product excellence, ambition, diversity of education and employees' work experience, education level of employees, management experience of the founder, and number of employees. However, the number of employees has both a strong and a weak effect on the firm's performance, depending on the type of indicator. The age of the firm has a negative effect on the performance and growth of the firm, but its influence is small. The influence of the reasons for starting a business is relatively strong, but the negative trend means that performance decreases as the psychological reasons for starting a business increase. The choice of industry also has a negative effect on firm performance, but the relevant consequences are only for one industry (NACE M). The determinants evidence of exceptionalism and explicit formulation of financial objectives have a negative effect, which is not in line with common experience.

Table 3. Group C: Results of regression analysis – short-term (2021) vs. long-term view (avg)

Dependent variable	Independent variable statistically significant	Influence	View
ln revenues 2021	number of employees	positive ↑	short-term
ln sales 2021	number of employees	positive ↑	
ln sales 2021	reasons for starting a business *	negative ↓	
econ. result 2021	level of education of employees	positive ↑	
econ. result. 2021	NACE M (Professional, scientific, and technical activities)	negative ↓	
econ. result 2021	evidence of product excellence *	negative ↓	
econ. result 2021	number of employees *	positive ↑	
econ. result 2021	ambitions*	positive ↑	
ln revenues avg	age of company	negative ↓	long-term
ln revenues avg	financial goals *	negative ↓	
ln revenues avg	ambitions*	positive ↑	
ln sales avg	age of company	negative ↓	
ln sales avg	evidence of product excellence *	negative ↓	
ln sales avg	homogeneity vs. heterogeneity of education level *	positive ↑	
ln sales avg	homogeneity vs. heterogeneity of working experience *	positive ↑	
econ. result avg	excellence of product	positive ↑	
econ. result avg	management experience of the founder*	positive ↑	
econ. result avg	ambitions*	positive ↑	

independent variables statistically significant at the 0.05 level

*independent variables statistically significant at the 0.1 level

Short-term factors (business performance in 2021):

- the number of employees is recorded three times as a relevant independent variable or an influential positive factor,
- the level of education of the employees is recorded as a relevant independent variable or an influential positive factor,
- ambition as a characteristic of an entrepreneur is recorded once as a relevant independent variable, it is an influential positive factor,
- reasons for starting a business are recorded once as a relevant independent variable or an influential factor, but with a negative impact (when the share of psychological reasons increases, the performance of the enterprise decreases),
- doing business in the industry of NACE category M has a negative impact on the company's performance in the short term, other NACE categories have no relevant impact on performance,
- evidence of product excellence is recorded once as a relevant independent variable or influencing factor, but with a negative impact.

Long-term factors (business growth over the monitored period):

- the age of the firm is recorded twice as a relevant independent variable or an influential factor, but with a negative impact,

- ambition as a characteristic of a business leading person is recorded twice as a relevant independent variable, and the founder's management experience before starting the business is recorded once, these are influential positive factors,
- the exceptionality of the product is recorded once as a relevant independent variable or an influential positive factor,
- the level of education and work experience of the employees in terms of their diversity are recorded as two relevant independent variables that have a positive effect on the company's performance as diversity increases,
- explicitly formulated financial goals are recorded once as a relevant independent variable or influencing factor, but with a negative impact,
- proof of product exceptionality is recorded once as a relevant independent variable or influencing factor, but with a negative impact.

Group D: Results of the analysis – range/scope of influence of determinants on performance indicators.

Determinants (independent variables) that affect more than one performance indicator (dependent variables) have a greater impact on business performance because they are more effective and universal than determinants that affect only one indicator. Determinants that affect two or more performance indicators are:

- * Number of employees: In revenues 2021, In sales 2021, economic result 2021 (3 performance indicators),
- * Company age: In revenues avg, In sales avg (2 performance indicators),
- * Ambitions: In revenues avg, economic result avg (2 performance indicators),
- * Proof of excellence: economic result 2021, In sales avg (2 performance indicators).

Group E: Analysis results – sensitivity or sensitivity of performance indicators to influential determinants.

Research shows that a varying number of determinants influence performance and growth indicators. Thus, there are indicators that are influenced more complexly or simply, indicators that are stimulated to change by a greater or lesser number of determinants, or to change them, a greater or lesser number of determinants must be activated. Indicators of performance and growth sorted by sensitivity to the number of determinants are economic results 2021 (influenced by 5 determinants), In sales avg (4), In revenues avg (3), hosp. result avg (3), In sales 2021 (2), In revenues 2021 (1).

5. Discussion

5.1 Positive Determinants

In particular, the number of employees and their ambitions have a positive effect on the company's performance and growth. The number of employees is a broad and immediate factor that, unlike production capacity, does not require significant investment. For firms that do not require a highly skilled workforce, which is the majority in the research sample, additional employees are relatively easily available from local sources. However, increasing the number of employees will eventually reach a limit beyond which a suitable workforce structure is no longer readily available. Brozović et al. (2023) also consider the lack of competent employees as an obstacle to SME growth. Growth ambitions drive the firm forward; they are evidence of the courage and self-confidence of the founder and his dissatisfaction with the performance and size of the firm. Other authors use modified terms for ambitions, such as desire for success (Ismail, 2022) and idiosyncratic characteristics of an entrepreneur (Vaz, 2021), which are positively and significantly associated with SME growth. Other ambition sources are questionable but likely to come from other identified determinants, namely the diversity of education and employees' work experience; diversity is recognized as a source of development and prosperity. Owalla et al. (2022) recommend a comprehensive approach to understanding human capital in SMEs, which also explains the growth opportunities for SMEs. The education and experience of employees as a growth factor are also mentioned by Vaz (2021), but only as a result of the literature review. The determinant of the level of education of employees confirms that education plays an important role in the development of society and business. Business growth is also based on the excellence of the product, which is probably related to all the positive determinants already mentioned.

5.2 Negative Determinants

The age of the company has a negative effect on its performance, which can be attributed to fatigue from long-term business, the exhaustion of innovative ideas, but also the reduction of business opportunities and the activity of competitors. The company grows over time, but at the same time, it ages over time, and therefore its growth slows down. The negative effect of the age of SMEs is also reported by Ur Rehman et al. (2019), but it becomes less significant in the later stages of the company's development. The age of SMEs is positively associated with growth according to Bartoloni et al. (2020), but this is not the case for the group of very small enterprises. Although they can be very strong in themselves, psychological reasons for starting a business seem to weaken the real interest in entrepreneurship because they are more idealistic than situational reasons, which are usually a life or career necessity. Psychological factors are, therefore weaker than situational factors in real entrepreneurship and have a negative effect. Evidence of product excellence makes the impact of product excellence on business performance more realistic; evidence of excellence is more real than the supposedly exceptional object of evidence. Companies in NACE M (professional, scientific, and technical activities) disrupt the usual picture of the positive impact of innovation on company performance or complement it in that innovation is also risky, and its positive link to company performance is not self-evident. Explicitly formulated financial goals are associated with a negative impact on performance, which again disrupts the conventional wisdom about the impact of formalizing business activities on firm performance. The reason for this phenomenon is probably that the formalization and explicit expression of precise goals conflicts with the informal internal processes of SMEs and the mostly opportunistic behavior of SMEs.

5.3 The Power of Influence of Determinants

The dominant qualitative factors are product excellence, ambition, education, and work and management experience, combined with a weak influence of the number of employees. Other researchers focus on innovation rather than product excellence. Innovation is considered a critical growth factor by Arcuri et al. (2023), Restrepo-Morales et al. (2019) write that the performance of SMEs depends on their internal innovation efforts focused on product development, and Dalgıç and Fazlıoğlu (2021) state that innovation fundamentally increases the probability of a firm becoming a high-growth firm. The age of the firm has a negative effect on the firm's performance, but the effect is very weak. Positive factors are the result of the selection and improvement of human resources, which are scarcer than traditional resources of a material and quantitative nature, which are freely available on the market. This also results from the relationship between the influence of the qualitative characteristics of human resources and the influence of the number of employees on performance indicators. The number of positive determinants clearly exceeds the number of negative determinants, and the power of influence of positive determinants also exceeds the power of influence of negative determinants. From the point of view of positive influence, the number of employees and the ambitions of the company's management can be considered as key factors in the growth of the company's performance. From the point of view of negative influence, the age of the company and evidence of product excellence can be considered as key factors that limit the growth of the company's performance. From the point of view of the power of influence, product excellence, ambition, education, work, and management experience can be considered as key factors in the growth of the company's performance. The intersection point between the view of the number of influencing factors and the view of the power of influence is the ambition of the company's management.

5.4 Short-term Determinants

Among the short-term determinants appeared: the number of employees, because it is a quickly mobilized positive factor; situational reasons for starting a business, because they work better in the short term than psychological reasons, but El Shoubaki et al. (2020) found that reasons for starting a business mediate the relationship between firm growth and the quality of human capital, especially managers; the impact of higher education, because it has immediate effects; ambition, because it is a necessary condition for growth, but it plays a smaller role in the short term than in the long term; Proof of product excellence does not support short-term growth, probably because excellence is initially misunderstood by customers; the business of SMEs in the NACE M industry category has a negative impact on their performance and growth, as it appears to require high-quality resources and the business results are subject to higher risks than in other NACE categories.

5.5 Long-term Determinants

The effect of firm age on performance and growth is manifested as long-term firm fatigue, which weakens growth. Still, persistent/sustained leadership ambition promotes growth and compensates for firm fatigue. The founder's experience from the previous business remains the engine of growth, driven by the employees' diversity of education and work experience. The influence of the founder's experience on SME growth has also been identified by Rafiki (2020) and Meressa (2020). Product excellence (impression) and evidence of product excellence (reality) have contradictory effects on long-term growth. Customers respond positively to the impression a product creates but confirmed exceptionality corrects that impression. The effort to formulate explicit long-term financial goals has a negative effect because it seems to place unattainable demands on SMEs given their size, position in the economy, competition, and volatile future. In the short term, the key determinant of the company's performance is the number of employees. In the long term, the critical determinant of the company's performance is the ambition of the leading person.

5.6 Range/Scope of Influence of Determinants on Performance Indicators

The influence of the determinants on the performance indicators is not equal. The largest influence is the number of employees, the age of the company, the ambition, and the evidence of excellence. Other factors have an impact on only one performance indicator. The four factors with the greatest impact can be divided into quantitative factors (number of employees and age of the company) and qualitative factors (ambition and evidence of excellence). Quantitative factors can be considered less sophisticated factors and qualitative factors can be considered more sophisticated factors. Looking further at the sophistication of the factors, it is clear that all other factors that affect only one performance indicator are sophisticated or qualitative. The predominance of sophisticated factors is obvious but not sufficient because the determinants work together and therefore all determinants identified as relevant (statistically significant) are necessary.

5.7 Sensitivity/Perception of Performance Indicators to Influential Determinants

Each performance indicator is influenced by at least one statistically significant determinant at the 0.05 level. However, there is no single universal, broad determinant that would affect each performance indicator. The largest number of determinants (5) affects the economic result 2021 indicator, which measures short-term profit. The economic result is a more complex indicator compared to revenues and sales because it is "pulled" by sales and "pushed" by costs; it is the difference between sales and costs, while sales and revenues are unidirectional indicators that are "pulled" by demand. The number of relevant determinants probably reflects this complexity. However, the economic result avg, which measures profit in the long run, is influenced by fewer determinants (3) and in a different composition. The long-term indicators ln sales avg (4) and ln revenues avg (3) are influenced by a larger number of determinants than the short-term indicators ln sales 2021 (2) and ln revenues 2021 (1). Sales are affected by one more determinant than revenues because sales are more subject to market influences.

The more determinants affect the company's performance indicator, the more difficult it is to achieve this performance indicator, but in addition, the mobilization and actionability of individual determinants must also be assessed. The number of determinants expresses the complexity and difficulty of achieving a specific performance indicator and business growth.

Conclusions

The main result of the research is two groups of determinants that have positive or negative impact, the power of influence, the extent of influence on several indicators of performance and growth, and their influence is short-term or long-term. The positive determinants are ambition (strong, extensive, and long-term influence), number of employees (strong to weak influence, extensive and short-term influence) and product excellence, diversity of educational level and work experience, educational level of employees, managerial experience of the founder (all with strong but limited long-term influence). The negative determinants are the age of the firm (small, medium, and long-term effects), evidence of product excellence (larger, medium, short-term, and long-

term effects), explicit formulation of financial goals (larger, limited, and long-term effects), and sophisticated NACE M business (larger, limited, and short-term effects).

The results of the research contributed to the deepening and broadening of the knowledge about the positive causes of business performance and growth, which are mainly the ambition and managerial experience of the leading person of the company, the quality of the company's employees expressed in terms of education and work experience, and an exceptional product. Equally important are the negative causes of business performance and growth, which are the effort to formalize some parameters of business activity, e.g., explicit setting of financial goals and argumentation of product excellence, operating in a sophisticated industry has a negative effect on performance, and performance slightly declines with increasing age of the company.

The practical consequences of the new knowledge are to respect and strengthen the positive determinants of performance and growth, the cultivation of which is mainly a matter of quality and targeted management of human resources. The influence of negative determinants can be weakened by leaving more room for the company's adaptive actions and by placing less emphasis on the fulfilment of clearly defined business parameters, which are generally incompatible with the opportunistic behaviour of SMEs. The slightly negative effect of the company's age can be corrected by revitalizing the corporate culture, conditioned by human resource diversity.

Research findings are naturally limited by the sample size, which in turn is limited by research capacity. Research studies work with different numbers and types of determinants. Still, the resulting number of statistically significant determinants is usually not large, suggesting that more reliable determinants would be identified in a larger sample. However, further research can also go in a different direction, such as increasing the sample size, by investigating a more profound and broader background of the already identified determinants and the form, content, and conditions of their influence.

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Appendix

List of independent variables (verified determinants) and their measurement scales

Independent variables	Numerical codes	Scale
Number of employees	no	quantitative variable
Age of company	no	quantitative variable (years)
Excellence of product	1	local
	2	regional to national
	3	Central European
	4	International (extraordinary product)
Evidence of product excellence	0	no (no proofs)
	1	yes
Management experience of the founder/leading person before starting a business	no	quantitative variable (years)
Reasons of the founder /leading person for starting a business	1	situational
	2	situational - psychological
	3	psychological
Growth ambitions of the founder/leading person	1	local
	2	regional to national
	3	cross-border and international
Explicit formulation of financial goals	0	no
	1	yes
Prevailing level of education of employees	0	no
	1	without a high school diploma (trained)
	1,5	without a high school diploma (trained) + secondary school
	2	secondary school
	2,5	secondary school and university 1st degree
	3	university 1st degree
	3,5	university 1st degree + university 2nd degree
	4	university 2nd degree
Homogeneity ↔ heterogeneity of the level of education of employees	1	completely/almost homogeneous education
	2	prevailing homogeneous education
	3	balanced education
	4	prevailing heterogeneous education
	5	completely/almost heterogeneous education
Homogeneity ↔ heterogeneity of employees' work experience	1	completely/almost homogeneous experiences
	2	prevailing homogeneous experiences
	3	balanced experience
	4	prevailing heterogeneous experiences
	5	completely/almost heterogeneous experiences
NACE	C - R	industry incorporation of researched SME

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KEY FACTORS AND CONDITIONS FOR IMPLEMENTING THE DROP-SHIPPING METHOD AS AN ALTERNATIVE TO TRADITIONAL SUPPLY CHAIN*

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Abstract. The drop-shipping method is an innovative alternative to the traditional supply chain, rooted in the principles of e-commerce. Drop-shipping has gained increasing popularity over the years. The main objective of this research is to identify the key factors and conditions for its implementation as part of the traditional supply chain. An empirical study was conducted among Bulgarian Small and Medium-sized Enterprises (SMEs) from various industries using survey and interview methods to gather the necessary data. Descriptive analysis was employed to examine the characteristics and distribution of the studied variables. Furthermore, regression analysis was conducted to explore the influence of various factors on delivery times and the average number of annual sales. Additionally, a correlation analysis was performed to examine the relationships between suppliers, delivery times, and levels of customer satisfaction when implementing the drop-shipping method. A variation analysis was also carried out to delve into the connections and changes between the two categories of factors – supplier-related and customer-related. The data from this study can serve as guidelines for implementing new innovative delivery methods within SMEs, aiming to provide the necessary factors and conditions for their successful operation.

Keywords: drop-shipping; supply chain; factors and conditions; alternative, e-commerce

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1. Introduction

The development of entrepreneurship is deeply influenced by technological advancements and the dynamic changes in the external environment of organizations necessitate the modernization of supply chain management processes. The automation of operations and the widespread use of the Internet in the activities of SMEs create a favourable environment for implementing new business models that enhance traditional ones. Many of these models are based on the principles of e-commerce, digital marketing, network marketing, advertising, drop-shipping, and others. The effective utilization of e-commerce platforms to support enterprises' commercial activities is a prerequisite for the potential elimination of geographical boundaries in an economic context, thereby creating equal business opportunities for entering various markets. In the context of global digitiza-

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tion, the supply chain is closely connected to developing and implementing e-commerce in business (Dimitrov & Koprinkova-Noncheva, 2021).

Drop-shipping entails the delivery of goods by sending them directly from the manufacturer or distributor to the end customer without them being held in the merchant's warehouse or store. Its application suits startup businesses, well-established SMEs with a rich history, and sole traders. The popularity and adoption of drop-shipping across various sectors are expanding in tandem with the development of entrepreneurship, e-commerce, and electronic commerce transactions. For SMEs, e-commerce can potentially become a source of competitive advantage. It is a profitable means of accessing customers globally and competes on an equal footing with large enterprises. (Kalakota & Whinston, 1997).

Retailers engaged in drop-shipping act as intermediaries in the supply chain since they are primarily focused on acquiring customers by providing information about prices and terms of service for the physical distribution of goods without performing transportation and delivery functions (Rabinovich et al., 2008). Due to its structure, drop-shipping is a streamlined method within the supply chain that effectively shortens the distribution of goods and services the supplier provides directly to the consumer. This method offers significant benefits to businesses as it reduces the usual operational costs. Drop-shipping is becoming increasingly applied in cases of low stock levels, from logistical perspectives, and for enhancing the delivery system. (Khouja, 2001, Ayanso et al., 2006, Khouja et al., 2009, Ma et al., 2017). Another critical advantage of drop-shipping is that it can be conducted from anywhere in the world, provided there is access to the electronic network (Hawk et al., 2016). The method allows businesses to offer a wide variety of different types of products. Companies are not confined to a single type of product due to limited resources, which brings satisfaction to customers (Waksman, 2016). The method is attractive due to its easy application and minimal storage costs, with the primary focus being on product delivery. In this case, the supply chain does not create dependence among participants and saves time. (Rheude, 2016; Chopra et al., 2007).

It is impossible to precisely identify when drop-shipping evolved into a functional e-commerce business model. However, the negative effects of the crisis on consumption, production, and the sale of new products certainly compel businesses to adapt their strategies to an environment where many households lack economic resources (Vellvé & Burgos, 2018). Particularly, the onset of the global economic crisis in 2008 stimulated the development of this new business model, as it is observed that drop-shipping clearly grows in parallel with the increase in e-commerce transactions (Kaluzhsky, 2011). The current assertion that there is a rapid increase in business interest in building sustainable organizations (Pfeffer, 2010) is directly related to the prospects for enterprises to use modern methods in structuring their operations. Drop-shipping is an evolutionary method within the traditional supply chain based on the principle of direct delivery of goods from the manufacturer to the customer. The retailer is positioned in the middle of the chain between the manufacturer and the customer, who acts as the primary driver of the information flow. Entrepreneurs dealing with physical products utilize drop-shipping services to achieve location independence (Daniel et al., 2014).

The elaboration on the subject of the achieved effects of implementing the method in business requires an examination of the close interrelationship among the key participants in the supply chain (manufacturer/distributor and retailer), within the context of the structure, sequence of actions, and types of products suitable for drop-shipping sales. It is important to emphasize that supply chain management has become an increasingly vital condition for success, both in manufacturing and the service sector. It involves handling the entire production process, information flow, and the distribution of goods and services, from raw material production to the delivery of the end product to the consumer. To fulfil this task, SMEs must establish a network of suppliers as links in the overall chain. The management of this supply chain facilitates the movement of the product or service from the raw material supplier to organizations closely connected to end consumers.

2. Theoretical background

Due to its inherent structure, drop-shipping represents a simplified business model that streamlines the delivery of goods and services to consumers, yielding substantial business advantages by reducing traditional operational costs (Dimitrov & Koprinkova-Noncheva, 2020).

The primary research objective is to identify the fundamental factors and conditions for implementing drop-shipping as an alternative method to the traditional supply chain. The central thesis of this research is rooted in the assertion that drop-shipping constitutes an alternative approach to the conventional supply chain. Key factors influencing its preference and adoption include the ability to offer lower prices and enhance logistical flexibility. Within this context, the study primarily focuses on analyzing these factors and their correlation with the competitiveness and efficiency of the supply chain.

The concept of introducing drop-shipping as an alternative method to the traditional supply chain emerged in connection with its increasing use as an innovative model based on internet technologies. Particularly after 2010, discussions regarding the existing alternative for SMEs began to take shape, focusing on whether to continue using the familiar classical delivery model or to modify the entire sales and distribution process. An idea was also developed to combine drop-shipping with the traditional supply chain model in cases where it was applicable. Business models in online retail underwent significant evolution with the emergence of various supply chain strategies, relying to varying degrees on vertical integration concerning inventory supply and product delivery (Boyer & Hult, 2005).

Different viewpoints exist based on developed mathematical models, simulations, and the interpretation of various scenarios. However, there is no unified, clearly formulated set of factors and conditions under which the evolutionary model is more appropriate. Following the development of their (Q, R) model in e-commerce through drop-shipping, based on two scenarios - inventory shortage with a short delivery time and missed sales, Moutaz and Stylianou maintain the thesis that the introduction of drop-shipping as a delivery system is more suitable in cases where the method can be implemented in deliveries with a more extended execution period (Moutaz & Stylianou, 2008). On the other hand, in the context of e-commerce, due to their economic power and various other influences, many retailers cannot provide a high level of logistic and distribution services, which limits the size of their sales. With the help of the drop-shipping method, the supplier of goods can leverage its economies of scale to reduce the unit selling price of the product and cut distribution costs. Compared to retailers, suppliers can offer high-quality logistic and distribution services, thereby improving the overall quality of the trading process and leading to increased sales (Lu, 2017).

The issue of choosing a supply chain when there is one supplier and several retailers has also been investigated. From this perspective, the traditional supply chain and the drop-shipping method are popular. Still, the decision-making regarding inventory management, risk allocation for inventory, and profit distribution among the supply chain members will differ. In terms of efficiency, the adoption of a hybrid strategy has been accepted. In the hybrid strategy, the traditional model is the primary supply mode, while drop-shipping is used as a backup delivery method (Netessine et al., Rudi, 2006). From the information presented so far, it becomes clear that the main factors for using the drop-shipping method as an alternative to the traditional supply chain are, firstly, the ability to offer a lower unit price for a product directly from the manufacturer, and secondly, the higher-quality and more flexible logistic service compared to that offered by retailers using the classical chain. As a condition for application, we identify the probability that, in some cases, the order may have a longer execution period. However, e-commerce retailers offering drop-shipping can actually lower end prices for consumers, making them willing to accept delayed delivery times (Chen, 2001).

Another perspective regarding the traditional supply chain and the new model emphasizes that drop-shipping benefits both suppliers and retailers. Suppliers can expand their sales, gather more information about consumers, and promptly identify market trends through its implementation. At the same time, retailers can minimize inventory holding costs and instead invest in product sales and marketing methods. Based on the supplier selection index in the traditional supply chain, combined with the characteristics of the drop-shipping model, the

authors propose a set of criteria for selecting drop-shipping suppliers - profit margin, quality, delivery, speed, and technological environment (Fitraharizki & Rahayu, 2023; Yao et al., 2008; Li & Xie, 2012).

A technological-organizational and ecological framework has been developed, which identifies three aspects of the organization's essence that influence the adoption of technological innovation: technological essence, organizational essence, and ecological essence. The technological context consists of both existing technologies and the technology that needs to be implemented in the business operations. The primary focus of the technological context is on how technological characteristics can impact adoption. The organizational context describes the organization's specific characteristics that either constrain or facilitate the adoption of technological innovations. The external ecological aspect is the external environment in which a firm operates, such as the industry it belongs to, its competitors, regulations, access to resources provided by others, and interactions with governments (Tornatzky & Fleischer, 2001).

The question of introducing drop-shipping as an alternative method to the traditional supply chain has also been examined from a different perspective. Khouja emphasizes that drop-shipping is applied in combination with the traditional model of goods delivery. Therefore, combining drop-shipping with the traditional supply chain, based on maintaining inventory, can be the optimal solution for e-commerce (Khouja, 2001). Retailers commonly tend to develop and use a dual channel to serve their end customers. This means synchronizing and using drop-shipping in combination with the traditional supply chain. The increased use of the Internet and drop-shipping enhances awareness not only among customers but also among retailers. In this sense, the focus is on creating a supply chain where drop-shipping collaborates with the traditional one. In cases where the quantity of orders from the retailer reaches a decentralized level, the profit of the supply chain will be increased (Zhao et al., 2013). The best perspective for online stores is adopting a hybrid inventory management strategy, which means achieving synergy between retailers engaged in drop-shipping and warehouses (manufacturers) (Agatz et al., 2006).

Despite the different starting points of proponents of the dual-component supply chain idea, we find that a necessary factor for using drop-shipping is achieving coordination in the delivery of goods, and good synchronization between the manufacturer and the retailer is a condition for successful collaboration between the parties. Drop-shipping is an advanced method built on the fundamental principles of the classic supply chain. The main factors for adopting the method as an alternative are:

- Minimal investment requirement: Drop-shipping does not require significant investments to start a business. Retailers need to create an online store and establish connections with various suppliers.
- Wide product variety: Drop-shipping offers a wide selection of products since retailers are not limited by physical inventories.
- Good communication with suppliers: To ensure the quality fulfillment of orders, retailers should maintain good communication with suppliers and establish clear procedures for order placement.
- Precise supplier selection: Retailers must choose suppliers that can guarantee fast and reliable delivery of orders and high-quality products.
- Need for an efficient order management system: To avoid errors in order processing, retailers must have an effective order management system.
- Achieving flexibility and coordination in deliveries.
- Quality control of products: Retailers need to control the quality of the products sent by suppliers to avoid potential issues with dissatisfied customers.
- Margin realization in the selling price through the online channel.
- Marketing and advertising: Retailers must develop effective marketing and advertising strategies to attract customers to their online stores.
- Internationalization of the products being sold.

The conditions for successful drop-shipping applications are related to providing a favorable external environment, and good organizational and technical infrastructure.

3. Research objective and methodology

The research objective and methodology of the study are based on conducted descriptive, regression, correlation, and variation analyses, related to the identification of key factors and conditions for the implementation of the drop-shipping delivery method as an alternative to the traditional supply chain. The application of statistical methods was carried out based on a survey, which involved the completion of a questionnaire consisting of 32 questions divided into three sections: general characteristics of the enterprises, the extent of e-commerce applicability, and the application of the drop-shipping delivery method. 372 SMEs from various sectors completed the questionnaire, and individual interviews were conducted with all respondents to gather additional information.

The use of descriptive analysis in this study aims to conduct an in-depth analysis of aspects related to the potential application of the drop-shipping delivery method in SMEs in Bulgaria. Specifically, it involves analyzing the following key areas:

- Price Analysis: Comparing delivery prices offered by different providers to determine the most economically advantageous option.
- Delivery Time Analysis: Measuring the delivery times of various products to establish the average delivery time.
- Order Volume Analysis: Quantifying the number of orders over a specific time period to assess the efficiency of the drop-shipping delivery method.
- Product Quality Analysis: Assessing the level of satisfaction with products delivered through the drop-shipping delivery method, considering both satisfaction levels and the number of products.

In the course of applying regression analysis, the strength and statistical significance of relationships between variables are examined. In multiple regression analysis, it is essential to investigate the strength and statistical significance of the relationships between independent and dependent variables through the analysis of correlation coefficients and the significance of parameters.

The parameters of the regression function demonstrate how the dependent variable changes when independent variables change. It is important to examine both the sign and the statistical significance of the parameters to understand their significance for the results. Additionally, an assessment of the model's significance should be conducted. Some independent variables may be more important than others in explaining the dependent variable. In this context, it is essential to explore which independent variables are significant and the strength of their relationship with the dependent variable. For the application of regression analysis in the research framework related to determining the influence of factors on product sales, the following variables (Table 1) and (Table 2) are defined:

Table 1. Determining the Factors Influencing Product Sales through the Application of the Drop-shipping Method

Dependent variable	Independent variables
Sales of a selected product	Product price
	Marketing expenses

Table 2. Investigating Factors Influencing Delivery Time in the Drop-shipping Method for SMEs:

Dependent variable	Independent variables
Delivery time, measured in days or hours	The distance between the supplier's warehouse and the recipient's address
	Order volume
	Seasonality (the number of orders may increase during holidays or weekends)
	Standard order processing and preparation time for shipping

Analyzing the factors influencing delivery times in the drop-shipping method for SMEs can provide valuable insights for optimizing delivery processes in drop-shipping businesses. This optimization may include route optimization, improving warehouse efficiency, or providing additional training for staff handling orders.

When multiple independent variables are used to predict a single dependent variable, the regression analysis is referred to as multiple regression analysis. In multiple regression analysis, it is essential to consider the interactions between independent variables because they can collectively influence the dependent variable. This means that interactions between product price and marketing expenses, for example, may impact sales. Therefore, when using multiple regression analysis, it is crucial to account for interactions among independent variables. Often, it is possible to predict the values of the dependent variable based on the values of the independent variables.

The application of correlation analysis as a research method allows us to describe the strength and direction of relationships between the variable quantities defined by the questionnaire data concerning the conditions and factors affecting the adoption of drop-shipping as part of the supply chain. The distribution of these dependencies provides a comprehensive overview of potential scenarios of relationships between factors such as company size, location, the average price of offered products and services, types of products sold, and the degree of applicability of e-commerce in business within the context of the adoption of a non-traditional delivery model. The obtained results can be interpreted depending on the distribution of the presented values, as follows: Value 0 - no dependency; Value up to 0.3 - weak dependency; Value from 0.3 to 0.5 - moderate dependency; Value from 0.5 to 0.7 - significant dependency; Value from 0.7 to 0.9 - strong dependency; Value above 0.9 - very strong dependency; Value 1 - functional dependency.

Analysis of variance is a statistical method used to examine the differences between the average values of three or more groups. The goal of the analysis of variance is to determine whether the average values of different groups are statistically significantly different or not. Analysis of variance can be very useful for investigating the effects of different factors on outcomes and can help make better decisions in various fields. The formulas used in conducting the analysis of variance are related to calculating the sums of squares, degrees of freedom, and means. One of the most commonly used formulas in the analysis of variance is the formula for the total sum of squares (SST), which is calculated as the sum of the squares of the deviations of each data point from their overall mean value.

SST measures the total variability in the data. In the analysis of variance, this total variability is partitioned into different components to assess the variability between groups and within groups, allowing you to determine whether there are significant differences among the group means. In this study, two main categories of factors were used: supplier factors and customer factors.

Supplier Factors:

- Source of Products: whether the products are directly sourced from the manufacturer or through a distributor.
- Level of Automation in the Production Process: whether the production process is fully automated or requires manual labor.
- Product Availability: whether the products are in stock or are produced on demand.
- Payment Method: whether customers can pay with a credit card or only through bank transfer.
- Return Conditions: whether customers can return products and under what conditions.
- Advertising and Marketing: whether the company uses advertising campaigns and their impact on sales.
- Customer Service: whether the company provides quality customer service and its impact on customer satisfaction.
- Competition: the level of competition in the market and how it can affect sales and expenses.
- Technological Innovations: what new technologies can be used to optimize delivery and their impact on the efficiency of the drop-shipping delivery model.

Customer Factors:

- Customer Location: whether customers are located in different geographic areas or all in one place. If customer location is identified as an important factor, a strategy for expanding the network of local suppliers may be chosen to reduce delivery time and costs.
- Order Size: whether orders are small or large in quantity.

- Delivery Time: whether delivery is fast or slower.
- Product Quality: whether the products are of high or low quality.
- Product Price: whether the products are priced high or low.

Once the possible factors have been identified, their significance on overall costs and delivery time can be determined to find the optimal strategy for improving the efficiency of the method. The methodology for conducting a variation analysis in the context of its application in studying the possibilities of applying the drop-shipping delivery method follows these described steps:

- Selection of metrics for evaluating the efficiency of the drop-shipping delivery method. These could include the company's overall costs, delivery periods, the number of returned products, and more.
- Identification of the factors that may influence the chosen metrics - supplier factors and customer factors.
- Selection of a statistical method for studying the impact of factors on the chosen metrics. One of the most widely used methods for this purpose is Analysis of Variance (ANOVA), which can be applied to assess the significance of factors.
- Conducting an experiment to allow the investigation of the impact of factors on the chosen metrics.
- Drawing conclusions from the studies and determining the best strategies for achieving greater efficiency in the drop-shipping delivery model.

4. Results and discussion

4.1. Analysis of the results of the descriptive analysis

In the contemporary world of business, where competition is ever-increasing and customer demands are on the rise, it is essential to conduct regular data analyses related to the respective business processes. This study focuses on one of the most critical elements of the online sales process - product delivery. Specifically, the goal is to examine and analyze data regarding delivery time, delivery cost, and product quality in the context of two different delivery models: drop-shipping and a traditional supply chain. In this context, the present study employs descriptive analysis, providing fundamental statistical data on the examined parameters to investigate their characteristics and distribution. Descriptive analysis has been applied to the average delivery time and delivery cost, utilizing data obtained from real online stores. Additionally, customer feedback has been collected and analyzed to assess product quality.

The findings derived from the descriptive analysis are of particular importance for achieving improved efficiency and effectiveness in the delivery process. They can serve as a basis for proposals to optimize business processes and enhance customer satisfaction. Figure 1 presents the results of the descriptive analysis for the average delivery time using the drop-shipping method, measured in days.

Average drop-shipping delivery time (in number of days)	
Mean	4,354014599
Standard Error	0,087496774
Median	4
Mode	3
Standard Deviation	1,448329319
Sample Variance	2,097657817
Kurtosis	1,031370458
Skewness	0,960290908
Range	8
Minimum	2
Maximum	10
Sum	1193
Count	274
Average	4,355

Figure 1. Average Delivery Time via the Drop-shipping Method in Days

The average delivery time through the drop-shipping method is 4.354 days, indicating that, on average, respondents receive their orders approximately 4-5 days after payment. The standard deviation is 1.448 days, illustrating the degree of variation in delivery times expected among respondents. A lower standard deviation typically suggests that the data is more concentrated around the mean value. The median delivery time is 4 days, meaning that half of the respondents receive their orders within 4 days or less. The mode of delivery times is 3 days, indicating that the most frequently occurring delivery time is 3 days. The range of delivery times spans 8 days, representing the difference between the shortest (2 days) and longest (10 days) delivery times.

Regarding the distribution curve, where Kurtosis is greater than 0, it indicates the presence of more than one mode, signifying that several delivery times occur frequently. Conversely, positive Skewness and the mean value's proximity to the median suggest a relatively symmetric distribution curve, where most delivery times are close to the mean.

The conclusion that can be drawn from the descriptive analysis is that, on average, respondents receive their orders approximately 4-5 days after payment, with the most frequently occurring delivery time being 3 days. The range is 8 days, indicating significant variability in delivery times. The distribution curve is relatively symmetrical, with more than one mode, suggesting that several delivery times occur frequently. From these data, conclusions can be drawn, and decisions can be made regarding the optimization of the delivery process, with a focus on increasing the number of orders delivered in the shortest possible time.

Figure 2 presents the results of the descriptive analysis for the average delivery time in days using the classical delivery chain. An average delivery time of 4.33 days can be used as a measure of the efficiency of the delivery chain. This means that deliveries within the chain are made in a relatively short period, which can lead to higher customer satisfaction and greater competitiveness for the SMEs.

Average delivery time (in number of days) using the traditional supply chain	
Mean	4,332116788
Standard Error	0,082472145
Median	4
Mode	4
Standard Deviation	1,365156906
Sample Variance	1,863653378
Kurtosis	-0,099694154
Skewness	0,652716186
Range	7
Minimum	2
Maximum	9
Sum	1187
Count	274
Average	4,33

Figure 2. Average Delivery Time – Using the Classical Delivery Chain in Days

The conclusion that can be drawn from the descriptive analysis is that, on average, respondents receive their orders approximately 4-5 days after payment, with the most frequently occurring delivery time being 3 days. The range is 8 days, indicating significant variability in delivery times within the chain. The distribution curve of deliveries is relatively symmetrical, with a kurtosis slightly deviating from the normal distribution, indicated by a Kurtosis value of -0.0996. The positive Skewness value of 0.652 suggests a slight rightward skewness in the data. These values can be used to assess the normality of the delivery distribution and identify possible anomalies that may impact the efficiency of the delivery chain.

Possible delivery values range from 2 to 9 days, with both the median and mode of the measured data being 4 days. This can be used as a reference point to assess the efficiency of the delivery chain and for comparisons with others. The results obtained provide a basis for the conclusion that, at this stage, there are no significant differences in the duration of product deliveries between the drop-shipping and classical delivery chain meth-

ods. It takes around 4 days on average to deliver ordered products, including order processing, confirmation, picking, and shipping to the end consumer.

The data for the average delivery cost in drop-shipping services are presented in Figure 3. The average delivery cost in drop-shipping is 8.24 BGN, which can serve as a reference point for future projects in the drop-shipping field. The standard deviation of the average delivery cost is 5.19, indicating that delivery cost values are dispersed around the mean. The median of delivery costs is 6, meaning that half of the delivery costs are below 6 BGN. The mode of delivery costs is also 6 BGN, representing the most frequently occurring delivery cost. The Skewness coefficient is 2.77, indicating a right-skewed distribution of delivery costs. The Kurtosis coefficient is 8.13, signifying a high distribution of delivery costs. The range of delivery costs varies from 5 BGN to 32 BGN.

There are 227 cases where delivery costs exceed 10 BGN, indicating a significant number of higher delivery costs (Figure 3). This data can be used to explore the possibility of optimizing delivery costs in drop-shipping, as well as to examine the factors that may lead to differences in delivery costs.

Average drop-shipping delivery cost	
Mean	8,237226277
Standard Error	0,313326638
Median	6
Mode	6
Standard Deviation	5,18647872
Sample Variance	26,89956151
Kurtosis	8,131554561
Skewness	2,765220058
Range	27
Minimum	5
Maximum	32
Sum	2257
Count	274
Average	8,237226277
upper bin	Frequency
10	227
15	28
20	9
25	5
More	5

Figure 3. Average Delivery Cost in Drop-shipping Services

In the perspective of a drop-shipping merchant, the majority of SMEs often can not exert control over the quality of the products shipped from manufacturers to the end customers. Frequently, merchants only become acquainted with the products they offer during initial negotiations with manufacturers before entering into a collaborative agreement. Subsequently, the process is managed automatically and electronically. This poses potential risks of customer dissatisfaction due to the possibility of receiving low-quality products that have not been inspected by the merchant. Quite often, the merchant bears full responsibility for customer dissatisfaction and potential claims, even without having seen the product subject to the order. This process should be regulated to specify the method.

To measure the quality of products offered through drop-shipping, we have created a rating scale based on feedback received from end customers, ranging from 1 to 3, where 1 represents a low degree (highly dissatisfied), 2 indicates a moderate degree (partly satisfied), and 3 is the highest possible degree (very satisfied). Since this method is an innovation in the Bulgarian market, 85% (233) of the study participants (only those participants who implement the drop-shipping method – 274 participants) seek subsequent feedback from their customers through several possible channels: phone calls, Viber messages, emails, allowing customers to rate both the products and the drop-shipping service on the 1 to 3 scale.

Based on the feedback collected from the merchants, a descriptive analysis was conducted, revealing that the average value of 2.61 indicates that the overall assessment of the service is slightly above average. The median and mode are both 3 (high quality), implying that the majority of study participants have rated the service with the highest score (Figure 4). The standard error of 0.04 provides information that the collected data can be considered sufficiently representative of the entire population of drop-shipping service customers. The standard deviation of 0.65 shows that quality ratings are dispersed around the mean value, with the data ranging from 1 to 3. A skewness coefficient of -1.41 indicates that the data slightly skews toward having ratings below the mean value. The total number of participants in the survey is 233, demonstrating that data has been collected from a sufficiently large number of participants to obtain representative results.

Analysis of the quality of products offered through drop-shipping and an overall evaluation of the service	
Mean	2,605150215
Standard Error	0,042940648
Median	3
Mode	3
Standard Deviation	0,655460551
Sample Variance	0,429628533
Kurtosis	0,709817106
Skewness	-1,414018607
Range	2
Minimum	1
Maximum	3
Sum	607
Count	233

Figure 4. Analysis of Product Quality Based on Feedback from End Customers

4.2. Analysis of the results of the regression analysis

The regression analysis conducted aims to study the influence of various factors on the delivery time and the average number of product sales annually. In the context of examining the influence of different factors on delivery time, the dependent variable is taken as the delivery time measured in days. The independent variables include the distance between the supplier's warehouse and the recipient's address (Independent Variable 1 - IV1), order volume (Independent Variable 2 - IV2), standard order processing time (Independent Variable 3 - IV3), and preparation for shipment (Independent Variable 4 - IV4) (Table 3). This type of regression analysis can be beneficial for retail companies looking to optimize their order delivery processes. The analysis can provide insights into which factor has the greatest impact on delivery time, allowing the company to focus its efforts on improving that specific factor. This, in turn, can lead to better customer service and increased customer satisfaction.

From the data presented in Table 3, Multiple R (1) is the correlation coefficient indicating the strength of the relationship between the dependent variable (delivery time) and the independent variables (distance between the supplier's warehouse and the recipient's address, order volume, seasonality, and standard order processing time). Since R Square and Adjusted R Square are both 1, this means that based on these variables, we can explain 100% of the variation in the dependent variable, which is the delivery time. The Standard Error shows the predictive error of the model, which in this case is very small - 8.278. The F statistic indicates that the model is statistically significant because the p-value is 0.

The data presented in the Coefficients table shows the values of the regression equation coefficients that we can use to predict delivery time based on the values of the independent variables. Specifically, the coefficient for distance is negative, meaning that a greater distance between the supplier's warehouse and the recipient's address leads to longer delivery times.

Table 3. Regression Analysis - Impact of Various Factors on Delivery Times of Products through the Drop-shipping

<i>Regression Statistics</i>						
Multiple R	1					
R Square	1					
Adjusted R Square	1					
Standard Error	8.2786E-17					
Observations	273					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	4	99,06227106	24,76556777	3,61352E+33	0	
Residual	268	1.83676E-30	6.85358E-33			
Total	272	99,06227106				
	<i>Coeff.</i>	<i>SE</i>	<i>tStat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	1	2.50789E-17	3.98742E+16	0	1	1
Distance between the supplier's warehouse and the recipient's address - IV1	-1.3784E-18	1.0924E-19	-12,42656737	2,65217E-28	-1.5968E-18	-1,16001E-18
Order volume -IV 2	-5.051E-19	1.06763E-19	-5,062715376	7.69359E-07	-7.0714E-19	-3,30311E-19
Standard order processing time - IV3	-3,4979E-18	5.2219E-18	-0,669845626	0,503532925	-1.3779E-17	6.7833E-18
Preparing and sending a shipment - IV 4	1	1.36445E-17	7.32897E+16	0	1	1

Additionally, the coefficient for order volume is insignificant, indicating that order volume does not significantly influence delivery times. Based on the provided results of the regression analysis, it appears that all independent variables affect the dependent variable (delivery time). This can be observed from the regression coefficients, where all four independent variables have different coefficients, signifying that they influence the dependent variable to varying degrees. Furthermore, the F-test value is significant (Significance F = 0), indicating that the regression as a whole is significant and that the independent variables contribute to explaining the variation in the dependent variable.

Table 4. Regression Analysis - Influence of Various Factors on the Average Annual Sales Volume through the Drop-shipping Method

<i>Regression Statistics</i>						
Multiple R	0,130441571					
R Square	0,017015004					
Adjusted R Square	0,006052346					
Standard Error	35664,04442					
Observations	273					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	3	5922412022	1974137341	1,552087421	0,201409813	
Residual	269	3,42148E+11	1271924064			
Total	272	3,4807E+11				
	<i>Coeff.</i>	<i>SE</i>	<i>tStat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	12518,41227	10563,34829	1,18507995	0,237031726	-8278,939962	33315,7645
Product price-IV 1	-67,78997502	45,27824703	-1,49718639	0,135517189	-156,9347827	21,35483268
Marketing expenses - IV 2	-411,3276749	1147,340667	-0,35850527	0,720246416	-2670,237192	1847,581842
Market competitiveness - IV 3	13825,99449	11447,06616	1,20781992	0,228177362	-8711,240902	36363,22988

The results of the regression analysis, aimed at studying the relationship between the average annual sales volume of products as the dependent variable and the product price (independent variable 1 - IV 1), marketing expenses (independent variable 2 - IV 2), and market competitiveness (independent variable 3 - IV 3) as independent variables (Table 4), show that the relationship between these variables is weak. The coefficient of multiple correlation is 0.13, indicating that the independent variables have a weak relationship with the dependent variable (Table 4).

The coefficient of determination is 0.02, which means that only 2% of the variation in average sales volume can be explained by the variables used in the analysis. The correction coefficient is very low, only 0.006, and does not explain the variation in the dependent variable. The result of the F-statistic is 1.55, with a p-value of 0.2014, indicating that the model is not statistically significant, and the null hypothesis that there is no relationship between the independent and dependent variables cannot be rejected.

The regression coefficients show that an increase in product price leads to a decrease in the average sales volume, with a coefficient of -67.79 for the first independent variable. The coefficient of the second independent variable is not statistically significant, and the coefficient of the third independent variable is 13825.99, indicating that higher market competitiveness leads to an increase in the average annual sales volume. The conclusion that can be drawn from the conducted study is that the independent variables (average annual sales volume, product price, marketing expenses, market competitiveness) do not have a statistically significant impact on the dependent variable (Average sales volume). This can be observed from the low value of the multiple correlation (Multiple R) of 0.130, as well as the low value of the coefficient of determination (R Square) of 0.017. Additionally, the analysis of variance shows that there are no statistically significant relationships between the group of independent variables and the dependent variable, as evidenced by the low value of the F-test coefficient (1.552) and low statistical significance (0.201).

4.3. Analysis of the results of the correlation analysis

A correlation analysis was conducted between suppliers, delivery time, and the level of customer satisfaction when using the drop-shipping delivery method. The purpose of this analysis is to study the relationship between suppliers, delivery time, and customer satisfaction level in the context of the modern business environment. The analysis allows us to understand how drop-shipping can impact customer satisfaction levels, with a particular focus on the key factors that may influence these relationships. The results of the correlation analysis between suppliers, delivery time, and customer satisfaction level are presented in Table 5.

Table 5. Correlation Analysis between Suppliers, Delivery Time, and Customer Satisfaction Level Using the Drop-shipping Delivery Method

	<i>Suppliers</i>	<i>Delivery time, excluding order processing time</i>	<i>Customer satisfaction level</i>
Suppliers	1		
Delivery time	-0,050410023	1	
Customer satisfaction level	0,090421227	0,849328485	1

From the obtained data, it appears that there is a weak negative correlation (-0.05) between suppliers and delivery time, indicating that faster deliveries are not associated with specific suppliers. This means that all suppliers offer similar delivery times.

There is a strong positive correlation (0.849) between delivery time and customer satisfaction level, indicating that customers are more satisfied when their products are delivered more quickly. This can be valuable information for improving the business by focusing on optimizing delivery times. Furthermore, there is a weak positive correlation (0.09) between suppliers and customer satisfaction level. This may suggest that some suppliers may provide better service and higher customer satisfaction than others, but the choice of supplier is not a critical factor in determining customer satisfaction.

The main conclusion from these results is that delivery time significantly influences customer satisfaction, while the choice of supplier is not a critical factor. Therefore, when optimizing the delivery process, the focus should be on improving delivery times rather than selecting a specific supplier.

4.4. Analysis of the results of the Analysis of Variance

During the application of the variance analysis, the dependent variable considered was the average annual sales, aggregated by categories in Table 6. A total of 12 categories were adopted, corresponding to an average number of sales ranging from 1,000 to 40,000 units.

Table 6. Classification of the Average Annual Sales

Classification of average annual sales volume
Up to 1000 items
Up to 2000 items
Up to 3000 items
Up to 5000 items
Up to 7000 items
Up to 10000 items
Up to 15000 items
Up to 20000 items
Up to 25000 items
Up to 30000 items
Up to 40000 items
Up to 40000 items

In the course of applying the multifactorial variation analysis, the following data for the factors and the dependent variable were used: Factor 1 – the source of products - directly from the manufacturer (1); through a distributor (2); Factor 2 – degree of automation of production - fully automated (1); requires manual labor (2); Factor 3 – product availability - in stock (1); on demand (2). Dependent variable - the average value of sales on an annual basis through the drop-shipping method.

Null hypothesis – there is no significant relationship between the average value of annual sales through the drop-shipping method and the different values of the source of products, the degree of automation of production, and product availability. The alternative hypothesis – there is a significant relationship between the average value of annual sales through the drop-shipping method and at least two of the values of the source of products, the degree of automation of production, and product availability.

Using the data from the variation analysis, we can perform a statistical analysis of the influence of the three factors (source of products, degree of automation of production, and product availability) on the average value of annual sales through the drop-shipping method. According to the obtained data (Figure 5), the value of the F-statistic for Factor 1 (source of products) is 1.237, indicating that there is a small but statistically significant relationship between the source of products and the average value of sales through the drop-shipping method. Therefore, we can assume that the source of products has some effect on sales.

Furthermore, the value of the F-statistic for Factor 2 (degree of automation of production) is 1.449, showing that there is a moderately large effect of the degree of automation of production on the average value of sales. This can be explained by higher production costs, which may reduce the company's profits and, consequently, the average sales value.

Finally, the value of the F-statistic for Factor 3 (product availability) is 1.106, indicating that there is a small but statistically significant effect of product availability on the average sales value (Figure 5).

Therefore, we can conclude that product availability, the source of products, and the degree of automation of production have an impact on the average value of sales through the drop-shipping method. Based on the data obtained from the variation analysis, there are statistically significant effects of the source of products, the degree of automation of production, and product availability on the average value of sales through the drop-shipping method. Therefore, we can reject the null hypothesis and accept that there is a significant relationship between the average value of annual sales through the drop-shipping method and at least two of the values of the source of products, the degree of automation of production, and product availability.

Source of products	274	339	1,237226277	0,18161279		
Degree of automation in the production process	274	397	1,448905109	0,2482955		
Product availability	274	303	1,105839416	0,09498409		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>Fcrit</i>
Rows	73,7141119	273	0,270015062	2,11878453	7,0197E-14	1,18506031
Columns	16,4184915	2	8,209245742	64,417232	7,6338E-26	3,01222921
Total	159,714112	821				

Figure 5. Influence of the factors - the source of products, degree of automation of production, and product availability on the dependent variable, the average value of annual sales through the drop-shipping method

Table 7. Classification of Factors in Relation to the Dependent Variable - Average Annual Sales via the Drop-shipping

Payment method	
With a credit/debit card	1
By bank transfer	2
Return conditions	
The products can be returned	1
The products cannot be returned	2
Advertising and marketing	
Advertising campaigns are used	1
No advertising campaigns are used	2
Market competition	
The products being sold face high competition	1
The products being sold do not face high competition	2

These factors include Factor 1 - payment method; Factor 2 - return policies; Factor 3 - advertising and marketing; Factor 4 - market competition.

The null hypothesis states that there is no relationship between the average number of sales and the different factors. The alternative hypothesis suggests that at least one factor has an impact on the average sales values. To analyze these data, ANOVA (Analysis of Variance) was used. The results indicate a statistically significant relationship between the dependent variable and the factors. The p-value of the F-test for the factors is 2.177, which is significant at a 0.05 level of significance. Therefore, we reject the null hypothesis and accept that at least one of the factors influences the average sales values (Figure 6).

Payment method	274	313	1,14233577	0,12252346		
Return policy	274	291	1,0620438	0,05840753		
Advertising and marketing	274	315	1,14963504	0,12771049		
Market competition	274	413	1,50729927	0,25086228		
ANOVA						
Source of Variation	ss	df	MS	F	P-value	Fcrit
Rows	68,1824818	273	0,24975268	2,41890375	8,7804E-22	1,17228502
Columns	32,4379562	3	10,8126521	104,722659	2,1779E-57	2,6157742
Total	185,182482	1095				

Figure 6. Influence of Payment Method, Return Policies, Advertising and Marketing, Market Competition on the Dependent Variable - Average Annual Sales

If the analysis of variance (ANOVA) is applied to the dependent variable, average annual sales through the drop-shipping method, and the factors that could potentially influence the dependent variable (Table 8) - the factors being order size, delivery time, product quality, product price, and customer location - the following hypotheses can be defined: The null hypothesis states that there is no significant relationship between the factors of order size, delivery time, product quality, product price, customer location, and the dependent variable - average annual sales through the drop-shipping method. The alternative hypothesis can be formulated as

follows: there is a significant relationship between the factors of order size, delivery time, product quality, product price, customer location, and the dependent variable - average annual sales through the drop-shipping method.

Table 8. Classification of Factors - Order Size, Delivery Time, Product Quality, Product Price and Customer Location

Order size	
Small quantities	1
Large quantities	2
Delivery time	
Fast delivery	1
Slow delivery	2
Product quality	
High product quality	1
Medium product quality	2
Product prices	
High prices	1
Low prices	2
Customer's location	
In different geographical regions	1
In a single geographical region	2

The p-value for the rows is 0.999, which is greater than 0.05. Therefore, there is not enough evidence to reject the null hypothesis. This means that there is no statistically significant relationship between the average number of sales among the groups defined by the independent factors. On the other hand, the p-value for the columns is significantly smaller than 0.05, allowing us to reject the null hypothesis. This indicates that the independent factors (order size, delivery time, product quality, product price, and customer location) have a statistically significant effect on the average number of sales (Figure 7).

Order size	274	489	1,78467153	0,16958103		
Delivery time	274	286	1,04379562	0,04203096		
Product quality	274	274	1	0		
Product price	274	460	1,67883212	0,21881768		
Customer's location	274	305	1,11313869	0,10070586		
ANOVA						
Source of Variation	S3	df	MS	F	P-value	Fcrit
Rows	20,5051095	273	0,07511029	0,65882574	0,99998384	1,16568359
Columns	155,105109	4	38,7762774	340,123958	4,228E-190	2,38007985
Total	300,105109	1369				

Figure 7. Influence of the factors order size, delivery time, product quality, product price, and customer location on the dependent variable, the average number of sales on an annual basis

Therefore, the alternative hypothesis is valid, meaning that the independent factors have a significant influence on the dependent variable, the average number of sales on an annual basis through the drop-shipping method.

Conclusions

The drop-shipping delivery method is an effective way for small and medium-sized enterprises (SMEs) to expand their e-commerce business and increase their sales not only in Bulgaria but also internationally. The research results show that e-commerce in Bulgaria has good development potential and can be used as a sales channel for goods using the drop-shipping method. The use of social media and digital marketing strategies will increase the number of potential customers and contribute to the success of drop-shipping businesses in Bulgaria.

The descriptive analysis of the average delivery time shows that respondents receive their orders in about 4-5 days after payment, with the most common delivery time being 3 days. The range is 8 days, indicating significant variation in delivery times. The descriptive analysis for the average delivery time in days through the traditional supply chain yields an average time of 4.33 days, which can be used as a measure of supply chain efficiency. This means that deliveries within the supply chain are made in a relatively short period, which can lead to higher customer satisfaction and better competitiveness for SMEs. There are no significant differences between the drop-shipping delivery method and the classical supply chain in terms of delivery times. Drop-shipping can offer an efficient alternative for delivering goods, which can be competitive with the classical supply chain. Furthermore, the analysis of delivery prices shows that prices are lower when using the drop-shipping method, which can contribute to better profitability for SMEs.

All the independent variables used, including the distance between the supplier's warehouse and the recipient's address, order volume, standard order processing time, and preparation for shipment, have a statistically significant impact on the dependent variable - delivery time. However, the relationship between the average number of product sales on an annual basis and product price, marketing expenses, and market competitiveness is weak and statistically insignificant. Therefore, it can be concluded that these independent variables do not have a statistically significant impact on the dependent variable - the average number of sales.

The goal of the conducted correlation analysis, focusing on the relationship between suppliers, delivery time, and customer satisfaction in the context of using the drop-shipping delivery method, is to examine the influence of these factors on customer satisfaction. The results show that delivery time significantly affects the level of customer satisfaction. However, the choice of supplier is not a critical factor in determining customer satisfaction. This means that when optimizing the delivery process, the focus should be on improving delivery times rather than selecting a supplier. These findings are crucial for modern businesses, as customer satisfaction plays a key role in a company's success.

Based on the conducted analysis of variance, it can be concluded that there are several key factors that are important in determining the average annual sales value when using the drop-shipping method. The source of the products, the degree of automation in production, and product availability are statistically significant and emphasize the importance of proper production planning, product availability, and selecting the right product source. Order size, delivery time, product quality, product price, and customer location also significantly impact the average sales value and can be used to optimize sales and increase revenue.

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THE INFLUENCE OF EDUCATION ON THE ISSUE OF HYBRID THREATS *

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Abstract. The contribution is devoted to the issue of hybrid threats in connection with the level of education achieved. Hybrid threats represent coordinated activities by which different interest groups try to influence people in other areas. The research subjects are the respondents divided according to their levels of education. Data for the research were collected through the questionnaire method. The study was based on predetermined hypotheses, subsequently verified by statistical tests. The research was conducted with 157 respondents. The research results reveal that the level of education impacts the knowledge of the concept of hybrid threats. The verified hypothesis confirms this conclusion, the result of which is at the level of value $p = 0.0482$. The second hypothesis proves the danger of hybrid threats and their relationship with achieved education, calculated at the level of $p = 0.0334$. The research also focused on the area related to information sharing and its subsequent verification. The hypothesis, aimed at verifying information from multiple sources, did not confirm the differences between university-educated respondents and respondents with secondary education. The verified hypothesis represented the value level of $p = 0.039$. To eliminate hybrid threats, effective and efficient measures would be used to prevent the spread of negative impacts on society. In this context, the hypothesis was established for examining the differences between educational attainment and protection methods against hybrid threats. The result of the verified hypothesis at the level of $p = 0.04$ confirms the differences between the level of education. It shows that people with higher education consider an effective educational process to protect against misinformation, compared to people with secondary education who favour repressive measures and various forms of control by the government.

Keywords: hybrid threats; education; disinformation; questionnaire survey; research

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1. Introduction

The current world is characterized mainly by the information and digital age, which generally creates positive elements (Cabinova et al., 2018; Balzer et al., 2020; Inkábová et al. 2021). They also bring plenty of negatives. Hybrid threats fit within the serious category. Many factors are attacking our society. Not long ago, it was the coronavirus pandemic, the energy crisis, and we are currently witnessing a war in Ukraine and Israel. All these negative situations are accompanied by misinformation, hoaxes, and different perspectives (narratives) on these events. Many people do not know how to find their way in the tangle of varying information hoaxes, to divide news into true and those whose purpose is only to polarize society. Various alternative media or disinformation websites infiltrated everyday life. They become assert themselves on the scene. Their content is often unregulated and inflammatory, and it is about the highest possible number of users who spread this harmful content. Hoaxes and misinformation are part of our daily lives today. By sharing various hoaxes and misinformation, users contribute to the spread of polarity in our society, which causes not only its cognitive but also moral decline. We face them on various social platforms, even on the home pages of alternative media. They belong to political groups and different interest groups. Our society should be able to avoid these misinformation and hoaxes. At the same time, the government must offer inhabitants both trustworthy and safe information.

The presented contribution deals with the issue of hybrid threats in society. It examines it from the point of view of education. The contribution structure is divided into individual chapters connected to the results of the questionnaire research and the discussion of the given findings.

2. Theoretical background

2.1 Historical starting points

The concept of security has existed since ancient times. At that time, however, it was not considered a matter of public interest but something necessary or by the gods' will. Modern ideas about safety only developed in the 19th century thanks to the Industrial Revolution when many factory accidents aroused people's interest in prevention. Today, global security concerns focus on many local, national, and international government and private agencies. This is where security science finds its place. Security thus becomes a process or means of protecting against external or internal errors, hazards, losses, criminals and other individuals or actions that threaten, hinder, or destroy the organization's "steady state" and deprive it of its intended purpose. (Oakes, 2009).

The concept of hybrid threats is closely related to the concept of security. Historical origins gave rise to several definitions and concepts related to hybrid threats. In general, however, it is an activity carried out by state and non-state entities to cause harm by influencing local, regional, state, or institutional decision-making.

As we have already mentioned, this problem did not arise in the 21st century. Its content was already known before our era. Let's mention e.g., Ramesses II, called the Great, the pharaoh of ancient Egypt. Even though he was the most famous pharaoh of the time, he was imposing and very vain. He spread misinformation and propaganda, exaggerated his actions, and fabricated some victories in battle (see the battle of Kadesh in 1274 BC). The well-known Chinese thinker Sun Tzu also drew attention to the use of misinformation in hybrid warfare in *The Art of War*, when he wrote that "The real secret is the ability to confuse the adversary so that he is unable to recognize our true intention" (Sarvaš, 2021). We also find mention of the content of the concept of hybrid threats in the life and work of Ptolemy I. Soter (367–283 BC), who was the Macedonian general of Alexander the Great. Alexander the Great and Ptolemy I. Soter were close friends from childhood. Ptolemy later founded the Ptolemaic dynasty. He accepted the title of Egyptian pharaoh (processed according to Wikipedia) in 305 BC. He spread misinformation around the country that he was Alexander's half-brother to secure his place on the throne after Alexander's death. Another representative was Augustus (63 BC – 19 AD), a ruler named Gaius Octavius, later

Gaius Iulius Caesar Octavius was the great-nephew of Gaius Iulius Caesar, who liked to use the tools of treachery, corruption, and manipulation to his advantage.

Many other examples of propaganda and hoaxes can be found in the so-called Nazi propaganda, which was behind the outbreak of World War II.

And now, let's talk about the views of the authors of the article on the investigated issue. At the end of the 20th century, optimistic scenarios for the further development of humanity began to prevail despite several regional and local global conflicts. The economic growth of many countries was on the rise. However, the end of the first decade brought mortgages and financial and economic crises. However, knowledge about economic growth and the cycle was already at such a level that it made it possible to consolidate the economic situation gradually. Unfortunately, armed conflicts of national and international dimensions have not stopped. These were the countries of Africa and the Middle East, but also Afghanistan, Syria, and the former republics of the Soviet Union. Especially in these republics, the Russian Federation positioned itself as a peace-making force. After Putin took power in Russia, he installed his followers at the head of these countries.

At the beginning of the 21st century, Frank G. Hoffman entered the scene. He, among other things, was a special assistant to the US Secretary of Defence in 2017 and worked on the national defence strategy. He is best known for his analysis of the Lebanon War from 2006. Based on these analyses, he defined a hybrid threat as purposeful with irregular tactics, terrorism, and criminal activity. He also understood it as a challenge at the military operational level. He talked about the fact that there are a whole range of different ways of waging war, both conventional and unconventional, different tactics, and acts of terrorism, including wanton violence. However, humanity is not only troubled by armed conflicts. In the late 1920s, the COVID-19 epidemic hit hard. The highly contagious, fast-spreading virus with frequent mutations killed an estimated 14.9 million people in 2020 and 2021. The World Health Organization (WHO) estimates that the pandemic has destroyed a total of 336.8 million human lives in its victims, including post-covid diseases. The WHO calculated that, on average, the life of one COVID victim was shortened by roughly 22 years. According to the organization's statistics, the pandemic also harmed the global fight against infectious diseases because vaccinations and health services were insufficient, or they operated with a lack of personnel and material medical equipment. Not only did COVID-19 cause a decrease in vaccination against measles, tetanus, and other diseases (RTVS + ČTK, 2023), but there accrued 2 war conflicts (Ukraine and Israel).

In an overall complicated situation, on February 24, 2022, the Russian Federation launched an unprecedented war against Ukraine, long termed by the Kremlin as a "Special Military Operation". The biggest victims of this aggression are in Ukraine, but significant negative consequences fall on most countries of the world. The events mentioned above became the basis for the emergence of an asymmetric hybrid, energy threats, raw materials, and food shortages. Examining the entire spectrum of problems is essential, above all from the point of view of the security situation.

2.2 Hybrid threats and education

Since the 1990s, Slovakia has experienced significant economic growth and country fully acquired its membership in both the European Union and NATO. However, support for democracy and commitment to democratic freedoms in the country is far from absolute. (European External Action Service (EEAS), 2022) In addition, Slovaks show a heightened sense of threat perception directed at various actors and groups. According to several public opinion polls by GLOBSEC and other institutions, Slovakia is the most prone to conspiracies of all Central European countries.

Interestingly, Slovakia is the only V4 country where it is possible to observe a direct correlation between belief in conspiracy theories and the level of higher education. Slovaks with higher education are more likely to agree with conspiracy statements than those with primary education (this hypothesis was confirmed in our research).

The data show an inverse correlation between belief in conspiracy claims and educational attainment. By authors view the widespread belief in conspiracy theories can also reflect gaps in the Slovak education system and indicate insufficient media literacy. Another explanation could be that Slovaks believed all the messages spread by their political representatives. While disinformation narratives were characteristic of far-right extremists, the emergence of a conspiracy could be observed among mainstream political figures. In this sense, "ordinary" people only follow the ideas of the political elites they have elected. Slovaks who are deeply suspicious of the mainstream media are well above the EU average. One of the explanations lies behind the massive number of alternative media available online, which claim to have the only truth about disputed matters (Konspiratori.sk 2022). According to Straková et al. (2021), social networks play a key role in managing people and society. It changes the way they communicate, engage in group discussions and shape their perception of the public as well as the world at large. Social media offers insights over time, allows for instant and direct communication and engagement, offers tons of data analysis, and more. They shape a person's mind, either in the right direction or in the wrong direction. According to the authors Korauš et al. (2022), Tvaronavičienė et al., 2020 and Milbradt et al., (2023) social networks are essential in today's digital age; on the other hand, they became a resource for information operations and cyber warfare. The impact of misinformation was manifested in an increase in online cyberbullying and the so-called trolling and there has also been a significant increase in political violence through the misuse of social media platforms (Hawi & Samaha, 2017). So, we ask ourselves what is common for both the hybrid threat for example through social media and education.

Given that information and communication technologies are currently essential in the lives of young people, we focused on the extent to which education and resilience against the negative consequences of hybrid threats are important. According to the authors Genys (2023), Almaiah, Al-Khasawneh & Thunibat (2020), Volchik, Posukhova & Strielkowski (2021), Bida et. al., (2021) and e.g. Ragnedda, Ruii & Addeo (2022) there has been a rapid shift towards digital education during the pandemic. This has prompted researchers to examine the impact of social networks and digital education on the educational content and social life of individuals as well. A consensus emerged on the advantages of digitization for education in terms of ensuring a smooth educational process due to its wide availability, ease of use, but also the social exclusion of the individual from the collective. Young people are spending much of their free time with information technologies means since elementary school. They chat a lot, blog, watch TV, play online games and others, and often publish their photos on the Internet through social media for communication and visibility. Young people tend to rely on most of information even many of them represent both the junk and hoax. The reason is simple they lack critical way of thinking, and their creativity is often deformed. Among the main problems of the contemporary world, which we encounter in several areas of human activity, in addition to globalization, migration, post COVID, climate changes, new work ethics, there is also a lack of creativity, which hinders the development of the human personality. (Korauš et al. 2020; Dragičević Šešić, 2021; Scanlon, 2005). According to authors of this article, the "fast time" and often insufficient technical ability to navigate the online space deprives parents of the possibility of thorough control. The dimensions of digitization and the influence of social media on people highlight the area of intervention in civic education and the direction of the educational process. Accordingly, the educational process also has its patterns. (Genys, 2023) The international environment has an increasingly hybrid character. International law is supposed to promote security, justice, cooperation, predictability, and shared values, but hybrid activities play the opposite role. The question of how to combat hybrid threats is fundamental, but by no means straightforward. Effective tools for combating hybrid threats, although military means may also be necessary, are precisely education, prevention, monitoring and raising social awareness. However, hybrid threats move between what is legal, illegal, and illegal. Therefore, grey area law is needed to determine whether activities fall within (Susana Sanz-Caballero, 2023; Sari, 2019, 2020) the limitations of the legal order, and if not, further legislation will again

be needed to combat such action or behaviour. These questions must be constantly confronted in the environment of any kind of school. It is, therefore, up to schools to provide their pupils and students with a critical view of online propaganda, disinformation and hoaxes and thus increase digital literacy and the ability to judge what is positive and what is not.

Council of Europe (2017) also has critical thinking and understanding of the world anchored in its core competencies based on the continuous education of individuals. Naturally, schools also face serious problems. Technologies are changing too quickly, and the activities of young people are enormous, which sometimes causes the teacher stress due to his inability to adapt rapidly to these problems. In this way, they limit their activities in information technology use and are restrained in relation to the problem. If teachers want to expand their media and information literacy, their superiors must train them. In this way, teachers at all levels of study can be expected to make the issue of hybrid threats visible. Preventing the negative consequences of hybrid threats will only be effective if the states also ensure the motivation of teachers to deal with the given issue. (European Council, 2017).

3. Research objective and methodology

The presented contribution deals with the issue of hybrid threats in relation to education. In addition to logical methods, we chose a questionnaire survey for our research to investigate the mentioned issue. Within our survey and elaboration of data obtained, we used the most methods aimed at this type of research. Such methods are often used in the social sciences. It allows data to be obtained relatively quickly on issues reflecting the relation between hybrid threats and education. The questionnaire research was based on predetermined hypotheses such as:

H1: We assume that there is a statistically significant difference between the level of education achieved and knowledge of the concept of hybrid threat.

H2: We assume that there is a statistically significant difference between the level of education and the perception of the dangerousness of hybrid threats.

H3: We assume that verification of information from more than one source occurs more among people with university education than among people with secondary education.

H4: We assume that there is a statistically significant difference between educational attainment and methods of protection/prevention against hybrid threats.

The questionnaire consisted of two main parts, which were logically connected. In the first part, we asked the respondents about their demographic characteristics. These characteristics include questions about gender, education, age, etc., while for the needs of the research, the authoritative question was focused on the respondents' education. We segmented the education of the respondents from elementary to university. In the second part of the questionnaire, the questions focused on the issue of hybrid threats. These questions were developed in such a way that some of them were open questions or closed. There were also questions in which we allowed respondents to express their opinions on a five-point Likert scale. (Joshi et al., 2015).

The range of answers allowed expressing options from complete agreement to the possibility of total disagreement. The research questions of the second part of the survey were focused on knowledge of concepts such as disinformation, hoaxes, and hybrid threats, on the perception of the dangerousness of hybrid threats, on the verification of sources when obtaining information, and on the possibilities that could prevent the spread of disinformation and hoaxes as hybrid threats for society. (Council of Europe, 2017).

The research took place online and was implemented using the Google Forms application. The research period was in the first half 2023 (from January to June). 680 respondents were approached with a questionnaire, of which

157 referees correctly filled and returned it. In percentage terms, this is a return at the level of 23.09%. We assumed it was an adequate return for research focus. We used a random sampling method in addressing respondents. The questionnaire survey was carried out anonymously, and research ethics were ensured. Participation in the research was voluntary, and the respondents were familiar with the research issues and personal data protection, which were not necessary for the study focused on hybrid threats.

The data obtained from the respondents were verified by mathematical-statistical methods based on established hypotheses, which quantify the research results. Analysis and synthesis methods, as well as contingency tables, were used for research purposes. Methods such as the Chi-square test of independence and the Mann-Whitney U-test were used. Data were evaluated using the statistical software Statistica, version 12. (QUEST.COM, 2010).

4. Results

The issue of hybrid threats was investigated through a questionnaire survey created based on predetermined hypotheses. The first hypothesis was focused on knowledge of the term hybrid threat in connection with the level of education achieved and was determined as follows:

H1: We assume that there is a statistically significant difference between the level of education achieved and knowledge of the concept of hybrid threat.

The hypothesis was tested using the two-sample Mann-Whitney test of independent variables. The test result confirmed a statistically significant difference, as the test characteristic (2.35) reached a greater value than the table test criterion (1.96). Confirmation of a significant result is also approved by the resulting p-value ($p = 0.0482$), which is lower than the tested level of significance $p = 0.05$. It follows from the above that there is a statistically significant difference between the level of education achieved and the knowledge of the concept of hybrid threat. We provide the resulting characteristics of the Mann-Whitney test in Table 1.

Table 1. Testing the first hypothesis

Test criterion name	Value of Test Criterion
Test characteristic (z)	2.35
Table value	1.96
U value	669.5
p-value	0.0482

Source: authors' processing

The confirmation of the hypothesis means that the level of education represents a factor that affects the knowledge of the concept of hybrid threat and proves that education impacts the spread of misinformation and hoaxes in the environment. The more educated a person is, the more he can distinguish the hybrid threats he encounters.

The second hypothesis was aimed at investigating differences in education in relation to the dangerousness of hybrid threats. Disinformation and hoaxes are dangerous in terms of their impact on society and cause potential threats. The research investigated whether there is an effect on the perception of the dangerousness of hazards depending on the respondent's level of education. The hypothesis was established as follows:

H2: We assume that there is a statistically significant difference between the level of education and the perception of the dangerousness of hybrid threats.

The investigated hypothesis was tested using the two-sample Mann-Whitney test of independent variables. The test characteristic (2.24) exceeded the table test criterion (1.96). The analysis thus confirmed a statistically significant difference in the relationship between the level of education and the perception of the danger of hybrid threats. A significant statistical difference is also confirmed by the resulting p-value ($p = 0.0334$), which is lower than the tested significance level of $p = 0.05$. The research shows a statistically significant difference between the level of education and the perception of the danger of hybrid threats. The resulting characteristics of the Mann-Whitney test are shown in Table 2.

Table 2. Testing the second hypothesis

Test criterion name	Value of Test Criterion
Test characteristic (z)	2.24
Table value	1.96
U value	598.3
p-value	0.0334

Source: authors' processing

The verification of the hypothesis represents the results of the research, which show that the higher the respondent's education, the higher the perception of the danger of hybrid threats. The above shows that educated people are more aware of the risk of spreading misinformation and hoaxes in society than the uneducated.

The subject of the third hypothesis was the examination of respondents from the point of view of verification of shared information. Also, in this context, the factor of achieved education was investigated in relation to the verification of information. The investigated hypothesis was established as follows:

H3: We assume that verification of information from more than one source occurs more among people with university education than among people with secondary education.

Spearman's correlation coefficient was used to verify the hypothesis. Through statistical evaluation, the coefficient reached $R = -0.039$, representing a negligible, negative degree of correlation between the observed variables. From the above, it follows that education has no influence on the verification of respondents' information, and whether they are university- or high-school-educated people, the verification of information from the point of view of the respondents' education is not an essential factor. The resulting criteria are listed in Table 3.

Table 3. Testing the third hypothesis

Test criterion name	Value of Test Criterion
Test characteristic (z)	0.379
Table value	1.96
U value	0.70
p-value	-0.039

Source: authors' processing

Graphic processing of the relationship between the verification of information from more than one source in terms of education is presented in Figure 1.

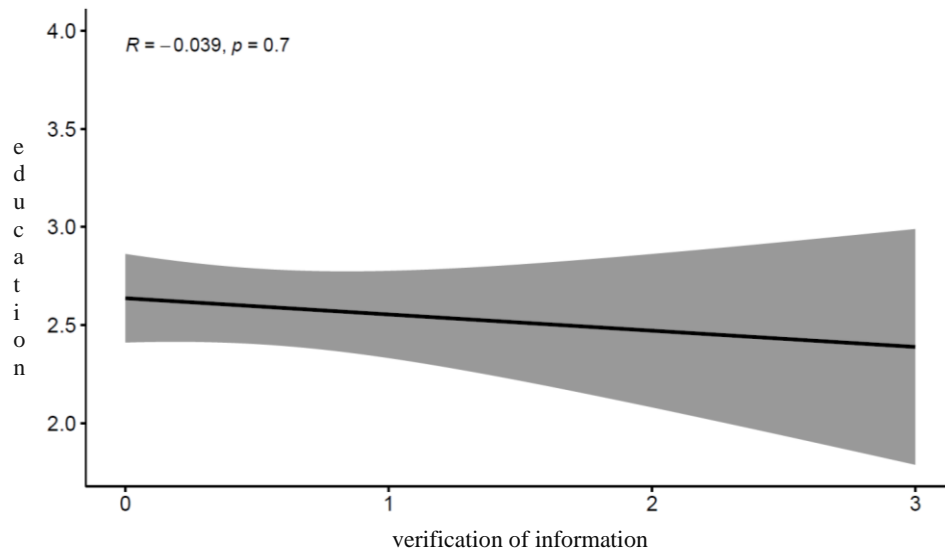


Figure 1. The relationship between verification of shared information and education
Source: authors' processing

The last hypothesis aimed to examine educational attainment in relation to the fight against hybrid threats. Respondents answered questions focused on the possibilities of combating hoaxes and disinformation. The answers related to methods of protection against hoaxes and disinformation were analysed from the point of view of their education. In this context, the hypothesis was established as follows:

H4: We assume that there is a statistically significant difference between educational attainment and methods of protection against hybrid threats.

The verification of the hypothesis was carried out employing the two-sample Mann-Whitney test of independent variables. The result of the analysis confirmed a statistically significant difference, as the test characteristic (3.35) reached a higher value than the table test criterion (1.96). The statistical difference is also confirmed by the resulting p-value ($p = 0.04$), which is lower than the tested significance level of $p = 0.05$. The verified hypothesis shows a statistically significant difference between the level of education and methods of protection against hybrid threats. The resulting characteristics of the Mann-Whitney test are shown in Table 4.

Table 4. Testing the fourth hypothesis

Test criterion name	Value of Test Criterion
Test characteristic (z)	3.35
Table value	1.96
U value	951
p-value	0.04

Source: authors' processing

The fourth hypothesis was focused on the possibilities of combating hybrid threats, and the result confirmed that university-educated people use different measures to combat hoaxes and misinformation than secondary-educated people. In the survey, university-educated people cited education and training in schools as the fight against hybrid threats, compared to secondary-educated people, who noted more repressive measures, such as control by government bodies, etc.

Discussion

Hybrid threats are the subject of research by many experts and studies. Authors Astafieva et al. (2023) mention in their research the strengthening of media and information education and the development of civic education as an effective method of combating hybrid threats. They emphasize the development of a comprehensive strategy of educational security and education for the resistance of university students to destructive informational influences. The mentioned contribution also confirms part of the solution of our presented research focused on the importance of education as an effective fight against hybrid threats. The issue of hybrid threats was investigated in the Czech Republic by the author Filipec (2019), who states that disinformation and hoaxes are currently a vital threat to modern democratic societies and fundamentally impact society's functioning. The contribution provides experience from the Czech Republic in eight areas related to the creation and dissemination of disinformation and the analysis of obstacles in building resistance to disinformation. The study also confirms the results of our research, in which the respondents perceive hybrid threats as a critical element of destabilization of society, whether they are respondents with secondary or university education. Hybrid threats act as a dangerous element in all countries. In research on disinformation and hoaxes in Bulgaria, the author Sharkov (2020) addresses the design and implementation of national cybersecurity strategies and programs to achieve cyber resilience.

The paper examines the evolution of national security strategies against hybrid threats, focusing on cyber maturity. The research presents Bulgaria's cybersecurity plan in the context of evolving hybrid threats and the need for institutionalized cooperation between the public and private sectors. Currently, artificial intelligence projects are coming to the fore. This project is not only related to a positive contribution to science and education but also brings a negative aspect, namely, using artificial intelligence to spread hybrid threats. Authors Freedman et al. (2023) state in their study that hybrid threats currently target critical infrastructure, especially vulnerabilities associated with human and artificial intelligence. Like our research, the study focuses on education in the field of hybrid threats. The paper recommends that colleges and universities add subjects, courses and training to counter hybrid threats to their curricula. The specifics of the study programs would include their learning objectives and associated planned learning outcomes with detailed information from personal knowledge, skills, beliefs, and values. In a study focused on investigating hybrid threats, the authors Daniel and Eberle (2021) state that the concept of a hybrid threat has gained awareness in discussions and political conversations about European security. Based on critical scholarship on narratives, security knowledge, and hybrid warfare, the research reports it creates a framework for studying security narratives around the four elements of threat, value at risk, response, and core knowledge. The research results in the creation of prerequisites for a healthy state policy, cultured information discussion and an educated public.

Conclusion

The issue of hybrid threats is highly topical because we encounter hybrid threats in our daily routine. Its impact on society is highly damaging. Therefore, we suggest that pupils and students be trained in the issue of hoaxes and misinformation. This results from the knowledge that many social network users do not know precisely what hoaxes and misinformation mean and whether they are dangerous for them. In this sense, it is, therefore, necessary to conduct training and courses for students, but also for other social groups, so that users of social networks can distinguish what misinformation and hoaxes lurk in the online space and how they are dangerous for society.

This distinguishing should be part/method of education. It is important to teach social network users how to communicate critically within them and fight against misinformation. The information environment is vast and complex. Misinformation – unintentionally false information – plays a prominent role in shaping public opinion on important topics such as politics, science, health, current events, and predicted situations. Each positive

learning experience will help us better understand how false information is created and how it affects 21st-century society.

Furthermore, safety-related subjects should also be included in the courses taught to university students. It is essential to adjust the learning materials yearly to cover the most critical changes in the dynamically developing and complex security environment. Subjects/courses should be constructed to include questions about the security environment. Knowledge of these subjects affects the safe function of machines, devices, means of transport, systems, operations, and laboratories from the point of view of professional employees and management with an emphasis on preventing threats. Eliminating risks associated with an increasingly higher degree of logistics autonomy, subsequent production, management, and often decision-making processes demands well and adequately educated and trained, not only the young generation. For this reason, universities should also provide students with the latest knowledge on the issue of security aspects of the current development of society in all spheres of life.

Special attention must also be paid to preparing future management officials and members of the defence and security forces and components to cope with increasingly severe challenges and threats. Within the education sphere, specific expertise exists for which training is necessary within the armed forces at the higher military schools and police or police academies. These institutions have a significant mission in developing the highest education standards. They must prepare enough specialists not only for both the army and police. Similarly, like in developed countries, they become lecturers and researchers at public and private universities, sharing their knowledge and opinions with the students in various study branches, no specialization does not relate to security and, of course, to the hybrid threats. The preparation of the whole society in resistance to hybrid threats and disinformation is the No. 1 issue of importance.

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ASSETS AND CAPITAL IN SMALL AND MEDIUM-SIZED WINERIES IN SLOVAKIA^{*}

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Abstract. Small and medium-sized companies make up approximately 99.9 % of the total number of all companies in Slovakia. Developing these companies is an essential prerequisite for significant economic growth in our country. The paper's primary goal is to analyse the development of assets and capital of small and medium-sized companies in viticulture in Slovakia. The monitored period was 2013-2021, and the forecast of the indicator's development until 2024. Viticulture in Slovakia has a long-term tradition not only of growing vines but also of wine production. In the analysed wineries, the value of assets and their basic components (non-current assets, current assets, and accruals) grew. We noticed the same trend in the development of equity and liabilities and its items (equity, liabilities, and accruals). Wineries mainly used debt to finance their activities, which prevailed over equity.

Keywords: assets; capital; SMEs; wineries

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1. Introduction and review of literature

Viniculture and viticulture belong to the traditional manufacturing industries in Slovakia. Slovakia has a long tradition of growing vines and wine production for over three thousand years (Némethová, 2013). Natural settings limit the distribution of vineyards predominantly to its southern parts, mainly to the lowlands and foothills of the Carpathians. In general, the area of vineyards decreased at the national level (Slámová & Belčáková, 2020). It can be stated that the quality of Slovak wine is at a high level, but the competitiveness of the sector in the EU market

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has a negative trend. In choosing the appropriate measures to improve this situation, we consider the critical management decisions of the Slovak wine industry enterprises (Rogovská, 2018). In the last 20 years, wine consumption has risen slightly. However, wine production is insufficient for the domestic market, and wine must be imported from abroad (Janšto et al., 2018). Wine exports have been concentrated in a few markets within the EU single market. Grape farmers in these countries must find ways to improve yield per hectare.

Similarly, export promotion should be encouraged and diversified beyond the EU markets to reduce external demand volatility or shocks (Verter & Hasíková, 2019). Wine character differs from continent to continent, country to country, region to region, vineyard to vineyard, and, of course, from producer to producer. These differences are affected by countless variables inherited from natural conditions, processing techniques, cultivar selection, tradition and human factors, which are difficult to define (Karlík et al., 2018; Aquilera et al., 2022).

Small and medium enterprises (SMEs) are essential contributors to boosting the world's economies (Chin, Zakaria & Keong, 2021; Moya & Rubio, 2020). EU integration brought expressive economic development to Slovakia. The development of SMEs in Slovakia is vital for the transition of the Slovak economy to the next level (Ahmadov, 2020). Improving business conditions and SME development are signs of a country's macroeconomic stability. The issue of identifying and removing barriers to the development of firms in the SME segment is a priority in all countries with developed economies, and its importance is currently increasing (Belas et al., 2020).

The accounting task is to provide information about a company's financial situation and its profit or loss for a given period. From the accounting records, it can also be seen how successful the company management is in ensuring the financial management of the entity, whether it is achieving a reasonable return on investment, whether the entity can repay its debts continuously and whether the long-term stability of the entity is ensured (Stárová & Čermáková, 2010). Suppose a company wants to achieve the set goals. In that case, it is crucial not only to have correct and precise corporate objectives and enough financial resources but it is vital to have enough assets (Martinovičová, Konečný & Vavřina, 2019).

The assets of a company can be defined in terms of the Act on Accounting, but also in terms of the Commercial Code. Act No 431/2002 Coll. on Accounting defines assets as those assets of an entity that are the result of past events, are almost certain to increase the entity's economic benefits in the future and can be reliably measured in accordance with Sections 24 to 28; they are recognised in the financial statements in the Balance Sheet or in the statement of assets and liabilities. Act No 513/1991 Coll., the Commercial Code, defines business assets as the aggregate of assets (assets, receivables and other rights and other values that are measurable in monetary terms) belonging to an entrepreneur and used or intended to be used in the entrepreneur's business. The composition of assets, their structure or quantity, always depends on the size of the enterprise and the nature of the enterprise's business activity (Majdúchová et al., 2020). The size of a company's assets is also influenced by its current goals, i.e., whether it wants to expand or focus on its survival (Sivák et al., 2019).

Assets can be classified from several perspectives (Mrkosová, 2020). In terms of the way the asset operates in the entity, i.e., its relationship to the operating cycle, i.e., the purpose of acquiring the asset, it is divided into:

- non-current assets
- and current assets.

In terms of time, the assets are divided into:

- long-term asset,
- current assets.

The cut-off point for the breakdown of assets into non-current and current assets is 1 year. In terms of liquidity, assets are classified according to the degree of liquidity, from the most liquid to the least liquid or vice versa. The

liquidity of an asset is its ability to be converted into cash or cash equivalents. It is determined by the time required for this conversion and the costs associated with it (Šlosárová & Blahušíaková, 2020).

Non-current assets include:

- intangible fixed assets, the valuation is higher than EUR 2,400 (Krištofik et al., 2009), resulting from research, development, and introduction of new procedures. These are capitalised development costs, software, patents, licenses, copyrights, import quotas, trademarks, marketing rights, etc. (Bohušová & Svoboda, 2010),
- tangible fixed assets whose valuation is higher than EUR 1,700. It includes land, buildings, flats, and non-residential premises, works of art and collections, objects made of precious metals, separate movable items and sets of movable items, cultivation units of permanent crops with a fertility period of more than 3 years, basic herd and draft animals, openings of new quarries, (Juhászová et al., 2021),
- non-current financial assets generally consist of securities and shares, long-term loans, works of art, collections, precious metal objects and land acquired by the entity to hold available funds (Farkaš, 2020).

Current assets are defined as cash and tangible assets that can be expected to be converted into cash within one year (Růčková, 2019). Included are the following:

- inventories,
- short-term financial assets,
- short-term receivables.

Inventories are classified according to the method of acquisition into (Cenigova, 2020):

- purchased supplies - materials, goods,
- stocks of own production - work in progress, semi-finished products of own production, products, animals.

According to Mateášová et al. (2018), short-term financial assets consist of marketable securities, securities held to maturity (one year or less), bank accounts, cash, and valuables. It also explains that a short-term receivable has a one-year or less maturity. Current assets are mainly used to settle liabilities. They are constantly in motion; one form passes into another. The money is used to buy materials, in the production process from it to create finished products; after delivery to customers, receivables arise, and after their payment, we have money again). Current assets turnover is in the order of days (in the store) to weeks (in production). The faster current assets turn under the same conditions, the greater the profit. Therefore, the speed of its turnover is an important indicator of the use of current assets. Current assets represent the working capital of the company. Working capital consists of inventories, receivables and financial assets. The main problem in managing working capital is to determine the optimal level of investment in current assets and to find ways to finance it properly (Šeligová & Koštuříková, 2022). A correct and accurate classification of assets will provide users with good information about the current solvency of the company, its future development, as well as whether the overall financing of the company is stable and will be sufficiently secured in the future (Dvořáková, 2022). The value of the asset must take into account the acquisition costs of the asset concerned, its degree of depreciation, and the development of market prices of the relevant components of the asset from the time of their acquisition to the time of their valuation (Adámiková & Čorejová).

The financial management of a company is an important part of the company's management. Research shows that the main factors in business failure include lack of financial planning, limited access to capital, lack of capital, unplanned growth, inaccurate strategic and financial forecasts, excessive fixed asset investment and lack of capital management (Huo, 2023). Capital structure is measured using three alternative ratios: total debt, long-term debt, and short-term debt, as the impact of the determinants can depend on debt maturity (Lisboa, 2017). Assets acquired by a company are funded by debt or equity capital. Finding a suitable capital structure is essential for

any firm. SMEs are more prone to go bankrupt by not considering the vitality of optimal capital structure (Rane, 2022). Capital structure decisions are crucial for any business. Still, they have a special meaning for SMEs because their strategic miscalculations can lead to a crisis or even bankruptcy much faster due to the limited scope of their activities (Panova, 2020; Saarani & Shahadan, 2013). Asset structure, company size, liquidity, profitability, and sales growth affect the capital structure. Errors in determining the capital structure can affect a company's sustainable development, increasing the company's financial risk (Fadhilah, 2022). Along with the standard factors of the company, analysed by Kokeyeva and Amangeldinovna Adambekova (2019), the impact of the company's industry affiliation on its capital structure.

2. Material and methodology

In the paper, we collected data from 107 small and medium-sized wineries. We drew the data from the Slovak Register of Financial Statements. We analysed the period of years 2013 – 2021. To evaluate the development, we used the calculation of the index (as the share of the last year and first year), the calculation of the change (as the difference between the last year and the first year) and the calculation of the average value for the analysed period. We used the forecast for the next three years to predict the indicators' development. We calculated the direction of the regression line fitted by the points in the areas for the dependent and independent variable using the SLOPE function. It is the vertical distance divided by the horizontal distance between two points. We used the INTERCEPT function to coordinate the point that intersects the y axis for $x = 0$. This is a point that is determined by fitting the regression line with known values from point x and y.

3. Results and discussion

Small and medium-sized companies, not only in the wine sector, but in each sector of the national economy, face different challenges to be competitive and gain a foothold in the market. They have irreplaceable importance for the economy of developed countries. The same opinion is shared by Hassan et al. (2021), Vracec (2017), Gunawan et al. (2023), Civelek (2023).

Every company should have some type of assets or appropriate sources (debt, equity). Double-entry bookkeeping aims to provide users with an overview of the state and movement of assets and their sources, profit or loss and changes in the entity's financial situation. Total Assets consist of three basic indicators: non-current assets, current assets, and accruals on the asset side. In Table 1, we focused on assessing the asset's development in wineries for 2013 – 2021 and its basic components. In Table 2, we focused on evaluating the development over the whole period with a forecast of these indicators. As can be seen, the value of assets grew year-on-year until 2019, when assets decreased by k€ 60, which caused a decrease in all three indicators (non-current assets, current assets, and accruals). Subsequently, from that year, the value of assets grew.

During the analysed period, the assets of wineries increased by 30.4 % respectively k€ 716 and were at an average level of 2,775. Non-current and current assets showed the same trend; they decreased in 2019. Non-current assets grew by 29.1 % and current assets by 32.1 %. Every year, non-current assets (average value k€ 1,597) outweigh current assets (average value k€ 1,172) in wineries. Accruals on the assets side showed a fluctuating tendency over the analysed years, but comparing years 2013 and 2021, they increased by k€ 2 51 %. The accruals of wineries consisted mainly of prepaid short-term expenses. According to our calculations, the next three years (2022 – 2024) are expected to increase all four indicators (total assets, non-current assets, current assets, and accruals).

Table 1. Development of Total assets and its items in the period of years 2013 – 2021 in k€

Indicator/year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total Assets	2 359	2 487	2 584	2 728	2 840	2 966	2 906	3 026	3 075
Non-current assets	1 377	1 447	1 491	1 572	1 625	1 682	1 675	1 729	1 777
Current assets	977	1 035	1 086	1 152	1 211	1 276	1 228	1 291	1 291
Accruals/Deferrals total	5	5	7	5	4	8	4	5	7

Source: Authors – own processing and calculations, Financial statements of wineries

Table 2. Evaluation of development and forecast of assets indicators

Indicator/year	Index 21/13	Δ 21-13	\emptyset 21-13	Forecast			Intercept	Slope
				2022	2023	2024		
Total Assets	1.304	716	2 775	3 222	3 311	3 400	2 327	89,407
Non-current assets	1.291	400	1 597	1 841	1 890	1 939	1 353	48,802
Current assets	1.321	314	1 172	1 374	1 415	1 455	969	40,507
Accruals/deferrals	1.510	2	5	6	6	6	5	0,098

Source: Authors – own processing and calculations

Non-current assets consist of three assets: non-current intangible assets, non-current tangible assets, and non-current financial assets. Their development over 2013 – 2021 is presented in Table 3, and the development assessment with forecast is in Table 4. Non-current assets have a company for more than one year. Non-current assets showed an increase of k€ 400 in 2021 compared to 2013. The only year non-current assets decreased by k€ 7 was 2019 compared to the previous year. This decrease was due to non-current tangible and non-current intangible assets. Non-current assets have the highest share (96 %), and the non-current tangible asset has an average value of k€ 1,543. In non-current tangible assets, items such as land, buildings, individual movable assets and sets of movable assets, perennial crops, and value adjustment to acquired assets are the most represented. Non-current tangible assets increased by 34.3 % respectively k€ 441 over the whole period. Non-current intangible assets had the lowest values of individual non-current assets in wineries. Its average value was k€ 2. The highest value of non-current intangible assets was recorded at the beginning of the analysed period k€ 11. Since this year, it has shown a fluctuating trend. Compared to 2021 and 2013, non-current intangible assets decreased by k€ 10. Wineries do not report this type of asset if it occurs in the form of software or other non-current intangible assets. Non-current financial assets reached the highest value in 2013 at k€ 79 and subsequently decreased by k€ 31 € until 2021. The non-current financial assets of wineries consisted mainly of share securities and other long-term securities and shares, and loans to the entity. From the point of view of forecasting the indicator's development of non-current assets, only non-current tangible assets show an increase.

Table 3. Development of non-current assets and their items in the period of years 2013 – 2021 in k€

Indicator/year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non-current Assets	1 377	1 447	1 491	1 572	1 625	1 682	1 675	1 729	1 777
Non-current intangible assets	11	2	2	2	2	0	0	0	2
Non-current tangible assets	1 287	1 376	1 423	1 501	1 589	1 648	1 638	1 693	1 729
Non-current financial assets	79	69	66	68	34	34	37	36	47

Source: Authors – own processing and calculation, Financial statements of wineries

Table 4. Evaluation of development and forecast of non-current assets indicators

Indicator/year	Index 21/13	Δ 21-13	\emptyset 21-13	Forecast			Intercept	Slope
				2022	2023	2024		
Non-current assets	1.291	400	1 597	1 841	1 890	1 939	1 353	48,801
Non-current intangible assets	0.142	-9	2	-2	-2	-3	7	-0,810
Non-current tangible assets	1.343	442	1 543	1 817	1 872	1 927	1268	54,908
Non-current financial assets	0.600	-32	52	26	20	15	79	-5,296

Source: Authors – own processing and calculation

Current assets and development of its items are shown in Table 5, and an evaluation of the development, including prognosis, is shown in Table 6. Current assets are assets of a short-term nature; they serve the current operation of the company. Current assets showed an increasing trend except 2019, when they decreased compared to 2018 by about k€ 48. The decrease in inventories, receivables, and short-term financial assets caused this decrease. The current assets of wineries increased about k€ 313 and reached an average value of k€ 1,172. From the point of view of the current assets, inventories and short-term receivables prevail.

Inventories increased in 2021 in comparison with 2013 about 34.6%. Its average value for the following period was at the level of k€ 631. Inventories are created mainly by raw materials, work-in-progress, semi-finished goods, finished goods, and merchandise. Short-term receivables exceeded long-term receivables every year. Short-term receivables were, on average k€ 371 for the analysed years, and compared to the last and the first monitored year, they increased by k€ 3.

This indicator mainly consisted of trade receivables, other receivables, and social insurance receivables. Short-term financial assets from individual items of current assets reached the lowest values. Its increase was recorded up to 2021 compared to 2013 by k€ 5. Financial accounts comprised cash on hand, and bank accounts reached an average value of k€ 140; by 2021, compared to 2013, their value had almost doubled. In the next three years, we expect an increase in current assets and inventories, long-term receivables, short-term financial assets, and financial accounts.

Table 5. Development of current assets and their items in the period of years 2013 – 2021 in k€

Indicator/year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Current assets	977	1 035	1 086	1 152	1 211	1 276	1 228	1 291	1 291
Inventory	540	521	552	569	657	701	694	717	726
Non-current receivables	11	16	28	34	36	34	33	33	32
Current receivables	336	379	372	393	391	399	354	375	339
Current financial assets	0	3	2	2	1	1	1	5	5
Financial accounts	89	117	132	154	126	140	147	162	188

Source: Authors – own processing and calculation, Financial statements of wineries

Table 6. Evaluation of development and forecast of current assets indicators

Indicator/year	Index 21/13	Δ 21-13	\emptyset 21-13	Forecast			Intercept	Slope
				2022	2023	2024		
Current assets	1.321	314	1 172	1 374	1 415	1 455	969	40,507
Inventory	1.346	186	631	777	806	835	485	29,157
Non-current receivables	2.863	21	29	40	43	45	17	2,376
Current receivables	1.009	3	371	368	368	367	373	-0,483
Current financial assets	14.579	5	2	4	4	5	0	0,335
Financial accounts	2.104	99	140	185	194	203	94	9,123

Source: Authors – own processing and calculation

Growth is one of the factors influencing a company's ability to obtain financial sources. Many SMEs still need help finding out finances for their business. Wineries can use equity and debt sources to finance their activities. Total equity and liabilities consist of equity, liabilities, and accruals. Since there is a balance between assets and total equity and liabilities, the development is the same. So, the only decrease was recorded in 2019, which was caused by liabilities and accruals. The equity value shows an increasing trend from year to year. Overall, the value of equity increased by 32.9%. The average value of equity reached k€ 1,238. Liabilities showed an increasing trend until 2018 and subsequently decreased by k€ 75 between 2019 and 2018; from 2020 they increased annually. Comparing the years 2021 and 2013 liabilities show an increase of 23.3 %. The average value of winery liabilities was k€ 1,289. Accruals grew yearly, but a year-on-year decrease was recorded in 2018, 2019 and 2021. Accruals increased by k€ 108. These indicators in wineries mainly consisted of short-term and long-term deferred income. Based on the indicators forecast, the increase was quantified for all indicators listed in Table 7 in the next three years.

Table 7. Development of total equity and liabilities and their items in the period of years 2013 – 2021 in k€

Indicator/year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total equity and liabilities	2 359	2 487	2 584	2 728	2 840	2 966	2 906	3 026	3 075
Equity	1 041	1 095	1 168	1 217	1 285	1 291	1 316	1 348	1 383
Liabilities	1 139	1 185	1 192	1 276	1 286	1 409	1 334	1 372	1 404
Accruals/Deferrals	179	207	224	235	269	265	256	306	287

Source: Authors – own processing and calculation, Financial statements of wineries

Table 8. Evaluation of development and forecast of total equity and liabilities indicators

Indicator/year	Index 21/13	Δ 21-13	\emptyset 21-13	Forecast			Intercept	Slope
				2022	2023	2024		
Total equity and liabilities	1.304	716	2 775	3 222	3 311	3 400	2 327	89,407
Equity	1.329	343	1 238	1 447	1 488	1 530	1 030	41,635
Liabilities	1.233	265	1 289	1 459	1 493	1 527	1 119	33,994
Accruals/deferrals	1.605	108	248	317	330	344	179	13,778

Source: Authors – own processing and calculation

Equity is a source which an entrepreneur invests in the business. Equity is more expensive than debt. In the balance sheet, equity consists of the following indicators: share capital, share premium, other capital funds, legal reserve funds, other funds created from profit, differences from revaluation, net profit/loss of previous years and net profit/loss for the accounting period after tax. The equity value grew every year. In total, equity increased by k€ 343. The highest share of the equity development had other capital funds, their average value for the monitored period was k€ 511 i.e., 41%. The share capital fluctuated, but in 2021, compared to 2013, its increase was recorded by 17.4% or by k€ 57. Except for one winery, wineries did not have a share premium; its value increased by approximately twofold in 2021.

Differences from revaluation showed a negative value, which deepened to a double negative value in 2021. Wineries had the profit of previous years, which increased by k€ 163. Its average value was k€ 253 during the analysed years. From the point of view of the profit for the accounting period after tax, it had from 2018 required an increasing trend. Based on this indicator, wineries could be considered as profitable.

Table 9. Development of equity and its items in the period of years 2013 – 2021 in k€

Indicator/year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Equity	1 041	1 095	1 168	1 217	1 285	1 291	1 316	1 348	1 383
Share capital	330	310	354	289	412	414	386	388	388
Share premium	13	25	25	25	25	25	25	25	25
Other capital funds	470	493	494	509	494	519	536	537	544
Legal reserve funds	25	25	26	31	32	33	35	29	29
Other funds created from profit	11	12	11	11	11	11	11	11	11
Differences from revaluation	-4	-4	-4	-4	-4	-5	-6	-9	-9
Net profit/loss of previous years	166	172	231	287	269	244	277	303	329
Net profit/loss for the accounting period after tax	30	63	32	71	46	50	52	64	67

Source: Authors – own processing and calculation, Financial statements of wineries

Table 10. Evaluation of development and forecast of equity indicators

Indicator/year	Index 21/13	Δ 21-13	\emptyset 21-13	Forecast			Intercept	Slope
				2022	2023	2024		
Equity	1.329	343	1 238	1 447	1 488	1 530	1 030	41,634
Share capital	1.74	57	363	418	429	440	309	10,877
Share premium	1.961	12	23	28	28	29	19	0,838
Other capital funds	1.158	74	511	554	563	571	467	8,684
Legal reserve funds	1.180	4	30	33	34	35	26	0,790
Other funds created from profit	0.940	-1	11	10	10	10	11	-0,097
Differences from revaluation	2.121	-5	-6	-8	-9	-10	-3	-0,574
Net profit/loss of previous years	1.983	163	253	344	362	381	162	18,247
Net profit/loss for the accounting period after tax	2.211	37	53	67	70	73	39	2,869

Source: Authors - own processing and calculation

Liabilities consist of long-term and short-term resources. Long-term sources include long-term liabilities, long-term bank loans and long-term reserves. Short-term resources consist of short-term liabilities, reserves, current bank loans, and short-term- financial assistance. Liabilities and development of their items are shown in Table 11, and an evaluation of the development, including the prognosis of development, is shown in Table 12.

Table 11. Development of liabilities and their items in the period of years 2013 – 2021 in k€

Indicator/year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Liabilities	1 139	1 185	1 192	1 276	1 286	1 409	1 334	1 372	1 404
Non-current liabilities	257	300	270	300	311	348	369	384	402
Long-term provisions	1	1	1	1	2	2	1	1	1
Long-term bank loans	119	94	86	168	180	230	226	211	208
Current liabilities	600	568	589	557	515	577	527	521	537
Short-term provisions	33	43	43	44	43	45	40	39	39
Current bank loans	80	132	148	131	174	158	132	163	163
Short-term financial assistance	49	47	54	75	63	49	39	52	54

Source: Authors – own processing and calculation, Financial statements of wineries

Table 12. Evaluation of development and forecast of liabilities indicators

Indicator/year	Index 21/13	Δ 21-13	\emptyset 21-13	Forecast			Intercept	Slope
				2022	2023	2024		
Liabilities	1.233	265	1289	1 459	1 493	1 527	1119	33,995
Non-current liabilities	1.566	145	327	417	435	453	237	17,996
Long-term provisions	0.430	-1	1	1	1	1	2	-0,077
Long-term bank loans	1.757	90	169	257	274	292	81	17,533
Current liabilities	0.896	-63	555	513	505	497	596	-8,255
Short-term provisions	1.185	6	41	42	42	42	40	0,146
Current bank loans	2.035	83	142	177	184	191	107	6,997
Short-term financial assistance	1.097	5	53	52	51	51	55	-0,345

Source: Authors - own processing and calculation

The drop in liabilities in 2019 was caused by a decrease in all liability items except long-term liabilities. Their value has grown every year since 2016. In total, long-term liabilities increased by 56.6%. Trade liabilities, other long-term liabilities and liabilities from the social fund had the largest share of the long-term liabilities. Long-term reserves were zero in most companies, but approximately three companies reported their value annually. Therefore, long-term reserve value is at the lowest level of all items forming liabilities.

On the contrary, wineries used short-term reserves, whether legal or other reserves. Their value increased by 18.5% until 2021. Wineries used long-term bank loans and current bank loans to finance their needs. The value of bank loans increased in 2021 compared to 2013. The drawing of long-term bank loans exceeded the drawing of current bank loans in 2013, 2016, 2017, 2018, 2019, 2020 and 2021. The highest item of liabilities are short-term liabilities, a value of more than k€ 500 annually. Short-term liabilities decreased by k€ 63 until 2021. Their average value was k€ 555. The short-term liabilities of wineries consisted mainly of trade liabilities, other liabilities, tax liabilities and subsidies, liabilities to employees and liabilities from social insurance. Short-term financial assistance increased by k€ 5; their average value was at k€ 53. From the point of view of the forecast for 2022 – 2024, an increase in all liabilities indicators is expected, except for long-term reserves, short-term liabilities, and short-term financial assistance.

Conclusions

Grape growing is a tradition not only in Slovakia but also one of the world's most crucial economic fruit crops (Aguilera et al., 2022). Viticulture has been facing various challenges in recent years that must be addressed. Accounting provides information on the use and appreciation of assets, the profitability of business inputs, the financial situation and economic stability. Accounting is required to provide information on the business activities undertaken and their results in the past, as well as on the expected future results (Baštincová, 2016). One financial statement of companies accounting in double-entry bookkeeping is the balance sheet, in which assets, equity and liabilities and their components are recorded. In the analysed wineries, the value of the assets grew every year except 2019. This year, a decrease was caused by basic asset indicators (non-current assets, current assets, and accruals). In companies, non-current assets prevail over current assets. In financing sources, in 2019, the decrease in equity and liabilities caused liabilities and accruals.

This research paper provides insight into fundamental economic indicators such as assets and capital and the structure of a selected group of wineries in Slovakia. The authors' research in Slovakia focuses on vine cultivation, its harvesting, processing, wine production and the wine market. In Slovakia, no one from the field of science and research is devoted to the financial and economic analysis of wineries in scientific papers. We want to continue our research in the future and bring insight into the financial management of this group of companies.

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EFFICIENCY OF INSTITUTIONS PROVIDING SPORTS ACTIVITIES: A CASE STUDY*

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Abstract. Sport as a public benefit activity is of social and economic importance and contributes to the objectives of national economies and the European Union. An economic view of sports involves assessing the costs and benefits associated with sporting activities, and sports can be categorised according to their public benefit character. Despite the specificities of sport, the analysis of the efficiency of institutions providing sporting activities is as relevant as in other public sector sectors. This paper aims to evaluate the success of individual sports in a selected public sector organisation using DEA analysis with a focus on technical efficiency. The paper covers 2016-2019, where sports are considered separate units with their own management. Analysing the efficiency of institutions providing sports activities using DEA analysis is not common, as the availability of relevant data limits quantitative analyses. Although sport is a public good, assessing the efficiency of these institutions is critical to optimising their activities. This specific analysis is essential, as it is for other public sector organisations, as it helps to identify areas for improvement and more efficient use of available resources. In this context, the contribution of the scientific article is also that it highlights the importance of evaluating the efficiency of sport at a higher level, which is becoming an important area within the general economics and economics of sport. The search for optimal ways to use resources in sports poses a challenge, especially when it comes to individual sports under the umbrella of relevant organisations. The performance of these sports will be evaluated in detail using technical efficiency, which will allow a more accurate assessment of individual sports' contribution to the organisation's overall efficiency. Given the specificities of the sporting environment and the decentralised management of individual sports, this analysis will contribute to gaining a better insight into how to optimise the conditions for achieving outstanding sporting results in the environment of the public sector organisation analysis.

Keywords: effectiveness of sports activities; individual sports; performance evaluation; optimisation of sports processes; DEA analysis; military sports programs

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1. Introduction and review of literature

Sport is legislatively defined as a public benefit activity in numerous countries, encompassing social and economic dimensions that play a crucial role in achieving the socio-economic goals outlined by national economies and the European Union. Simultaneously, it generates positive externalities, leading to substantial economic and social advantages (Novotný et al., 2011; Onwumechili, 2018, Potts & Thomas, 2018; Leeds, 2022; Zhou, Ke & Waqas, 2023). From an economic perspective, understanding the costs and benefits associated with sports activities becomes pertinent. Thus, assessing the efficiency of implementing such activities is of significance. Depending on the primary bearer of costs related to a specific type of sport, it can be categorised as a pure public good, a mixed public good, or a private good (Dittrichová, 2010; Andreff, & Szymanski, 2006, Hronec et al., 2021).

There is a separate strand of literature devoted to the various facets of sports institutions' efficiency (e.g., Kahane & Shmanske, 2012; Lee, 2019; Kahane, 2022; Mardosaite, & Jasinskas, 2021; Griban et al., 2022; Bogatyrev et al., 2022; Zhang et al., 2023; Abrahamyan, 2023; Feng, 2023; Lefebvre et al., 2023).

Analysing the efficiency of institutions covering sports activities using DEA analysis is rare (Lozano et al., 2002; Meza et al., 2015; Alyaseri, 2023; Ortiz et al., 2023; Miragaia, Ferreira, & Vieira, 2023).

The data availability necessary for these analyses also limits deeper quantitative analyses. Despite the specific nature of sport as a public good, examining the effectiveness of institutions covering sporting activities is as relevant as for other public sector organisations.

It was also the intention of the paper to show that the evaluation of the efficiency of sport and sporting activities at the top level is a legitimate area of analysis within general economics and the economics of sport. Therefore, on this basis, we consider the treatment of the above topic to be beneficial.

The paper's main objective is to evaluate the success of the individual sports activities covered by the Military Sports Centre Dukla Banská Bystrica (hereinafter referred to as MSC) in the form of a small case study. The success of the sports was evaluated by means of data envelopment analysis (DEA) and identified with their efficiency. In this paper, we analysed the so-called technical efficiency. Simplistically, it can be described as the capacity of the MSC to produce a certain volume of outputs (number of medal placements, number of 4-20 placements, athletes' limit fulfilment) for a given set of inputs (total number of athletes, number of active athletes, resources for training).

The sports supported by the MSC were seen as separate decision-making units (as each sport type has its own decentralised management) with some kind of "production" means necessary to achieve sporting success. Four years from 2016 to 2019 were considered, using aggregated (summary) data for 25 sports covering the entire four-year period.

2. Determination of input data and their characteristics

Just as education has effects at the macroeconomic level, its positive effects can also be expected to be felt in the local government environment. Since few authors have addressed the educational attainment of elected officials at the local level and the context of local government economic indicators (Mihályi, 2019), we have to rely on the research conducted at the economy level as a whole.

The evaluation of the success (effectiveness) of the sports covered by the MSC was based on three input variables:

- Total number of athletes in a given year,
- the number of active athletes in a given year,
- the total financial resources allocated to the training of athletes in a given year (€)
- and several variables on the output side:
- number of 1st to 3rd place finishes in a given year,
- number of placements in 4th to 10th place in a given year,
- number of placements in 11th to 20th place in a given year,
- number of placements in 21st to 50th place in a given year,
- the total number of placement requirements (thresholds) met,
- total number of placements not meeting the requirements (thresholds)

In this form, it was not possible to consider input and output variables because there were data for 25 sports and the entire menu had 3 inputs and 6 outputs, which would make the DEA have no discriminatory power. Another problem was that from the point of view of the funding of the MSC and the internal evaluation of its sports results, rankings above 20th place have no justification. In addition, there were very often zero rankings for some places in the rankings. Another characteristic of the output variables available was that unmet thresholds actually represent an undesirable outcome to be avoided. The DEA solver at our disposal did not allow the selection of a DEA model with undesirable outputs. Finally, not all inputs and outputs were equally relevant to the evaluation of sports or did not carry enough relevant information: specifically, the total number of athletes in a given year, which includes not only active athletes (a separate variable) but also athletes who the MSC registered without submitting performances.

Therefore, four different choices of inputs and outputs were considered in solving the input-output situation, as shown in Table 1. Models 1 to 4 each have 2 inputs and 3 outputs and differ in one input and one output at each time.

Table 1. Selected inputs and outputs for models 1 to 4

	Limits fulfilled	Net limits fulfilled
	Model 1	Model 2
Athletes together	<u>Inputs:</u> <i>sport_together, funds</i> Number of athletes Allocated funds (€) <u>Outputs:</u> <i>place1_3, place4_20, limits_fulfilled</i> Number of 1st to 3rd places Number of 4th to 20th places Number of fulfilled limits	<u>Inputs:</u> <i>sport_together, funds</i> Number of athletes Allocated funds (€) <u>Outputs:</u> <i>place1_3, place4_20, limits_fulfilledNETTO</i> Number of 1st to 3rd places Number of 4th to 20th places Number of fulfilled minus unfulfilled limits
	Model 3	Model 4
Active athletes	<u>Inputs:</u> <i>sport_together, funds</i> Number of active athletes Allocated funds (€) <u>Outputs:</u> <i>place1_3, place4_20, limits_fulfilled</i> Number of 1st to 3rd places Number of 4th to 20th places Number of fulfilled limits	<u>Inputs:</u> <i>sport_together, funds</i> Number of active athletes Allocated funds (€) <u>Outputs:</u> <i>place1_3, place4_20, limits_fulfilledNETTO</i> Number of 1st to 3rd places Number of 4th to 20th places Number of fulfilled minus unfulfilled limits

Source: own elaboration

Models 1 and 2 consider the total number of athletes (sport_total), while models 3 and 4 consider active athletes (sport_active). Models 1 and 3 use the number of fulfilled requirements (limits_fulfilled) and models 2 and 4 in turn rely on the newly introduced variable "number of fulfilled minus unfulfilled requirements" (limits_fulfilled_NETTO). This variable is created by reducing the number of requirements met by the number of requirements not met, thereby accounting for the undesirable status of the number of requirements not met variable and allowing the resulting net variable to be used as a more comprehensive desired output. On the input side, the four placement count variables are considered in a modified form: the number of placements in 1st to 3rd place and the number of placements in 4th to 20th place. In the short term, active athletes are primarily important (Models 3 and 4). Still, inactive athletes should also be considered for longer-term sustainability, and the number of all athletes should be calculated (Models 1 and 2). But obviously, the results with respect to models 3 and 4 are more interesting.

Models 1 to 4 view individual sports as units that have athletes and financial resources and use these to achieve performance. The analysis uses data for the years 2016 to 2019. Because using data for only one year can be highly biased and affected by multiple one-off factors (e.g. if there were no European or World Championships in a given sport), a 4-year period corresponding to the Olympic cycle was used. The data for all 4 years were summed so that e.g. the variable sport_total finally represents the total number of athletes recorded in total over the 4-year period. The same athlete could have been counted once up to four times.

The economic and personnel indicators necessary for the elaboration of the paper on the evaluation of the efficiency of the sports peak training (number of athletes, training costs, athletes' fulfilled limits and points placements) were obtained from the annual reports, from the information system of the MSC and from the invoice records - the use of funds. As the MSC does not have the necessary data in a suitable structure, the data had to be mechanically retrieved from a large number of electronic and written documents and subsequently processed into the required form. Therefore, the acquisition and processing of the data required for the analysis was time-consuming.

Table 2. Statistical indicators of input and output variables

Indicator	Maximum	Minimum	Average	Standard deviation
sport_together (number)	188	4	42,960	44,413
sport_active (number)	114	4	29,480	29,147
funds (€)	494901	8923	120122	147343
place1_3 (number)	19	0	3,880	4,710
place4_20 (number)	54	0	14,480	18,296
limits_fulfilled (number)	114	4	29,160	29,143
limits_fulfilledNETTO (number)	41	0	14,040	11,975

Source: own elaboration

Table 2 shows the statistics of the input and output variables in each of the 4 models. There is obvious variability across sports. Some sports had only one athlete each year (these were always active athletes). Consequently, the minimum value of 4 for sport_total occurred 8 times (these are the sports of boxing, cyclocross, track cycling, kickboxing, bodybuilding, archery, triathlon, and aquatics). In contrast, the sport with the most athlete support was athletics with 188 registered athletes over 4 years and 114 active. The high variability can be seen not only in the minimum and maximum values, but also in the standard deviations, which, except for the variable limits_fulfilledNETTO, are approximately the same or substantially larger than the mean values. At the same time, the existence of null values for the variables place1_3, place4_20 and limits_splneneNETTO (17, 16 and 7 sports, respectively) can be seen. The occurrence of null values will be treated by selecting an appropriate DEA model, but it is also important that the newly defined variable is always non-negative, as this would probably pose a more serious problem. This means that each sport has always met more limits in total over the 4-year period than it has not.

Table 3. Correlations between the input and output variables considered

	sport_together	sport_active	funds	place1_3	place4_20	limits_fulfilled	limity_fulfilled NETTO
sport_together	1,000	0,968	0,801	0,514	0,668	0,967	0,871
sport_active	0,968	1,000	0,834	0,666	0,756	0,999	0,895
funds	0,801	0,834	1,000	0,663	0,641	0,839	0,655
place1_3	0,514	0,666	0,663	1,000	0,740	0,337	0,220
place4_20	0,668	0,756	0,641	0,740	1,000	0,706	0,528
limits_fulfilled	0,967	0,999	0,839	0,673	0,762	1,000	0,886
limits_fulfilledNETTO	0,871	0,895	0,655	0,489	0,648	0,886	1,000

Source: own elaboration

The correlation matrix in Table 3 shows that there is a high correspondence between the number of athletes and active athletes (correlation coefficient of 0.968) and similarity with the resources spent (correlation coefficients of 0.801 and 0.834). Interestingly, the number of athletes and active athletes are highly correlated with the number of limits met (correlation coefficients of 0.967 and 0.999, respectively). After accounting for unmet limits, the correlation of this variable with the other variables decreased.

3. Choice of model and justification of methods

Since models with different inputs and outputs can produce differentiated results, we decided to develop 4 models for evaluating efficiency and then compare the results. Obviously, each model has its limitations resulting from the parameters set and the model inputs and outputs used. Using the models, we tried to identify efficient and inefficient sports and the differences in the range of efficiency between them. In the database for each of the 4 models, there were zeros for the output variables that precluded the use of basic DEA models. Both because of this limitation and for a more reliable measure of efficiency, a slacks-based measure (SBM) model was used, which accounts for the non-proportional slips of inputs and outputs, while also allowing for a convenient solution to the situation of how to measure even with negative or zero values (Tone, 2001; Cooper, Seiford, & Tone, 2007). In the evaluation situation under consideration, the proportionality of inputs or outputs cannot be automatically assumed. There are better-funded sports (in € per athlete or active athlete), such as in this case aquatics, downhill skiing, biathlon, water slalom, while the counterparts in financial support are wrestling, gymnastics, luge, and weightlifting. This is related to economies of scale and some sports' material and technical needs. It cannot be assumed that an increase in the number of (active) athletes should be matched by an equal increase in financial resources. Similar considerations appear on the output side, where the numbers of placements and the numbers of limits met (net) are shown. The correlation analysis in Table 3 shows that the output variables are not even as strongly correlated as the chosen inputs. Placements in 1st to 3rd place and placements in 4th to 20th place are also influenced by the quality of athletes other than those from the MSC, and many random factors, not just the quality of training, affect sporting performance. Proportionality cannot be expected here, either. The observed disproportionality of the inputs and outputs of the individual sports precludes the constancy of returns to scale, and as a result, variable returns to scale were used. For the same percentage increase in the number of athletes and resources, the same increase in placements and number of limits cannot be expected at all.

The nature of the sports activity implies a higher influenceability of the inputs involved (number of athletes, resources allocated), while placements and limit fulfilments are beyond the control of MSC DUKLA. Thus, the appropriate orientation is input. On the other hand, in this case, the role of inputs in achieving outputs is significantly differentiated. In the same way, the output variables for the evaluation are necessarily of different importance. To take into account the different importance of inputs and outputs, a non-oriented model was

preferred, allowing full incorporation of the different weights of inputs and outputs into the measurement. For inputs, weights of 0.40 (sport_total/sport_active) and 0.60 (prostr) were used for each model. For outputs, the weights were 0.50 (place1_3), 0.10 (place4_20) and 0.40 (limits_fulfilled/limits_fulfilled_NETTO).

Thus, the calculations included in the electronic appendix were obtained using a weighted non-oriented SBM model. For models 2 and 4, the transformed variable (limits_fulfilled_NETTO) was used. The transformation and aggregation of the 4-year data were explained and justified in the previous chapter.

4. Results and discussion

The results are presented in Tables 4 to 9. The computed efficiency scores for the 25 sports evaluated in turn and the reference sets for Models 1 and 2 are included in Table 4 and for Models 3 and 4 are presented in Table 5. The reference sets are presented only for the inefficient sports along with the lambda coefficients, which sum to one for variable returns to scale. The basic statistics of the summed scores for each model are presented in Table 5.

Table 4. Efficiency scores and reference sets for models 1 and 2

Nr.	Sport	Model 1		Model 2	
		Score	Reference sports	Score	Reference sports
1	Athletics	1		1	
2	Biathlon	0,4947	Water motor racing 0,042 Water slalom. 0,016 Weightlifting. 0,943	0,4536	Weightlifting 1
3	Bobsleigh	0,3861	Kickboxing 1	0,423	Box 1
4	Box	0,9355	Kickboxing 1	1	
5	Road cycling	0,0853	Water motor racing 0,228 Weightlifting 0,772	0,0907	Water motor racing 0,091 Weightlifting 0,909
6	Cyclocross	0,7091	Kickbox 1	0,7463	Box 1
7	Track cycling	1		1	
8	Judo	0,1844	Kickbox 0,246 Weightlifting 0,754	0,1921	Kickboxing 0,125 Weightlifting 0,875
9	Gymnastics	1		1	
10	Karate	1		1	
11	Kickboxing	1		1	
12	Bodybuilding	0,336	Kickbox 1	0,4679	Box 0,333 Kickbox 0,667
13	Archery	0,6331	Track cycling 0,286 Kickboxing 0,714	0,8322	Box 0,25 Track cyc. 0,279 Kickbox 0,441 Water mot. 0,029
14	Modern pentathlon	0,5884	Track cycling 0,286 Kickboxing 0,714	1	
15	Motorcycle sport	0,6495	Kickbox 1	0,6892	Box 1
16	Swimming	0,4709	Kickboxing 0,204 Weightlifting 0,796	0,496	Kickboxing 0,204 Weightlifting 0,796
17	Speed canoeing	0,4065	Water motor racing 0,123 Weightlifting 0,877	0,2703	Kickbox 0,241 Weightlifting 0,759
18	Tobogganing	0,5377	Track cycling 0,632 Weightlifting 0,368	1	
19	Sport shooting	1		0,5265	Gymnastics 0,201 Kickboxing 0,293 Weightlifting 0,506
20	Triathlon	0,7005	Kickboxing 1	0,7367	Box 1
21	Water motor racing	1		1	
22	Water slalom	1		1	
23	Weightlifting	1		1	
24	Wrestling	1		1	
25	Downhill skiing	0,1429	Water motor racing 0,298 Weightlifting 0,702	0,1243	Kickboxing 0,594 Weightlifting 0,406

Source: own elaboration

Table 5. Efficiency scores and reference sets for models 3 and 4

Nr.	Šport	Model 3		Model 4	
		Score	Reference sports	Score	Reference sports
1	Athletics	1		1	
2	Biathlon	0,6102	Water motor racing 0,042 Water slalom 0,016 Weightlifting 0,943	0,5706	Water motor racing 0,042 Water slalom 0,016 Weightlifting 0,943
3	Bobsleigh	0,7551	Kickbox 1	0,7858	Box 1
4	Box	0,9463	Kickbox 1	1	
5	Road cycling	0,1121	Aquatics 0,228 Weightlifting 0,772	0,999	Road cycling 1
6	Cyclocross	0,7576	Kickbox 1	0,7886	Box 1
7	Track cycling	1		1	
8	Judo	0,158	Track cycling 0,246 Weightlifting 0,754	0,2136	Swimming 0,058 Bobsleigh 0,435 Weightlifting 0,507
9	Gymnastics	0,5544	Track cycling 0,173 Kickboxing 0,427 Wrestling 0,4	1	
10	Karate	1		1	
11	Kickboxing	1		1	
12	Bodybuilding	0,4334	Kickbox 1	0,5179	Kickboxing 0,667 Modern pentathlon 0,333
13	Archery	0,6589	Track cycling 0,5 Kickbox 0,5	0,6838	Modern pentathlon 1
14	Modern pentathlon	0,7144	Track cycling 0,5 Kickbox 0,5	1	
15	Motorcycle sport	0,7746	Kickbox 1	0,8077	Box 1
16	Swimming	1		1	
17	Speed canoeing	0,5704	Water motor racing 0,123 Weightlifting 0,877	0,3982	Modern pentathlon 0,26 Weightlifting 0,74
18	Tobogganing	0,3241	Track cycling 0,632 Weightlifting 0,368	1	
19	Sport shooting	0,5358	Water motorcycling 0,404 Weightlifting 0,596	0,5279	Kickboxing 0,438 Weightlifting 0,562
20	Triathlon	0,7504	Kickbox 1	0,7806	Box 1
21	Water motor racing	1		1	
22	Water slalom	1		1	
23	Weightlifting	1		1	
24	Wrestling	1		1	
25	Downhill skiing	0,1071	Swimming 0,708 Weightlifting 0,292	0,0908	Track cycling 0,593 Swimming 0,068 Weightlifting 0,339

Source: own elaboration

On the one hand, there are no critical differences between the models in terms of overall average scores, but on the other hand, models 1 and 2 (using sport_together) give efficiency scores on average lower overall than models 3 and 4 (using sport_active). Thus, the use of active athletes on the input side puts the individual sports in a more favourable light overall, as can be seen not only in the averages but also in the value of the worst (smallest) score. Considering unmet thresholds as a (negative) desirable outcome in Models 2 and 4 leads to an increase in the overall efficiency level, most noticeably in Model 4 when combined with sport_active. According to the standard deviations, the least variability is for model 4 and the most variable results are for model 2, although there is no dramatic difference. Each model identified a different number of effective sports, ranging from 9 (model 3) to 13 (model 4).

For each model, inefficient sports found were biathlon, bobsledding, road cycling, cyclocross, judo, bodybuilding, archery, motorcycle sport, speed canoeing, triathlon, and downhill skiing (11 sports in total). In some cases the differences in scores for the different models were not significant, e.g. for cyclocross the scores for the different models were between 0.7091 and 0.7886, while for speed canoeing, for example, the scores were 0.2703 (model 1) and around 0.4 (models 1 and 4) and 0.5704 (model 3), respectively. Some sports were effective for at least one of the models (6 sports). The sports of boxing, modern pentathlon and luge became efficient for models 2 and 4, i.e., considering the unmet thresholds. Swimming was effective when using active athletes, i.e., for models 3 and 4, and sport shooting only for model 1. Gymnastics was effective for three models, with only model 3 having a relatively low effectiveness of 0.5544. Thus, for gymnastics, there is some margin in the total number of athletes combined with the limits met. The remaining sports, athletics, track cycling, karate, kickboxing, aquatics, water slalom, weightlifting and wrestling, are still found efficient regardless of the choice of model (8 sports).

Models 1 and 3 are similar in terms of patterns. The most common pattern for inefficient sports for Model 1 is kickboxing (6 times with a weight of 1,000 and 4 times in proportion). In addition, track cycling, aquatic motoring, and weightlifting occur a few times in some proportion. Water slalom occurs only once. For model 3, again the most frequent pattern is kickboxing (6 times with a weight of 1,000 and 3 times with a lower weight) then track cycling, aquatic motoring, weightlifting and once also water slalom appear in common combination (also with kickboxing). The patterns of models 1 and 3 are almost identical for each sport (with modification of weights). There are more substantial differences between models 2 and 4. For model 2, boxing dominates as a pattern (4 times with a weight of 1,000 and 2 times with a weight lower), then kickboxing (7 times in the co-participation). Other patterns are weightlifting, aquatics, gymnastics, and track cycling. For pattern 4, boxing is also the most common pattern (4 times with a weight of 1,000) but concurrent with weightlifting (4 times in a sub-pattern). Other patterns are aquatics, water slalom, swimming, luge, modern pentathlon and road cycling. The clear conclusion is that, with respect to overall athletes, the "most exemplary" sport is kickboxing (patterns 1 and 2), while for active athletes it is boxing (patterns 3 and 4).

Table 6 below gives the correlation coefficients. The table provides information on the effectiveness of these models within the implemented sports and enables a comparison of their performance based on various indicators. Model 4 stands out for its high mean efficiency and low standard deviation, which could indicate its better ability to predict the efficiency results of individual sports.

Table 6. Efficiency score statistics for models 1 to 4

Indicator	Model 1	Model 2	Model 3	Model 4
Average	0,6904	0,722	0,7105	0,8066
Maximum	1	1	1	1
Minimum	0,0853	0,0907	0,1071	0,0908
Standard deviation	0,3139	0,3226	0,300	0,2729
Number of effective sports	10	12	9	13
Number of inefficient sports	15	13	16	12

Source: own elaboration

All four models are relatively efficient on average, with values ranging between 0.6904 and 0.8066. This value provides an overall view of how well these models predict the efficiency results of individual sports. Regarding the maximum efficiency score value, all four models achieve the highest possible score of 1 for some sports, indicating that some of the sports analysed within these models were absolutely efficient. The minimum values of the efficiency score indicate the possible significant inefficiency of some sports within the developed models. The results suggest that there are substantial differences between individual sports in this indicator. The measured minimum efficiency scores ranged from 0.0853 to 0.1071. The standard deviation made it possible to measure the variability of the efficiency score within individual models. Model 4 has the lowest standard deviation, indicating

that its predictions were more consistent compared to the other models. The number of sports that were considered efficient within the developed models differed between individual models, with Model 4 predicting efficiency in the largest number of sports - 13. The number of sports that did not achieve efficiency within the investigated models also varies strongly between the developed models. Model 2 had the lowest number of ineffective sports - 12. Table 7 provides information on the correlations between the models. The correlations can provide insight into the extent to which these models are similar or different in their predictions. The results are shown in the following table.

Table 7. Correlations between efficiency scores for models 1 to 4

Indicator	Model 1	Model 2	Model 3	Model 4
Model 1	1.0000	0.8624	0.7897	0.6133
Model 2	0.8624	1.0000	0.7322	0.7524
Model 3	0.7897	0.7322	1.0000	0.6630
Model 4	0.6133	0.7524	0.6630	1.0000

Source: own elaboration

The correlation coefficients in Table 7 indicate that there is generally not much difference in the sports rankings by the different models (correlation coefficient values between 0.7322 and 0.8624 indicate a direct strong linear fit). A slightly larger difference occurs between the scores of models 1 and 4 (correlation 0.6133) and the scores of models 3 and 4 (correlation 0.6630). In the former case, a marked difference of 0.914 occurs for road cycling (scores of 0.085 in model 1 and 0.999 in model 4), while for the sports of swimming, sport shooting, luge and modern pentathlon the difference is between 0.400 and 0.529. In the latter case, road cycling is the most different with a difference of 0.887 (score of 0.112 in model 3 and score of 0.999 in model 4), followed by luge with a difference of 0.675 and gymnastics with a difference of 0.446. In all these cases, the Model 4 score is higher (1 or nearly 1). These are essentially the same sports viewed differently by these models. In practice, this means that these sports look different in terms of efficiency when evaluated over the total number of athletes and the number of limits met (Model 1) and over the number of active athletes and the number of limits after accounting for unmet limits (Model 4). Differences also emerge when different values for the number of active athletes are used for the number of limits (Models 3 and 4). This is consistent with the differences in mean scores in Table 6 (but which apply to all sports).

Table 8. Percentage slips for models 1 and 2

Sport	Model 1						Model 2					
	Score	Slips (%)					Score	Slips (%)				
		sport_together	funds	place1_3	place4_20	limits_fulfilled		sport_together	funds	place1_3	place4_20	limits_fulfilledNE TTO
Athletics	1	0	0	0	0	0	1	0	0	0	0	0
Biathlon	0.495	12.13	75.66	0	5.64	0	0.454	9.09	76.08	0	10.2	26.92
Bobsleigh	0.386	80	48.97	48.97	48.97	0	0.423	80	42.84	42.84	42.84	0
Box	0.936	0	10.74	10.74	10.74	0	1	0	0	0	0	0
Road cycling	0.085	35.36	52.05	931.58	747.37	0	0.091	24.71	48.15	972.73	887.27	0
Cyclocross	0.709	0	48.48	48.48	48.48	0	0.746	0	42.28	42.28	42.28	0
Track cycling	1	0	0	0	0	0	1	0	0	0	0	0
Judo	0.184	32.76	29.9	364.04	918.42	0	0.192	22.81	19.78	406.25	1081.25	0
Gymnastics	1	0	0	0	0	0	1	0	0	0	0	0
Karate	1	0	0	0	0	0	1	0	0	0	0	0
Kickboxing	1	0	0	0	0	0	1	0	0	0	0	0
Bodybuilding	0.336	0	26.65	300	300	0	0.468	0	23.71	166.67	166.67	0
Archery	0.633	0	38.53	42.87	0	0	0.832	0	27.97	0	0	0
Modern pentathlon	0.588	33.33	25.36	42.87	0	0	1	0	0	0	0	0

Motorcycle sport	0.65	20	45.08	45.08	45.08	0	0.689	20	38.47	38.47	38.47	0
Swimming	0.471	18.04	10.95	139.35	0	33.48	0.496	18.04	10.95	139.35	0	10.34
Speed canoeing	0.407	31.98	50.32	77.19	16.43	0	0.27	40.54	58.73	55.25	0	129.97
Tobogganing	0.538	35.65	10.73	10.73	474.74	0	1	0	0	0	0	0
Sport shooting	1	0	0	0	0	0	0.526	0	47.1	68.42	20.53	0
Triathlon	0.701	0	49.91	49.91	49.91	0	0.737	0	43.88	43.88	43.88	0
Water motor racing	1	0	0	0	0	0	1	0	0	0	0	0
Water slalom	1	0	0	0	0	0	1	0	0	0	0	0
Weightlifting	1	0	0	0	0	0	1	0	0	0	0	0
Wrestling	1	0	0	0	0	0	1	0	0	0	0	0
Downhill skiing	0.143	32.01	74.91	152.63	1192.98	0	0.124	58.36	86.59	71.09	631.26	0

Source: own elaboration

Table 9. Percentage slips for models 3 and 4

Sport	Model 1						Model 2					
	Score	Slips (%)					Score	Slips (%)				
		sport_together	funds	place1_3	place4_20	limits_fulfilled		sport_together	funds	place1_3	place4_20	limits_fulfilledNETTO
Athletics	1	0	0	0	0	0	1	0	0	0	0	0
Biathlon	0.61	0	75.66	0	5.64	0	0.571	0	75.66	0	5.64	21.21
Bobsleigh	0.755	0	48.98	48.98	48.98	0	0.786	0	42.83	42.83	42.83	0
Box	0.946	0	10.74	10.74	10.74	0	1	0	0	0	0	0
Road cycling	0.112	0	52.05	931.58	747.37	0	0.999	0	0.02	0.13	0.14	0
Cyclocross	0.758	0	48.48	48.48	48.48	0	0.789	0	42.28	42.28	42.28	0
Track cycling	1	0	0	0	0	0	1	0	0	0	0	0
Judo	0.158	0	29.45	314.91	1004.39	0	0.214	0	30.26	190.58	701.48	0
Gymnastics	0.554	0	0	0	241.11	0	1	0	0	0	0	0
Karate	1	0	0	0	0	0	1	0	0	0	0	0
Kickboxing	1	0	0	0	0	0	1	0	0	0	0	0
Bodybuilding	0.433	0	26.65	300	300	0	0.518	0.01	15.85	233.29	233.29	0
Archery	0.659	0	35.27	0	75.02	0	0.684	0	17.64	0	0	100
Modern pentathlon	0.714	0	21.4	0	75.02	0	1	0	0	0	0	0
Motorcycle sport	0.775	0	45.08	45.08	45.08	0	0.808	0	38.47	38.47	38.47	0
Swimming	1	0	0	0	0	0	1	0	0	0	0	0
Speed canoeing	0.57	0	50.32	77.19	16.43	0	0.398	14.48	59.22	44.33	0	131.45
Tobogganing	0.324	21.88	10.73	10.73	474.74	0	1	0	0	0	0	0
Sport shooting	0.536	0	24.96	144.74	45.31	0	0.528	5.1	43.38	98.44	32.07	0
Triathlon	0.75	0	49.91	49.91	49.91	0	0.781	0	43.88	43.88	43.88	0
Water motor racing	1	0	0	0	0	0	1	0	0	0	0	0
Water slalom	1	0	0	0	0	0	1	0	0	0	0	0
Weightlifting	1	0	0	0	0	0	1	0	0	0	0	0
Wrestling	1	0	0	0	0	0	1	0	0	0	0	0
Downhill skiing	0.107	0	72.14	51.04	1440.28	0	0.091	41.91	86.4	0	884.18	0

Source: own elaboration

Tables 8 and 9 give the percentage lags by which the original inputs and outputs need to be adjusted to make the respective sports efficient relative to the others. The problem with the recommendations derived from Tables 8 and 9 is that they are sometimes more difficult to achieve and often clearly unrealistic. This can be illustrated by the example of a selected sport, where the applicability of all these calculations can be shown.

Conclusions

All models rate downhill skiing as a weak sport covered by MSC DUKLA. It scores best in Model 1, where the active number of athletes is used, regardless of the number of unmet limits. In this case, the score is 0.1429. This value takes into account excesses in inputs and deficiencies in outputs. Downhill skiing should be compared with aquatics and weightlifting, which represent theoretically achievable patterns with unequal weights (aquatics 0.298 and weightlifting 0.702). Interpretation of the recommendations and slips is complicated because data aggregated over 4 years were used. Over this period, downhill skiing had 44 met thresholds, which are not required to be adjusted to achieve a technically efficient optimum with a score of 1.000. Slips and necessary adjustments are identified in other directions. To achieve technically efficient performance, downhill skiing would need to have only 50.32 persons on the athlete register for the years 2016 to 2019 instead of 74 persons (i.e. 32.01% less) and €99,923 (i.e. 74.91% less) instead of the cumulative total of €398,245 allocated for these 4 years (i.e. 74.91% less). On the output side, it would be necessary to increase the number of placements in the first 3 places from 4 to 10.11 (i.e. increase placements by 152.63%) and the number of placements in the next 17 places from 3 to 38.79 (i.e. up by 1,192.98%). The values of the percentage slippages given in parentheses can be found in Table 8. These recommendations are clearly not realistic, but the valuable information is that we should look to aquatic sports and weightlifting for inspiration in managing downhill skiing. For other models, somewhat different recommendations and even patterns emerge. These sports are significantly different from downhill skiing, and their adequacy needs to be understood in managerial terms.

The performed research allows us to claim that data envelopment analysis (DEA) can be successfully used to estimate the efficiency of sports institution performance in selected areas.

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