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Dear readers,

Today I am introducing to your attention a new issue already of established international scientific journal *"Entrepreneurship and Sustainability Issues"*. This journal tackles wide range of processes and problems, which we encounter in our current lives. It could be claimed that the journal serves as contemporary chronicle of our turbulent reality.

Here new urgent issues are being raised, which contribute to contemplating of entrepreneurship and sustainability phenomena, which transform and obtain new content, which is gradually enriched by increasing number of facets.

Scientists, practitioners, students and society, all of them are important protagonists of building our secure and sustainable future. Let all of us support on-going discussion, share and come to the best solutions for sustainable future. Since good understanding and correct evaluation of multi-faceted reality is primary precondition of international understanding, which ultimately leads to relevant policy implications for common affluent and sustainable wellbeing.

With best regards

A handwritten signature in black ink, appearing to read 'Vlado Dimovski', with a large, stylized flourish at the end.

Professor VLADO DIMOVSKI

Member of European Academy of Sciences and Arts

Former Minister for Labor,

Family and Social Affairs of Slovenia



Publisher



THE MEASUREMENT OF THE INNOVATIVENESS OF HEALTH TOURISM SERVICES USING AN ADEQUACY MATRIX TITLE OF THE ARTICLE*

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Abstract. The main aim of the article is to identify the optimum measures of the innovativeness of providers of health tourism services. Two detailed objectives were set out: the identification of the measures of innovative activities and the identification of the measures of the effects of innovative activities implemented by respondents. The measurement covered two areas: the involvement in innovative activities and the effects of these activities. Two research hypotheses were verified: Hypothesis 1 – *The optimum measure of the involvement of providers of health tourism services in innovative activities is a separate budget earmarked for the implementation of innovations*; Hypothesis 2 – *The optimum measure of the effects of innovations introduced is a higher number of commercial tourists using the services of a given enterprise*. 438 providers of health tourism services in Poland took part in the research with using methods of a diagnostic survey and a telephone interview. An adequacy matrix was used to analyse the 15 innovation measures selected in an expert (Delphi) survey. As a result five optimum measures were determined, the most important of which was the elaboration of a strategy for introducing innovation and a higher number of tourists as the effect of innovative activities.

Keywords: innovations, service innovativeness, tourism, health tourism

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JEL Classifications: O31, I15

1. Introduction

Innovativeness is one of the most important management issues. Innovativeness is defined as the ability of organisations, sectors, regions or countries to seek, implement and disseminate innovations, i.e. this means doing something new or introducing significant changes which can be measured and assessed (Hilami, Ramayah, Mustapha, & Pawanchik, 2010). With respect to an organisation, innovativeness involves its ability to place new

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products on the market or to open new markets by combining a strategic orientation with innovative behaviour and processes (Danneels & Kleinschmidt, 2000).

Whereas on the macroeconomic level changes in the innovativeness level of countries and indicators for their measurement have been identified on the lowest levels there is still no uniform catalogue of measures. This issue is particularly complex in the service sector. The research problem addressed in this paper was a search for the measures of the innovativeness of providers of health tourism services. Health tourism is defined as a type of tourism the main purpose of which is to improve or maintain health (Boruszczak, 2010). The measurement difficulties result from the dichotomy of the investigated area made up by the tourism and medical sectors. The tourism sector provides services related to travel, accommodation and visits to tourist attractions, whereas the medical sector renders medical services which are in this case the purpose of a tourist travel.

A group of enterprises which provided health tourism services in Poland was selected for the research. The issues were chosen on the basis of three main premises. Firstly, the growing demand for the development of health tourism services, which is related to the ageing of society and the increasing leisure budget of certain customer groups. This has been indicated by the research done by Deloitte. Although the research covered the United States market, still it may provide guidance for other areas, including the countries of the European Union. As a result of the research, it was diagnosed that the tourism movement related to health tourism doubled in the USA in barely 5 years (from 2007 to 2011). The drivers of changes should be considered to include economic growth and the related higher per capita revenues (Rudawska, 2009).

Secondly, the dynamic development of medical sciences and enhanced international linkages. This development is a consequence of globalisation processes and a changed perception of medicine as no longer only services with healing functions (helping those in need) but also services with modelling and aesthetic functions. This change results from a holistic and optimistic understanding of the term “health”, i.e. a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (according to the World Health Organization (WHO)), ensuring a socially productive life in social, economic and mental terms, also in the spiritual dimension. Responses to the globalisation processes in medical services include e.g. the signing of multilateral contracts on medical care (Reismann, 2010), the liberalization of medical regulations (Lunt & Carrera, 2010; Morgan, 2010) and, in consequence, the efforts taken by certain countries to specialise in health tourism services (Brazil, India, Hungary, Costa Rica).

The third premise encouraging one to address the issue of innovativeness of health tourism is the emerging possibility of co-financing from the European funds (in the programming perspective of 2014-2020) for projects which are most important from the point of view of the social demand and enhanced innovativeness of the economy. The research has an interdisciplinary character and covers two research areas; specifically, medicine and the tourism economy. Therefore, this study is conducted to create a new way of looking at health tourism innovativeness and a method for its measurement. The researchers hope that this study will build foundations for both innovation theory and practice for entrepreneurs operating at the interface between tourism and medicine in order for the results of the research to be applied in their economic activities.

An indication of the measures of the innovativeness of health tourism will contribute to eliminating the existing gap in knowledge. This study is pioneering in character, since the innovation indicators used for health tourism have not been verified and classified to date.

1. Research objectives

The main aim of the research is to identify the optimum measures of the innovativeness of providers of health tourism services.

The detailed objectives were formulated:

- C1.** The identification of the measures of the involvement of providers of health tourism services in innovative activities;
- C2.** The identification of the measures of the effects of innovative activities implemented by providers of health tourism services;
- C3.** An indication of discrepancies occurring between experts' opinions and the market realities in the scope of the assessment of the measures of the innovativeness of providers of health tourism services;
- C4.** The adoption of innovation monitoring targets for the innovation policy of health tourism.

In order to achieve the objectives listed above, the following research questions were formulated:

- What is the innovativeness level of the investigated enterprises?
- What are the optimum indicators used to examine the innovativeness of a selected group of service enterprises?

2. Literature review

2.1. Innovativeness of service enterprises and its measurement

The concept of innovation brings to one's mind primarily such terms as change, improvement or reform. In the Polish legislation, innovation is defined as an activity related to the preparation and launch of the manufacture of new or improved materials, products, equipment, services, processes or methods intended to be placed on the market or for another use in practice (Ustawa (Act), 2015). Thus, innovation means a technical and organisational change which is expressed by a modification of existing products, practices or processes. The main issues of interest to the researchers in the world who deal with the issues of innovativeness in the economy include:

- innovation policy (Furman, Porter, & Stern, 2002; Grupp & Moge, 2004; Balezentis, & Balkiene, 2014; Chen, & Nie, 2014; Chen, Nie, & Wen, 2015; Djeri, Armenski, Tesanovic, Bradic, & Vukosav, 2014);
- the innovation drivers in the economy (Hollenstein, 2003; Gault, 2011; Rezk et al. 2016);
- the innovative activity of enterprises (mainly production enterprises) (Tuominen, Rajala, & Möller, 2004; Perunovic & Christiansen, 2005) with particular consideration given to technological progress and R&D expenditure as well as their roles in the innovation process (Aw, Roberts, & Xu, 2011; Urban & Czerska, 2016; Ahmed et al., 2017; Mouraud, 2017; Barberis et al., 2017; Passerini et al., 2017);
- sector-specific research on the innovativeness of the economy (Garcia & Hollanders, 2009; Pauceanu, 2016; Laužikas, et al, 2016);
- the innovativeness of small and medium-sized enterprises (Frel, 2003),
- the innovativeness of tourism enterprises (Hjalager, 2010; Szymańska, 2009, 2013);
- innovativeness in the context of a knowledge-based economy and in the globalisation process (Rycroft, 2003; Ejdyś, Ustinovicius, & Stankevičienė, 2015; García-Fuentes, de Torre, 2017; Zemlickiene, et al. 2016);
- attempts are also taken to seek innovation in different areas of social activity and to link completely different phenomena (Deshpande & Farley, 2004; Ejdyś, 2015) or spatial planning the city (Hajduk, 2015).

Innovativeness in the service sector can be related to both products and the process of providing services, enterprise management, marketing, logistics or relationships with the business environment. Bosworth and Triplett (2007) found that a substantial part of an increase in productivity was a result of innovations introduced in the service sector.

Scandinavian countries were precursors of innovation research; still, it was in Switzerland that in 1999 accurate research was carried out on the innovativeness of the service sector. The Swiss Innovation Survey which gave the results of research at three research centres (in Austria and Switzerland) was presented by Hollenstein (2003). This publication indicated numerous difficulties related to the measurement of innovation in this area. Ulrike de Brentani (2001) indicated the importance of services as a driver of an economic success. But it was not until 2008 that an initiative was launched to combine international efforts within the European Union in the scope of research on the innovativeness of the service sector. Gallouj (2002), Gallouj & Windrum (2009), Gault (2011, 2013) and Hollanders should be regarded as the leading researches on the issues of the innovativeness of services at the international level. The latter two are members of the United Nations University Maastricht Economic and Social Research Institute on Innovation and Technology, specialise in research on service innovativeness and are experts involved in the preparation of a European report on the innovativeness of services. After 2000 Hollanders has been the author or co-author of more than 60 publications. He was also one of the initiators of, and participants in, research on the innovativeness of the service sector in the OECD (inter alia, Kanerva, & Hollanders, 2009). In turn, Gault coordinates the international cooperation in research on the innovativeness of service enterprises. The scope of his interest included, among others, sectoral innovativeness, including that of the aviation and tourism sectors.

Most of research on the assessment of the innovative activity of the service sector uses indicators defined and adopted by the OECD and applied to assess the innovativeness of the economies of the EU countries. It is important to note the Summary Innovation Index (SII) and the European Innovation Scoreboard (EIS). These are indices for which a methodology has been developed and their measurements have been carried out for a dozen years or so, enabling comparative assessments to be performed. The SII index is calculated on the basis of 25 sub-indices representing three areas of innovativeness (Hollanders et. al., 2014):

- enablers; this category includes the main drivers external to the enterprise which affect its innovation processes,
- firm activities; this category includes the areas related to the level of research and development outlays in the private sector, the number of patent rights granted to enterprises, the number of publications arising as a result of cooperation between the private and public sectors,
- innovation outputs, defined on the basis of sub-indices, representing the economic effects of the innovative solutions implemented. They include the number of enterprises which place innovative products on the market or apply innovative production methods, innovative marketing strategies or organisational arrangements, or indicators defining the employment at enterprises in the sectors considered to be innovative, the share of products from the high-tech technology sector in the trade balance, the revenues from the sales of licence and patent rights abroad and the employment in professions requiring expertise.

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The European Innovation Scoreboard (EIS) is an index which is also quite often used in the measurement of the innovativeness of the economy. The measurement distinguishes two areas (Kaźmierczak & Wilińska, 2010):

- the area reflecting expenditure on the innovative activity. The indicators in this area describe the innovation capability of the economy, i.e. its potential to create and commercialise innovations. The indicators distinguished in this area include those that measure financial resources, human resources and the environment which supports the innovative activity;
- the area which describes the results of the innovative activity. The indicators measure the effects of the combination of the creativity of society with financial resources in a specific economic and institutional environment. The measures include research on the areas of the effects of the research and innovative activities and commercialisation of knowledge.

The measurement of the innovativeness of services is a complex issue. On the one hand, most indicators used in official statistical research do not reflect the specificity of the service sector, and, on the other hand, the official indicators refer to the research on the level of the economies and are not suitable for the research on the level of sectors or individual fields, in particular service-based ones. This results from the fact that the research on the innovative activities of production organisations, individual sectors or fields can use statistical measures (e.g. the level of R&D expenditure, the number of patents and licences), while the absence of patents or separate research and development units in service enterprises makes it significantly difficult to assess their innovative activity.

Statistical offices in Poland try to unify the research on the innovativeness of services using statistical indicators, including, among others, those applied by the OECD. Consideration is given to the indicators of innovative activities, the types of innovations implemented and R&D expenditure. A drawback of this research is that the studies on service fields are limited to medium-sized and large enterprises. It is recognised that the problem related to the innovativeness of services arises from the fact that the set of indicators applied to measure innovativeness was originally developed for industrial sectors (Camison & Monfort-Mir, 2012). Given this, certain researchers (Lightfoot, & Gebauer, 2011) propose that the research on the innovativeness of the service sector should be separated from the research on the innovativeness of the production sector. This follows from the fact that the scores for the innovative activity for the whole service sector are underestimated in official statistics (Hollenstein, 2003).

2.2. Health tourism as a research area

The health tourism market based on health resort-based, spa & wellness, aesthetic medicine and medical services (Szymańska, 2015) develops dynamically as a result of the continuously increasing availability of the services listed above as well as cheap and fast means of transport. On the one hand, this relates to changing social needs and lifestyles. The change of lifestyles from passive rest to active one is based on the enhanced awareness of the significance of health in human life and, at the same time, the launch of actions to improve health and to regenerate the physical, mental and spiritual strength stressed by the technicised civilisational development. Active rest often entails preventive rehabilitation delivered by visits to health resorts or relaxing activities during visits at spa and wellness clinics, as well as in recent years even medical services. As a result, health improvement is the purpose of tourist travels and, at the same time, the basis for the development of the health tourism market. The demand for health services has become a global phenomenon related to economic growth, increasingly good education and enhanced revenues (Rudawska, 2009). On the other hand, significant changes can be seen in medicine. A wide offer of high-quality medical services is a response to the globalisation of health services (Lunt & Carrera, 2010; Morgan, 2010). Moreover, the causes of travels for health purposes are considered to include the availability of cheaper, alternative procedures conducted outside of the country of residence (Hazarika, 2010) and the unavailability of services in the country of residence, caused, among others, by procedural barriers to availability and long waiting lists (Burkett, 2007) (in particular, medical services). An important driver of the development of this market is also the incorrect health policy of countries, e.g. 47 million Americans live without health insurance (Amodeo, 2010) and it also results from the signing of multilateral intergovernmental agreements on medical care (Reismann, 2010). Moreover, medical services have gone beyond the traditional perception of medicine based on its healing functions, understood to mean helping those in need, to include modelling or aesthetic functions. Its broader meaning derives from a holistic and optimistic understanding of the term “health”, according to the World Health Organization (WHO, 2016) “a state of complete physical, mental and social well-being, ensuring a socially productive life in social, economic and mental terms, also in the spiritual dimension”. The actors on the health tourism market include not only persons suffering from specific disease symptoms, but also physically healthy persons who wish to change the everyday rhythm of their lives, to experience new challenges or to improve their current health condition. Because of the factors listed above health tourism already develops in more than 35 countries in the world (Amodeo, 2010). The main destination markets are the countries which can ensure care of foreign patients, easy and relatively cheap access to medical procedures, including

cardiological, orthopaedic, dental and plastic surgery procedures (Untii, 2009), as well as health resort-based or aesthetic medicine procedures. E.g. such countries as India, Singapore and Thailand have become world leaders in the field of medical tourism, to control more than 80% of the market (Newswire, 2012). Thailand specialises in aesthetic surgery or sex change, while Singapore attracts patients in the segment of advanced methods for the treatment of circulatory system diseases, neurosurgery or stem cell-based therapy (Newswire, 2012).

In conclusion, it can, therefore, be said that the health tourism market develops as it goes beyond the institutional boundaries in the cooperation between tourism and medicine.

2.3. Innovativeness of health tourism and its measurement

Similarly, the research on the innovativeness of the tourism services sector based on such indicators as research and development expenditure, the number of patents granted and the number of product innovations implemented can significantly underestimate the real effects of innovation processes in tourism (Sunbdo, Orfila-Sintes, & Sorensen, 2007). This results from the fact that the indicator of research and development expenditure is not applicable to tourism. The innovation process in these services is based on the creation of values and changes of behaviour and does not include research and development activities. The indicator of the number of patents granted is not applicable, either, since in tourism innovations in the form of industrial inventions represent very rare and single cases. The indicator of the number of product innovations implemented in the tourism sector is hardly identifiable. Innovations often take on the form of a chain and it is difficult to precisely separate product innovations from process ones. Moreover, to a large extent a new value is created in the field of marketing (Sunbdo, Orfila-Sintes, & Sorensen, 2007). The innovativeness of the tourism sector services has been explored only slightly (Szymańska, 2009; Hjalager, 2010; Camison & Monfort-Mir, 2012). Detailed research on the innovativeness of the tourism services indicates that this is a sector with a low innovativeness level (Hjalager, 2002); no research has been carried out, either, to analyse the factors which drive this negative result (Hjalager, 2009). It is believed that the indicator presented in official statistics, e.g. Community Innovation Surveys, often fails to represent the real status of the innovativeness of this sector (Camison & Monfort – Mir, 2012).

Research indicates that the situations where the institutional boundaries are crossed and demolished are a favourable environment for the creation of innovations (Garcia – Altes, 2005). Therefore, innovations in medicine contribute to the growth of tourism and new preferences in the field of tourism affect the search for medical products and their commercialisation. Thus, the development of medicine can be one of the drivers of tourism, while, medical innovativeness can be an indicator for the activities of enterprises operating on the tourism market (Hjalager, 2002). In addition, it is recognised that the innovation capabilities are much greater in larger tourism enterprises and those connected to the web and other horizontal groups (Hjalager, 2002).

The research on the innovativeness of health tourism has been carried since only recently by few researchers and included studies on the innovativeness of the market of health tourism and its forms (Hjalager, 2009; Szymańska, 2013; Szymańska, 2015; Panasiuk, Panfiluk, & Szymańska, 2016; Panfiluk, 2016.) In contrast, the innovativeness of the medical sector has been widely described, mainly in specialist medical journals and also in economic publications. A review of these issues was carried out, among others, in the *Report on the innovativeness of the medical sector in Poland* (2012). The American, Hungarian and French experiences can turn out to be particularly useful in this respect.

The measurement of the innovativeness of health tourism is particularly important given the fact that this is a new tourism segment whose services develop on the basis of two separate sectors, i.e. tourism and medicine. In this combination, the health tourism segment represents an innovative, specialised form of tourism which counteracts the effect of seasonality and contributes to the growth of the tourism movement. In consequence, it can significantly help stabilise the tourist demand out of season. In conclusion, a distinct shortage of scientific

publications on the innovativeness of health tourism should be noted. Therefore, the exploration of these issues is a pioneering challenge facing researchers.

The following research hypotheses were verified:

Hypothesis 1 - *The optimum measure of the involvement of providers of health tourism services in innovative activities is a separate budget earmarked for the implementation of innovations.*

Hypothesis 2 - *The optimum measure of the effects of innovations introduced is a higher number of commercial tourists using the services of a given enterprise.*

The Figure 1 shows the theoretical framework of the research.

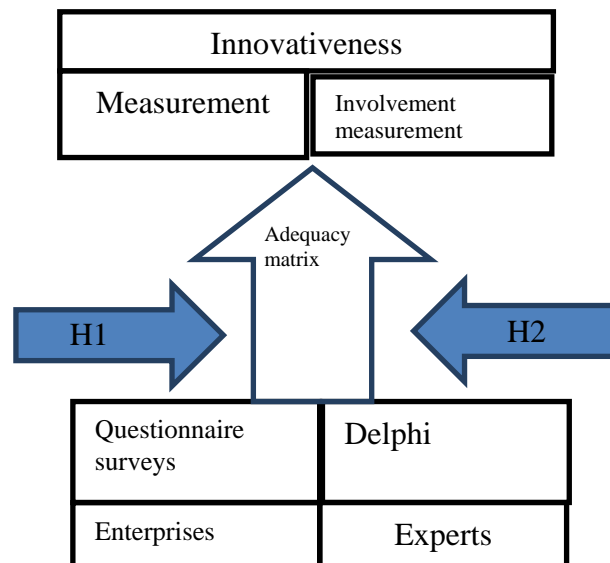


Fig. 1. Theoretical framework of research

3. Research methodology

In order to achieve the preset objectives and verify the hypotheses posed, two types of studies were carried out: qualitative and quantitative surveys. The Delphi and questionnaire methods, which were suitable in light of the research objectives, were applied (Fig. 1).

The respondents, the indicators of their measurement and their significance in the assessment of the innovative activity in health tourism services were identified using the Delphi expert method. The identified indicators were empirically verified by the questionnaire method using the technique of a diagnostic survey.

The application of the Delphi method enabled a synthesis of important knowledge (including undisclosed one) for a given subject (Popper, 2008). Delphi is one of the methods used in the foresight research also in the area of tourism management (Szpilko, 2016). The research was carried out in 2015 in three stages. At the first stage, the implementers' team formulated research theses based on a theoretical analysis of the research literature (Nazarko & Kononiuk, 2013). The second research stage involved the performance of the first round of the Delphi process using electronic CAWI forms. 12 experts representing a field of economic sciences and having scientific achievements in the scope of innovation and the economics of tourism, including health tourism, were invited to

take part in the research. The experts included practitioners. At the third stage, the experts received a form which contained in graphic form the summary results of the first round. In the second round of the survey, the experts could change their minds on a given subject, marking a new answer or reiterating the previous one. As a result of this survey, a set 12 measures was recommended for measuring the innovativeness of health tourism, including: 5 measures of the actions for innovation and 7 measures of the assessment of the innovative actions taken. Moreover, a complementary objective of the Delphi survey was the identification, based on the scientific literature, of the types of providers of health tourism services which must be taken into account in the research on the innovativeness of this sector.

The health tourism providers operating in Poland were empirically verified by the method of a diagnostic survey. In order to determine the size of the research sample, the experts indicated four groups of entities according to the Polish Classification of Activities (PKD, 2014): a) hospitals, physicians' offices (medical practice), the other activities in the scope of health care (excluding providers of health resort-based services), social assistance with accommodation and ensuring a nurse's care, b) health resorts and health resort-based treatment facilities, c) hotels and similar accommodation facilities providing spa & wellness services, d) the activities of travel agencies and intermediaries as well as tour operators.

The size of the investigated population was determined on the basis of data from the Local Data Bank (BDL, 2014) as 241,393 entities. The size of the representative sample was calculated using the calculator of the research sample. The following parameters were adopted for calculating the size of the investigated sample: the confidence level: 0.95, the population size: 241,393, the expected fraction size: 0.5 and the maximum error: 0.05. As a result of the calculations, the minimum sample size was determined as 384 entities.

The research was carried out using a survey questionnaire as a tool in the period from November 2015 to March 2016. Two techniques were applied to collect data: CAWI[†] and CATI[‡]. Following negative verification, 446 entities were ultimately subjected to the research. The most numerous group among respondents consisted of outpatient clinics, private doctors' offices and hospitals (47% respondents). Accommodation facilities providing spa and/or wellness procedures (23%) as well as tour operators and travel agencies and intermediaries (21%) represented a more than twice as small a group. The least numerous respondents' group consisted of health resorts and health resort-based hospitals (9%).

The results obtained were analysed and assessed in accordance with the research questions presented in the Introduction. The analysis was carried out in a structural approach (the frequency of occurrence). The results obtained were compared using an adequacy matrix. An adequacy matrix is a graphic and tabular tool applied to present dependencies. The present study presents the theoretical and empirical dependencies in the scope of the measurement of the innovativeness of enterprises and the effects of their innovative activities. The graphic and tabular form of the presentation of results shows, on the one hand, the measures of the innovativeness of health tourism recommended by experts and, on the other hand, the empirical results of the measures applied by

[†] At the first stage of the research, 35,000 e-mail addresses were purchased and the link to the questionnaire placed after the link ankietka.pl was distributed, 51 questionnaires were returned until 31 December 2015.

[‡] A telephone interview was carried out by trained interviewers, the students of the Tourism and Recreation 1st degree studies, semester IV, at the Management Faculty of the Białystok University of Technology. In the course of the interview, the interviewers recorded the answers in the paper version of the questionnaire. After the interview had been carried out the interviewers recorded the results of the questionnaire in the CAWI version. In the course of the interviews, part of respondents expressed their willingness to fill in the questionnaire on their own in the CAWI version. The CAWI version was filled in by a total of 37 entities. As a result of a telephone interview, 373 questionnaires were acquired (representing a return rate of 10%).

providers of health tourism services. The data are presented in a coordinate system where the vertical axis represents the values of the recommended indicators, while the horizontal axis shows the values of the applied indicators. The variable adopted in the theoretical and empirical analysis of the measures and their hierarchisation are the indications from the particular groups of respondents: experts and entrepreneurs. In designing the adequacy matrix, the recommended indicators were placed on the theoretical side, while the indicators implemented in enterprises were featured on the empirical side. In its graphic form, the adequacy matrix is a plot where two axes represent, respectively, the effect of recommendation and the effect of implementation. In turn, in its tabular form, it is a matrix with the dimensions of 3x3 areas which distinguishes three scoring levels of the recommended indicators, i.e. those with low, average and high theoretical significance for the research on the innovativeness of enterprises, and three scoring levels of the recommended indicators, i.e. those with low, medium and high application levels. In order to determine the boundaries between the particular levels, the following values were adopted for the external boundaries: the minimum number of indications (in %) and the maximum of indications (in %), while for the internal boundaries: the average value minus the standard deviation and the average value plus the standard deviation (Fig. 2).

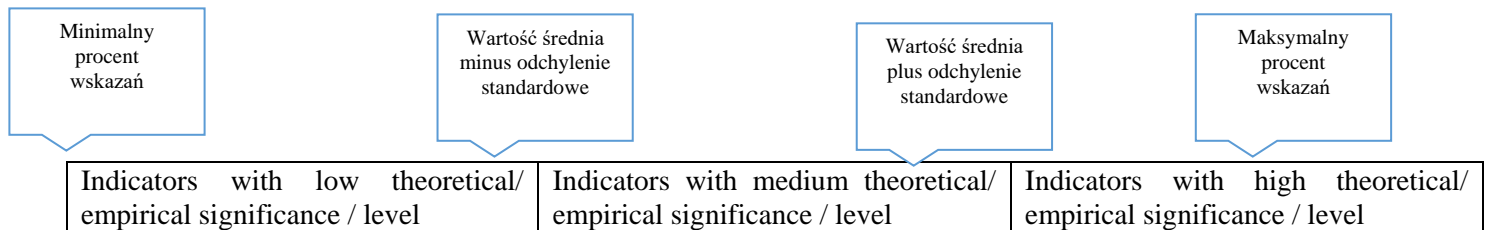


Fig 2. The boundaries between the theoretical and empirical levels in the tabular matrix

Source: K. Dębkowska, W. Zalewski (2011). Wielowymiarowa analiza poziomu ubóstwa powiatów województwa podlaskiego [Multivariate analysis of poverty of the Podlaskie province districts. *Ekonomia i Zarządzanie*. Vol. 3, 7-16.

Figure 2 shows the three basic areas which represent the research results. The first area contains indicators with low significance for a given independent variable. In this research, this variable is innovativeness. These indicators are characterised by the minimum percentage of indications. The next area contains indicators with medium significance, calculated on the basis of the difference between the average value and the standard deviation. The last, most important area of the matrix shows indicators with high significance for the independent variable, falling between the average value plus the standard deviation and the maximum percentage of indications. The template of the tabular matrix is illustrated below.

Table 1. The template of the tabular matrix

Indicators with high significance	I C	II C	III C
Indicators with medium significance	I B	II B	III B
Indicators with low significance	I A	II A	III A
	Indicators with low application level	Indicators with medium level	Indicators with high application level

Source: Own work.

The nine-field matrix enables the identification of three types of indicators serving to investigate innovativeness, distinguishing between the recommended indicators and those implemented by enterprises. These are indicator types which indicate:

- high theoretical and empirical balance (the fields marked with the lightest colour: I A; II B; III C);
- medium theoretical and empirical balance (the fields marked with a light grey colour: I B; II A; II C; III B);
- low theoretical and empirical balance (the fields marked with a dark grey colour: I C; IIIA).

A high theoretical and empirical balance occurs when the significance of a recommended indicator assessed on a 3-point scale adequately corresponds to the same application level.

This relates to the situations in which the low significance of the recommended indicator is balanced by the low application level of the applied indicator, the medium significance of the recommended indicator is balanced by the medium application level and the recommended indicators with high significance are balanced by the high application level. The situation which occurs here is the one where the recommended indicators are implemented

by enterprises. This means that these indicators can be used for the general measurement of the level of innovativeness of enterprises. However, a high level of recommendation and application of the indicator applied is most desirable.

A low theoretical and empirical balance occurs in the extreme situations in which the recommended indicators with high significance are used at a low application level and, conversely, the recommended indicators with low significance are used at a high application level. In the former of the cases analysed here, the action strategy should consist in encouraging enterprises to use them. In the latter situation, the action strategy should consist in encouraging enterprises to give up the indicators with low significance for the research on the innovativeness of enterprises. A medium theoretical and empirical balance occurs in the remaining cases of relationships between recommended and applied indicators, as shown in the matrix.

The adequacy matrix is used to investigate the theoretical and empirical correlations between the indicators for the measurement of the involvement of enterprises in innovative activities and to examine the level of their application at enterprises. 5 indicators to choose from were proposed here. The adequacy matrix is used to investigate the theoretical and empirical correlation between the indicators of the assessment of enterprises' innovative activities and also to show their application in practice by entities in their assessment of enterprises' innovative activities. Here, the experts adopted 7 categories of indicators.

In the present research, two types of adequacy matrices were elaborated (in graphic and tabular forms) for the two abovementioned types of indicators for the measurement of the innovativeness of health tourism services. They were:

- the indicators for the measurement of the involvement of enterprises in innovative activities (5 categories of indicators),
- the indicators of the assessment of the effects of enterprises' innovative activities (7 categories of indicators).

The research covered innovative activities carried out for 3 years, i.e. in the period from 2013 to 2015.

4. Research results and findings

4.1. The involvement of enterprises in innovative activities

The adequacy matrix elaborated for the measurement of the involvement of enterprises in innovative activities contained five categories, specifically:

- the elaboration of the development strategy providing for innovations;
- the expenditure on the implementation of own research and development work;
- a special budget for the implementation of innovations;
- the financial resources for training recalculated per employee in a year;
- the establishment of a work post / unit responsible for the collection of market information.

Fig. 3 shows the results obtained for one of the preset objectives (C1) and the first hypothesis (H1).

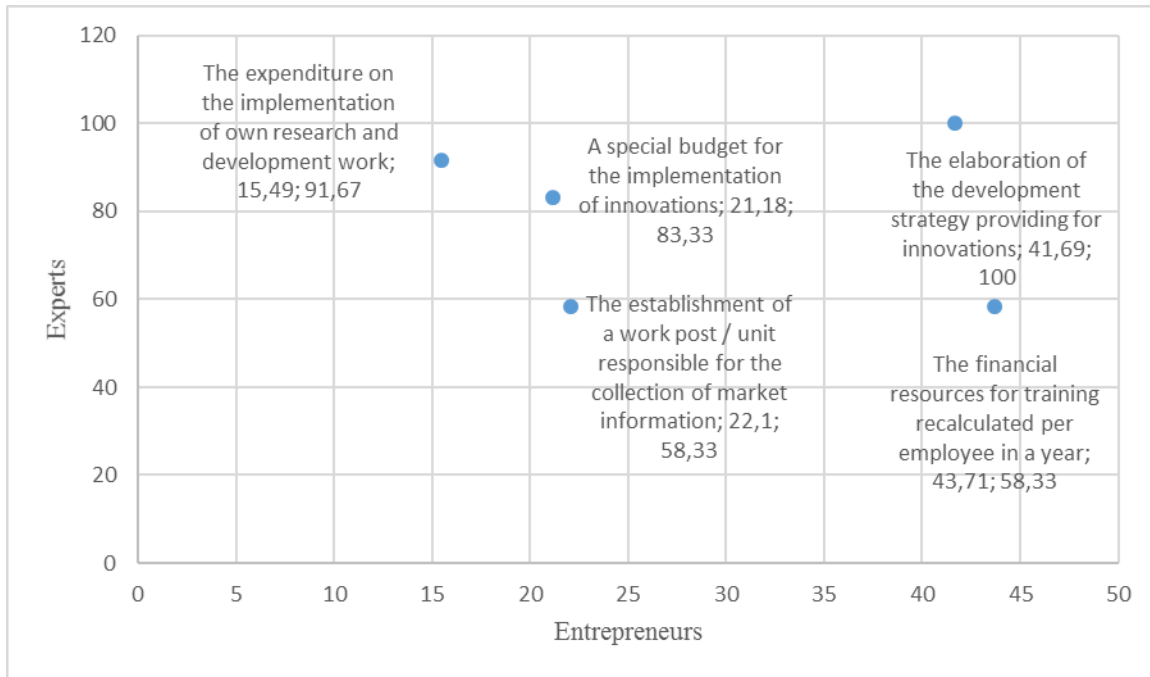


Figure 3. A graphic theoretical and empirical adequacy matrix of the indicators for the measurement of the involvement of providers of health tourism services in innovative activities

Source: Own elaboration based on the results of quantitative (questionnaire) and qualitative (Delphi) surveys.

In the experts' opinion, in the research on the innovativeness of health tourism enterprises the following was significant for the measurement of the involvement of enterprises in innovative activities: the elaboration of the development strategy providing for innovations (100% of indications), a separate special budget for the implementation of innovations (83.33%) and the expenditure on the implementation of research and development work (91.67%). The indicators: the financial resources for training recalculated per employee in a year (58.33%) and the establishment of a separate work post / unit responsible for the collection of market information (58.33%) were slightly less significant.

It followed from the respondents' statements that in the period from 2013 to 2015 innovations were implemented by 359 entities, representing 82% of the investigated entities. 152 respondents (i.e. 35%) admitted that they did not apply any indicators for the measurement of innovativeness. In the remaining group of enterprises, 44% had separate financial resources for employee training and 42% of entities had their development strategies providing for innovations. Every fifth investigated entity (22.18%) had a separate work post or unit responsible for the collection of market information and a separate special budget for the implementation of innovations. The smallest number of entities (15.49%) reported their expenditure on the implementation of own research and development work.

The detailed results of the research shown in Fig. 3 are presented in the tabular matrix below (Table 2).

Table 2. A tabular theoretical and empirical adequacy matrix of the indicators for the measurement of the involvement of enterprises in innovative activities

Theoretical recommendations

Max. 100

97.52	Indicators with high significance		The elaboration of the development strategy providing for innovations	
59.14	Indicators with medium significance	The expenditure on the implementation of own research and development work	A special budget for the implementation of innovations	
Min. 58.33	Indicators with low significance		The establishment of a work post responsible for the collection of market information	The financial resources for training recalculated per employee in a year
		Indicators with low application level	Indicators with medium application level	Indicators with high application level
	Min. 15.49	15.90	41.77	Max. 43.74

Empirical results

Source: Own elaboration based on the results of quantitative (questionnaire) and qualitative (Delphi) surveys.

The application of the matrix indicated that the measure of a special budget for the implementation of innovations demonstrated a high theoretical and empirical balance, although it had medium significance for the measurement of innovative activities. A medium theoretical and empirical balance was demonstrated by the indicators of the elaboration of the development strategy providing for innovations, the expenditure on the implementation of own research and development work and the establishment of a work post / unit responsible for the collection of market information. In the experts' opinion, the indicator of the elaboration of the development strategy providing for innovations had high significance for the measurement of innovativeness and a medium application level. In the experts' opinion, the indicator of the expenditure on the implementation of own research and development work had medium significance for the measurement of innovative activities and a low application level. In the experts' opinion, the establishment of a work post responsible for the collection of market information had low significance for the measurement of innovative activities and a medium application level. A low theoretical and empirical balance was demonstrated by the indicator of the financial resources for training recalculated per employee in a year and was characterised, at the same time, by low significance for the measurement of innovative activities. In market realities, it was applied relatively often and its application level was high.

4.2. The assessment of the innovative activities of enterprises

Another investigated area was the assessment of the innovative activities of the surveyed enterprises. The adequacy matrix elaborated for the assessment of the effects of enterprises' innovative activities contained seven categories of indicators (Fig. 4):

- employees' higher productivity;
- lower costs of the provision of services;
- the registration of a trade name or trade mark;
- higher revenues from the sales of services;
- the limitation of the seasonality of tourism;

- a higher number of tourists visiting a given area in a year.

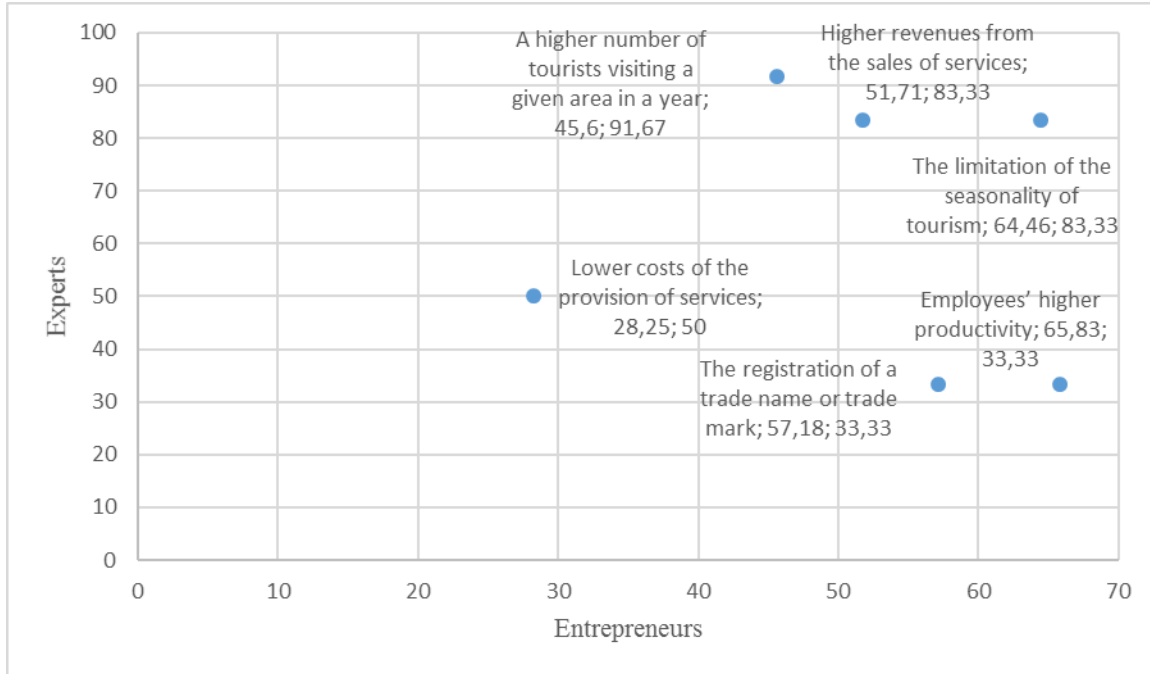


Fig. 4. A theoretical and empirical adequacy matrix of the assessment of the effects of innovative activities at providers of health tourism services

Source: Own elaboration based on the results of quantitative (questionnaire) and qualitative (Delphi) surveys.

In the experts' opinion (Fig. 4), the indicators with high significance for the measurement of the effects of innovative activities carried out by health tourism enterprises included the following indicators: a higher number of tourists visiting a given area in a year (91.67% of indications), higher revenues from the sales of services (83.33% of indications) and the limitation of the seasonality of tourism (83.33%). The experts recognised that such indicators as the registration of a trade name or trade mark (66.67% of indications each), lower costs of the provision of services (50.00% of indications) and employees' higher productivity (33.33% of indications) had slightly lower significance for the measurement of the effects of innovative activities.

Entrepreneurs' opinions did not always coincide with practice. Empirical studies showed that enterprises assessed the effects of the innovative activities implemented on the basis of the following measures: a higher number of tourists visiting a given area in a year (45.6%), higher revenues from the sales of services (64.46%), the limitation of the seasonality of tourism (51.71%), the registration of a trade name or trade mark (66.67% of indications), lower costs of the provision of services (28.5% of indications) and employees' higher productivity (65.83% of indications). Detailed results are shown in Table 3.

Table 3. A tabular theoretical and empirical adequacy matrix for the balancing of the assessment of the effects of the innovative activities carried out at the examined enterprises.

Theoretical recommendations

Max. 91.67

89.67	Indicators with high significance		A higher number of tourists visiting a given area in a year	
	Indicators with medium significance	Lower costs of the provision of services	The registration of the trade name or trade mark, the limitation of the seasonality of tourism	Higher revenues from the sales of services
45.44	Indicators with low significance		Employees' higher productivity	
Min. 33.33		Indicators with low application level	Indicators with medium application level	Indicators with high application level
Min. 28.25		38.18	64.16	Max. 65.83

Empirical results

Source: Own elaboration based on the results of quantitative (questionnaire) and qualitative (Delphi) surveys.

Using a theoretical and empirical adequacy matrix in tabular form, it was found that such factors as the registration of a trade name or trade mark and the limitation of the seasonality of tourism demonstrated a high theoretical and empirical balance. They had medium significance for the measurement of the effects of innovative activities. A medium theoretical and empirical balance was demonstrated by all the other investigated measures, i.e. a higher number of tourists visiting a given area in a year, lower costs of the provision of services, employees' higher productivity and higher revenues from the sales of services. In turn, in the experts' opinion, a higher number of tourists visiting a given area in a year had high significance for the measurement of the effects of innovation, although in practice its application level was a medium one. In the experts' opinion, another factor, specifically: lower costs of the provision of services, had medium significance for the measurement of the effects of innovative activities, while, at the same time, its application level was a low one. In the experts' opinion, still another factor, i.e. higher revenues from the sales of services, had medium significance for the measurement of the effects of innovative activities, although its application level was a high one. In the experts' opinion, the last of the measures considered, i.e. employees' higher productivity, had low significance for the measurement of the effects of innovative activities, with a medium level of its application by enterprises (Table 3).

5. Limitations, discussion and conclusion and recommendations

Based on the research results, recommendations can be drawn up and objectives can be laid down for monitoring the innovation policy of health tourism.

5.1 Limitations

In the course of the research certain limitations occurred. They were caused by the need to formulate the drivers (measures) of innovativeness which were patterned on the previous studies, mainly dealing with service enterprises. Given that this research is *in statu nascendi*, other, more precise groups of indicators should be added to the proposed two groups of them. Action should be launched to assess customers' opinions on the innovations introduced.

5.2 Discussion

In accordance with expectations, as a result of the research on the innovativeness of health tourism, the financial effects gained by introducing innovations turn out to be most important among the measures of the effects of this activity. Our research confirmed the thesis put forth by Sundbo, Orfila-Sintes, & Sorensen (2007) that the innovativeness of the tourism services sector should not be assessed on the basis of such indicators as the expenditure on the implementation of own research and development work and the number of patents granted. Instead, more detailed research should assess innovations in terms of linkages (processes) in chain form.

In turn, it is difficult to agree with Hjalager (2002) that tourism services, in particular providers of health tourism, represent a low level of innovativeness; quite on the contrary, since 82% respondents implemented innovations over 2 years.

The research is novel in character; therefore, undoubtedly one needs to agree with the opinions of Szymańska (2009) that the issues of innovativeness of health tourism has been explored only slightly.

The results of the present research confirm the earlier conclusions of Garcia-Altes (2005) that the combination of tourism and medicine, i.e. activities going beyond sectoral boundaries, are a favourable environment for creating innovations.

5.3 Conclusions

As a result of the implementation of the present research, the main goal and detailed objectives were achieved. The measures of the assessment of the level of the involvement of providers of entities in innovative activities as well as the measures of the assessment of the effects of innovative activities were identified.

Hypothesis (H1), providing that the optimum measure of the involvement of providers of health tourism services in innovative activities is a separate budget earmarked for the implementation of innovations, was verified negatively. It had medium significance for the measurement of the drivers of enterprises' innovative activities, although the experts recommended its use. In contrast, the other hypothesis (H2), indicating a higher number of commercial tourists as the best measure of the effect of the innovations implemented, was confirmed.

The application of an adequacy matrix enabled the experts' opinions to be confronted with market realities in respect of the innovativeness of providers of health tourism services. Using the matrix important conclusions could be drawn. First of all, the elaboration of the development strategy providing for innovations was a measure with high significance. And although it was recommended by the experts for the measurement of the drivers of innovative activities, it was not implemented correctly by enterprises.

Three measures should be applied in the measurement of the effects of innovative activities:

- the limitation of the seasonality of tourism. The recommended indicator was correctly implemented by enterprises. It had medium significance for the measurement of the effects of innovative activities;
- the registration of a trade name or trade mark. The recommended indicator was correctly implemented by enterprises. It had medium significance for the measurement of the effects of innovative activities;
- a higher number of tourists visiting a given area in a year. This was an indicator with high significance for the measurement of the effects of innovative activities. The recommended indicator was not correctly implemented by enterprises.

5.4 Recommendations

Two measures of the involvement of entities in innovative activities should particularly be recommended for further research on innovativeness:

- the elaboration of the development strategy providing for innovations;
- the separation of a special budget for the implementation of innovations.

In the category of the assessment of the effects of enterprises' innovative activities, the following measures are recommended:

- the limitation of the seasonality of tourism;
- a higher number of tourists visiting a given area in a year;
- the registration of a trade name or trade mark.

In the scope of the monitoring of the innovation policy of health tourism, it is recommended that support should be given to the elaboration of the development strategies providing for innovations and enterprises should be encouraged to prepare and implement them.

In conclusion, it should be recognised that the research results make a contribution to economic sciences, particularly to innovation theory and innovation management. Given the specific results which it proved possible to formulate, they should be applied in economic practice by providers of health tourism services when they implement

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ON SUSTAINABLE PRODUCTION NETWORKS FOR INDUSTRY 4.0*

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Abstract. Re-industrialization enjoys a renaissance in Western economies due to the role of the industrial sector for innovation, productivity, and job creation. A very promising approach to bring back competitiveness in production seems to be the fusion of the virtual and the real world leading to smart manufacturing and logistics concepts. In Germany, the leading industrial country in the European Union this approach has been called “Industry 4.0” aiming to develop cyber-physical systems (CPS) and dynamic production networks in order to achieve flexible and open value chains in manufacturing of complex mass customization products in small series.

Currently, manufacturing companies gaining experiences in production in networks and smart logistics and develop new organisational structures and business models which better benefit from the new technologies and which adapt faster to the rapidly changing network environments. The modern manufacturing models embrace modular and fractal approaches as well as network-orientation, flexibility and responsiveness.

The paper investigates the relationship between networking, organizational development, structural frame conditions and sustainability in the context of Industry 4.0. The research is empirically validated by using data samples from a business reengineering project in an internationally operating high-tech manufacturing enterprise located in Estonia. The empiric analysis is based on semi-structured expert interviews and secondary data together with a case study approach.

Keywords: modular factory, Industry 4.0, production in network, fractals, sustainability

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1. Introduction

Within the last years, many initiatives towards smart manufacturing have been started all over the world in order to re-establishing and regaining a significant industrial share in the economy (Tvaronavičienė 2014; Travkina, Tvaronavičienė 2015; Prause 2015). A promising concept is the fusion of the virtual and the real worlds of manufacturing to realise concepts for smart manufacturing and logistics by using cyber-physical systems (CPS)

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together with dynamic production networks in order to achieve flexible and open value chains for complex mass customization products. The Germany interpretation of smart production, Industry 4.0, goes even beyond these objectives by additionally tackling energy and resource efficiency, increasing productivity as well as shortening innovation and time-to-market cycles (Kagermann et al. 2013). Internet-based linked machine-to-machine-interaction paves the way to networked manufacturing systems and cross-company production processes which shall enable the design and control of the entire supply chain of a product during its full life time (Bauer et al. 2014; Brettel et al. 2014).

By scanning the scene of already existing production structures which might be compatible with Industry 4.0, literature review reveals modular and fractal approaches as well as networked production concepts. Current research results on Industry 4.0 highlight that modular or fractal company concepts together with new business models for smart supply chain management might be suitable even for the integration of the SME sector (Olaniyi, Reidolf 2015; Prause 2015, 2016). Historically, Wildemann (1988) brought modular production structures into the academic discussion by stressing the intra-company view whereas Sturgeon (2002) focussed more on cross-company value chains by considering modular production networks by investigating market similar relations between designers and integrators on one side and contract manufacturers on the other side. In the case of US American contract manufacturers Lüthje et al. (2002) pointed out that these system suppliers realised scale benefits by working for different integrators at the same time. Within the concept of modular production networks the integration of different companies into a united production process are already stipulated. A cognate construction of integrating independent business units into common production processes was also coined by Warnecke (1996) in his visionary concept of a fractal enterprise for modern operations management which emphasised self-similarity, self-organization, self-optimization, goal-orientation, and dynamics as winning attributes of flexible and adaptable manufacturing organizations.

All mentioned concepts embrace intrapreneurship and entrepreneurship issues as important success factor since the underlying organizational units of a common, cross-company production process have to be able to decide and behave entrepreneurially in accordance with their self-organisation and self-optimisation objectives. Both Warnecke (1996) as well as Canavesio and Martinez (2007) stressed for manufacturing fractals the importance of a flexible relationship network made up of autonomous, but interdependent manufacturing fragments into the organizational structure which are usually linked via ICT systems. For modular or fractal production networks the importance of the entrepreneurial dimension is self-evident due to the legally independent company units in the case of modular production networks but also for the intra-company structures of modular production intrapreneurial aspects play a more important role (Wildemann 1988; Sturgeon 2002). Altogether, the modular and fractal approaches are capable to realise highly complex patterns for manufacturing that merges all the enterprise functions of an integrated organisation to improving the speed of operations and the ability to adapt quickly to changes in the environment (Shin et al. 2009).

As an important case Sydow and Möllering (2015) depicted the “Smart” car production plant of Daimler-Benz in Hambach (France) for modular structuring in the context of a production network. The Hambach plant enjoys a very small production depth of only 10% and it is organised in such a way that the supplying system partners install their delivered components or modules with their own workforce directly into the Smart car during the assembly process. Such a networked production process with modular or fractal structural components will be investigated and discussed in this paper in accordance with the already mentioned concepts we will call such structures a networked modular factory (Olaniyi, Reidolf 2015; Prause 2015).

Until now, only little research has been carried out on the sustainability of production networks in the context of Industry 4.0. The literature review of existing sustainable business and network structures together with their frame conditions in the context of Industry 4.0 indicates a research gap. For this reason, the paper addresses the

research questions of how sustainable production networks and their frame conditions for Industry 4.0 might look like and how the intrapreneurial and entrepreneurial environment influences the success of networked production structures.

The paper is subdivided into the following parts. First part provides the theoretical background for modular and fractal production networks in the context of Industry 4.0 with an emphasis on entrepreneurship issues. Afterwards, the research methodology for the empirical part is described. Subsequently, the empirical results of the case studies and the conducted expert interviews are presented and discussed. Finally, the paper finishes with conclusions.

2. Theoretical background

Industry 4.0 seems to be one of the most promising concepts to spur re-industrialisation and industrial competitiveness in EU countries. Germany as the most important industrial European country aims with the implementation of Industry 4.0 for the development of cyber-physical systems and dynamic production networks in order to achieve flexible and open value chains coping with mass customisation products in small series up to lot size 1. But Industry 4.0 also targets on energy and resource efficiency, the shortening of innovation and time-to-market cycles, as well as on the rise of productivity. In this sense, Industry 4.0 represents nothing less than the fourth industrial revolution, comprising 3D printing, big data, Internet of Things and Internet of Services, i.e. all the ingredients needed to facilitate smart manufacturing and logistics processes (Kagermann et al. 2013).

The implementation of Industry 4.0 leads to new supply chain paradigms based on complex and intertwined manufacturing networks with changed roles of designers, physical product suppliers, clients and logistics service providers making it possible to identify and to trace single products during their entire life-cycle. As a consequence, Industry 4.0 will enable products to organise and find their own way through the production processes and the final distribution channels to the client based on open, dynamic and smart production and logistics networks (Bauer et al. 2014). Despite the fact that Industry 4.0 aims for horizontal integration, Industry 4.0-related value chains will take place in complex and intertwined manufacturing networks where the underlying supply chains can be characterized by a high degree of fragmentation (Dujin et al. 2014). This fragmentation lowers the entry barriers for SMEs and opens up new R&D strategies in multinational value chains and the creation of new business models (Belussi, Sedita 2010; Prause 2015).

The organisational aspects of fragmented value and supply chains have been discussed intensively in literature. Wildemann (1988) studied modular structures by concentrating more on intra-company production by emphasising the client focus. Sturgeon (2002) discussed modular production networks and the relationships between the corporate entities consisting of designers, integrators and contract manufacturers. Lüthje et al. (2002) analysed the case study of an US American contract manufacturers and highlighted that these system suppliers were able to realise scale benefits by cooperating with different integrators parallel. Another, but close concept was coined by Warnecke (1996) with his operations management model of a fractal enterprise which emphasised self-similarity, self-organization, self-optimization, goal-orientation, and dynamics as winning attributes of flexible and adaptable manufacturing organizations. Olaniyi and Reidolf (2015) pointed out the compatibility of fractal structures with Industry 4.0 by highlighting the ability for self-organization, self-optimization, goal-orientation, and dynamics as success factors. But all concepts dedicate large attention to disposition, decision making and innovation.

Pinchot (1984) introduced the term intrapreneurship and defined intrapreneurs as "Those who take hands-on responsibility for creating innovation of any kind, within a business". Most scholars have investigated research questions how managers and employees could be inspired to behave entrepreneurially, to create innovations, to obtain profit and growth through these innovations and to foster the creation of new businesses within existing

organizational framework (Burgelman, 1983; Zahra 1993; Brazeal 1993; Bowman 1999; Sathe 2003; Rezk et al. 2016).

In this understanding intrapreneurship refers to initiatives of employees in organizations to undertake something new, i.e. the intrapreneur uses innovation and creativity to transform an idea into a profitable venture within an organizational environment so that an intrapreneur can be considered as an “inside entrepreneur” who follows the objectives of his organization.

In his modern concept of a lean startup Eric Ries (2011) investigates companies that are both more capital efficient and that leverage human creativity more effectively. His lean entrepreneurship approach is inspired by the lean manufacturing concept of Toyota and aims to reduce wasted time on creating elaborate business plans and instead to more rely on testing visions continuously, to adapt and adjust “validated learning,” rapid scientific experimentation, as well as using practices to shorten product development cycles and measure actual progress (Womack, Jones 1996). Thus, the lean start-up approach enables a company to shift directions with agility and to alter plans step by step. In the interpretation of Eisenmann et al. (2012) lean start-ups represent companies that follow a hypothesis-driven approach to evaluating entrepreneurial opportunity, i.e. the entrepreneur in a lean start-up translates his vision into falsifiable business model hypotheses, and then tests the hypotheses in series of "minimum viable products" which represent the smallest set of features needed to validate empirically a concept. On the base of the test feedback the entrepreneur has then to decide if he wants to stick to their business model by modifying some business model elements or to abandon the start-up. By doing so the lean start-up approach evaluates the entrepreneurial opportunities in an evolutionary way by mitigating cognitive biases that lead to bad decisions.

Until now literature review reveals that the lean entrepreneurial concept has not been adapted to intrapreneurship. Besides that, the lean start-up approach embraces characteristics of agility which is atypical for lean manufacturing concepts since the evolution from lean manufacturing to the younger agile and responsive production concepts was mainly initiated by a changing manufacturing focus towards flexibility and responsive supply chains in order to be able to cope with the needs of mass-customization (Maskell 1994; Womack, Jones 1996; Christopher 2000). But the realisation of agility requires dynamic capabilities together with an organisational slack which comes along with a higher level of entrepreneurial and intrapreneurial freedom for the involved employees and teams. (Cyert, March 1963, Teece et al. 1997; Brown et al. 2000; Sydow, Möllering 2015). Consequently, the lean entrepreneurship or intrapreneurship approach fits well with agile and responsive manufacturing concepts despite the conflicts between lean manufacturing and agile or responsive production in the context of supply chain models.

Beyond that, current research point out the importance of intrapreneurial and entrepreneurial capacity in the context of Industry 4.0 due to self-organisation and self-optimisation needs of the underlying organizational units for their business success in a dynamic and open production network environment (Olaniyi and Reidolf, 2015; Prause, 2015, 2016; Atari, Prause, 2017). The fragmentation of Industry 4.0 – value chains facilitate the integration of SMEs into fractal and modular manufacturing organisations since they offer solutions for the agile work of SMEs as virtual entities in the network in cooperation with much bigger and grounded enterprises since those organisations are designed to combine the logistic attributes of manufacturing with the strategic configuration of agile capabilities (Panetto, Molina 2008; Raye 2012). Especially, the fractals concept gives room for the integration of information and manufacturing structures which facilitates to cooperate and to optimise the resource allocation (Panetto, Molina 2008; Shin et al. 2009). Such networked approaches require less supervision which amplifies the freedom for intrapreneurial and entrepreneurial activities for the employees in the fractals and modules and consequently the control is less complicated and more easily understood (Ryu et al. 2003).

3. Methodology and case study

Primarily, the research used a qualitative approach to the problem solving. Nevertheless, the research employed practices of both qualitative and quantitative research, i.e. both forms of data were collected at the same time during 2016 and then integrated the information in the interpretation of the overall results. The research methodology was based on a mixed exploratory approach by using qualitative case study methods together with semi-structured expert interviews as well as quantitative analysis of internal business process data. Additionally, other field methods such as observations were combined quantitative assessments. The empiric measures concern the Estonian production plant of an international operating high-tech company which headquarter is based in Scandinavia. The research was conducted during in the packaging department in Tallinn during a business process reengineering project in the company which was initiated by the management of an Estonian production plant in order to improve performance.

The Estonian production plant started in the 1990ies when Estonia became independent from Soviet Union. Most of the products manufactured in Tallinn plant are delivering to the target market's customers located in Eastern Europe and Central Asia. A couple of years ago the company faced economic and political recession which had a negative impact and it causes the rapid decrease in production. Consequently, the company started downsizing plans accompanied by the introduction of lean concepts in order to cut costs and to avoid losses. The business reengineering activities also touched the packaging department of the Estonian where the first decision of the management at the beginning of the costs cutting activities in the packaging department was dedicated to downsize the packaging unit by reducing the space and man power for completing the packaging cycle and the inventory.

After the economic situation recovered the management of the Estonian production plant had to react on increasing incoming orders despite the fact that the full implementation of the lean management concept has been only partly realised comprising a Kanban system, just-in-time logistics and Kaizen events but unfortunately no lean culture with a corresponding mind set of the workers has been developed at this time. Nevertheless, since the handling of the incoming orders needed more space that was not available space in the vicinity of the factory the management decided to outsource parts of the production processes including the packaging activities. Since the Scandinavian headquarters of the Estonian production company decided to re-establish only those business units in Estonia which are needed for the delivery of products to the customers, important business units were no longer available in the Estonian packaging department including the packaging design part which existed only once as a central packaging design unit in the headquarters.

Consequently, three new partner companies for logistics and the completion of the packaging cycle were contracted for Estonia in order to form a new packaging department realising a networked modular enterprise for consisting of four different company units, namely the packaging department of the Estonian production plant itself, the subunit of the global logistics service provider and the three Scandinavian packaging materials suppliers which are integrated into the supply chain in a form of cooperative engineering partners for packaging providing more than 90% of the complete packaging solutions. The global logistics service provider is fully independent of the Scandinavian company and has its headquarters in Germany whereas the three packaging materials suppliers also have their headquarters in Scandinavia and during later the expert interviews it turned out that the two packaging material suppliers are linked together with the production company by cross-ownerships via a Scandinavian financial holding.

The packaging process can be described so that the unpacked final products come from the manufacturing site into the residual packaging line of the plant where they are prepacked in form of a single shrink pallet. For the finalisation of the packaging they are transferred with the help of an inbound logistic supplier to the packaging production area of a subcontractor not far away from the production site where the packaging process is

completed. In this construction all autonomous business units of the four involved companies are acting together in an operations network which is linked by the operations process of packaging and where the operations within the integrated process are realised by own company employees comparable to the modular company concept of the “Smart” car production in Hambach (Sydow, Möllering 2015).

Unlike the situation in Hambach the packaging process blueprints an organisational form of a strongly structured with standardised and uniform tasks so that the networked modular packaging can be considered as an assembly process without variants. Nevertheless, all included business units in the packaging process are realising their own contributions with their own workers so that from outside the construction looks like a virtual company and by considering the inner structure together with the discussed literature the networked packaging company can be characterised as being fractal or modular. By comparing the underling business structure to concepts of Industry 4.0 it turns out that no flexible network of autonomous operations units exists and also the cyber-physical manufacturing systems instead of workers is missing. Thus, the full dynamics of an Industry 4.0 – production network is not entirely realised in the case study because the products are not finding their own way through the network and the production process is still strongly prescribed. Nevertheless, the modular packaging company might be considered as a pre-Industry 4.0 production structure and solutions concerning sustainability and the performance shall be discussed in the sequel.

The implementation of the modular networked packaging enterprise delivered a running stable solution and the construction had the advantage that it avoided a duplication of business units. But at the same time another problem appeared all process modifications in the Estonian plant needed to be negotiated and approved in the central design unit in the headquarters which made changes, adaptations and innovations in packaging department and as well in the networked packaging enterprise complicated and time consuming. Thus, a packaging process change had to be transferred after approval by the headquarters to all packaging partners companies and the concerning business processes had to be redesigned and implemented in cooperation with the partner companies in order to implement the new packaging solutions in accordance with to the company's guidelines. This procedure was very slow and limited significantly the intrapreneurial freedom in the networked packaging enterprise. In addition to that a lack of packaging designers in the Estonian production plant made all changes in the packaging department to a big challenge and lowered the innovation level. Furthermore it turned out that the business structures of the four involved independent fractals in the Estonian packaging unit were not fully compatible due to different organisational standards so that the performance of the virtual packaging unit was weak.

Consequently, the management of the Estonian production plant initiated a business reengineering project in order to increase efficiency and performance of the complete the production cycle including the packaging department. The business reengineering project focussed on technical improvements by neglecting intrapreneurial and cultural aspects as well as the implementation of compatible organisational standards. The objective for the packaging department was to reduce the packaging material cost and to create a new design for the full product packaging. The targets for the cost reductions in the packaging department were savings up to 80% which turned out to be a very ambitious objective. In order to reach these targets the Estonian management integrated external research units into the business reengineering project and the results of the research and simulation showed cost savings potential for the packaging department up to 60% due to the use of new packaging materials and designs which was not possible to be implemented immediately so that the reengineering process was on hold for a longer period. Additionally, the cost savings of the packaging processes in the modular packaging enterprise required new process design and new workflows in all involved fractals so that the implementation of the new solutions to the production line needed more time than expected. Another important reason for the delay and the implementation problems was related to the lack of authority in decision making processes, the dependency from the headquarters and ongoing cultural mismatches within the networked modular enterprise caused problems until

now to unlock the efficiency gains for the modular packaging enterprise, i.e. due to underdeveloped intrapreneurial freedom together with a non-consistent business environment within the networked modular company was responsible for delays in the implementation of efficiency gains.

In addition to the fact that the production company as well as its principal partners have their headquarters in Scandinavia, the expert interviews revealed conflicts appearing from the financial linkage by cross-ownerships of the three packaging material suppliers and the production company in the same Scandinavian holding controlled by family investors. Regardless that Morck and Yeung (2003) stress the important role that family firms play in free economies, it is important to analyse how the parts of a family business are linked together. In the case study the main policies of the owners was to force the cooperation between firms of the family group with the consequence that competition was abolished which reduced significantly the competitive advantages of the common holding. In addition to that, the forced cooperation in the financial holding cancelled the freedom of choice and with it the competition among a variety of suppliers which was exactly the case in the principal production company when the sourcing of packaging material was restricted to only the three packaging providers.

From the expert interviews the authors also gained the insight that the main company and its suppliers did neither have the same vision nor the idea which kind of a common management system or an organisational standard to implement. Thus the experts stated that the non-existing organisational standards generated frictional costs at the interfaces between the different parts of the virtual company. Furthermore, the experts added that the information exchange together with an integrated IT system was always missing so that one crucial requirement for successful and sustainable fractal or modular structures was not realised. Consequently, it was nearly even impossible to acquire management relevant information in order to decide or behave entrepreneurial. One high profile engineer made clear in an interview that access to relevant data is problematic so that decisions related to efficiency and business performance. Thus the controllability of the business process was not safeguarded by the existing information infrastructure so an adequate entrepreneurial and intrapreneurial decision making was possible which impacted negatively the efficiency and performance of the virtual packaging company.

4. Discussions

Self-organization, self-optimization, goal-orientation and dynamics are success factors for flexible and adaptable manufacturing organizations, fractal enterprises as well as for Industry 4.0 (Warnecke 1996; Olaniyi, Reidolf 2015). Since self-organisation and self-optimisation requires entrepreneurial and intrapreneurial freedom to be able to control and improve the business processes of the involved units. The forced cooperation policy of the financial holding company together with required approvals from the Scandinavian headquarters for business process changes in Estonia reduced the entrepreneurial freedom of the Estonian subsidiary and its departments significantly with the consequence that it was impossible for the Estonian production company to improve efficiency by looking for new reliable suppliers with more competitive prices. These results stress again the need for entrepreneurial freedom together with self-organisation and self-optimisation properties for the creation of efficient networks of productions which are based on autonomous units like in the context of Industry 4.0 (Warnecke 1996; Sturgeon 2002; Kagermann et al. 2013). A possible mitigation strategy for fixing these inefficiencies might be a “lean intrapreneurship” approach in the sense of Ries (2011) which could safeguard the right entrepreneurial freedom in the fractals of the networked modular company. But the case also showed that in an operations network with autonomous components the organisational standards and cultures must be compatible in order to ensure seamless organisational interfaces.

This is of special interest for operations networks in Industry 4.0 because of the use of cyber-physical systems and self-guided product flow through the network the interfaces of the different network components have to be

unified to avoid frictions which result in inefficiencies, longer throughput time or additional costs. Even in the case study of the packaging department where compared to Industry 4.0 only a minimal organisational slack was necessary to construct and operate the networked modular company the absence of entrepreneurial or intrapreneurial freedom caused in the packaging department a deadlock in the field of innovation due to constraints and blockings for the implementation of improvements. In the case of Industry 4.0 the availability of organisational slack is even more crucial to enable the development of “dynamic capabilities”, to facilitate flexibility and responsiveness of the supply chain and open resources for self-organisation and self-optimisation. The empiric results of the case study also revealed that the Estonian production plant never develop a mature organisational culture so that the employees were missing a common organisational mind-set which caused organisational inefficiencies within the production plant and which it also made complicated to communicate and cooperate efficiently at the cross-company interfaces within the virtual packaging company and which caused high transaction costs due to organisational frictions. By following Liker and Rother (2011) it can be stated that continues improvement is something that the personnel is not assured automatically how to achieve, so it needs entrepreneurial mind set and skills as well as the appropriate frame conditions, which was not safeguarded in the investigated situation. Consequently, various expensive reengineering projects were initiated in the packaging unit but they all failed to a big extent.

Finally the case study pointed out a lack of access to process data making it impossible to measure, control and improve the business processes. Thus, the quality of communication and the information exchange in networked environments was not appropriate to secure efficiency, performance and the achievement of the unit goals of the underlying operations network. In this sense the information exchange is the glue that links the parts and that integrate the parts to an operations network. The timely information for fractals is crucial to make decisions and respond to issues as they come up (Strauss, Hummel 1995). But information is also necessary to back and support the intrapreneurial decisions in the fractals to safeguard costs, time, quality and allocation of resources as well as collaboration with other fractals (Strauss, Hummel 1995). All these frame conditions were not realised in the modular packaging company so that it no surprise that the performance gains were not able to unlock until now. Changes in the frame conditions represent necessary preconditions to improve the efficiency in the production network. But the frame conditions for Industry 4.0 have to be further investigated and developed especially in the context of organisational slack, dynamic capabilities and openness.

5. Conclusions

Industry 4.0 aims to develop cyber-physical systems (CPS) and dynamic production networks in order to achieve flexible and open value chains in manufacturing of complex mass customization products in small series. Currently, manufacturing companies gain experiences in production in networks, smart logistics and the development of new organisational structures and business models. Modular and fractal approaches can help to benefit from network-orientation, flexibility and responsiveness.

The case study of an internationally operating high-tech manufacturing enterprise located in Estonia highlights the relationship between networking, organizational development, structural frame conditions and sustainability in the context of Industry 4.0. The empiric analysis of the packaging department which is organised in form of a networked modular production unit reveals that beside technical aspects the performance of a networked construction suffered heavily under the underdeveloped organisational environment. By transferring the results in the context of Industry 4.0 it turned out that a successful networked approach require intrapreneurial freedom in the sense of Ries’ “lean entrepreneurship” approach, a suitable local decision power and organisational standards as well as an adequate information supply. In the context of Industry 4.0 these frame conditions have to be further developed towards agile and responsive supply chain structures, “organisational slack” and dynamic capabilities.

Since in the case study these frame conditions were not fulfilled, it was impossible to unlock significant efficiency gains in the planned range.

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TECHNOLOGIES FOR SUSTAINABLE CIRCULAR BUSINESS: USING CRUSHING DEVICE FOR USED TIRES

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Abstract. Technological entrepreneurship plays increasing role in our path towards sustainable economy. Tires, stored in landfills, pose a risk to human health and environment. There may be long and dangerous fires, combustion process produces pollution, extremely dangerous to human health and environment. Therefore, in order to reduce the surplus of tires in landfills, this work investigates the dependence of tyre tread crushed machine output on the usage of the saws with different technical characteristics as well as the dependence of the machine output on the feed rate and the crushed cutting angle. The temperature dependence on the crushed cutting angle and feed is investigated. The particle sizes obtained during tyre tread crushed are also analysed. The study showed that the maximum machine output is 502 g/min, and as much as 62% of the resulting particle sizes are up to 0.63 mm, which is the most suitable size for the use as an adsorbent for oil products. It was established that the increase of the crushed cutting angle leads to the increase of the temperature of the circular saw by 26%.

Keywords: technological entrepreneurship, tires, crushed, sustainability, production

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1. Introduction

The goals of the 2030 AGENDA for Sustainable Development of the United Nations is to achieve the environmentally sound management of wastes throughout their life cycle and significantly reduce their release into air water and soil in order to minimize the adverse human health and the environment impacts till 2020 (Bazienė *et al.* 2014; Bazienė and Vaiskunaite 2016; Tetsman *et al.* 2017).

Technological entrepreneurship plays crucial role in the process of moving towards circular economy and is widely discussed (e.g. Bilan *et al.* 2017; Tvaronavičienė, Černevičiūtė 2015; Teletov *et al.* 2017; Strielkowski *et al.* 2016; Banaitė, Tamošiūnienė 2016; Barberis, *et al.* 2017; García-Fuentes, de Torre 2017).

Tires, stored in landfills, pose a risk to human health and environment. Leaching of hazardous substances (heavy metals, carcinogenic organic compounds) into soil or groundwater is possible (Chitsan *et al.* 2010; Alisauskas *et al.* 2012). There may be long and dangerous fires, combustion process produces pollution, extremely dangerous to human health and environment. Tires in landfills create favourable conditions for the multiplication of dangerous pathogens. They occupy large areas of land. All these factors only confirm the need to recycle used automotive tires.

Pyrolysis (decomposition at high temperature about 500°C) of raw materials results in rather low quality technical hydrocarbon (due to the high ash, coke and oil content) and combustible gas, which is used in maintaining the operation of the machine, and metal cord. The main drawback to this method is its cyclical nature; it is not possible to carry out continuous production, and the emission levels of toxic pyrolysis products, that are dangerous to environment and human health, are high. The resulting product is of low quality and expensive, this leads to economic inefficiency of the process, but there ways for improvement to make this method efficient.

Dissolution of raw materials in hot bitumen. The recycling by using this method produces the raw material for road building, and modified bitumen is produced. The technology is highly energy-consuming and the product obtained is more expensive than the traditional asphalt concrete mixtures.

Burning of partially crushed tires. This method is widely used in the United States, where the raw material is mixed into the coal used for burning in thermal power plants and for drying cement. The burning of tires in cement plants is quite efficient, as the combustion process takes place at high (1100°C) temperatures, and the quantity of toxic materials generated is low, and those generated settle in cement and are not released into atmosphere.

Thermo-mechanical method. The thermo-mechanical method is technically perfect rubber regeneration method that allows speeding up the process significantly and making it continuous as well as ensuring the lowering the regenerate production costs due to the maximization of process mechanisation and automation. By applying this method for rubber waste processing, rubber crumbs are continuously mixed with plasticizer and pass through the worm press with an extended housing. The devulcanised product, when leaving the press, is processed with refining rollers to obtain a regenerate (Ayse *et al.* 2010; Čereška *et al.* 2016).

Mechanical-pressure destruction method is one of the most widely used rubber waste processing methods. Processed rubber powder is marketed as a secondary raw material. Physical analysis aimed to establish qualitative indicators of rubber particles is carried out periodically to meet environmental challenges and to obtain economic benefits (Uruburu *et al.* 2013). By applying this method tyre rubber is turned into powder, scrap metal and textile fibres. The protecting steel rings are removed from tyre at the beginning of the process and the tyre is cut into several pieces. Passenger car tires up to 20 kg are recycled without any preparatory phase (they are neither crushed nor their steel rings are removed). A tyre is placed into a cylindrical press chamber and substantially compressed with the help of a plunger. The major part of the rubber with textile cord is pressed out through the holes at the bottom of the camera. Thus obtained, rubber pieces with textile are further crushed and metal separated by magnetic separators. The textile cord is separated from the crushed rubber. The collected rubber is

further chipped in the final crushed device. The resulting rubber particles are separated into desired particle sizes by the vibrating sieve.

2. Use of crushed tyre particles as an adsorbent

Adsorption is the absorption of a substance from a gas or liquid at the adsorbent surface. Adsorption treatment method is based on the use of the physical properties of some solid materials, having ultramicroscopic structure, so as to isolate individual components from a fluid mixture and keep them on the surface. The adsorption process consists of three successive stages: diffusion of the absorbed material from the flow to the outer surface of the adsorbent (external diffusion), the access of the molecules, having reached the outer surface, to sorption areas inside a porous grain (internal diffusion) and molecular sorption on the inner grain surface (Wu *et al.* 2009).

Adsorbents are insoluble materials, which, without getting swelled by more than 50% in excess liquid, retain the liquid in its capillaries and pores on its surface. In order to use the sorbents for the removal of oil spill, they are to be hydrophobic and, at the same time, absorbing oil well. Sorbents are commonly used for the removal of oil product residues or in the places where oil products cannot be reached when using special equipment. Sorbents can also be used for removal of minor oil spillages. When used to for the elimination of oil products, they are, in accordance with the approved local and state rules and requirements, to be removed. All oil products, extracted after sorbent regeneration, are to be properly removed or recycled (Chitsan *et al.* 2010).

When choosing one or another type of sorbent for the liquidation of oil products, one must take into account certain properties of sorbents and oil products: keeping of oil products, adsorption speed, sorbent customisation. Keeping of oil products. The sorbent may release oil accumulated in its pores, when it is collected from the water surface. Lower viscosity petroleum products are released from pores much easier compared with more viscous ones. Adsorption speed. More viscous oil products adsorb on the adsorbent surface much more effectively compared with the lighter ones. Sorbent customisation. Sorbents may be supplied to oil pollution sources mechanically (using a blower fan) or manually. However, clay and vermiculite, natural inorganic sorbents spread dust and it is difficult to supply them by blowing.

Many natural sorbents are adapted to absorb oil products and are modified. These changes increase the sorbent regeneration capabilities, make them widely used and, at the same time, increase their price. Sorbents used for the removal of oil products are classified according to their use specifications: adsorbents for the adsorption of oil products from the water surface, adsorbents for the adsorption of industrial pollutants, adsorbents for the adsorption of oil products from the ground.

Aisien *et al.* (2012) had demonstrated the ability of the recycled rubber to adsorb oil and manage simple oil pollution processes due to inner rubber qualities. Laboratory results had shown that tyre powder can be used repeatedly and it is elastic. The tyre powder has a lower adsorption capacity compared with materials that were specially invented to absorb oil. The advantage of tyre powder is that it is possible to use it repeatedly, adsorbing oil after recovery.

3. Progress of tyre tread crushed experiment

The tyre with the dimensions of 17.5R25 was used during the research tests. 29 circular saws NOOK 200x50x1.5-36 and 5 circular saws NOOK 450x50x2-z56 were applied on the cutting for tyre tread crushed. It is worth to note that the crushed cutting of the patented device was at the angle β , which may not be reduced, so crushed cutting angle β was only to be increased during further testing. Hence the crushing-cutting angle was changed to 5°, 6°,

7° and 8°. Before the test the ambient temperature was measured as being $T = 13.6\text{ }^{\circ}\text{C}$. The relative humidity of the air was also measured and was $r = 55\%$.

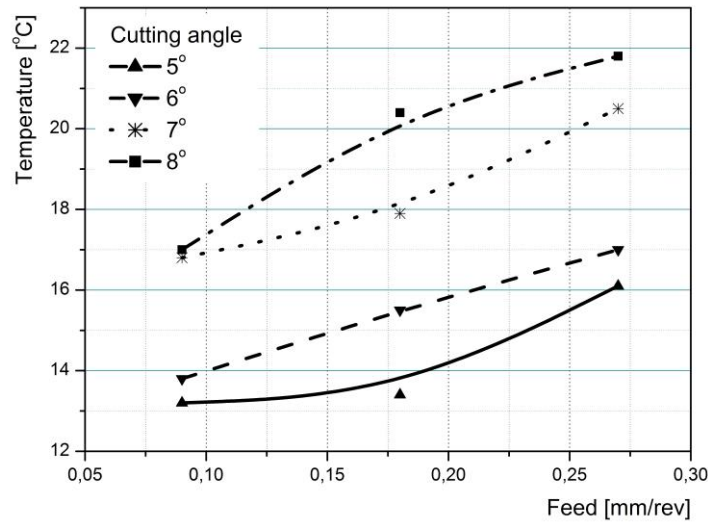


Fig 1. Dependence of temperature from feed and cutting angle of circular saw NOOK 200x50x1.5-36
Source: authors.

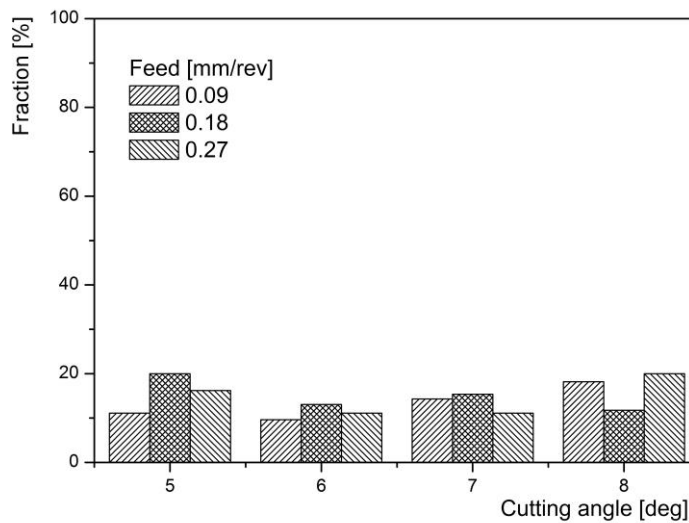


Fig 2. Dependence of fraction $\leq 0.63\text{ mm}$ from feed and cutting angle of circular saw NOOK 200x50x1.5-36
Source: authors.

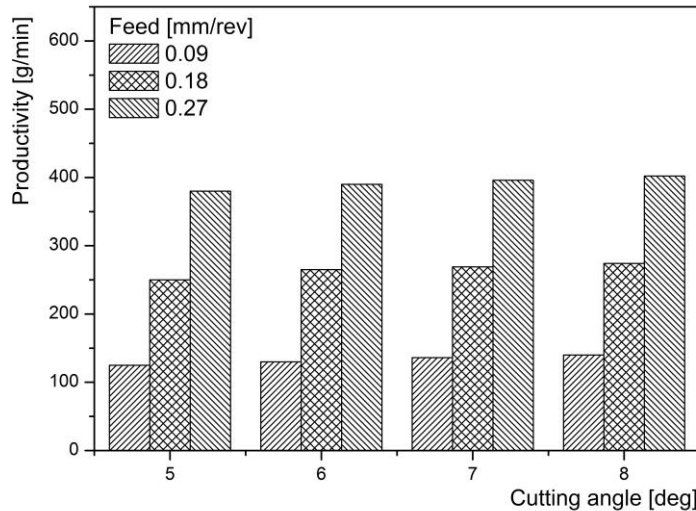


Fig 3. Dependence of production from feed and cutting angle of circular saw NOOK 200x50x1.5-36

Source: authors.

The analysis of the diagram in Fig. 1–3 leads to the conclusion that the tyre tread crushed with the saw NOOK 200x50x1.5-36 tends to overheat. However, it is not recommended to renounce the use of the maximum cutting feed rate, i.e. 0.27 mm/rev, to reduce the crushed saw average temperatures, as this would reduce the output of the used tyre tread crushed device. However, the angle of the crushed cutting, which has a major impact on the crushed saw temperature increases (Fig. 1), but has not get any impact on the production (Fig. 3). The diagram in Figure 3 shows that the quantities of the smallest particles, which are up to 0.63 mm, are in percentages of between 9.63% and 20%. It is worth to note that there is no clear trend of the dependence on the crushed cutting angle or on the feed. However, it can be maintained that it would be sufficient to maintain the initial crushed cutting angle and simply increase the feed rate up to the maximum in order to obtain about 20% of the sizes up to 0.63 mm. This would reduce the heating problem, and the quantity of the smallest particle sizes up to 0.63 mm obtained would be very similar to that at the maximum crushed cutting angle.

The use of the saw NOOK 450x50x2-z56 during the research test has shown (Fig. 4–6) the maximum device output is achieved at the highest possible tyre tread milling machine feed rate, i.e. at 0.27 mm/rev. From 380 grams to 402 grams are obtained, depending on the crushed cutting angle, and one can see that the increase of the crushed cutting angle β increases the output by 5.47%. However, one has to keep in mind that the temperature of the circular saw NOOK 450x50x2-z56 rises with the increase of the crushed cutting angle β . Fig. 4 shows that the temperature increases as much as by 25.69%. Therefore it would not be appropriate to increase the device output by increasing the crushed cutting angle β , as it escalates the circular saw overheating problem.

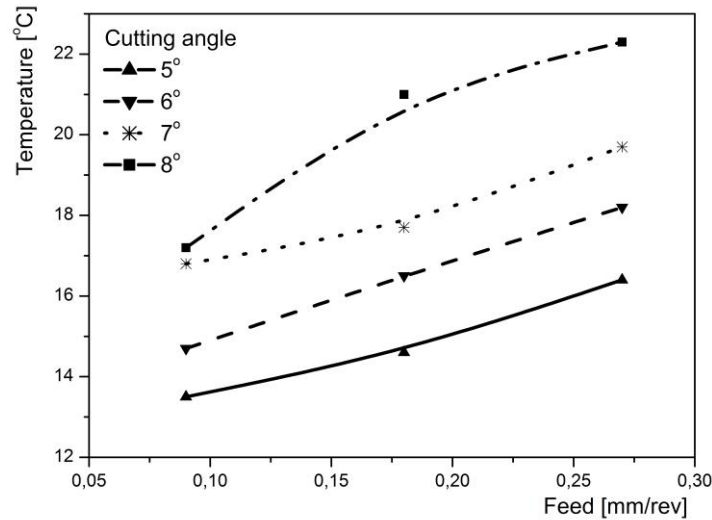


Fig 4. Dependence of temperature from feed and cutting angle of circular saw NOOK 450x50x2-z56
Source: authors.

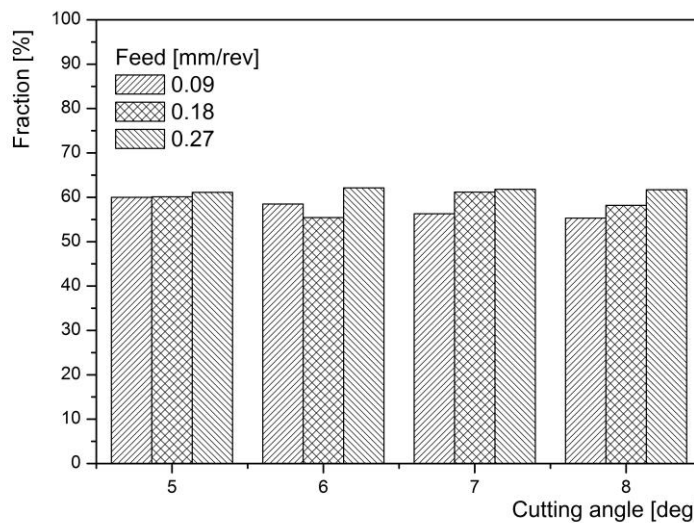


Fig 5. Dependence of fraction (till 0.63 mm) from feed and cutting angle of circular saw NOOK 450x50x2-z56
Source: authors.

The diagram in Fig. 5 shows that the crushed of the tyre tread with a saw NOOK 450x50x2-z56 also tends to overheating. However, it is necessary to use the maximum cutting feed rate of 0.27 mm/rev, because otherwise the used tyre tread crushed device output would be reduced. Therefore, the crushed saw heating reduction potential also remains without changing the crushed cutting angle; but it can only be confirmed by the comparison of the dependence of the crushed particle sizes on the crushed cutting angle β .

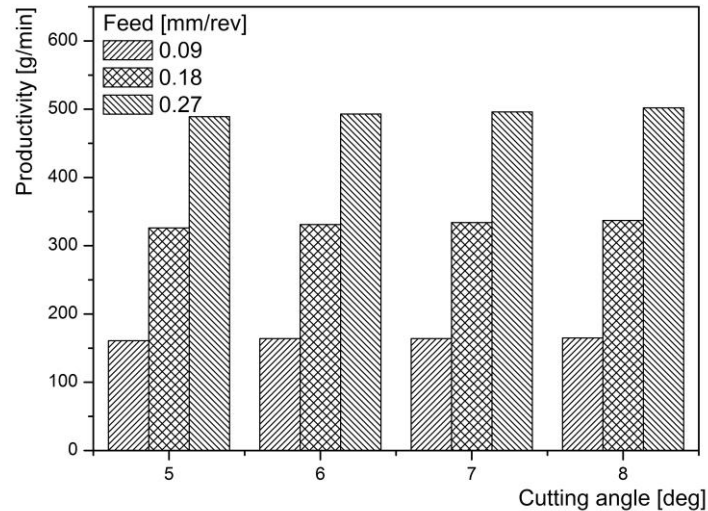


Fig 6. Dependence of production from feed and cutting angle of circular saw NOOK 450x50x2-z56
Source: authors.

The diagram in Fig. 6 shows that the increase of crushed cutting angle β had no impact on the increase of the quantity of the crushed particles of the sizes up to 0.63 mm, however the maximum feed rate should be used in order to obtain the smallest particle sizes. The trend observed is that in all the tests when crushed cutting angle is increased and maximum feed rate, which is 0.27 rev/min, approximately 62% of the particle sizes obtained is up to 0.63 mm. Fig. 6 shows that the maximum tyre tread crushed device output is achieved at the maximum device feed rate, which ranged, depending on the crushed cutting angle β , from 489 grams to 502 grams per minute, i.e., the output had increased by further 2.59% with the increase of the crushed cutting angle. However, the increase of the crushed cutting angle led to the increase of the circular saw temperatures, see Fig. 5, by as much as 26 per cent. Therefore, the tests with the first and saw 450x50x2-z56 lead to the conclusion that the maximum feed rate could be used for the improved device output, the increase the crushed cutting angle to increase the device output is a wrong decision.

The comparison of the first (Fig. 3) and second (Fig. 6) tests shows the 40 % increase of the quantity of the particle sizes up to 0.63 mm during the second test. One can maintain that the saw 450x50x2-z56 should be used for the crushed of used tyre tread to obtain as small particle sizes as possible.

Conclusions

The study revealed the possibility for the sustainable circular business use of tires as a reuse material using crushing device. Technological solutions can help to minimise the usages of raw material and this requires new additional studies.

The maximum yield of 502 g/min is obtained when operating of the saw 450x50x2-z56, the technical characteristics of which are shown in fig 6.

The test had shown that the heating of the device circular saw is reduced by 26.46 per cent, when the saw 450x50x2-z56 is chosen, the crushed cutting angle β is not changed and the maximum feed rate of 0.27 mm/rev is used.

The sieving of the particles obtained during the tests into four size groups resulted in approximately 62% of the smallest particle sizes up to 0.63 mm, having the best adsorption properties. When using the saw 450x50x2-z56, under the following conditions: feed rate of 0.27 mm/rev; crushed cutting angle β of 5°.

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THE ASSESSMENT OF CORPORATE SOCIAL RESPONSIBILITY: APPROACHES ANALYSIS¹

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Abstract. The problem of the last period becomes the assessment of individual areas of Corporate Social Responsibility, which is associated with a number of CSR approaches and with their "ability" to measure achieved level in every CSR item. The aim of this study is, based on a comparative analysis, to identify appropriate approach to assessing the achieved level of Corporate Social Responsibility. The study is organized as follows: the theoretical background (studies) of approaches to evaluating the CSR; the findings about primary and secondary data on structure, purpose and application of approaches to evaluating the CSR, the appropriate approach to evaluating the CSR activities of the company in the light of any previous research; conclusions in dealing with the issues and future research opportunities of the study.

Keywords: corporate social responsibility, assessment, business excellence, models, indexes, sustainability, environmental, social, economic, stakeholder, voluntariness

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JEL Classifications: M14, Q56

1. Introduction

Corporate social responsibility comes in many different shapes and sizes which is demonstrated by many authors (Carroll, 1979; Búciová, 2008; Dahlsrud, 2008; Mutz, 2008; Gjørlberg, 2009; Kuldová, 2010; Lakin and Scheubel, 2010; Remišová, 2011; Sapkauskienė and Leitoniene, 2014; Figurska, 2014; Tvaronavičienė, 2014; Raudeliūnienė, Tvaronavičienė, Dzemyda and Sepehri, 2014; Grubicka and Matuska, 2015; Baronienė and Žirgūtis, 2016).

- A watershed in CSR was 1971 when the Committee for Economic Development (CED) published its Social Responsibilities of Business Corporations. As a code of conduct (Committee for Economic Development,

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1971), the CED outlined a three-tiered model of CSR: the inner circle, the intermediate circle and the outer circle. The inner circle means, that the basic responsibilities an organization has for creating profit and growth. The intermediate circle means, that an organization must be sensitive to the changing social contract that exists between business and society when it pursues its economic interests. The outer circle means, that the responsibilities and activities an organization needs to pursue towards actively improving the social environment e.g. poverty or urban crowding issues.

- Archie B. Carroll (Carroll, 1979) based his definition of CSR from the following three distinct aspects of corporate social performance (Carroll, 1979): 1. A basic definition of social responsibility, 2. An enumeration of the issues for which a social responsibility exists, 3. A specification of the philosophy of response. First (Carroll, 1979) he stated four areas of CSR – the economic, legal, ethical and discretionary. The economic component of CSR represents the fundamental social responsibility of business. The legal component recognizes the obligation of the enterprise to obey laws. The ethical responsibilities have been considerably more difficult to define and interpret. Referred to as the "grey area", this component "involves behaviors and activities that are not embodied in law but still entail performance expected of business by society's members". The fourth area of responsibilities is called discretionary or voluntary. This category of social responsibility is totally dictated by the "discretion" of the organization as there are no laws or codified expectations guiding the corporations' activities. Later Carroll (Carroll, 1991) defined this component as philanthropic because this term provides a more specific description of how this component is typically implemented in organizational practice.
- John Elkington (Elkington, 1994) and later used in his 1997 (Elkington, 1997) book "Cannibals with Forks: The Triple Bottom Line of 21st Century Business" introduced the CSR concept as "triple bottom line", consisting of three items, namely the economic, social and environmental (it consists of three Ps, also profit, people and planet). A triple bottom line measures the company's economic value, "people account" – which measures the company's degree of social responsibility and the company's "planet account" – which measures the company's environmental responsibility.
- Philip Kotler and Nance Lee (Kotler and Lee, 2005) distinguished six major types of corporate social initiatives. These initiatives include ones that are marketing related (corporate cause promotions, cause-related marketing, corporate social marketing and corporate philanthropy) as well as ones that are outside the typical functions of marketing departments (i.e., employee volunteering and socially responsible business practices).
- Jana Trnková (Trnková, 2005) and Martina Prskavcová, Kateřina Maršíková, Pavla Řehořová and Magdalena Zbránková (Prskavcová, Maršíková, Řehořová and Zbránková, 2008) perceive the corporate social responsibility at three levels, namely economic, social and environmental.
- Researchers from the Ashridge Business School (Danish Commerce and Companies Agency, 2005) divided the corporate social responsibility into the following seven main groups: a) leadership, vision and values, b) marketplace activities, c) workforce activities, d) supply chain activities, e) stakeholder engagement, f) community activities, g) environmental activities.
- Alexander Dahlsrud (Dahlsrud, 2008) specified in his work "How Corporate Social Responsibility is defined: an Analysis of 37 definitions" five basic CSR items, namely the environmental, social, economic, stakeholders and voluntariness. He determined that four of these five items appear min. in 80% of definitions and moreover at least three of five items occur in as much as 97% of definitions.
- Nick Lakin, Veronica Scheubel (Lakin and Scheubel, 2010) and Gerd Mutz (Mutz, 2008) claim that the corporate responsibility is formed by three items: economic, social and environmental. As the ethical and legal responsibilities are part of every item, they do not have a separate place.
- The approach of Zuzana Búciiová (Búciiová, 2008) and Anna Remišová (Remišová, 2011) is the opposite, as it includes ethical, economical and legal responsibility into the corporate social responsibility.

- L. Kuldová (Kuldová, 2010) distinguishes three components within the corporate social responsibility: social, environmental and economic.

In (Schwartz and Carroll, 2003) it is stated that "Carroll's four categories or domains of CSR have been utilized by numerous theorists (Wartick and Cochran 1985; Wood, 1991; Swanson, 1995; Swanson, 1999) and empirical researchers (Aupperle, 1984; Aupperle, Carroll and Hatfield 1985; Burton and Hegarty 1999; Clarkson, 1995; Ibrahim and Angelidis, 1993; Ibrahim and Angelidis, 1994; Ibrahim and Angelidis, 1995; Mallott, 1993; O'Neill, Saunders and McCarthy, 1989; Pinkston and Carroll, 1996; Smith, Wokutch, Harrington and Dennis, 2001; Spencer and Butler, 1987; Strong and Meyer, 1992). Several business and society and business ethics texts have incorporated Carroll's CSR domains (Boatright, 1993; Buchholz 1995; Weiss, 1994) or have depicted the CSR Pyramid (Carroll and Buchholtz, 2000; Carroll and Buchholtz, 2003; Jackson, Miller and Miller, 1997; Sexty, 1995; Trevino and Nelson, 1995)".

Alexander Dahlsrud (Dahlsrud, 2008) in his paper "How Corporate Social Responsibility is defined: an Analysis of 37 definitions" specified five primary areas of CSR, namely: environmental, social, economic, stakeholder and voluntariness (Table 1). He found that four of these five areas appear in 80% of the definitions and at least three of the five areas are in 97% of the definitions. Despite the fact that many authors (Table 2) are inclined to the categorization into three areas (like Elkington, 1994), authors inclined to approach of Dahlsrud (Dahlsrud, 2008). The reason for this choice is also the fact (Jankalová, 2016; Jankal and Jankalová, 2016) that companies that wish to successfully develop their activities are forced to engage all key partners into the corporate social responsibility (stakeholder), including all links of the production process, item of providing quality products and services, transparent company management (economic), care of employees (social), environmental protection (environmental) and cooperation with the local community (voluntariness).

Table 1. The five dimensions, how the coding scheme was applied and example phrases

CSR dimensions	The definition is coded to the item if it refers to	Example phrases
environmental	the natural environment	"a cleaner environment" "environmental stewardship" "environmental concerns in business operations"
social	the relationship between business and society	"contribute to a better society" "integrate social concerns in their business operations" "consider the full scope of their impact on communities"
economic	socio-economic or financial aspects, including describing CSR in terms of a business operation	"contribute to economic development" "preserving the profitability" "business operations"
stakeholder	stakeholders or stakeholder groups	"interaction with their stakeholders" "how organisations interact with their employees, suppliers, customers and communities" "treating the stakeholders of the firm"
voluntariness	actions not prescribed by law	"based on ethical values" "beyond legal obligations" "voluntary"

Source: Dahlsrud, 2008

Table 2. CSR items in the literature

Approach	CSR items
Committee for Economic Development (1971)	inner circle, intermediate circle, outer circle
Archie B. Carroll (1979)	economic, legal, ethical, discretionary
Archie B. Carroll (1991)	economic, legal, ethical, philanthropic
J. Elkington (1994)	economic, social, environmental
P. Kotler, N. Lee (2005)	corporate cause promotions, cause-related marketing, corporate social marketing, corporate philanthropy, employee volunteering, socially responsible business practices
J. Trnková (2005)	economic, social, environmental
Researchers from the Ashridge Business School in Danish Commerce and Companies Agency (2005)	leadership, vision and values; marketplace activities; workforce activities; supply chain activities; stakeholder engagement; community activities; environmental activities
M. Prskavcová, K. Maršíková, P. Řehořová, M. Zbránková (2008)	economic, social, environmental
A. Dahlsrud (2008)	economic, social, environmental, stakeholder, voluntariness
G. Mutz (2008)	economic, social, environmental
Z. Búciová (2008)	economic, ethical, legal
N. Lakin, V. Scheubel (2010)	economic, social, environmental
L. Kuldová (2010)	economic, social, environmental
A. Remišová (2011)	economic, ethical, legal

Source: prepared by paper authors, based on Committee for Economic Development, 1971; Carroll, 1979; Carroll, 1991; Elkington, 1994; Danish Commerce and Companies Agency, 2005; Kotler and Lee, 2005; Trnková, 2005; Búciová, 2008; Dahlsrud, 2008; Mutz, 2008; Prskavcová, Maršíková, Řehořová and Zbránková, 2008; Kuldová, 2010; Lakin and Scheubel, 2010; Remišová, 2011

The problem of the last period becomes the assessment of individual areas of Corporate Social Responsibility, which is associated with a number of CSR approaches (Business Excellence models, sustainability indexes, standards, initiatives) and with their "ability" to measure achieved level in every CSR item (from the perspective of the authors in the environmental, social, economic, stakeholder and voluntariness item). The aim of this study is, based on a comparative analysis, to identify appropriate approach to assessing the achieved level of Corporate Social Responsibility in the areas mentioned above.

The study is organized as follows: section 2 describes the theoretical background (studies) of approaches to evaluating the CSR; section 3 review the findings about primary and secondary data on structure, purpose and application of approaches to evaluating the CSR; section 4 discusses the appropriate approach to evaluating the CSR activities of the company in the light of any previous research; section 5 are conclusions and discuss the issues and future research opportunities of the study.

2. Theoretical background

2.1. Business Excellence models

"The fact that the excellence models give a comprehensive definition of the meaning of quality management has stimulated the use of these models not only for applying for an award, but for internal self-assessments to monitor and guide the organization in its quality management implementation" (Kok, Wiele, McKenna and Brown, 2001). The two excellence models which have been studied in relation to the social responsibility are The EFQM Excellence Model and The Malcolm Baldrige Model for Performance Excellence.

Although **The EFQM Excellence Model** is used as the basis of the EFQM Award, from 2004 is also used as "Framework for Corporate Social Responsibility". This framework drew together the expertise from a number of leading companies, as well as including the then recently formed United Nations Global Compact. Since then, the

knowledge and understanding of topics like "Corporate Social Responsibility" and "Sustainability" have progressed significantly. The new EFQM Framework for Sustainability follows The EFQM Excellence Model 2013. The assessment framework is non-prescriptive and can be used in any organization, regardless of size or sector (EFQM, 2015a).

The EFQM Excellence Model was the first model, which explicitly showed that social responsibility is strongly related to the quality thinking (Kok, Wiele, McKenna and Brown, 2001). Today it is based on 8 fundamental concepts of excellence, and at least one of those concepts has always been linked with corporate social responsibility (value for customers; creating a sustainable future; leading with vision, inspiration and integrity; succeeding through the talent of people; sustaining outstanding results). It was initially called "public responsibility", later "corporate social responsibility". Actually it is called "creating a sustainable future" and characterized as (EFQM, 2015b) *"excellent organizations have a positive impact on the world around them by enhancing their performance whilst simultaneously advancing the economic, environmental and social conditions within the communities they touch"*.

Studies on the CSR concept in The EFQM Excellence Model can be divided into two main sections (Jankal and Jankalová, 2016):

- those that explore the link between the CSR concept and The EFQM Excellence Model as a framework for its evaluation, and
- those that explore the effect of such CSR evaluation on company sustainability performances.

The European Foundation for Quality Management defines CSR in relation with The EFQM Excellence Model as (EFQM, 2004) *"a whole range of fundamentals that organizations are expected to acknowledge and to reflect in their actions. It includes among other things respecting human rights, fair treatment of the workforce, customers and suppliers, being good corporate citizens of the communities in which they operate and conservation of natural environment"*. These fundamentals are seen as not only morally and ethically desirable ends in themselves and as part of the organization's philosophy; but also as key drivers in ensuring that society will allow the organization to survive in the long term, as society benefits from the organization's activities and behavior. This opinion has also Gorenak, who expressed that (Gorenak, 2015) *"Using EFQM model, organizations have the support of a performance excellence framework founded on the social responsibility principles to develop sustainable approaches on for business excellence for people, planet, and profit. Each organization has to include social responsibility as part of its strategy, but these approaches have to be measured continuously, and the results have to be reviewed and improved as necessary. EFQM 2013 helps organizations to manage quality successfully and operate according to sustainable determination"*. In (Margaria, 2004) it is stated that *"The EFQM framework for CSR is a new and integrated approach that uses The Excellent Model as a common base. The EFQM has been eager to promote The Excellence model as a tool for effective implementation of CSR"*. Also Abuhejleh and Yehia (2014) expressed, that *"The EFQM Excellence Model Framework for CSR is a fresh and integrated approach that practices The Excellence Model as a mutual foundation"*.

Other studies (Neergaard and Pedersen, 2003; Porter and Tanner, 2004) argue that the model is based on a stakeholder view of the company and companies can be excellent if they satisfy the needs of their stakeholders – stakeholder theory is a common platform for the model as well for much of the literature in CSR. This opinion has also Bucur (2008) and Gorenak (2015). Bucur (Bucur, 2008) considers this model as a very effective management tool that combines CSR with stakeholder engagement in every activity and with many of the performance indicators of the organization. It focuses not only on direct results, but also on the causes and how to get there. Additionally, organizations can easily integrate their existing standards into the EFQM Framework for CSR (for example ISO 9000, ISO 14000 etc.), since it is a management framework, not a standard. Gorenak expressed that (Gorenak, 2015) *"The basic concepts of this model are extensive and involve results orientation. Customers are*

one of the main stakeholders; their satisfaction and loyalty are important for each organization. Leadership plays the crucial role; it must be the model as well as the motivator and strategic processes, which are focused on quality, stakeholder partnerships, and sustainability. Employees are one of the main stakeholders, and their involvement reflects as their contribution to innovativeness, improvement, and competitiveness. Stakeholder partnership is a long-term process and is part of the holistic and systemic social responsibility in organizations". In (Abuhejleh and Yehia, 2014) it is stated that "The EFQM CSR Toolbox provides complete and compatible formats for CSR self-assessment, evaluation, and reporting that can be used by any organization. Undertaking this process gives an organization the opportunity to take a step back from its daily operations and assess its overall CSR performance in the form of a series of strengths and areas for improvement, and through a means of comparison to other organizations". A critical review is presented in (Jankalová and Jankal, 2016) who found that "The CSR concept can be found in The EFQM Excellence Model, but it lacks activities especially in the environmental and voluntariness items", and in (Kok, Wiele, McKenna and Brown, 2001) who argued that "ethics and social responsibility are not incorporated in the excellence model which have been developed the European Quality Award. The EFQM Excellence Model's criteria are focused on the needs of all stakeholders, however, only as far as there is a direct relation with the economic responsibility of the organization. The model does not stimulate or demand a position that is more in line with change ethics and proactive change in relation to social responsibility".

About **The Malcolm Baldrige Model for Performance Excellence**, similar to The EFQM Excellence Model, may be considered as a framework for evaluating the CSR activities of the company. Corporate social responsibility has been an element of the Malcolm Baldrige Criteria for Performance Excellence since 1988. In the initial 1988 Criteria (like Foote, Gaffney and Evans, 2010) *"public responsibility was focused narrowly on mechanisms used for external communication of information concerning corporate support of quality assurance or improvement activities outside the company. Over the next several years, this item was expanded to include how the company extended its quality leadership to the external community and integrated its responsibilities to the public for health, safety, environmental protection, and ethical business practice into its quality policies and activities"*. A significant revision was made to this core value in 2000 (American Society for Quality, 2000): *"An organization's leadership should stress its responsibilities to the public and needs to practice good citizenship. These responsibilities refer to basic expectations of your organization related to business ethics and protection of public health, safety, and the environment"*. In 2003 the core value was re-named "Social Responsibility" although the content remained essentially unchanged (American Society for Quality, 2003). Today, three of 11 core values and concepts are very closely tied to CSR principles (NIST, 2015):

- Societal responsibility (by health care "societal responsibility and community health"): Leaders should stress responsibilities to the public, ethical behavior, and the need to consider societal well-being and benefit, which refers to leadership in and support – within the limits of an organization's resources – of the environmental, social, and economic systems in the organization's sphere of influence.
- Ethics and transparency: Ethical behavior and transparency build trust in the organization and a belief in its fairness and integrity that is valued by all key stakeholders. Organization should stress ethical behavior in all stakeholder transactions and interactions. Transparency is characterized by consistently candid and open communication on the part of leadership and management and by the sharing of clear and accurate information.
- Delivering value and results: By delivering value to key stakeholders, organization builds loyalty, contributes to growing the economy, and contributes to society. Results should be used to deliver and balance value for organization's key stakeholders – students, customers, workforce, stockholders, suppliers, and partners; the public; and the community. Thus results need to be a composite of measures that include not just financial results, but also educational program and service results, process results; student, other customer, and workforce satisfaction and engagement results; and leadership, strategy, and societal performance.

Craddock (2013) expressed that *"The Malcolm Baldrige Criteria for Performance Excellence defined sustainability as your organization's ability to address current business needs and to have the agility and strategic management to prepare successfully for your future business, market, and operating environment. Further expanded the sustainability considerations to include "workforce capability and capacity, resource availability, technology, knowledge, core competencies, work systems, facilities, and equipment. The environmental and societal responsibilities are included as part of the overall leadership governance and societal responsibilities. In other words, sustainability is infused throughout the criteria"*. Leonard and McAdam stated that (Leonard and McAdam, 2003) *"One of the best examples of quality frameworks that incorporate core elements of CSR is the Malcolm Baldrige Criteria for Performance Excellence"*. Similarly, Fibuch and Van Way observed that the Baldrige Health Care Criteria for Performance Excellence (Fibuch and Van Way, 2012) *"provided a clear model for organizational sustainability"*.

A critical review is presented in (Jankalová and Jankal, 2016) who found that *"The CSR concept can be found in The Malcolm Baldrige Model for Performance Excellence, but it lacks activities especially in the environmental and voluntariness items"*, and in (Kok, Wiele, McKenna and Brown, 2001) who argued that *"ethics and social responsibility are not incorporated in the excellence model which have been developed for the Malcolm Baldrige National Quality Award (MBNQA). The MBNQA criteria are mainly related to transaction ethics, where in a very restricted way also the customer needs are taken into account. The model does not stimulate or demand a position that is more in line with change ethics and proactive change in relation to social responsibility"*.

2.2. Sustainable indexes

Jankalová stated that (Jankalová, 2016), *"existing independent agencies (Dow Jones from Switzerland, Ethibel from Belgium, FTSE from UK, Business in the Community from UK, James Ethics Centre from Australia, ECPI from Belgium, EIRIS from UK, OEKOM Research AG from Germany), which deal with the rating of corporate social responsibility. Their contribution is in the creation of own indexes with which they measure the performance of companies that behave responsibly towards society. A decision which companies may be included in these indexes depends on the fulfillment of the criteria of "socially responsible behavior" that is setting individually by the agencies. Between the major international indexes belong Dow Jones Sustainability Index, FTSE4Good Index, Ethibel Index, Global Challenges Index and MSCI World ESG Index. In recent years, increased in importance also indexes applied only at regional level. Examples are DAXglobal Sarasin Sustainability Germany Index EUR, Global Challenges Index, STOXX Global ESG Leaders, STOXX Sustainability Indices, Dax Global Alternative Energy Index, Stoxx Europe Christian Index and Hang Seng Corporate Sustainability Index"*.

Studies on sustainable indexes can be divided into three sections (Jankalová, 2016):

- those that explore the structure of sustainability indexes (Sjöström, 2004; Holt, Kido, Kolind, Mitchell, Song and Swartz, 2004; Hamner, 2005; Kašparová, 2006; ...),
- those that explore the purpose of sustainable indexes (Sjöström, 2004; Beurden and Gössling, 2008; Cerin and Dobers, 2008; ...) and
- those that explore other dimension, such as their application by the evaluation of Corporate Social Responsibility activities of companies (Avlonas, 2004; Jankalová, 2013; ...).

A combination of the first two approaches is research of E. Sjöström (2004), in which he identified thirteen companies providing sustainability indexes for European, American, Asian, and/or Global markets. It was showed that (Sjöström, 2004) all indexes also do an evaluation of the financial robustness of the companies, because there wouldn't be much of a point of these indexes if there was a financial trade-off. No investor would sacrifice financial pay-off even if it was for a "good cause", because their one and only mission is to maximize the return

on the investment. The different providers draw the index constituents from varying investment universes: Some use "conventional" indexes, such as Standard and Poor's Global index or Dow Jones World Index. Most sustainability indexes are market capitalization weighted, which means that each stock's weight in the index is proportionate to that stock's total market value. Many indexes have a fixed number of constituents, so if one company is excluded it is immediately replaced with another. The number of constituents in the identified indexes varies from 45 to 2,343. The indexes are normally reviewed every three or four months to ensure that the index composition accurately represents leading sustainability companies, and some are also monitored daily for environmental, economic and social crisis situations that may lead to exclusion from the index. The major underlying purpose behind the sustainability indexes is to measure the performance of companies that meet certain sustainability criteria, and to provide investors with an SRI benchmark (Sustainable Responsibility Investment). In other words, they want to facilitate socially and environmentally responsible investments. Some index providers have a more extensive purpose, in that they also want to increase awareness about CSR and SRI and encourage socially and environmentally responsible behavior, and one could suspect that they are not only profit-driven but also values-driven in their pursuit.

Hamner (Hamner, 2005) examined and analyzed the structure of 12 indexes (Dow Jones Sustainability Index, Ethibel Global Index, Ethical Global Index, FTSE4GOOD Global 100 Index, Humanix 200 Global, ASPI Eurozone Index, Ethinvest Environmental Index Australia, Jantzi Social Index Canada, Johannesburg Stock Exchange / FTSE 4Good Index South Africa, Humanix 50 Index Sweden, Calvert CALVIN Social Index USA, KLD Domini 400 Index USA) with the aim to find the core sustainability criteria used by the 12 indexes and to count the criteria by conceptual groups. The results are in Table 3 and it shows the most popular criteria used by the analyzed indexes.

Table 3. Frequency analysis of criteria in indexes of sustainable corporations

Frequency	Sustainability criteria	Frequency	Sustainability criteria
9x = 75%	Health and safety	4x = 33%	Communication Discrimination Legal compliance
8x = 67%	Corporate governance CSR performance reporting Labor and union relations Pollution prevention	3x = 25 %	Contracts Codes of ethics Animal relations Risk management Environmental performance Relations to customers and suppliers Energy sources
6x = 50%	Training and education Quality Compensation Diversity	2x = 17%	Leadership and incentives Management Non-executive director remuneration Conduct of business Sustainability assessment Rights Management Profit sharing Family support Product safety Recycling Environmental management system
5x = 42%	Innovation Benefits Human rights		

Source: Hamner, 2005

This research provides (Hamner, 2005), that the most significant observation is the strong focus on internal employee relations for sustainability, such as health and safety, labor relations and pollution prevention. Hamner's point of view, investors understand that good performance is created by a good business culture and sustainability programs should focus on internal development first and external efforts second. It was also being noted that three of the dominant criteria are often integrated: training and education leads to pollution prevention which improves health and safety. Hamner's research confirmed earlier realized research (Holt, Kido, Kolind, Mitchell, Song and Swartz, 2004), who analyzed indexes DJSI, Ethibel, FTSE4Good, Domini400 and Calvert. By the comparison of monitoring areas, he came to the conclusion that the monitored area of the individual indexes differed evidently. On the discrepancy of indexes also pointed Kašparová (2006), her research was based on extensive research of Hamner (2005).

The second section on studies focuses on the purpose of sustainable indexes, which explore the link between sustainable indexes and areas as Corporate Social Performance (CSP) and Sustainable Responsibility Investment (SRI). Beurden and Gössling (2008), also in line with Sotorrio and Sanchez (2008), describe CSP as a concept of three categories (Comincioli, Poddi and Vergalli, 2012):

- CSP1: social disclosure about social concern (Orlitzky, Schmidt and Rynes, 2003; Wu, 2006),
- CSP2: corporate action, such as philanthropy, social programs and pollution control,
- CSP3: corporate reputation ratings or social indices that may be provided by social rating institutions, such as KLD, EIRIS, Fortune, Moskowitz or ad hoc indices drawn up by the researchers themselves (Beliveau, Cottrill and O'Neill, 1994; Brammer and Pavelin, 2006; Hillman and Keim, 2001; Johnson and Greening, 1999; Mahoney and Thorne, 2005; Moore, 2001).

Cerin and Dobers (2008) in their study "The contribution of sustainable investments to sustainable development mentioned" (Cerin and Dobers, 2008): *In the last decade there has been a surge of new sustainable investment mutual funds and indices* (SiRi Company, 2004; Sjöström, 2004). This has spurred critical research on their compositions, including ratings (Koellner, Weber, Fenchel and Scholz, 2005; SustainAbility, 2004; Figge, Schaltegger, 2000). Cerin and Dobers (2001a) found that other factors than sustainability (e.g. market capital size and back casting methodology) explained the Dow Jones Sustainability Group Index (DJSI) out performance of Dow Jones Global Index (DJGI). The likely reason is the fact that DJSI has selected its components mainly on the basis of information from the companies themselves (Cerin, Dobers, 2001b). Illnitch, Soderstrom and Thomas (1998) evaluated environmental ratings and found them to rely on public reactions rather than on precise and measurable outcomes. Instead the subjectivity in their formulations may raise a dangerous circularity where the rankings are based on reputation and the reputation is partly based on the ranking. Hawken and the Natural Capital Institute (2004) have, moreover, detected that almost identical constituents have been chosen (as of Oct. 2003) in the combined portfolio holdings of American SI mutual funds as of the 30 largest market capitalization size firms composing the Dow Jones Industrial Average. Some researchers (Cerin and Dobers, 2001a; Louche, 2004), however, also conclude that sustainability indices have indeed contributed to making sustainable investments a viable commercial project and transformed sustainable investments to an element of the broader Corporate Social Responsibility field.

The last groups are studies dealing with the application of the sustainability indexes by the evaluation of Corporate Social Responsibility activities of companies (Avlonas, 2004; Jankalová, 2013; Jankalová, 2016). It is especially this research field that indexes are the tools of reporting, self-assessment and assessment of CSR activities of companies (Table 4).

Table 4. Research on CSR models, standards, guidelines and indexes

CSR approach	Tool for reporting	Tool for self-assessment	Tool for assessment
The EFQM Excellence Model	++	+++	+++
Social Accountability – SA 8000	+	+	+++
ISO 14000		++	+++
EMAS	+	++	+++
AccountAbility 1000 (AA1000)	++	+	+++
Global Reporting Initiative (GRI)	+++	++	
Value Management System (VMS)		++	++
Dow Jones Sustainability Index	+	++	
FTSE4good		++	

Source: a comparison by Avlonas, 2004

3. Interpretation of the approaches analysis

3.1. Business Excellence models

The EFQM Excellence Model includes CSR in various forms in all examined items (Leadership; Strategy; People; Partnerships and Resources; Processes, Products and Services; Results). The EFQM Framework for CSR provides guidelines (EFQM, 2004) *"on how to identify, improve and integrate the social, environmental and economic impacts of its operations into policy and strategy and the day-to-day management of an organization, taking all stakeholders into account"*. The model is divided into the same nine criteria as The EFQM Excellence Model. Five of these are "Enablers" and four are "Results". A separate criterion for measuring the organization's impact on the society is the criterion 8 "Society Results", according to which (EFQM, 2013) *"excellent organizations achieve and sustain outstanding results that meet or exceed the needs and expectations of relevant stakeholders within society"*. The weight of sub-criteria is shifted with regard to perception and internal indicators. The sub-criterion 8a Measurement of Perception has the weight of 25% and the sub-criterion 8b Performance Indicators has 75%. This indicator with the weight of 10% within the whole model indicates the rate of corporate social responsibility, level of its influence over the environment and its benefits and significance for the society. The measurement of CSR activities of the enterprise according to criteria of The EFQM Excellence Model is significantly exact. The rate of meeting sub-criteria of assumptions and sub-criteria of results is assessed within individual criteria in the range from 0 to 100% on the grounds of the RADAR principle. Together with this scoring methodology are the organizations able to identify the strengths and the items where they need to focus on improvement.

The criteria for Performance Excellence in **The Malcolm Baldrige Model for Performance Excellence** include CSR in various forms (NIST, 2015), mostly in the categories Leadership and Results (Senior Leadership, Governance and Societal Responsibilities, Customer-Focused Results, Leadership and Governance Results). The CSR concept is in other criteria linked within their individual items (Jankalová and Jankal, 2016). Already (Jankalová and Jankal, 2016) when creating the Organizational Profile, some supporting questions are aimed at the CSR item, such as in the part Organizational Relationships – Customers and Stakeholders: *"What are your key market segments, customer groups, and stakeholder groups, as appropriate?"*, in the part Strategic Context: *What are your key strategic challenges and advantages in the areas of business, operations, societal responsibilities, and workforce?"* Between strategic advantages (mentioned in the part Organizational Situation) are listed also (NIST 2015): *Environmental ("green") stewardship and Social responsibility and community involvement*.

The measurement of CSR activities of the enterprise according to criteria of The Malcolm Baldrige Model for Performance Excellence is also significantly exact. The scoring of responses to items is based on two evaluation dimensions: Process and Results, in the range from 0 to 100%. The four factors used to evaluate process are Approach, Deployment, Learning and Integration (ADLI). The four factors used to evaluate results are Levels,

Trends, Comparisons and Integration (LTCl). Together with this scoring methodology are the organizations able to identify the strengths and the areas where they need to focus on improvement.

Jankalová and Jankal in (Jankalová and Jankal, 2016) identified the proximity rate of the CSR concept in two models, namely The EFQM Excellence Model and The Malcolm Baldrige Model for Performance Excellence, as they belong to frequently used approaches in the practice. The calculation of the proximity rate of the CSR concept in the analyzed models depends on the number of sub-criteria or criteria of the model, in which the i -th CSR item appears. The determination of the proximity rate was preceded by:

- determination of sub-criteria in the analyzed models in the i -th CSR item appears,
- determination of the number of criteria of the model in the i -th CSR item appears (N_{cCSR_i}),
- calculation of the model CSR criterion score ($_{mCSR_{ics}}$).

The results of these findings are stated in the Table 5, where N_{cCSR_i} = number of criteria of the model in the i -th CSR item appears; N_{mc} = number of all criteria of the analyzed model; $_{mCSR_{ics}}$ = model CSR criterion score; $NR_{mCSR_{ics}}$ = proximity rate of the CSR concept in criteria of the respective model.

Table 5. The proximity rate of the CSR concept in criteria of the respective model

CSR item	The EFQM Excellence Model $N_{mc} = 9$		The Malcolm Baldrige Model $N_{mc} = 7$	
	N_{cCSR_i}	$_{mCSR_{ics}}$	N_{cCSR_i}	$_{mCSR_{ics}}$
environmental	5	55,56%	4	57,14%
social	6	66,67%	6	85,71%
economic	9	100,00%	5	71,43%
stakeholder	7	77,78%	7	100,00%
voluntariness	4	44,44%	5	71,43%
$nCSR_i = 5$	$NR_{mCSR_{ics}} = 68,89\%$		$NR_{mCSR_{ics}} = 77,14\%$	

Source: Jankalová and Jankal, 2016

The main conclusions of the study of Jankalová and Jankal (2016) are (Jankalová and Jankal, 2016):

- the CSR concept can be found in each of the analyzed models, the difference is in the determined proximity rate of the concept in those models,
- the shortcoming of the analyzed models is the uneven representation of individual CSR items in sub-criteria – the calculated weightings of the five CSR components in The EFQM Excellence Model were (after recalculation): environmental = 1,20; social = 2,00; economic = 2,60; stakeholder = 3,00; voluntariness = 1,20; the weightings of the five CSR components in The Malcolm Baldrige Model for Performance Excellence were (after recalculation): environmental = 1,35; social = 2,40; economic = 2,20; stakeholder = 2,70; voluntariness = 1,35,
- the analyzed models lack the list of activities within individual CSR items,
- the analyzed models lack activities especially in the environmental and voluntariness items.

3.2. Sustainable indexes

The problem of the indexes (Jankalová, 2013) is the objectivity of the data collected, since the source of them are personal interviews, websites, annual reports, reports on sustainable development and proper environmental protection of analyzed companies. Despite verification by the independent auditor, these reports often show signs of subjectivity due mainly mutual incomparability of data. Another problem is transparency in the evaluation of corporate social responsibility provided by rating agencies, since these agencies often use a methodology which is not disclose, because it is their know-how. Some rating agencies published indexes that assess only the company's

reputation. In this case, the starting point is stakeholders' views on the company obtained especially by questionnaire survey. The problem in this case is known favoring of large companies, as these communicate with the public more often than small, of which beneficial activities know often only closed group of people. Mentioned indexes are also the basis for sustainable investments. The problem is that, since individual indexes are different in analyzed areas and also in indicators in the various areas and scales defined for each area, it is very difficult to compare these indexes.

Incomparability of indexes also causes (Jankalová, 2016):

- The various definitions of corporate social responsibility that ambiguously identify the desired behavior of the business entity. While in overseas countries, we can talk more about corporate philanthropy (for many companies is that donations to foundations and support non-profit projects) in Europe CSR reflected in integration of principle areas of corporate social responsibility into the business strategy of the company.
- Different views on the identification of the areas of corporate social responsibility, what is proven by statements of domestic and foreign authors as A. B. Carroll, N. Lakin, V. Scheubel, G. Mutz, Z. Búciová, A. Dahlsrud, A. Remišová, L. Kuldová, J. Trnková, M. Prskavcová.
- Various purposes of sustainable indexes.

4. Identification of the appropriate approach to evaluating the CSR activities of the company

Research problem of this study is the identification of the appropriate approach to evaluating the CSR activities of the company in five areas of CSR, namely: *environmental, social, economic, stakeholder and voluntariness*. The identification of the appropriate approach is presented as multi-criteria analysis. The approach of Jankalová and Jankal (Jankalová and Jankal, 2016) for the calculation of the model CSR criterion score was used also for sustainable indexes (namely FTSE ESG and RobecoSAM). The selection of sustainable indexes was determined by the availability of the structure used by the evaluation. Five areas of CSR are used as the *criteria* with the *equal importance*. The evaluation matrix is in the Table 6.

Table 6. The evaluation matrix

Variant Criteria	The EFQM Excellence Model	The Malcolm Baldrige Model	FTSE ESG	RobecoSAM
environmental	55,56%	57,14%	35,71%	25,71%
social	66,67%	85,71%	35,71%	34,28%
economic	100,00%	71,43%	28,57%	40,00%
stakeholder	77,78%	100,00%	64,28%	25,71%
voluntariness	44,44%	71,43%	28,57%	20,00%

Source: authors, based on Jankalová and Jankal, 2016

At the next stage, all evaluation values from the Table 6 are normalized and the new normalized decision matrix is in the Table 7.

Table 7. The normalized decision matrix

Variant Criteria	The EFQM Excellence Model	The Malcolm Baldrige Model	FTSE ESG	RobecoSAM
environmental	0,97	1,00	0,62	0,45
social	0,78	1,00	0,42	0,40
economic	1,00	0,71	0,29	0,40
stakeholder	0,78	1,00	0,64	0,26
voluntariness	0,62	1,00	0,40	0,28

Source: authors

Finally, according the results from Table 7 the variants' ranking is ordered and the best ranked variant is proposed as a solution (Table 8). In case that the criteria have different importance, it is necessary to make conversion of normalized values to the weighted values.

Table 8. The final score and ranking

Variant	Score	Ranking
The Malcolm Baldrige Model	4,71	1
The EFQM Excellence Model	4,15	2
FTSE ESG	2,37	3
RobecoSAM	1,79	4

Source: authors

From the Table 8 follows that the best approach for evaluating the CSR activities of the company may be considered The Malcolm Baldrige Model for Performance Excellence.

Conclusions

Praxis is proof of the fact that there are currently methods, norms and initiatives that enable evaluation of the CSR activities of the company. As the framework can be used Business Excellence models, sustainability indexes, standards and initiatives.

Business Excellence models, as the models with fixed scale of criteria, has recently, with the increase of importance of corporate social responsibility, also became the framework for evaluating the CSR activities of the company. Between the best known models belong The EFQM Excellence Model in Europe and The Malcolm Baldrige Model for Performance Excellence in the USA. According to the own multi-criteria analysis, The Malcolm Baldrige Model for Performance Excellence is more suitable framework for evaluating the CSR activities of the company, as The EFQM Excellence Model, or sustainability indexes (namely FTSE ESG and RobecoSAM).

Despite the number and variety of approaches to the evaluation of CSR activities of the company authors of this study recommends companies to evaluate their own activities based on their selected approach. The question is "Which one?". By the approach of Avlonas (Avlonas, 2004) important is also the purpose of the evaluation of CSR activities of the company – *Tool for reporting, Tool for self-assessment or Tool for assessment?*

According to the aim of the study, decisive was the approach that is suitable as the tool for self-assessment and tool for assessment too. Approach which would only serve as a tool for reporting would cover only part of the CSR and we could not talk about the complex approach for evaluating the CSR activities of the company. For company reporting are essential standards as Global Reporting Initiative, World Business for Sustainable

Development Reporting Project and AA1000 AccountAbility/Assurance Standard. The GRI Sustainability Reporting Guidelines (ISO, 2014) are the most widely used sustainability reporting framework in the world and enable all companies and organizations to report on their economic, environmental, social and governance performance. GRI's mission is to make sustainability reporting standard practice.

Due to changes in the requirements of stakeholders, there is a constant revision of Business Excellence models, sustainability indexes, standards and initiatives, which are suitable for the evaluation and reporting of CSR activities of the company. Therefore, dealing with this issue is important in the future because it is necessary to continuously monitor CSR activities of the company.

The results of the study may represent a starting point for future research, oriented also on the possibilities of application of other Business Excellence Models as the approaches to evaluating the CSR activities of the company.

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TOWARDS SUSTAINABLE LOGISTICS: STUDY OF ALTERNATIVE DELIVERY FACETS

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Abstract. The Courier, Express and Parcel services (CEP) sector is a constant growing one. The changes concerning e-commerce have impact in the industry which is looking for solution. This research, based on a web survey with 1019 computer assisted web interviews, presents e-commerce customer expectations in alternative delivery time frames and considers the impacts in the last mile of attended home delivery, reception boxes and collection-and-delivery points. The analysed alternative delivery time frames are Express delivery within 3 hours, evening delivery, Saturday delivery, Sunday delivery and customer selected time frame. Within these the focus is on e-commerce purchase habits, frequency of purchase, products, time of purchase, interest in alternative delivery time frames, usage or preferences and finally the willingness to pay for an alternative delivery. The results show a tendency of more than two thirds towards consumer selected delivery time frame, Saturday delivery and evening delivery, which is accompanied by easy accessible Reception Boxes (RBs). The research study also performs regression analysis and finds a significant impact of Alternative Delivery Time Frame (ADTF), and Delivery Methods (DM) on customer's willingness to pay.

Keywords: sustainable logistics, parcel delivery customer expectations; e-commerce, last mile problem, courier express parcel services, delivery time windows

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1. Introduction

Well organized logistics is important constituent of sustainable entrepreneurship and overall sustainable development (e.g. Samašonok et al., 2016; Beifert, 2015, 2016; Urbonas, Alonderis 2016; Vaško, Abrhám, 2015). As music, software and information are the only things that can be sent digitally, the online purchase of physical products in a virtual online shop is just midway of e-commerce – with physical delivery seeming to be still a weak-point with complex challenges (Heiserich & Helbig & Ullman, 2011). And the last mile is one of the key factors for e-commerce-failures (Xu & Ferrand & Roberts, 2008). Regarding this, the aim of this article is to get a detailed analysis of the e-commerce-costumer needs in alternative parcel delivery time frames, focusing primarily on delivery time – considering and combining the effects of the last mile problems and barriers in the Courier, Express and Parcel services (CEP) sector and the results of the web-survey.

To achieve this goal, 1019 computer-assisted-web-interviews were analysed. The analysed alternative delivery time frames, a part of the regular daytime delivery from 8 o'clock in the morning to 6 o'clock in the afternoon and night time delivery in general, are evening delivery, Saturday delivery, Sunday delivery, delivery within 3 hours and delivery within a selectable time frame. The fields analysed within the alternative delivery time frames are e-commerce-purchase habits, like purchase frequency or products, interest and willingness to pay for an alternative delivery time frame. To be able to repeat sustainable advantage in the market, companies operating the last mile need to have strategies (Boyer & Frohlich & Hult, 2004) and alternatives. This paper focuses on these alternative time frames.

2. Literature review

Under a historical point of view the CEP growth started in the 60s (Fenkart, 2000) and courier-companies, like FedEx, TNT or UPS came to Europe in the 70s (Olfert, 2014) having already started with a 24-hour service (Dreier, 2000), which is to be considered almost a norm service (Gilbert, 1989), even though not guaranteed (Müller, 2002). The parcels are collected on day one until the evening, sorted and transported during night-time and delivered on day two (Fortmann & Kallweit, 2007). Due to the internationalisation of added value systems in industry and commerce (Baum & Fransoo & Göpfert, 2004) and the growth in e-commerce business-to-consumer, which rises the cost of the last mile, the CEP-market is expanding (Schneider & Siebel, 2002) and within the last years a constant growing one (Fenkart, 2000; Wang & Zhan & Ruan & Zhang, 2014).

Especially small items transportation within the regular online markets, which minimize stress-factors and save time during purchase for the customer (Lammers, 2012), and consumer-to-consumer-markets (Potzmann, 2006) are the main drivers.

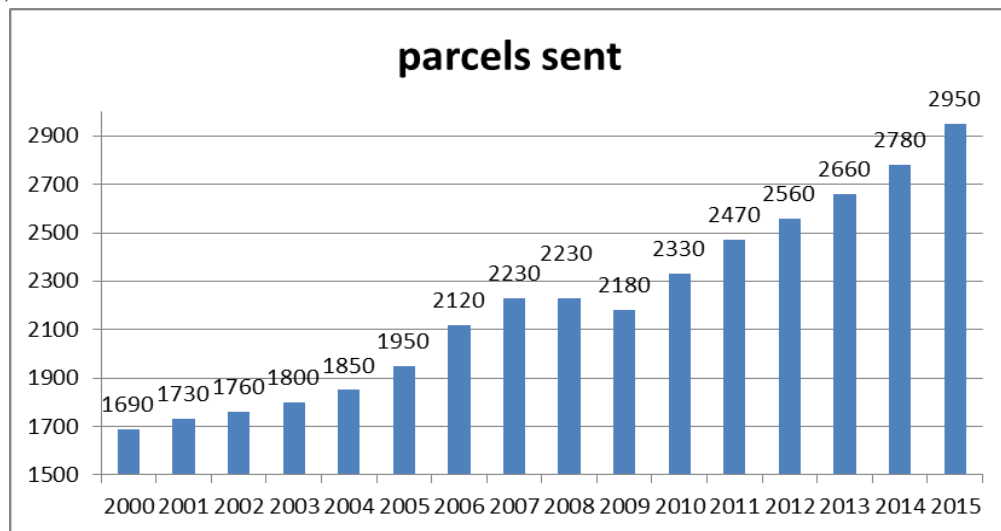


Fig.1. German CEP market in the years 2000 to 2015 in million parcels sent (Bundesverband Paket & Express Logistik, 2016)

In Germany, the volume of delivered goods increased from the year 2000 to 2015 about 74% and from 2014 to 2015 the volume increased by 5,9% (Figure 1) (Bundesverband Paket & Express Logistik, 2016). Similar results are seen in the figures on the Austrian CEP-Market, with an increase of the volume of the parcel business, for example the Austrian Post AG, from 59 million parcels in 2009 to 80 million parcels in 2015, which is to be

ascribed to the increase of e-commerce (Österreichische Post AG, 2016), that provokes consumers to have their purchase delivered at home rather than pick goods up in stationary retail shops (Klaus, 2002).

The CEP-market divides into courier services, which are delivering fast small documents or good up to 2 kilograms (Köberlein, 1997; Gilbert, 1989), express-service, without weight limit and door-to-door-service (Ihde & Bloech, 1997) and the parcel service, with parcels up to 31,5 kg (Hornbacher & Horvath & Munstermann, 1997; Mencler, 2006) - highly systemized and mass-oriented (Vahrenkamp, 2000). Especially integrators, like UPS or DHL, try to provide services in all three parts (Mencler, 2006; Gogic, 2005; Aberle, 1991) and the logistic structural offer of a transportation service provider from picking up to deliver within an international frame (Gleißner, 2008).

The creation of competitive advantage within the CEP-market is reached through the differentiation of the service (Gebhard & Jäger & Schlichting, 1997), which leads to a customer-needs-evaluation within the growing market of e-commerce-based parcel delivery, considering the accompanying last mile problems and barriers. Basic hypothesis is that e-commerce-customers are interested in times of delivery, apart from regular business-hours-delivery, i.e. evening-delivery, Saturday, Sunday, customer-specified-time or delivery within 3 hours – followed by the hypothesis that customers are willing to pay for it. Within this research influencing elements like time of online purchase, purchased product, frequency of purchase, living area and building were evaluated, especially to be able to connect to the delivery process and the last mile barriers.

The delivery process is roughly separated in sender → sending hauler → freight carrier (airline) → receiving hauler → recipient (Hornbacher et al., 1990). The receiving hauler, if integrated, is a part of the same company as the sending-hauler and freight carrier with the same quality standards (Vahrenkamp, 2003) and is responsible for the last mile (Bachmeier, 1999), which is to understand as the delivery to the recipient after the last hub (Meffert, 1997).

The last mile is, with 30% of the cost (Wang et al., 2014), a costly part of the delivery (Brown & Guiffrida, 2014), especially considering the delivery to customers (Kummerer & Grün & Jammerneegg, 2013), because there is a higher possibility, that they are not present during daytime (Mencler, 2006; Fernie & Sparks & McKinnon, 2010; Maurer, 2013). These cases are likely to rise, as e-commerce rises (McKinnon & Tallam, 2003). Nevertheless, an intense customer orientation in logistic processes is constructive, concerning an increase in customer loyalty (Zadek, 1999), and that customers tend to avoid online-shops, if they are dissatisfied with the delivery (Richter, 2015; Lee & Wang, 2001). On a meta-level, there are three ways of delivery in the e-logistics: The attended home delivery (AHD), the reception boxes (RBs) and the collection-and-delivery points (CDPs) (Wang et al., 2014).

CDPs are primarily shops or chain-stores, with storage areas and staff, where customers have to go to (Weltevreden, 2008), to pick up their parcel. On one side, if it is not open 24-7, it comes with the disadvantage of opening-times and on the other side with the necessity and at least imputed costs of employees. There are central located automated CDPs to pick up parcels (Fernie et al., 2010), with the need of technical functionality (i.e. lock, power) and high investment costs (Bensinger, 2012) and long amortization (Punakivi & Tanskannen, 2002). There are four different possibilities of a RBs. Directly at the customer's door (or close to it) can be a permanently installed box or a lock into system for delivered boxes (Punakivi, 2003), or the similar system within a multi-party house, with shared permanently installed boxes (Wang et al., 2014) or lock into systems. The AHD requires the customer to be present and personally receive the parcel (Punakivi, 2003), especially if a signature is needed (Macharis & Melo, 2011). If the customer is not present, this leads to rising costs (Richter, 2015; Heiserich et al., 2011). If the customer is present, there are still higher costs- in comparison with RBs or CDPs, due to stop-costs, i.e. checking and signing the parcel. Concerning the cost-sensitivity of the last mile, distributors are looking for ways to reduce costs (Felisberto & Finger & Friedli & Krähenbrühl & Trinker, 2006). Pick-up points (CDPs) or

safe-deposit-box-systems (RBs) are possible solutions (Schneider et al. 2002; Mencler, 2006) to minimize costs up to 60% (Punakivi & Yrjölä & Holström, 2001). Regularly CDPs are the most cost efficient, then RBs and followed in the end by AHD – although considering small amount of orders, the investment costs of CDPs or RBs can even turn it to the opposite (Wang et al., 2014).

Cost influencing elements, besides the already mentioned ones, are practical ones within the last mile. Driven kilometers per parcel are different in rural than in urban areas, due to population density (Macharis et al., 2011), traffic flow affects the possible delivery speed and parking possibilities are different (Morris, 2009). Even on the last meters there are different building entry barriers in family homes and multi-party houses, with digital or mechanical locking systems (Biehling, 2005). During the last year the locking systems in multi-party houses have changed through technical possibilities. The number of digital locking systems is rising, although they are by far not as widespread as conventional mechanical key systems (Ohland, 2015). The card based digital systems uses standardized and individually programmable passive transponder technologies (e.g. RFID), that enables different card holder groups, like firefighters, trash collectors, newspaper deliverer or CEP services, to enter the building within certain time frames (Begeh, 2016).

3. Methodology

The survey started with preliminary research, development of the questionnaire (Callegaro & Manfreda & Vehovar, 2015) and a pre-test of the questionnaire with minor changes. The used methodology was a web survey. The paper analyses empirical data of a sample of 1019 computer-assisted web interviews with semi-standardized questionnaire. The sample was taken in Austria in November 2016 being active for two weeks. 19 contacted interviewees were screen outs, because they had not purchased any goods online so far, which makes 98,14% of internet users, and these being 85% of Austrians between the age of 16-74 years (KMU, 2016), potential online-customers. The target group were online oriented adults who had already experience with online purchase, which makes the significant disadvantage of web surveys – that non-internet-users are inaccessible – insignificant (Häder, 2015). The participants attended the survey anonymously and were asked to leave socio-demographic information. A 4-point Likert-type scale was used to measure interest in the different services, for time measurement there were specific time frames to choose of, i.e. for the purchase frequency there was weekly, monthly, quarter, annual, for the will to pay a slide control (€ 0 to € 20) was used for a placement on the continuum. The statistical fluctuation range is within +/- 3,2%. Contacts were taken randomly, but with a focus on rural and urban equilibrium, considering the differences in CEP-distribution in these areas. Data analysis was performed by SPSS 20.0. The research method is based on the studies of Maurer (2013), who analysed the last mile problem in online ordered food delivery to customers with 543 interviews (Maurer, 2013), and Richter (2015), who analysed the same day delivery in e-commerce with 243 interviews (Richter, 2015).

The structure of the sample included 74% employees and 26% unemployed participants and 51,3% male and 48,7 % female. 18% were single households, 38% couples, 26% families, 19% others. 42% live in one-family homes and 58% in multi-party houses - 57,4% in rural areas and 42,6 % in urban areas. The age distribution is evenly distributed as follows: < 29 years 21,7%, < 39 years 22,3%, < 49 years 22,8%, <59 years 20,7% and > 60 years 12,5%. The income distribution turned out to be < € 1.000 5,7%, € 1.000 - € 2.000 24,8%, < € 2.000 - € 3.000 26,5% > € 3.000 39,3% and not specified 3,7%.

The questionnaire consisted of 46 questions, focussing on the topics - apart from sociodemographic questions: purchase frequency, purchased products, physical distance to next stationary purchase possibility, time of online purchase, time frames of delivery and interest in it, ways of delivery, willingness of additional payment.

4. Goals

Going back to the basics, logistics has to make sure, that the right product in the exact amount is delivered in the right condition, to the correct place at the exact expected time – with minimal costs (Pfohl, 1996). Considering customer's needs, the questions are: Which alternative delivery time frame is the customer interested in, focussing on the different delivery areas and buildings? Is the customer willing to pay for alternative delivery time frames? Which effects are to expect for delivery companies in the CEP sector?

5. Research results

Within the presentation of the survey results within this article, the primary focus is on e-commerce purchase habits - like frequency, products or time of purchase - and alternative delivery time frames – like interest, usage or preferences – and finally the willingness to pay for an alternative delivery time frame.

5.1. E-Commerce Purchase Habits

83,4 % of the Austrian population has already purchased at least once a product in an online shop. Already 63,0% shop online weekly or at least once a month - another 30,6% once every 3 month (Figure 2). The purchase in rural areas is significant lower than in urban areas, which increases the problem of delivery density on the country side.

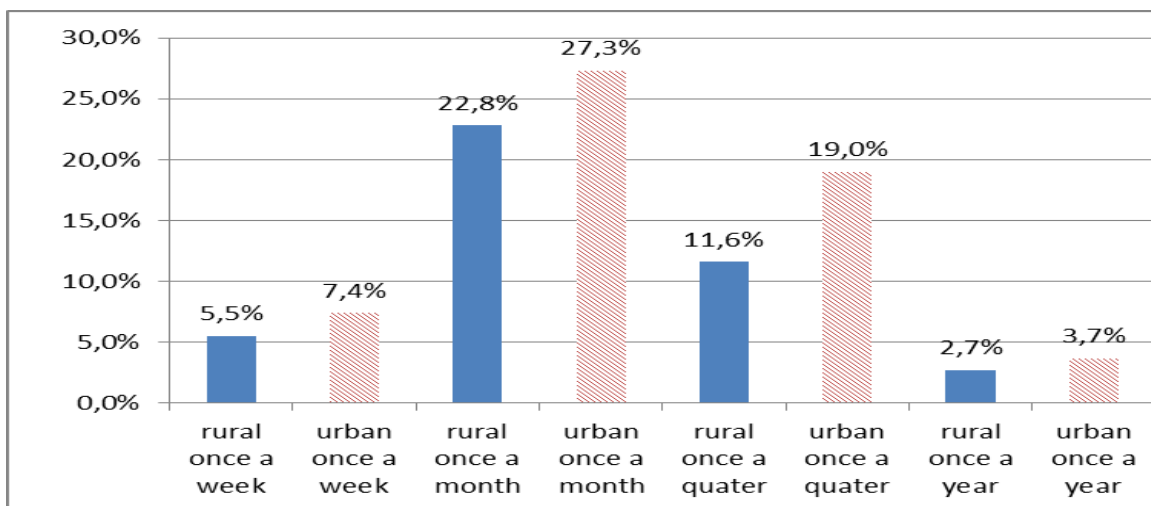


Fig. 2. Purchase frequency in rural / urban areas in percent (n=1000) of consumers

In the statistic scales the leading online most purchased product groups are books, music, videos, games, sports goods, clothes with over 50% (up to around 80%) - the end of the scale usually are food products (Eurostat, 2016; Richter, 2015; Edwards & McKinnon & Cullinane, 2009). Similar is the outcome of this study, with books, music, videos and games being purchased by 89,4% and the different food clusters between 13,9% (dairy products) and 17,0% (grain-products). Combining purchase frequency and purchased products shows that the top groups leading the purchased products are purchased monthly (15,8%-20,9%) in the quarter (34,5% -39,7%) and annually (29,5% - 30,8%) in a high frequency but weekly in a low frequency (1,1% to 3,2%). On the other hand, food products are with up to 8,6% (grain-products) weekly purchase on the top (Figure 3) of the scale, making it a niche delivery segment with high frequency.

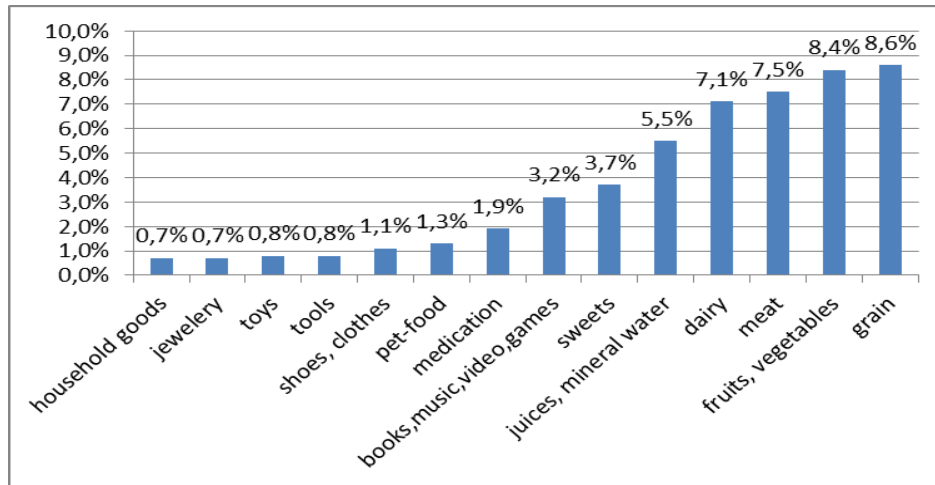


Fig. 3. Weekly online purchased products in % of consumers (n=1000)

For evaluating alternative delivery time frames, the time of the actual online shopping process is of interest, especially considering same day delivery (SDD) or express delivery (ED) within 3 hours. Figure 4 shows that the next day delivery leads the consumer expectations with 55,8% of the consumers. For SDD 27,7% would shop in the forenoon 20,2% in the afternoon. 37,0% would shop two days and the rest 3 days or more before delivery.

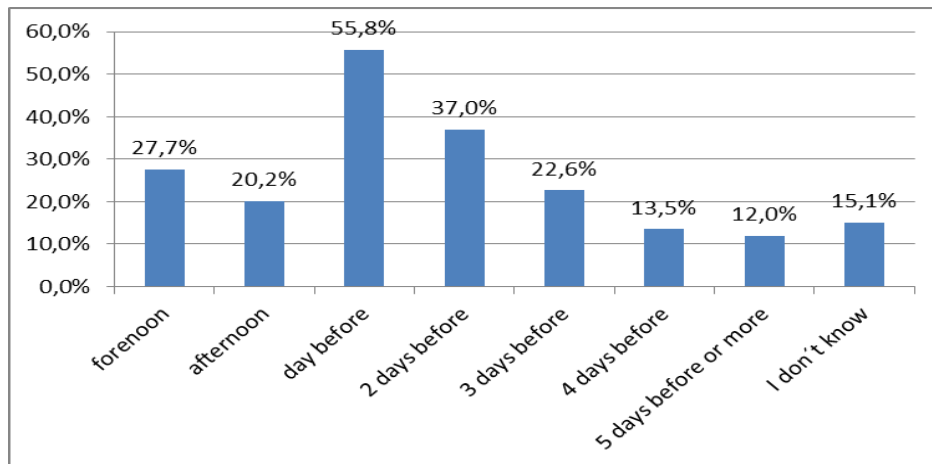


Fig. 4. Time of actual online shopping, if delivered when wanted in % of consumers (n=853, multiple selections possible)

5.2. Alternative Delivery Time Frames

Basically, delivery process can take place 24 hours a day, not everywhere and not always with the possibility of personal handover. The regular daytime parcel delivery time is between 8 – 18 o'clock, UPS for example until 17 o'clock (United Parcel Service, 2017). The time before the daytime delivery, from 9 o'clock in the evening until the morning, can be described as night time delivery, where e.g. newspapers are delivered. The downside of night time delivery is that personal handover, with exception of a concierge service, is not common within the B2C distribution; nevertheless, a distribution in RBs or CDPs can be a possibility. The analysed alternative delivery time frames for AHD, a part of daytime delivery and night time delivery, are evening delivery, delivery within 3 hours, delivery within a selectable time frame, Saturday delivery and Sunday delivery. As Figure 5 shows Sunday

delivery has the least of interested or very interested consumers with only 31,4%. The most interest with 76,1% is in the personal selected time frame, followed by Saturday delivery (72,9%) and evening delivery with 68,8%. Furthermore, these three time frames have the highest results within purchase frequencies as well, which makes them the favourite alternative delivery time frames of the consumer perspective within the evaluated ones.

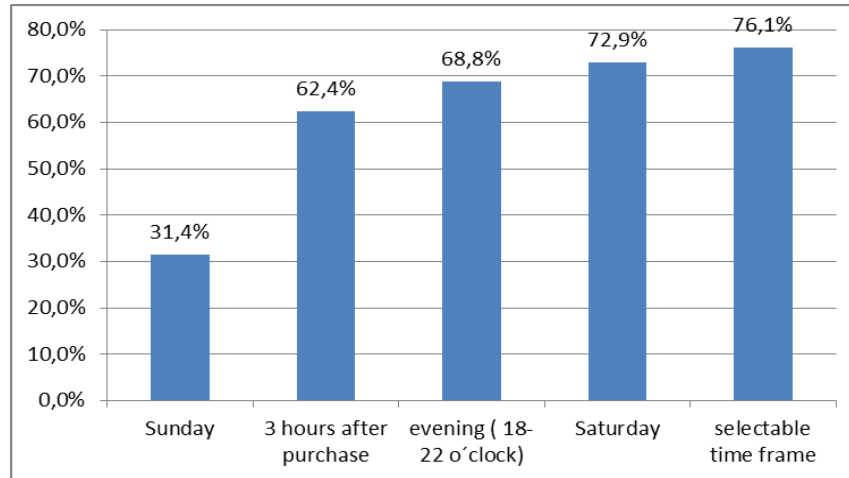


Fig. 5. Interested and very interested consumers in alternative time frames in % of consumers (n=1000)

Combining alternative time frames and purchasable products leads to a similar result seen in other researches based on regular daytime delivery, with books, music etc. with the highest results (Einwiller, 2013) and food with the least percentage (Ahrhold, 2009; Eurostat, 2016; Richter, 2015), in this research an average of 22,8%. Exceptions are Sunday delivery, where the delivery of food products, e.g. grain products with 40,8% of consumers (top figure is books, music etc. with 48,8%) would use the service, and delivery within 3 hours, where food products 35,2% would use the delivery (top figure is books, music etc. with 45,5%). To be able to perform an alternative delivery time frame, it is necessary to know, how the order behaviour is, especially the point of time the order is done (multiple selections possible for the following answers). With the ED purchase within 3 hours, as an SDD service, two thirds are interested in, 20% would order until 8 o'clock in the morning, 47% between 8 and 12 'clock and 30% in the afternoon, which makes the main delivery time frame between noon and early afternoon. On Sunday one third are interested, 37,3% would like to order until 12 o'clock and 23,3% still in the afternoon. Basically, it can be said, that order times for alternative time frame delivery is less before noon then in the afternoon and that almost two thirds would order one day in advance and approximately 30% two days before. Surprisingly 88,5% (evening delivery) up to 93,0% (delivery within a selectable time frame) want to receive their ordered product personally, which implies the necessity of AHD for consumer satisfaction, and only in average 28,4% would want their products in RBs and in average 11,4% in CDPs.

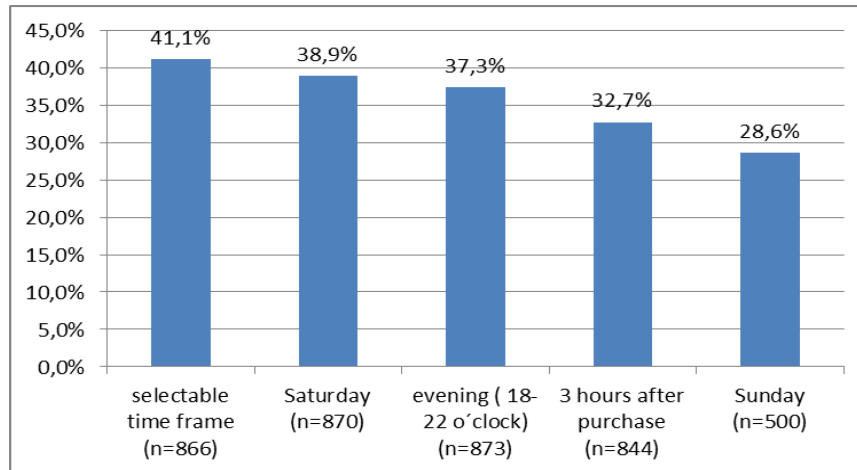


Fig.6. Purchase frequency (Σ of weekly and monthly) in % of potential alternative time frame delivery users

In purchase frequency (Figure 6: Σ of weekly and monthly estimated usage) the top three are selectable time frame delivery (41,1%), Saturday delivery (38,9%) and evening delivery (37,3%). If the two parameters, purchase frequency (weekly & monthly) and interest in service, are considered, Sunday delivery is the one with only 12,2% of potential customers.

5.3. Willingness to Pay

In the times of Amazon prime, when Amazon prime member pay a yearly fee and enjoy free shipping besides other benefits (Welch, 2015; Krämer & Kalka, 2017) and approximately 60% of online retailers cite “free shipping with conditions” (Yang & Essegai & Bell, 2005), it seems questionable if costumers are still willing to pay for extra service. To answer this question for each alternative time frame delivery the interviewees where asked, if they are willing to pay and how much they are willing to pay. One third of the consumers are not willing to pay, with the exception of Sunday delivery (50,2%; n=450) and ED (46,3%; n=805). On average the consumers would be willing to pay € 4,88 for the services. At a closer look between 82,5% (evening delivery; n=263) and 91,4% (ED; n= 373) would pay € 3,- or more for the delivery.

5.4. Relationship between Alternate Delivery Time Frames (ADTFs), Delivery Methods (Last Mile), and Customers' Willingness to Pay

The section examines relationships between different constructs related to E-customer expectations in alternative delivery time frames. It includes interest of the customers in various alternative delivery times, preference towards the three delivery methods (AHD, RB, and CDPs), and customers' willingness to pay. The variables, measured via multiple items in the questionnaire, are computed using factor analysis.

Table1. Relationships between Interest in ADTFs and Willingness to pay (Source: Author's own estimation)

Relationships	Chi Sq.	Sig.	Cramer's V	Strength
Interest in ED * Willing to Pay for ED	37.892	Yes	0.213	Moderate
Interest in BD * Willing to Pay for BD	70.163	Yes	0.295	Moderately Strong
Interest in SatD * Willing to Pay for SatD	26.394	Yes	0.177	Weak
Interest in SunD * Willing to Pay for SunD	12.604	Yes	0.167	Weak
Interest in DPD * Willing to Pay for DPD	38.113	Yes	0.211	Moderate

The Table 1 computes relationships between Interest in ADTFs (Evening delivery, block delivery, delivery on Saturdays, delivery on Sunday, and delivery within desired period) and customer's willingness to pay for the respective ADTFs using Chi square statistic. According to the result, the association between each of the given set of variables is statistically significant at 0.05 level. In other words, interest in ADTFs and willingness to pay are not independent. However, the relationships with respect to delivery on Saturday and delivery on Sunday are weak.

Table.2. Correlation between ADTFs and Delivery Methods (Last Mile)

Correlations			
		Alternate Delivery Time Frame	Delivery Methods
Alternate Delivery Time Frame	Pearson Correlation	1	.234**
	Sig. (2-tailed)		.000
	N	1000	1000
Delivery Methods	Pearson Correlation	.234**	1
	Sig. (2-tailed)	.000	
	N	1000	1000

** . Correlation is significant at the 0.01 level (2-tailed).

The association between ADTFs and delivery methods is statistically significant at 0.01 level (Table 2). The Pearson correlation coefficient is equal 0.234 (weak correlation). It suggests that increasing interest of the customers in various alternative delivery times is associated with high preference of the customers towards the three delivery methods.

Table.3. Regression Analysis

Coefficients^a				
Model		B	t	Sig.
1	(Constant)	.997	14.125	.000
	Alternate Delivery Time Frame (ADTF)	.116	6.560	.000
	Delivery Methods (DM)	.130	6.098	.000
a. Dependent Variable: Willingness to Pay				
Sig. Value		0.000		
F Statistic		49.63		
R Square		0.093		
Adjusted R Square		0.092		

The study proposes a regression model in the context of E-customer expectations in alternative delivery time frames (Table 3). The model examines the impact of ADTFs and preference towards delivery methods on willingness to pay of the customer. The results show a statistical significant impact of the regression model on

customers' willingness to pay at 0.01 level. The R-square value is equal to 0.093; it means that 9.3% of the variance in the dependent variable is explained by the two predictors. Both predictors (independent variables) are individually significant (at 0.01 level) with positive beta values. It suggests that with an increase in customer's interest in ADTFs and preference towards the three delivery methods, customer's willingness to pay increases.

On the basis of the above analysis, the regression model of the study is:

$$WTP = 0.997 + 0.116 (ADTF) + 0.130 (DM)$$

Where WTP, ADTF, and DM represent willingness to pay, alternative delivery time frame, and delivery methods respectively.

6. Discussion

The discussion focusses on the different alternative time frames, last mile problems and barriers as well as financial factors, that applies to the consumer requested kind of delivery. Not considered are national employment laws or environmental topics, e.g. CO2 emissions.

In urban multi-party houses 74,2 % (fig. 7) are interested in evening delivery and over 32,5 % are willing to pay that makes 24,1% of total potential customers (family homes a maximum between of 15,3% urban and 18,4% rural) who are willing to pay for the service with 37,3% using the service at least monthly, particular consumers until the age of 39 years. The upside of evening delivery is that it starts with the end of rush hour at 6 o'clock (Zhang & Batterman & Dion, 2011) with less risk of traffic disadvantage and time controlled locking systems being closed. The possibility of encountering the consumer rises as well after working hours. A higher rate of encounter minimizes costs, as well as faster average speed due to less traffic. As the consumers are not used to evening delivery and could be offended by an interruption in their private sphere, in the questionnaire it was asked until when an evening delivery could be possible. 91% accept a delivery until 20 o'clock, 61% until 21 o'clock and 31% until 22 o'clock in the evening, which leaves a two to three-hour time frame for delivery.

38,9% would use Saturday delivery at least once a month (notably almost half of families would use it once a month) with up to 74,5% (Figure 7) consumer interest within urban multi-party houses and 31,1% of these are willing to pay for it (similar results in the rural areas). 61% of the potential customers would want the delivery until 12 o'clock, with young customers until 29 years being more flexible and accepting delivery in the afternoon. The risk of traffic or parking disadvantage is less than Monday to Friday, which has a direct impact on speed and costs. On the other hand, the possibility of locked doors is rising on weekends. With the same last mile problems and barriers, the least of interest is in Sunday delivery - from 23,6% in family homes to 39,0% in urban multi-party houses - but the highest results in willing to pay - up to 56,2 % in rural areas. Furthermore, the product interest tends more to food products, e.g. grain products (40,8%), with a tendency towards consumers of higher age. Like on Saturday is with 57% preferred until noon. This makes Sundays an economical niche for food products.

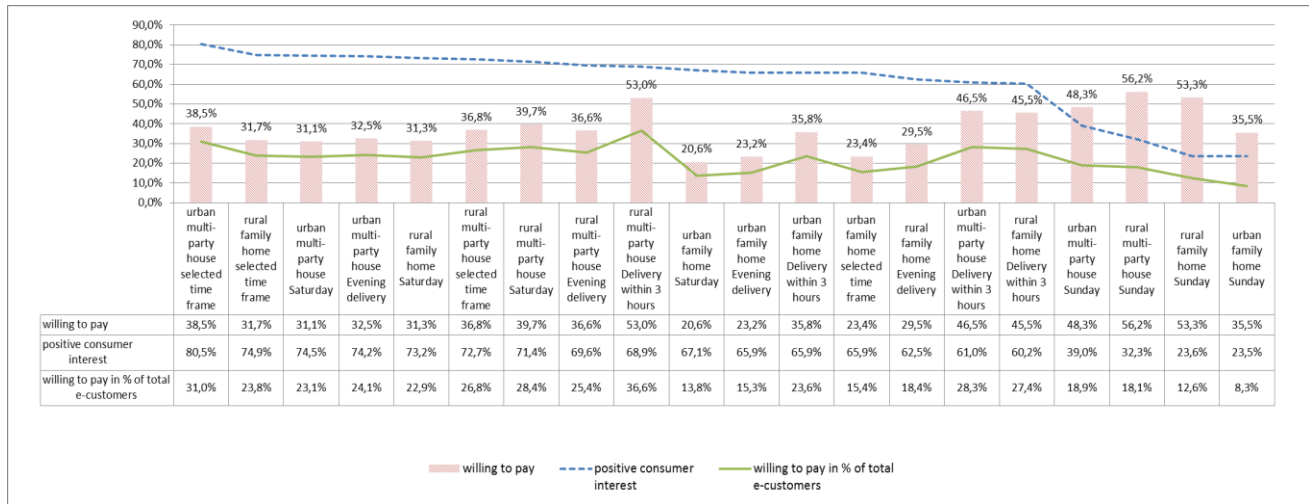


Fig.7. Consumer interest, willingness to pay (of interested consumers) and willing to pay of total e-customers in % related to urban / rural alternative time frame delivery

Express delivery within 3 hours is of interest for more than 60% of e-customers. Out of these are 46,3% willing to pay for it, but only one third would use it once a month or more often. High costs in transportation come with this service (Geimer & Becker, 2001) and it needs for the availability of the products additional advanced warehousing solutions. Decentralized storage facilities, which enable a short delivery time, raise costs additionally. Parking, traffic and locked door risks depend on the purchase and delivery time. The risk of consumer absence is lower than on the regular daytime delivery without delivery awareness.

The delivery within a selectable time frame is of high interest, especially for urban multi-party house e-consumers with 80,4% and still over 72,6% in rural areas, with a low willingness to pay for the service (23,4% to 38,5% - fig.7). Customer selectable narrow time windows are more costly, up to 45% for a 3 hours delivery window (Boyer & Prud'homme & Chung, 2009), due to minimized routing efficiency (Agatz & Campbell & Fleischmann & Savelsbergh, 2011). The last mile risks still depend on the customer selected time frame, with the advantage for the online shop of being able to set an earliest delivery time after the purchase and the length of the time frame. This reduces the problem of decentralized storage facilities, raises the plannability of delivery tours and the probability of the presence of the customer for an AHD. The recent tests of DHL (DHL, 2017) in Germany with selectable time frames and UPS having a patent on "parcel or service delivery with partially scheduled time windows" (Young, 2007) shows that service will go this direction.

The AHD is not possible between 22 o'clock in the evening and 6 o'clock in the morning - the night time delivery. Nevertheless, it can be the most cost efficient way of delivery, considering the fact that traffic is less of a problem. To be able to use this time frame, the delivery has to be in RBs or CDPs that are accessible and the customer does not have to be present to sign an acceptance. The accessibility of CDPs that are part of the delivery company or contract partners can be achieved easier than the accessibility RBs on private property. RBs on private property need permission, space and a box with an easy operable locking system and furthermore the general door locking system of the building has to let the carrier pass during night time. The base of this delivery choice has to be a data base that collects constantly all this information of the building for the last mile delivery. RBs, besides decreasing costs up to 60%, there is one further strategical point of few: If the RB on private property is only usable by the delivery company that mounted the RBs, it is building up a market entry barrier (Trinker & Holznagel & Jaag & Dietl & Haller, 2012), like letterboxes in the USA, that only can be used by one

deliverer, USPS (Kruse & Liebe, 2005; Dieke & Jung & Zauner, 2010). This market barrier will pull the consumer towards the delivery company for the convenience of having the purchased goods delivered to a save and close delivery point. Still there is limited investment in RBs by delivery companies (Fernie & Leigh, 2014). The results of the survey show that an average 28,4% would accept a delivery in an RB by the first delivery and only 11,4% to the CDPs, which are useful for returning the online purchased products (Weltevreden, 2008).

7. Conclusions

From a consumer point of view, e-commerce and distribution of physical products start with an actual online purchase within a web shop. There are the possibilities for a consumer to make choices concerning the delivery, if the necessary delivery information data are available. Choices such as which delivery company should deliver, the time frame of delivery, preferred delivery (AHD, RB, CDP) should be available for an optimum of consumer satisfaction with immediate presentation of prices. As 90% of consumers prefer AHD, personal handover to the consumer within a personal selected time frame, which 76,1% are interest in, is most likely to be selected. If the consumer is not present within the selected time frame, although he had been noticed shortly before the arrival of the deliverer, the delivery should go to the nearest RB, preferably in the building or walking distance, which as well the consumer chose during the purchase process (as alternative deposit if not present). The last choice should be a CDP, the consumer has to go or drive to. As evening delivery and Saturday delivery are of interest for two thirds of the consumers, it should be a selectable alternative. ED can be an option for specific products, with low purchase frequency, but 46,3 % willing to pay for the service. Sunday delivery can be seen as a niche product for weekly food consumers, with 50,2% are willing to pay for the service.

Considering the delivery companies side delivery within a consumer selected time frame can be a distinguishing feature or selling proposition, if the choice is available in the online shop. It can have positive effects on the first-time delivery rate to the customer, as the probability of the customer being presence increases. The option of a selected time frame will have effects on the route planning and will lead to more kilometers within the last mile (Macharis et al., 2011), which has effects on the costs. An efficient route planning software and not to narrow time frames can antagonize this effect. As tracking systems are already advanced, an automatically generated notice on a phone (e.g. SMS, APP) should notify the customer before the AHD. The selectable time frames do not necessarily have to be a part of the regular daytime delivery, but it can be a possibility of service differentiation if evening delivery and Saturday delivery is provided. If the consumer can choose a second alternative deposit possibility, if not present, it is most likely to choose the service provider that has the nearest facility, which will be the one with an RB within the property. If RBs are available, they even can be a market barrier. CDPs should be provided for pick up products, that have to have an acceptance signed and for a possibility to send back goods.

The results from statistical analysis suggests the significance of ADTFs and DMs (AHD, RB, CDP) in driving customer's purchase intention. As delivery companies start to develop and test consumer selected time frames for delivery, it will be an asset that comes as soon as technology makes it possible. The density of RBs will rise, especially provided by national market leaders who have enough financial resources to mount RBs and defend their market. As drones or robots, which are tested already in Hamburg (Hermes, 2016), RBs can be a solution for delivery and return. The combination of alternative selected time frame delivery and second deposit possibility, the RBs, will reduce second deliveries and costs as well as increase consumer satisfaction.

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TACKLING PROJECTS ON SUSTAINABILITY: A LITHUANIAN CASE STUDY*

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Abstract. Companies are increasingly coming under strong global pressure to incorporate sustainability considerations into their project decision-making process. This is where project managers play a vital role. However, how project managers approach sustainability in their daily work still has to be explored. Therefore, this article seeks to determine whether and to what extent project managers take into account sustainability in project management decision making. Research was carried out in Lithuania, selecting two industries: construction and automotive. The case study revealed that project managers in Lithuania still do not give much regard to sustainability when making their decisions. Only a limited number of sustainability criteria are taken into account by project managers in their decisions. Research also showed that a project manager gives more consideration to sustainability in project management decision making than a project team member.

Keywords: sustainability, project, project management, project manager, decision making.

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1. Introduction

At present, both sustainability and project management are important and expected to grow in importance even more in the future. The relationship between project management and sustainability is rapidly gaining interest from both practitioners and scholars (Silvius 2014; Dobrovolskienė and Tamošiūnienė 2015; Økland 2015; Marcelino-Sádaba et al 2015; Dobrovolskienė and Tamošiūnienė 2015a; Silvius 2016; Dobrovolskienė and Tamošiūnienė 2016; Carvalho and Rabechini 2017; Silvius et al 2017). Sustainability is one of the most important

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issues that need to be taken into account in decision-making process at different levels of project-oriented organization (Daneshpour 2015). It has to be incorporated within a project and project portfolio to support and achieve the objectives of organization (Tufino et al 2013; Hope and Moehler 2014; Sanchez 2015; Priess et al. 2017; Sulphrey, Alkahtani 2017; Čirjevskis 2016; Strielkowski et al. 2016; Jurigová et al. 2016; Doubravský et al. 2016; Traversari et al. 2017; Barberis et al. 2017).

With a relationship between projects and sustainability being established, it is recognized that project managers are in the best position to contribute to sustainable management practices (Silvius et al 2017). By virtue of their central position in the project, project managers are able to influence many aspects of the project (Silvius 2016). At the 22nd World Congress of the International Project Management Association (IPMA) in 2008, IPMA President Mary McKinlay stated that “the further development of the project management profession requires project managers to take responsibility for sustainability”. Today’s project manager not only performs traditional project management roles but also has to manage the project as efficiently and effectively as possible taking account of sustainability (Hwang and Ng 2013; Goedknegt 2013; Silvius et al 2017). However, project managers are still lagging behind when it comes to incorporating the concept of sustainability into core practices of project management (Banihashemi et al 2017). Silvius and Schipper (2014) stated that it has to be looked into how project managers approach sustainability in their operational daily work. Therefore, this study aims at clarifying whether project managers take into account sustainability in project management decision making.

In this research, two industries were selected, namely construction and automotive. The construction sector was chosen for three reasons. First, projects in the construction industry are among the most important, as this sector is one of the largest sectors and of major importance for the national economy (Dobrovolskienė and Tamošiūnienė 2015). Second, construction projects have a huge impact on the environment and society (Yao et al 2011). Third, within project management, sustainability, and more specifically the environmental dimension, is widely applied in construction projects (Marcelino-Sádaba et al 2015). The second sector, that is, automotive, was chosen to ascertain whether project managers working in companies in different industries have differing views on sustainability in project management decision making.

This article is structured into sections. Section 2 presents a review of the literature on sustainability in project management. Section 3 describes decision making in project management. The results of a case study are provided in Section 4. The paper is finished with some conclusions and suggestions for further research.

The research methods are: analysis of scientific literature and other information sources, survey and statistical analysis. Statistical analysis was performed by using SPSS24 software.

2. Sustainability in project management

The link between sustainability and project management is increasingly being addressed in numerous publications (Silvius and Schipper 2014; Økland 2015; Marcelino-Sádaba et al 2015; Dobrovolskienė and Tamošiūnienė 2015a; Silvius 2016; Dobrovolskienė and Tamošiūnienė 2016; Silvius and Schipper 2016; Carvalho and Rabechini 2017; Silvius et al 2017). Sustainability in project management is primarily focused on the preservation of natural resources, positive impacts on the society and the strengthening of the global economy. The Project Management Institute states that sustainability in project management is a new global model of doing business and managing a project to incorporate sustainability in every phase (Gutierrez 2014; Dobrovolskienė and Tamošiūnienė 2015a).

The review of the academic literature indicates that some researchers have particularly focused on the link between project management and ecodesign, that is, the environmental dimension of sustainability (Knight and

Jenkins 2009; Brones et al 2014; Brones et al 2017; Oates et al. 2017; García-Fuentes, de Torre 2017; Gandini et al. 2017).

For example, Bovea and Pérez-Belis (2012) referred to three parameters in order to optimize a product's ecodesign process: (a) introducing environmental aspects into product design and the development process at an early stage; (b) life cycle focus; and (c) multi-criteria focus, given that environmental and traditional criteria have to be regarded concurrently. Pigosso et al (2013) proposed an ecodesign maturity model for manufacturing organizations that serves as a framework for its progressive implementation.

Quite a few authors have addressed sustainability in project management in the context of Triple Bottom Line, that is, considering all three aspects of sustainability (environmental, social and economic) (Fernández-Sánchez and Rodríguez-López 2010; Dobrovolskienė and Tamošiūnienė 2015a; Marcelino-Sádaba et al 2015; Sánchez 2015; Martens and Carvalho 2016; Siew et al 2016; Pimentel et al 2016; Dobrovolskienė and Tamošiūnienė 2016; Banihashemi et al 2017; Kivilä et al 2017). For instance, Marcelino-Sádaba et al (2015) showed the interrelations between sustainability and project management as well as outlined a new conceptual framework to manage sustainable projects. Their work is based on the assumption that project products developed in accordance with sustainability criteria, sustainable project processes, sustainability-oriented organizations, and project managers trained in sustainability are the key elements underlying sustainable projects.

Within project management, sustainability is widely applied in construction projects. Sustainability in construction covers not only environmental issues, technical efficiency and functional requirements, but also urban renewal and social aspects. Sustainable construction aims to design buildings that would allow saving energy and resources, protecting the health of residents and ensuring their well-being (Dobrovolskienė and Tamošiūnienė 2015). Construction projects have been explored in more depth because of their significant impact on the environment, society and economy (Yao et al 2011).

The review of the academic literature also shows that some authors considered the problem of building the best portfolio in terms of the organizational strategy incorporating sustainable goals. Vandaele and Decouttere (2013) developed a data envelopment analysis (DEA) model designed to support strategic research and development portfolio management. Khalili-Damghani and Tavana (2014) proposed a comprehensive framework for sustainable strategic project selection problem. Siew (2016) proposed methods whereby sustainability is taken into consideration during two crucial stages: screening and optimal portfolio selection. The screening stage involves proposing sustainability criteria and measuring the sustainability of projects. The means and variances derived from the screening stage are then used to find the efficient portfolio frontier (the expected return being substituted by the expected sustainability score of projects, and the variance of return being substituted by dispersion of the sustainability score). Dobrovolskienė and Tamošiūnienė (2016) developed a sustainability-oriented model of financial resource allocation in a project portfolio. The use of the model would allow decision-makers to decide on their optimal portfolio taking into account their respective preference with regard to return, risk and sustainability, i.e. they should decide what projects to finance and execute (e.g. those providing the greatest business value with the acceptable level of sustainability, or those providing the greatest value of sustainability with acceptable level of return). The model is therefore a suitable tool for most decision-makers to express their individual preference.

The majority of recognized project management standards, such as PMBOK of PMI (Project Management Institute 2012) or ISO 21500, are based on processes. Many authors (Marcelino-Sádaba et al 2015) applied the process approach for the purpose of introducing sustainability in project management. The following are among the most frequently mentioned processes: stakeholder management, life cycle management, assessment and decision making (Marcelino-Sádaba et al 2015). From the sustainability point of view, stakeholder management is

focused on balancing their interests, and in particular the pursuit of personal economic benefit against social and environmental goals (De Brucker et al 2013). Some authors (Pade et al 2008; Gareis et al 2009; Eskerod and Huemann 2013) stress the importance of stakeholder participation in projects. The life cycle is the focus paradigm for business and projects based on sustainability criteria. Nearly all sustainability elements identified across the projects, take the life cycle focus (Marcelino-Sádaba et al 2015). According to Labuschagne and Brent (2005), as a starting point for aligning project management standards against sustainable development principles, one needs to understand that several life cycles are involved in a project interacting with each other. The sustainability assessment can be applied in implementing projects and in making strategic decisions (Marcelino-Sádaba et al 2015). Assessment tools are techniques used to facilitate the comparison of different project alternatives (Gasparatos and Scolobig 2012) and decision making (Bond et al 2012). The sustainability assessment process must be designed explicitly to deliver sustainable results. Ness et al (2007) developed a holistic framework for sustainability assessment tools, which includes three categories: (a) indicators and indices; (b) product-related tools; and (c) integrated assessment. Sustainability assessment is linked to decision making. Sustainability assessment is increasingly introduced as a key decision making tool (Bond et al 2012). The most frequent decision making support systems related to sustainability are based on indicators or indices (Marcelino-Sádaba et al 2015).

Although there are over 200 publications dealing with sustainability and project management (Økland 2015), many questions still need to be answered (Marcelino-Sádaba et al 2015). This means that sustainability in project management still represents a vast untapped research area (Singh et al 2012, Martens and Carvalho 2016). Furthermore, more empirical, not conceptual, studies need to be carried out look into how sustainability could be practically implemented in the field of project management.

3. Decision making in project management

In the complex global business environment, decision makers find themselves faced with increasing challenges and exposed to unforeseen circumstances. On the other hand, decision making is crucial to every aspect of business, and in particular project management, which involves making a multitude of decisions on a daily basis about priorities, approaches, resources, and timelines (PMI 2015). Within project management, decision making has a primary role in determining success or failure of a project. There is no question that poor decisions lead to negative consequences for project outcomes. The most effective decision making – the kind that contributes to achieving better project outcomes – results from a formal, methodical approach, such as the five-step process described in A Guide to the Project Management Body of Knowledge: (1) problem definition; (2) problem solution generation; (3) ideas to action; (4) solutions evaluating planning; and (5) evaluation of the outcomes and process. So, decision making does not merely mean making a specific choice at a particular point in time. Decision making is a process (Kock and Georg Gemünden 2016), which can be influenced by many factors (Behrens et al 2014; Kester et al 2014; Marcelino-Sádaba et al 2015). The stage-gate process facilitates the decision-making process in projects. The purpose of the gates is not only to decide on the continuation of the process, but also to identify failure at an early stage so that resources would not be wasted but would be allocated to activities with better prospects (Silvius et al 2017). Decision making in project management is traditionally based on the three constraints or “iron triangle”, i.e. cost, time and quality (Papke-Shields et al 2010; Silvius et al 2017). The factor “risk” is also among the control variables in project management (Silvius et al 2017). Decisions in projects are made under risk and uncertainty, which means that decision makers do not fully know what the states of nature will occur and what payoffs will be achieved for each state of nature.

Thus, decision making in project management is traditionally dominated by considerations relating to cost, time, quality and risk. However, some authors (Hwang and Ng 2013; Silvius et al 2017) argue that sustainability aspect should be also considered in decision making and that decision making is a critical skill for sustainable projects.

4. Case study: sustainability in project management decision making

In order to ascertain whether project managers and project team members consider sustainability in project management decision making, reference was made to the study carried out by Silvius et al (2017). A two-part questionnaire was prepared. Two questions were defined in the first part, namely: (1) How well is sustainability incorporated in the strategy of your company? and (2) How well is sustainability incorporated in your daily work? The second part included a list of 14 statements. Each statement was related to aspect of sustainability (Table 1).

Table 1. Statements

No	Statements	Sustainability dimensions
S1	Within decision making in projects the ecological footprint should be taken into account	Sustainability is about balancing or harmonizing social, environmental and economic interests
S2	Within decision making in projects a percentage of project time and budget should be spent on health and safety practices	Sustainability is about values and ethics
S3	Within decision making in projects sustainable resources should be used	Sustainability is about consuming income, not capital
S4	Within decision making in projects we listen to other people's point of view, seeking to understand them	Sustainability is about stakeholder orientation
S5	Within decision making in projects the economic, social and environmental consequences are crucial	Sustainability is about balancing or harmonizing social, environmental and economic interests
S6	Within decision making in projects the amount of energy used in the project is essential to take into consideration	Sustainability is about balancing or harmonizing social, environmental and economic interests
S7	Within decision making in projects stakeholder engagement is vital	Sustainability is about stakeholder orientation
S8	Within decision making in projects we need to be aware of the community's opinion	Sustainability is about transparency and accountability
S9	Within decision making in projects health and safety issues are checked	Sustainability is about values and ethics
S10	Within decision making in projects the amount of waste produced in the project is key	Sustainability is about eliminating waste
S11	Within decision making in projects the carbon footprint is crucial to take into account	Sustainability is about balancing or harmonizing social, environmental and economic interests
S12	Within decision making in projects the sustainability of the project life cycle is important	Sustainability is about both short-term and long-term orientation
S13	Within decision making in projects sustainable procurement is a must	Sustainability is about both local and global orientation
S14	Within decision making in projects renewable resources are vital	Sustainability is about consuming income, not capital

Source: Silvius et al 2017

Our study was carried out in Lithuania. It involved companies operating in two industries (construction and automotive). Questionnaires were sent out to 185 companies. Respondents were selected on the basis of the following criteria: their position, work experience. After questionnaires were sent out, including follow-up reminders, a total of 28 responses were received (a response rate of around 15%). Our response rate is consistent with other studies, e.g. Martens and Carvalho (2016) had a 13.6% response rate, Pagell et al (2015) had a 12.1% response rate in their study.

Thus, 28 respondents took part in research: 71% from the construction industry and 29% from the automotive industry. The respondents were project managers (43.75%) and project team members (56.25%). The respondents were 33 years old (on average), with seven years of experience in project management (range 5...22). 17.86 % of the group had a Bachelor's or Master's degree in the field of project management.

As already mentioned above, the respondents were first asked two questions about (1) the incorporation of sustainability in the strategy of the company and (2) the incorporation of sustainability in their daily work. The respondents rated these questions on a scale from one to ten. Table 2 shows the results on two initial questions.

Table 2. Incorporation of sustainability

Questions	Minimum	Maximum	Mean	Std. Deviation
Construcion industry				
How well is sustainability incorporated in the strategy of your company?	1	9	5.88	2.53
How well is sustainability incorporated in your daily work?	1	8	5.50	2.33
Automotive industry				
How well is sustainability incorporated in the strategy of your company?	1	8	5.38	2.20
How well is sustainability incorporated in your daily work?	1	8	5.13	2.30

Source: authors

The average value of the incorporation of sustainability in the strategy of a company is a little bit higher than the incorporation of sustainability in the daily work. This trend is characteristic of both industries. These findings are not contrary to the results obtained by Silvius et al (2017). Moreover, these findings seem to support the statement of Briassoulis (2001) that it remains difficult to express sustainability in concrete, operational terms. When the two industries are analyzed separately, it is clear that the average values of both questions are slightly higher in the construction industry. This could be due to the fact that sustainability is widely used in construction projects (Yao et al 2011; Bal et al 2013; Marcelino-Sádaba et al 2015). The respondents were then asked to rate each statement on a 5-point Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree. The results are presented in Table 3.

Table 3. Consideration of sustainability

Statement No	Construction industry				Automotive industry			
	Minimum	Maximum	Mean	Std. Deviation	Minimum	Maximum	Mean	Std. Deviation
S1	3	5	4.00	0.53	2	5	3.75	1.16
S2	3	5	4.12	0.64	2	5	3.62	1.18
S3	3	5	3.87	0.83	1	4	3.00	1.06
S4	2	4	2.87	0.64	1	4	2.75	1.16
S5	3	4	3.25	0.46	1	4	2.75	1.16
S6	3	5	4.12	0.83	3	4	3.50	0.53
S7	2	4	3.00	0.53	1	5	3.00	1.41
S8	1	4	2.25	0.88	1	3	1.87	0.99
S9	4	5	4.75	0.46	4	5	4.50	0.53
S10	3	4	3.62	0.51	1	4	3.25	1.03
S11	2	4	2.87	0.83	1	5	2.62	1.18
S12	1	4	2.75	1.03	1	5	2.62	1.18
S13	1	4	2.50	1.30	1	4	2.12	0.83
S14	1	4	2.25	1.16	1	2	1.87	0.35

Source: authors

The analysis of the findings shows that, when taking decisions, both construction sector project managers and automotive sector project managers take the utmost account of health and safety (statement No S9). This shows that the social dimension receives a lot of attention. It is an interesting insight, once some studies suggest that the social dimension represents a major gap (Singh et al 2012). There is also a difference between our findings and the results obtained by Silvius et al (2017). The study carried out by Silvius et al (2017) showed that the statement “Stakeholder engagement is vital” is most present in the project managers’ considerations. Moreover, the statement “We need to be aware of the community's opinion” was also among the top ranked statements in their research, whereas our research revealed that the community's opinion does not perform a significant role in the decision-making process of project managers.

When rating the statements, the respondents could have assigned a maximum of 70 points and a minimum of 14 points. The figures in Table 4 lead to the conclusion that project managers employed in construction companies put more emphasis on sustainability in their decisions than project managers employed in automotive companies (the average score in the construction industry is 12% higher than in the automotive industry). As already mentioned above, it could be due to industry-specific features.

Table 4. Consideration of sustainability by industry

	Construction industry	Automotive industry
Minimum	61	52
Maximum	34	22
Mean	46,25	41,25
Std. Deviation	8,68	11,66

Source: authors

Furthermore, the analysis of the survey data revealed that there is a moderate correlation (Pearson Correlation is 0.55, correlation is significant at the 0.05 level (2-tailed) between position (project manager or project team member) and sustainability considerations. Project managers’ considerations of sustainability are higher (the highest score was 61) than project team members’ considerations (the highest score was 52). This could be due to the fact that project managers are more aware of the benefits of sustainability. The analysis of the survey data by industry showed that this correlation is stronger in the construction industry (Pearson Correlation is 0.74) than in the automotive industry (Pearson Correlation is 0.53).

Conclusions

This paper contributes to discussions on sustainability in project management. The paper presents an empirical study on how sustainability considerations are integrated into the decision-making processes of project managers. We found that only a limited number of sustainability criteria are taken into account by project managers when making their decisions, health and safety being most present in project managers’ considerations. The priority for health and safety issues may be explained by industry-specific features.

Our research also revealed a moderate correlation between position and sustainability considerations (Pearson Correlation is 0.55). Overall, project managers give more consideration to sustainability in project management decision making than project team members. This could be due to the fact that project managers, being responsible for the success of a project, are more aware of the benefits which sustainability can bring. Moreover,

this correlation is stronger in the construction sector (Pearson Correlation is 0.74) than in the automotive sector (Pearson Correlation is 0.53)

The findings of the study should be interpreted with caution due to some limitations. The sample size was relatively small. Moreover, the respondents came only from two industries. These findings do not necessarily reflect the viewpoints of project managers working in other business sectors. These limitations give grounds for further investigation using larger samples across different industries. Furthermore, different phases of project management can be measured in the decision-making process. For instance, sustainability might be the most important issue when making decisions on project financing and play a less important role during project implementation.

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EVALUATION OF RESILIENCE IMPACT ON SOCIO-ECONOMIC INEQUALITY*

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Abstract. This paper presents a new approach according to which the issue of socio-economic inequality is addressed not by applying social or fiscal policy measures, but by strengthening societal psychological resilience: by shaping a society characterized by a high level of social culture and education, by fostering a society in which individuals are resistant to life difficulties. In this paper, we pursue the aim of demonstrating the socio-economic vulnerability factors, the importance of strengthening resilience and reduction of socio-economic inequality, by analyzing data of a survey which was conducted in 2016 (representative sample, n=1001). The research results have demonstrated statistically significant differences of resilience in different income quintiles' groups and resilience in different subjective socio-economic status groups and have revealed statistically significant differences in reaction to life difficulties in different income quintiles' groups and in different subjective social economic status groups.

Keywords: socio-economic inequality, vulnerability, vulnerable social groups, resilience, hardiness, household income, subjective socio-economic stratification, Lithuania

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JEL Classifications: D63; D31; A14; Z13

1. Introduction

The UNDP stresses that real progress on human development is not only a matter of enlarging people's critical choices and their ability to be educated, be healthy, have a reasonable standard of living and feel safe. It is also a matter of how sustainable these achievements are and whether conditions are sufficient for sustained human development. An account of progress in human development is incomplete without exploring and assessing vulnerability (Human Development Report, 2014). In recent years, a number of researchers have discussed the impact of societal psychological resilience on socio-economic inequality and quality of life. "We have to think of inequality not as a moral issue, but as an economic challenge, closely linked, firstly, to economic growth and, secondly, to the increase of vulnerability" (Stiglitz 2012). Many researchers have analyzed the issues of vulnerability and resilience and proposed assessment methodologies and comparative analyses by various

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composite indicators. The question is, why some individuals are more resilient to life's difficulties and achieve more than others? The main point here is individual endurance, the ability to withstand the trials of life, which ensures sound choices, stability, both now and in future, and allows better coping with difficulties and adapting to them. The surveys conducted in 2014-2016 at Mykolas Romeris University show that in recent years, the largest concern for more than 80.0% of the Lithuanian population has been the threat of an increase in individual vulnerability (unemployment, fall in the standards of living, threat of income loss). Vulnerable social groups comprise children, the youth, the elderly, females, the disabled. Various other social groups may be vulnerable too – the poor, individuals exposed to social exclusion, migrants etc. The insecurity of these groups as a structural issue is increasing and extends over a long term, which further exacerbates their inequality in respect of employment, social status, income, and standards of living. It is not easy for vulnerable groups to overcome all these obstacles. Although Lithuanian researchers have suggested resolving the issue of vulnerable groups through active employment and social policy measures, there is a lack of research on strengthening resilience. Therefore, in order to determine the most effective ways of reducing socio-economic inequality by increasing psychological resilience, vulnerability and resilience as objects of research require more in-depth analysis.

2. Theoretical aspects of socio-economic vulnerability and resilience

The concept of *social vulnerability* began to be used primarily in the context of natural hazards and disasters (e.g., floods, earthquakes), hence it is common that this concept is often used in risk management literature (Alwang, Siegel, etc., 2001; Conway, Norton, 2002). However, social vulnerability has recently been understood as a current condition that describes individual (public) social conditions and the ability to recover after facing life challenges.

According to researchers, the concept of social vulnerability emphasizes two central aspects:

1. both the causes and the phenomenon of a disaster are defined by social processes and structures. Thus, it is not only a geo- or biophysical hazard, but rather the social context that is taken into account to understand 'natural' disasters (Hewitt 1983);
2. although different groups of a society may share a similar exposure to a natural hazard, the hazard has varying consequences for these groups, since they have diverging capacities and abilities to handle the impact of the hazard (Gulf Writing Services, 2016).

Social vulnerability is partially the product of social inequalities – those social factors that influence or shape the susceptibility of various groups to harm and that also govern their ability to respond (Cutter *et al.*, 2003). It is important to note that social vulnerability is not registered by exposure to hazards alone, but also resides in the sensitivity and resilience of the system to prepare, cope and recover from such hazards (Turner *et al.*, 2003). Another concept encountered in scientific literature is *economic vulnerability*, which is defined as “the exposure of an economy to exogenous shocks, arising out of economic openness, while economic resilience is defined as the policy-induced ability of an economy to withstand or recover from the effects of such shocks” (Briguglio, Cordina, etc, 2008). In this article, the authors perceive vulnerability in a broader sense – as a potential risk, faced by certain social groups or communities, of failures, stressful situations, economic difficulties, natural disasters, climate change, and military conflicts, which are collectively referred to as *socio-economic vulnerability*.

Vulnerability is often understood as the counterpart of *resilience*. The theory of resilience emerged from clinical psychology, representatives of which worked with the juveniles who successfully established themselves despite the serious troubles and difficulties of life experienced by them (Masten, 2001, cit. Luthans *et al.*, 2008). *Resilience (hardiness)* shows the ability of a personality to cope with a stressful situation, while maintaining internal balance and continuing successful activity. The problem, raised by psychologists, of an individual's ability to cope with stress, diseases, increase of productivity, and improvement of the quality of life at work grew into an entire theory of resilience and the concept models which are widely used worldwide. Human resilience to

life's difficulties means ensuring of choices now and in the future, which allows to better cope with adverse life events and to better adapt to them. From the psychological point of view, resilience to life's difficulties is a system of a person's attitudes and beliefs about himself, the world and the relationship with the world. This is a certain inner courage that enables the person to be less dependent on circumstances. This feature helps a person to cope with anxiety, fear, and threats and helps to take the right decision.

In its most general sense, resilience to life's difficulties means a fast and effective recovery from a situation causing severe stress (Luthans, Avey, Clapp-Smith, Li, 2008), constructive behavior under significant unfavorable circumstances (Masten, Obradović, 2006), "a positive psychological ability to recover from a difficult situation, insecurity, conflict, failure or increased responsibility" (Luthans, 2002, cit. Luthans *et al.*, 2008). The individuals characterized by resilience possess the following features: conscious acceptance of reality; a deep belief that life is meaningful; this belief is often based on a firm value system; a strongly expressed ability to flexibly adapt to significant changes in life and to overcome life's challenges and difficulties, including economic ones.

Resilience is relatively variable and can be strengthened. A few decades ago, it was believed that resilience is a rare feature, but now it is recognized that it is a psychological ability that all individuals possess and can be developed. In other words, every person has the potential for resilience, but it is actual possibilities of the individuals to make use of this resource during a negative stress or an emergency that differ (Luthans, Avey, Clapp-Smith, Li, 2008). It is interesting that there is evidence that, once activated, the power of resilience not only allows an individual to recover from a particular event which affects him, but also to operate even more successfully than in the previous equilibrium, for example, if a negative event occurs at a workplace, a worker possessing this feature returns to a higher motivation level (Luthans, Avey, Clapp-Smith, Li, 2008). As early as in 1987, Maddi found that hardy and fast recovering employees of an organization which went through mass job cuts retained better health and happiness and maintained the previous level of performance (Luthans *et al.*, 2007). Another study showed that the resilience of a Chinese factory's workers involved in major organizational changes was associated with the performance appreciated by their managers (Luthans *et al.*, 2005). To sum up, resilience is a potentially developed and enhanced positive psychological construct, an adaptive system enabling an individual to quickly recover from a significant adverse event experienced by him; resilience is associated with satisfaction with life, happiness, and commitment (Yossef, Luthans, 2007). Resilience by Salvatore Maddi is a system of an attitude towards oneself and the world and relationships with the world that reduces (alleviates) internal tension in stressful situations and promotes coping with stress.

Resilience to life's difficulties is the ability to eliminate the obstacles that prevent a person from functioning freely, taking part in the creation of his life, his destiny. Its promotion means increasing choices, building competence and capacities, and strengthening psychological traits, which the authors emphasize as one of the potential ways of reducing social and economic inequality. According to the UNDP report, "vulnerability threatens human development – and unless it is systematically addressed, by changing policies and social norms, progress will be neither equitable nor sustainable" (Human Development Report, 2014). Thus, the authors believe that the issue of socio-economic vulnerability must be addressed not only by means of traditional social or taxation policies, but also by investing in science and education, strengthening human and societal resilience to life's difficulties, creating an educated and solidarity-based society, thus reducing social tension and inequality. The interaction of socio-economic vulnerability and resilience is described by means of the following groups of factors: 1) vulnerable social groups (who is vulnerable), 2) difficulties, hazards, threats (in what way the society or its social groups are vulnerable), and 3) risk of threats or reduction of their consequences through promotion of resilience to life's difficulties – public awareness raising and education, creation of a solidarity-based community, development of independent living skills, etc. (Figure 1).

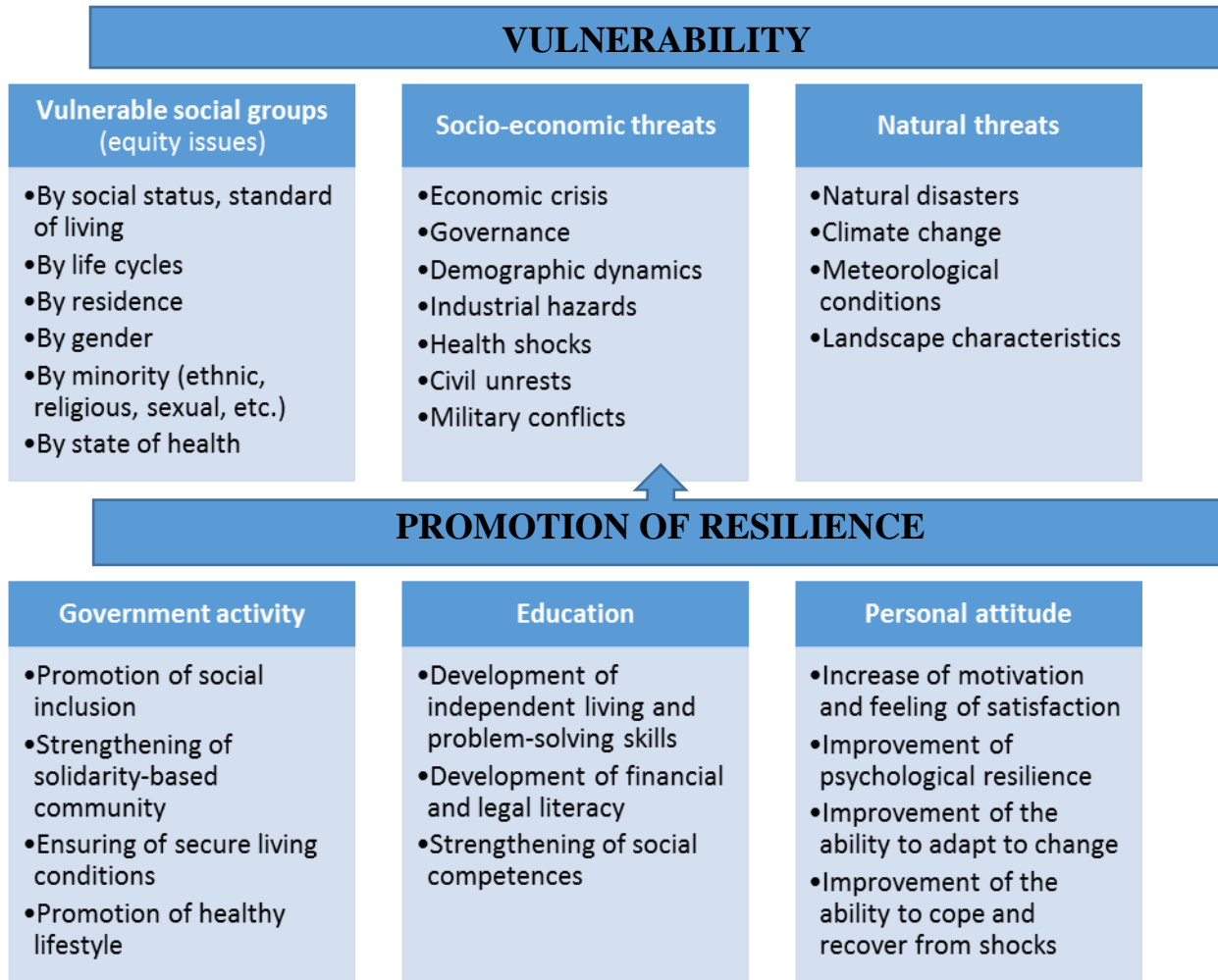


Figure 1. Vulnerability and resilience interaction
Source: developed by the authors, 2016

The chances of the population to overcome difficulties are also significantly increased by state economic policy, the approach of state authorities to the macroeconomic factors determining the well-being of the population, i.e., not only to employment, taxation and income distribution and social policy, but also to cultural and educational policy and the psychological factors affecting the socio-economic vulnerability of society through state economic policy.

3. Survey and sample characteristics

This study used a test design utilizing a heterogeneous random sample of 1001 persons representing the Lithuanian population. Object of the research: Lithuanian inhabitants aged 18 and over. Method of sampling: multi-stage random sampling. The respondents were personally interviewed at their home, the interview took approximately 1.5 hours. The Lithuanian sample was selected in a multi-scaled probabilistic way so that every

inhabitant of Lithuania could have an equal chance to be interviewed. The survey was performed in 2016 and was conducted in 19 cities and 24 villages. K means that the analysis was applied to cluster the respondents into low, medium and high household net income groups.

4. Results

4.1. Level of vulnerability and resilience of the Lithuanian population

In performing a study of Lithuanian society, the authors sought to identify the key threats and factors that determine its vulnerability and to assess the psychological resilience of inhabitants and their ability to overcome difficulties by different subjective socio-economic stratification and income quintiles' groups.

The results of the survey show a high level of vulnerability of the Lithuanian population. Depending on risk factors, 30-60 per cent of the population experience anxiety caused by various fears and threats.

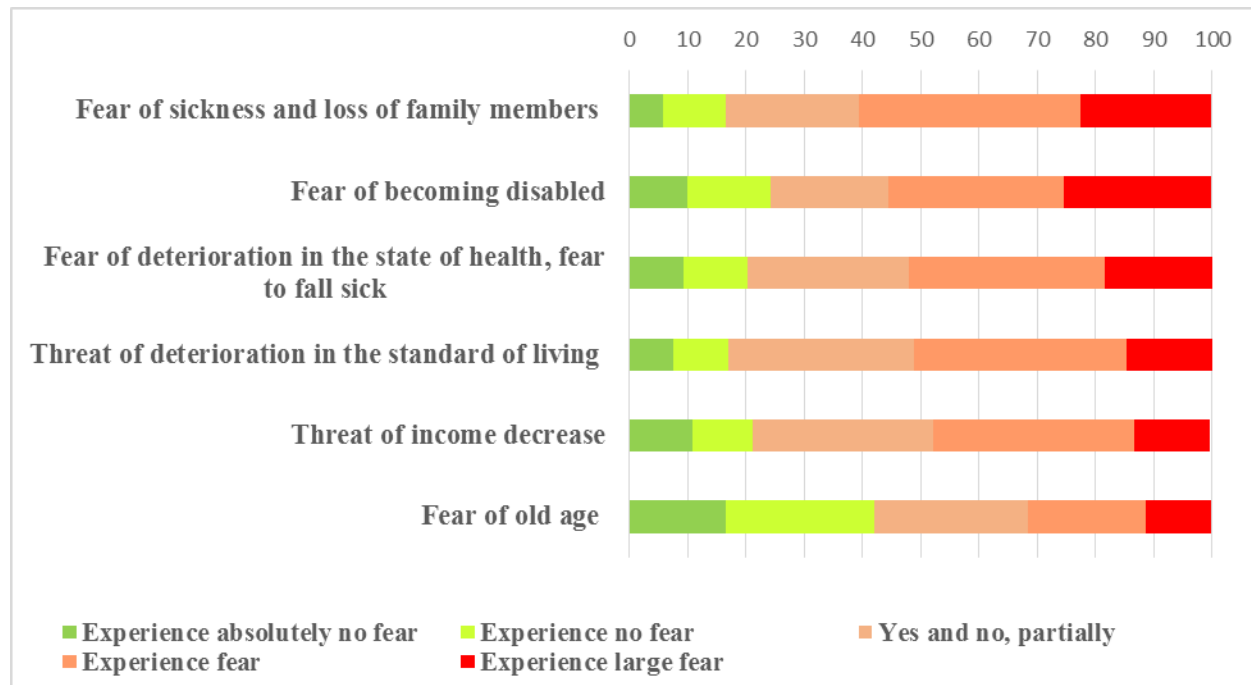


Figure 2. Vulnerability, per cent (N=1001, public opinion survey 2016)

Source: developed by the authors, 2016

The respondents perceive vulnerability as individuals' fear of sickness and disability, decline of income, losing job, deterioration in material well-being, fear of old age, of loneliness, and of emigration.

More than half of the population fear relatives' disease and loss (60.5 per cent), deterioration in the state of health and disease (52 per cent), developing disability (as much as 55.4 per cent of the respondents). This kind of anxiety can be explained also by the fear of becoming incapable of work, because the social benefits payable in Lithuania in the event of decrease in the level of capacity for work or the loss of such capacity are one the lowest in the EU, hence in the event of an emergency a person does not expect to receive any state aid.

The second group of threats comprises threats of deterioration in the standard of living, i.e., deterioration in material well-being and income decrease, the risk of poverty, which are faced by respectively 51.1 per cent, 47.6 per cent and 47.3 per cent of the population.

Approximately half of the Lithuanian population fear deterioration in material well-being, approximately one-third of the inhabitants (31.2 per cent) are negatively affected by social injustice and socio-economic inequality. It should be noted that the fear of not finding a suitable job or losing it is characteristic of the majority of young people and partly – of middle-aged people, while the fear of emigration is experienced by 16.3 per cent of people. However, the majority of Lithuanian inhabitants consider the following as the biggest threats in the country increasing vulnerability: unemployment (83.8 per cent), ineffective economic policy (indicated by 82.3 per cent of the population), and poverty (81.7 per cent).

Responses of the respondents regarding resilience to life's difficulties show that over 60.0 per cent of the Lithuanian population respond to current difficulties calmly and without panic and try to do everything in their power: 63 per cent try to resolve problems calmly and step by step; 66.2 per cent do everything in their power and then leave events to chance; 69.7 per cent calmly respond to stress and gradually solve problems. Helplessness in overcoming difficulties of life is experienced by only about 20 per cent of the population: as little as 17.6 per cent of the population postpone resolution of problems and do not struggle; problems crush 20.7 per cent of the population and do not elicit their willingness to act. Moreover, approximately 42.3 per cent of the population view emerging life's difficulties as the challenges that must be overcome without fear by checking oneself, gaining experience and developing one's capacities.

4.2. Relationship between socio-economic inequality and psychological resilience

This study analyzed how socio-economic inequality is related to personal psychological resilience. The Subscale of Resilience, as part of the Psychological Capital (PsyCap) Scale constructed by F. Luthans (Luthans, 2007), was used for this study. The questionnaire included some additional statements based on literature review and previous research on resilience and its cognitive and emotional resources (Andres, Collings, Qin, 2010; Brown, Beck, Steer, & Grisham, 2000; Arria *et al.*, 2009; Brown *et al.*, 2000; Khan, Leventhal *et al.*, 2002; Sareen, Cox, Afifi, de Graaf, Asmundson, *et al.*, 2005; Have, de Graaf, van Dorsselaer, Verdurmen *et al.*, 2009; Crump, Sundquist, Sundquist, Winkleby, 2013; Ishtiak-Ahmed, Perski, Mittendorfer-Rutz, 2013).

The results of the research have revealed statistically significant differences in resilience in different income quintiles' groups ($H(2)=137.710$, $p=0.000$) (Table 1). Mean ranks in the lowest income quintile K1 were about two times lower than mean ranks in the highest income quintile K5.

Table 1. Resilience in different quintiles' groups: independent groups comparisons, F. Luthans resilience subscale, Kruskal-Wallis test ($n=1001$)

	Income quintiles	N	Mean ranks	H (2) Chi square	df	p
Resilience	K1	172	335.69	137.710	4	<0.001
	K2	199	428.98			
	K3	249	490.26			
	K4	194	593.88			
	K5	187	647.64			

The research results have also revealed statistically significant differences in resilience in different subjective socio-economic status groups ($H(2)=132.364$, $p=0.000$). Mean ranks in subjectively the poorest group were almost three times lower than in subjectively the richest group of people (Table 2).

Table 2. Resilience in different subjective socio-economic status groups: independent groups comparisons, F. Luthans resilience subscale, Kruskal-Wallis test (n=998)

	Subjective socio-economic status groups	N	Mean ranks	H (2) Chi square	df	p
Resilience	Subjectively rich enough	125	625.51	132.364	3	<0.001
	Middle level, but not always have enough money	552	554.37			
	Poor, sometimes cannot satisfy basic needs	276	374.87			
	Total poverty - subjectively the poorest	45	240.82			

This study also aimed at analyzing differences in reaction to life's difficulties in different income quintiles and different subjective socio-economic status groups. The research results (Table 3) have revealed statistically significant differences in reaction to life's difficulties in different income quintiles' groups. The lowest income quintile K1 demonstrated the highest mean ranks in the following reactions: "life problems and challenges are perceived as paralyzing will and initiative" (H(2)= 58.956, p=0.000), "extremely sensitive and stressful reaction to life problems and challenges" (H(2)= 38.452, p=0.000), "procrastination of problem solving, belief that the life will solve the problems somehow" (H(2)= 25.641, p=0.000). On the contrary, the highest income quintile K5 demonstrated absolutely different reactions: "moderate stress to life challenges and balanced step by step approach to problem solving" (H(2)= 75.036, p=0.000), "mindful personal efforts and acceptance of whatever life could bring" (H(2)= 31.618, p=0.000), "problems are perceived as life challenges which might inspire personal growth" (H(2)= 39.441, p=0.000), "life problems and difficulties are perceived as stimulating initiative, activity, 'fighting' to win" (H(2)= 13.904, p=0.000).

Table 3. Reactions to life difficulties in different quintiles' groups: independent groups comparisons, Kruskal-Wallis test (n=1001)

Reaction to life difficulties	Income quintiles	N	Mean ranks	H (2) Chi square	df	p
Life problems and challenges are perceived as paralyzing will and initiative	K1	172	591.79	58.956	4	<0.001
	K2	199	520.90			
	K3	249	533.13			
	K4	194	470.10			
	K5	187	385.59			
Extremely sensitive and stressful reaction to life problems and challenges	K1	172	561.95	38.452	4	<0.001
	K2	199	510.78			
	K3	249	537.03			
	K4	194	486.90			
	K5	187	401.18			
Moderate stress to life challenges and balanced step by step approach to problem solving	K1	172	380.72	75.036	4	<0.001
	K2	199	460.61			
	K3	249	498.69			
	K4	194	573.21			

	K5	187	582.78			
Constructive coping, mobilization of resources and problem solving	K1	172	393.02	58.012	4	<0.001
	K2	199	464.87			
	K3	249	508.26			
	K4	194	561.53			
	K5	187	566.29			
Mindful personal efforts and acceptance of whatever life could bring	K1	172	414.18	31.618	4	<0.001
	K2	199	475.78			
	K3	249	522.33			
	K4	194	541.99			
	K5	187	536.76			
Procrastination of problem solving, belief that the life will solve the problems somehow	K1	172	564.91	25.641	4	<0.001
	K2	199	521.81			
	K3	249	511.34			
	K4	194	479.55			
	K5	187	428.57			
Problems are perceived as life challenges which might inspire personal growth	K1	172	426.78	39.441	4	<0.001
	K2	199	469.46			
	K3	249	490.18			
	K4	194	523.37			
	K5	187	594.03			
Life problems and difficulties are perceived as stimulating initiative, activity, 'fighting' to win	K1	172	466.25	13.904	4	0.008
	K2	199	472.85			
	K3	249	493.95			
	K4	194	512.94			
	K5	187	559.92			

The research results have also revealed statistically significant differences in reaction to life difficulties in different subjective social economic status groups (Table 4). Mean ranks in subjectively the poorest group of individuals were significantly higher for the following reactions: “life problems and challenges are perceived as paralyzing will and initiative” ($H(2)= 75.350, p=0.000$), “extremely sensitive and stressful reaction to life problems and challenges” ($H(2)= 50.134, p=0.000$), “procrastination of problem solving, belief that the life will solve the problems somehow” ($H(2)= 32.861, p=0.000$). On the contrary, subjectively richer individuals reacted differently: “moderate stress to life challenges and balanced step by step approach to problem solving” ($H(2)= 41.724, p=0.000$), “constructive coping, mobilization of resources and problem solving” ($H(2)= 38.524, p=0.000$), “problems are perceived as life challenges which might inspire personal growth” ($H(2)= 26.466, p=0.000$), “life problems and difficulties are perceived as stimulating initiative, activity, ‘fighting’ to win” ($H(2)= 33.522, p=0.000$).

Table 4. Reactions to life difficulties in different subjective socio-economic status groups: independent groups comparisons, Kruskal-Wallis test, (n=998)

Reaction to life difficulties	Subjective socio-economic status groups	N	Mean ranks	Chi square	df	p
Life problems and challenges are perceived as paralyzing will and initiative	Subjectively rich enough	125	405.02	75.350	3	<0.001
	Middle level, but not always have enough money	552	461.23			
	Poor, sometimes cannot satisfy basic needs	276	589.24			
	Total poverty – subjectively the poorest	45	680.94			
Extremely sensitive and stressful reaction to life problems and challenges	Subjectively rich enough	125	411.58	50.134	3	<0.001
	Middle level, but not always have enough money	552	477.65			
	Poor, sometimes cannot satisfy basic needs	276	550.54			
	Total poverty - subjectively the poorest	45	698.72			
Moderate stress to life challenges and balanced step-by-step approach to problem solving	Subjectively rich enough	125	561.35	41.724	3	<0.001
	Middle level, but not always have enough money	552	523.46			
	Poor, sometimes cannot satisfy basic needs	276	452.21			
	Total poverty – subjectively the poorest	45	323.78			
Constructive coping, mobilization of resources and problem solving	Subjectively rich enough	125	548.97	38.524	3	<0.001
	Middle level, but not always have enough money	552	524.23			
	Poor, sometimes cannot satisfy basic needs	276	455.56			
	Total poverty – subjectively the poorest	45	328.23			
Mindful personal efforts and acceptance of whatever life could bring	Subjectively rich enough	125	470.48	3.680	3	.298
	Middle level, but not always have enough money	552	512.06			
	Poor, sometimes cannot satisfy basic needs	276	492.10			
	Total poverty – subjectively the poorest	45	471.43			
Procrastination of problem solving, belief that the life will solve the problems somehow	Subjectively rich enough	125	424.30	32.861	3	<0.001
	Middle level, but not always have enough money	552	477.77			
	Poor, sometimes cannot satisfy basic needs	276	568.08			
	Total poverty – subjectively the poorest	45	554.32			
Problems are perceived as life challenges which might inspire personal growth	Subjectively rich enough	125	554.21	26.466	3	<0.001
	Middle level, but not always have enough money	552	520.84			
	Poor, sometimes cannot satisfy basic needs	276	452.12			
	Total poverty – subjectively the poorest	45	376.36			
Life problems and difficulties are perceived as stimulating initiative, activity, ‘fighting’ to win	Subjectively rich enough	125	528.58	33.522	3	<0.001
	Middle level, but not always have enough money	552	523.06			
	Poor, sometimes cannot satisfy basic needs	276	472.89			
	Total poverty – subjectively the poorest	45	292.94			

Conclusions:

1. Research results have revealed significant subjective vulnerability of the Lithuanian population: vulnerability is perceived as individuals' fear of sickness and disability, decline of income, losing job, deterioration in material well-being, fear of old age, of loneliness, and of emigration. More than half of the population fear relatives' disease and loss (60.5 per cent), deterioration in the state of health and disease (52 per cent), developing disability (as much as 55.4 per cent of the respondents). Approximately half of the Lithuanian population fear deterioration in material well-being, approximately one-third of the inhabitants (31.2 per cent) are negatively affected by social injustice and socio-economic inequality. However, considering characteristics of the country's population according to the criteria of resilience to life's difficulties as specified by US psychologist Salvatore Maddi, the resilience of the inhabitants to life's difficulties is nonetheless relatively high.
2. The research has revealed statistically significant differences in resilience in different income quintiles' groups. Mean ranks in the lowest income quintile K1 were about two times lower than mean ranks in the highest income quintile K5.
3. The research results have demonstrated statistically significant differences in resilience in different subjective socio-economic status groups. Mean ranks in subjectively the poorest group were almost three times lower than in subjectively the richest group.
4. The research results have revealed statistically significant differences in reaction to life difficulties in different income quintiles' groups. The lowest income quintile K1 demonstrated the highest mean ranks in the following reactions: "life problems and challenges are perceived as paralyzing will and initiative", "extremely sensitive and stressful reaction to life problems and challenges", "procrastination of problem solving, belief that the life will solve the problems somehow". On the contrary, the highest income quintile K5 demonstrated absolutely different reactions: "moderate stress to life challenges and balanced step-by-step approach to problem solving", "mindful personal efforts and acceptance of whatever life could bring", "problems are perceived as life challenges which might inspire personal growth", "life problems and difficulties are perceived as stimulating initiative, activity, 'fighting' to win".
5. The research results have also revealed statistically significant differences in reaction to life difficulties in different subjective socio-economic status groups. Mean ranks in subjectively the poorest group were significantly higher for the following reactions: "life problems and challenges are perceived as paralyzing will and initiative", "extremely sensitive and stressful reaction to life problems and challenges", "procrastination of problem solving, belief that the life will solve the problems somehow". On the contrary, subjectively richer people reacted differently: "moderate stress to life challenges and balanced step-by-step approach to problem solving", "constructive coping, mobilization of resources and problem solving", "problems are perceived as life challenges which might inspire personal growth", "life problems and difficulties are perceived as stimulating initiative, activity, 'fighting' to win".

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INTELLECTUAL CAPITAL AS A DRIVING FORCE OF INTERNATIONALIZATION: A CASE OF LITHUANIAN SMEs

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Abstract. Constantly changing technologies, increasing competition, unstable demand of consumers, economic and political changes encourage managers to seek new opportunities abroad and thus, expand their firms' activities. Considering the importance of knowledge in a number of industries, competition is shaped by the firms' intellectual capital. Referring to the intellectual capital theory, the assumption about the importance of intellectual resources in internationalization process is suggested. Grounded on intellectual capital theory and the main aspects of SMEs internationalization the paper aims to reveal the significance of some important factors in internationalization of Lithuanian SMEs. The study is based on expert evaluation method and reports the findings from questioning the representatives of science and business. The internationalization of SMEs is driven by work experience of employees, ability to transmit experience and international orientation of managers. These factors contribute to the development of technical knowledge and strategy development processes. Consequently, obtained technical expertise and strategies lead to the higher reputation of managers in international context. The findings are significant for entrepreneurs having strong intentions to expand their businesses and policy makers, concerning about promotion and support of internationalization processes. The insights into the development of future investigations are suggested.

Keywords: intellectual capital, human capital, structural capital, relational capital, internationalization, SMEs

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1. Introduction

Constantly changing technologies, increasing competition, unstable demand of consumers, economic and political changes encourage managers to seek new opportunities abroad and thus, expand their firms' activities. Considering the importance of knowledge in a number of industries, competition is shaped by the firms'

intellectual capital (IC). Thus, IC is seen as a source of competitive advantage and significantly contributes to the performance of firms.

The role of small and medium size enterprises (SMEs) in the countries' economies is crucial and thus, determines the growth potential. On the other hand, small firms have limited resources and capabilities, limiting their ability to use international opportunities. Thus, a vast literature on SMEs internationalization aims to suggest the insights contributing to the expansion processes of small firms. While some studies emphasized a significance of human capital (Cerrato, Piva 2012; Colombo, Grilli, 2005; Galabova, McKie 2013), other studies investigated social capital (e.g. Johanson, Vahlne 2006), personal and inter-firm networks and their interrelationships with internationalization (e.g. Manolova et al. 2007). The investigations focused on IC of small firms are limited and are focused on the management of intangible assets (Cohen, Kaimenakis 2007). A significant number of reported researches were carried out in the context of developed countries. Meanwhile, the investigations of small firms in emerging markets contexts are less developed (Korsakienė, Baranauskienė 2011; Korsakienė, Tvaronavičienė 2012; Korsakienė et al. 2015). Hence, investigations of IC and interrelationships with internationalization of the SMEs is seen as a fruitful venue in the scientific literature. Grounded on IC theory and the main aspects of SMEs internationalization the paper aims to reveal the significance of some important factors in internationalization of Lithuanian SMEs.

2. Literature review

Intellectual capital

Intellectual capital is one of the main organisation's sources, contributing to competitive advantage, long-term prosperity and effectiveness. Though IC has attracted a significant number of researchers, the common agreement about the concept has not been achieved. Thus, the different scholars provide different definitions and adopt different approaches.

Early definitions on IC emphasise to the wealth contributing knowledge, information, intellectual property and experience (Stewart 1997). Notably, the definition provided by Stewart (1997) was grounded on the analysis of several organizations (e.g. Skandia, Hughes Aircraft, etc.), which achieved appropriate level in managing IC phenomenon. Edvinsson and Sullivan (1996) assert that IC is a knowledge which can be transformed to value. The definition imply that the value of organisation lie in IC, comprised of knowledge, experience, organisations' technologies, relationships with customers and skills of employees, contributing to the achieved competitive advantage. Meanwhile, other scholars distinguish IC as the intangible assets of the organisation and the value of these assets "cannot be deducted from routine market transactions" (Bontis 1998). Therefore, IC do not comprise intellectual property such as copyrights, patents, design rights, trade and service marks and etc. Later on, Cohen and Kaimenakis (2007) defined IC as "the combination of knowledge-bearing intangible resources that the firm has at its disposal" whose effective management impact sustainable competitive advantage. The definition implies that the organisation doesn't own or control all these resources despite the fact that the non-competing contracts with former employees are signed. These resources are at the disposal of organisation and the effective management of these resources lead to the positive results. Grounded on previous investigations, the scholars concluded that IC is "total stocks of all intangible assets and capabilities in the company" at employee level and organisational level, comprised of human, structural and relational capital (Zerenler et al. 2008). The concept stems from the assumptions about tacit knowledge, personal knowledge and interactions through network relationships (Hsu, Wang 2010). Contrary to the early investigations on IC, the literature suggests main elements of IC such as, human capital, structural capital and relational capital.

Human capital (HC) is one of the most important components of IC. Hsu and Wang (2010) assert that HC is defined as knowledge, skill, innovations and abilities of organisation's employees, impacting the development of

intellectual assets and rights. HC is related to the individuals, working in the firm, and demonstrate their obtained knowledge and abilities (Korsakienė et al. 2015). Some scholars, investigating HC, suggest to include personal attitude, obtained relationships, loyalty and motivation, health and work ability (Galabova, McKie 2013). The contribution of individuals' knowledge and skill to the firm's productivity and efficiency stems from HC theory. Though aiming to "estimate employees' income distribution from their investments in human capital" (Unger et al. 2011), HC theory attracted considerable attention of scholars, working in entrepreneurship and management field. From the strategic management perspective, human capital is assumed as a considerable source of competitive advantage (Galabova, McKie 2013). Meanwhile, a number of studies revealed that human capital (e.g. education, industry specific knowledge, etc.) is related to the success of entrepreneurial firms (Collombo, Grilli 2005; Manolova et al. 2007; Rauch, Rijsdijk 2013). Thus, it appears that the productivity and efficiency of the firm can be increased through appropriate investments into employees.

Structural capital (SC), comprising the infrastructure of the firm, is another component of IC. SC include a stock of knowledge owned by the firm, corporate culture, information technologies, explicit knowledge, process optimisation and others. The explanation of SC resides in the answers "what happens among people, how people are connected and what stays when the employees leave" (Halim 2010). Some scholars assert that structural capital include organisational capital which consists of the embedded knowledge, driving the performance of the firm and relational capital comprising relationships with stakeholders (Cohen, Kaimenakis 2007). Meanwhile, Hsu and Wang (2010) assert that SC should be conceptualised in terms of processes and information systems. Though, the adopted definition is different to the approaches suggested in strategic management literature, it discloses the importance of the way how employees use the information or in the workplace available knowledge resources and the information technologies used in managing knowledge.

The relationship capital (RC) is focused on the development, maintenance and nurturing relationships with organisations, individuals or groups of individuals (Welbourne, Pardo-del-Val, 2009). It appears that the conceptualisation of RC stems from social capital and network theories and thus, is concerned how to mobilise the resources through social structure. Some scholars suggest to define RC as implicit set of available resources and ongoing relationships (Shipilov, Danis 2006). The adopted approach implies that RC vary and depend on investigated relationships and the resources deployed through these relationships. In the small firm context, RC enable entrepreneurs to develop critical resources and capabilities required for both local and international expansion. On the other hand, the scholars emphasise key aspects of RC such as, trust, trustworthiness and cognitive dimensions, determining the perceptions of fairness in the relationships (Hsu, Wang 2010).

A stream of investigations on IC aimed to disclose how to manage intangible assets, knowledge stock and capabilities of organisation (Chen 2007). Thus, the investigations were concerned with value creation or competitive advantage of the firm achieved through intangible assets and capabilities. Another stream of studies was triggered by the attempt to measure intellectual capital. The scholars sought to measure intangible assets which are not represented by the financial reports. Meanwhile, the importance of IC on the firms' internationalisation is less investigated and thus, the phenomenon of IC in relation to internationalization of small firms requires deeper understanding.

Internationalization and intellectual resources

The increasingly integrated economy, continued decline of various barriers imposed by governments and advances in technology significantly contribute to internationalization of firms. The investigations of internationalization, especially in the small firm context, have gained vast popularity in the last few decades. While some scholars referred to the growth of the firm and internationalization as the interrelated concepts (Buckley and Ghauri 1993), others emphasized unique features to internationalization and disclosed the difference between growth at home and growth internationally (Ruzzier et al. 2006). The investigations have led to the

conclusion that internationalization activities are different from domestic activities because “they entail exchange between firms located in different countries” (Agndal 2004).

Internationalization of the firm is seen as a complex and multidimensional process. Thus, the definition can be conceptualised as the increased involvement of the firm in international operations, the expansion of geographical markets, the supply of products to the wider groups of customers, the change of operational methods, management philosophy and organisational behaviour. Notably, internationalization process is interrelated to the consistent international activities, experience and accumulated knowledge. International business literature, focused on large companies, has led to the insights that internationalization processes require more financial and non-financial resources, contributing to the successful performance (Caves 1982). The assumptions lie in the resource-based theory, emphasising the development of unique, difficult to imitate and immobile resources, contributing to competitive advantage in the market (Barney 2001). A stream of studies, adopting resource-based view, emphasise knowledge and thus, assume that knowledge is unique resource of the firm. Organisational processes, required for integration of various types and forms of knowledge, are essential aiming to gain and maintain competitive advantage (Grant 1996). Meanwhile, another stream of studies assume that higher performance lie in the developed network and the ability to manage various stakeholders (Dyer, Singh 1998). Thus, the network compensates the shortage of available resources and leads to the acquisition of essential resources outside the boundaries of the firm.

The studies, focused on the small business internationalization, emphasise the scarce resources as the main obstacle to expand business abroad (Ruzzier et al. 2006). A number of studies investigated the importance of various types of resources (human, financial, organisational, etc.) and the role of knowledge in internationalization processes (Cerrato, Piva 2012; Casillas et al. 2014). Referring to the IC theory, we recognize the importance of intellectual resources in internationalization process. Thus, combination of human, structural and relational capital is seen as significant contributor to the expansion of small firms and especially to the firms, operating in knowledge-based industries.

3. Method

Lithuanian SMEs

The number of Lithuanian SMEs comprises 99,8% of all Lithuanian businesses and play a significant role in Lithuania’s economy growth and development. Statistical data reveal that the biggest share of SMEs predominates by very small firms having less than 10 employees. The majority of all firms are established and operate in the biggest cities of Lithuania (e.g. Vilnius, Kaunas, Klaipeda) and thus, demonstrate uneven distribution of small firms among all municipalities. On the other hand, Lithuanian firms tend to be bigger than in the EU (Table 1).

Table 1. Small and medium-sized enterprises in Lithuania

	Number of enterprises			Value added		
	Lithuania		EU27	Lithuania		EU27
	Number	Share	Share	Bill. EUR	Share	Share
Micro	143 843	91,5%	92,8%	2,3	17,3%	21,2%
Small	10 913	6,9%	6,0%	3,3	25,0%	18,0%
Medium-sized	2 064	1,3%	1,0%	3,7	28,1%	18,2%
SMEs	156 820	99,8%	99,8%	9,2	70,3%	57,4%

Source: SBA Fact Sheet 2016-Lithuania

Considering value added of SMEs by sectors, transportation sector, construction sector information and communication sector and manufacturing demonstrate positive trends. For instance, SMEs contribute by 30% of value added in transportation sector and exceeds the EU average. Meanwhile, in 2010-2015 value added in construction sector more than doubled, in information and communication sector increased by a quarter and in manufacturing increased by almost a third (SBA Fact Sheet, 2016). Despite the positive trends, Lithuanian SMEs, in comparison to the EU average, demonstrate lower performance in terms of internationalization. The explanation resides in the fact that the Russian Federation is country's main trading partner and thus, the negative tendencies are reflected in the World Bank's evaluation.

Expert selection and data collection

The study, aiming to reveal the significance of IC on internationalization of Lithuanian SMEs, is grounded on expert evaluation method. To date, expert evaluation is assumed as the approach suitable to investigate a problem, process or phenomenon requiring vast knowledge, skill and experience (Vveinhardt, Gulbovaitė 2016). The method has been applied in various investigations and thus, is suitable for scientific investigations in social sciences. The procedure leads to the combined opinions and suggested solutions of experts. Considering the fact, that the method relies on competent persons, we decided to combine knowledge and experience of experts, representing science and business. Thus, a group of experts include five experts, representing Lithuanian high education institutions (1st group), five experts (owners and managers), representing Lithuanian SMEs (2nd group) and five experts (consultants dealing with SMEs), representing a branch of Scandinavian bank, operating in Lithuania (3rd group). The experts from high education institutions were selected considering the following criteria: field of scientific research, scientific degree and work experience. Meanwhile, owners and managers of SMEs were selected considering their management experience, business founding experience and international experience. The experts, representing a branch of Scandinavian bank, operating in Lithuania, were selected considering the following criteria: work experience in a field of small business, work experience in a banking sector and high education diploma. Notably, the work experience in a field of all experts range from 5 to 15 years. The number of experts correspond to the suggested in scientific literature and thus, guarantee reliable and objective results (Podvezko 2008).

The analysis of scientific literature on IC let us develop the questionnaire. Grounded on scientific investigations, the questionnaire included factors from HC, SC and RC perspectives (Table 2).

Table 2. Components of intellectual capital

Intellectual capital	Factors	References
Human capital	Attitude of employees	Hornsby, Kuratko (2003)
	Educational level of employees	Wang (2008)
	Ability to transmit experiences	Jardon, Martos (2012)
	Work experience of employees	Ruzzier et al. (2007)
	Formal human resource management practices	Hayton (2003)
	International orientation of managers	Manolova et al. (2002)
	Ability to evaluate investment risks	Jardon, Martos (2012)
	Capacity for innovations in processes, products or markets	Ireland, Webb (2007)
	Training of employees	Jardon, Martos (2012)
	Productivity of employees	Hsu, Wang (2010)

	International business skills	Ruzzier et al. (2007)
Structural capital	Organisational culture	Jardon, Martos (2012)
	Organisational structure	Chen et al. (2004)
	Product technologies	Jardon, Martos (2012)
	Strategy development process	Jardon, Martos (2012)
	Customer databases	Chen (2008)
	Total innovations	Ordóñez de Pablos (2004)
	Product development processes	Jardon, Martos (2012)
	Supply processes	Jardon, Martos (2012)
	Marketing processes	Jardon, Martos (2012)
	Service processes	Jardon, Martos (2012)
	Intellectual property rights	Sharabati et al. (2010)
	Infrastructure of the firm	Ordóñez de Pablos (2004)
Relational capital	Managerial reputation	Castro et al. (2004)
	Distribution channels type	Jardon, Martos (2012)
	The direct relationships with end customers	Jardon, Martos (2012)
	Relationships with government agencies	Castro et al. (2004)
	Relationships with partners	Jardon, Martos (2012)
	Relationships with community	Castro et al. (2004)
	Financial reputation	Castro et al. (2004)

Selected experts received individual questionnaires by e-mail. Thus, the adopted approach corresponds to the suggested in the scientific literature (MacCarthy, Atthirawong 2003) and let us assure that the experts do not affect each other's views.

Assessment procedure and consistency of experts' opinions

The experts were asked to assess what factors affect internationalisation of SMEs and to assign a rank to each factor from separate groups. The approach imply that the most important factors are assigned the highest ranks and the sum of all rankings is equal to 100 points.

The obtained data are assumed to be reliable if the assessments of all experts are consistent. A stream of scholars adopted a view how to assure consistency of experts' opinions (e.g. Podvezko, 2005; Zavadskas, Vilutienė 2006, etc.) Thus, the literature suggests to calculate concordance coefficient W . Though the experts can apply different measurement scales, the concordance coefficient requires to apply preliminary ranking of all ratings. The ranking imply that the most important criterion is assigned the highest value equal to 1, the next important criterion is assigned the value equal to 2, etc. The least important criterion is assigned to the value equal to m . The value m refers to the number of investigated criteria. Notably, equivalent parameters have equal value - arithmetic mean of ordinary rankings.

The concordance coefficient W is calculated as follows:

$$W = \frac{12S}{r^2 m(m^2 - 1)} = \frac{S_f}{S_{max}}, \quad (1)$$

where: m – the number of investigated criteria (factors), r – the number of experts.

The sum of the squares (S_f) is calculated as follows:

$$S_f = \sum_{i=1}^m (e_i - \bar{e})^2. \quad (2)$$

Meanwhile, the mean of all ranks is calculated as follows:

$$\bar{e} = \frac{\sum_{i=1}^m e_i}{m} = \frac{\sum_{i=1}^m \sum_{j=1}^r e_{ij}}{rm}. \quad (3)$$

The highest value, calculated as the sum of the squares (S_{max}), is as follows:

$$S_{max} = \frac{r^2 m(m^2 - 1)}{12}. \quad (4)$$

If the opinions of experts are consistent, the value of obtained concordance coefficient W is close by 1. Meanwhile, if the opinions are different, the value of W is close by 0.

Additionally, the opinions of experts are checked by calculating the significance of concordance coefficient. If the number of investigated objects is $m > 7$, the literature suggests to determine the significance of concordance coefficient by applying criterion χ^2 (Podvezko 2005). The random value of χ^2 is calculated as follows:

$$X^2 = Wr(m - 1) = \frac{12S}{rm(m+1)}. \quad (5)$$

4. Results

The aspects of IC let us develop the system of investigated factors and carry out expert evaluation. The investigation of obtained data let us reveal that the representatives of higher education distinguish educational level and productivity of employees as the main factors impacting internationalisation. In addition, attitude of employees and training of employees are assumed as important in internationalisation process. The least important factors comprise international business skills, formal human resource management practices and work experience of employees. Meanwhile, the representatives of business firms distinguish work experience of employees, ability to transmit experience and international orientation of managers. Notably, the representatives of bank emphasise ability to transmit experience, work experience of employees and international business skills. Though educational level is seen as one of the most important aspects of human capital, surprisingly, the representatives of business indicate that educational level is the least important to internationalisation of small firms (Table 3).

Table 3. Assessment of human capital

	1st group		2nd group		3rd group	
	Ranking	Weight	Ranking	Weight	Ranking	Weight
Attitude of employees	1	0.25	9	0.08	10	0.066
Educational level of employees	9	0.06	11	0.05	4	0.08
Work experience of employees	10	0.056	1	0.13	2	0.156
Formal human resource management practices	6	0.06	10	0.06	6	0.08
Ability to evaluate investment risks	5	0.078	7	0.08	8	0.07
Capacity for innovations in processes, products or markets	7	0.06	5	0.1	7	0.08
International orientation of managers	8	0.06	3	0.11	5	0.082
Ability to transmit experiences	4	0.11	2	0.11	1	0.144
Training of employees	2	0.11	4	0.11	9	0.06
Productivity of employees	11	0.056	6	0.09	11	0.062
International business skills	3	0.1	8	0.08	3	0.12

Source: own

The responses of experts have led to the calculation of the consistency of experts' opinions. Considering formulas (1-5) the following data were obtained. The responses of the 1st group have led to: $\bar{e} = 30.0$; $S_f = 1390.5$; $W_f = 0.506$; $\chi^2 = 25.282$; $\chi^2_{kr} = 18.307$; $S_{max} = 2750$. The responses of the 2nd group have led to: $\bar{e} = 30.0$; $S_f = 1153.5$; $W_f = 0.419$; $\chi^2 = 20.973$; $\chi^2_{kr} = 18.307$; $S_{max} = 2750$. Finally, the responses of the 3rd group have led to: $\bar{e} = 30.0$; $S_f = 1096.5$; $W_f = 0.399$; $\chi^2 = 19.936$; $\chi^2_{kr} = 18.307$; $S_{max} = 2750$. The obtained data let us observe that the calculated value χ^2 is higher than critical value, i.e. $\chi^2 > \chi^2_{kr}$. Thus, grounded on prevailing investigations (Podvezko 2005), we can conclude that the opinions of experts are consistent.

Meanwhile, the assessment of structural capital let us disclose that the representatives from high education institutions distinguish product technologies, total innovations and organisational culture as the most important factors of internationalisation. The least important factors comprise infrastructure of the firm, supply processes and intellectual property rights. The representatives of business firms emphasised product technologies, strategy development process and marketing process as the most important in internationalisation of the firms. Finally, the representatives of the bank distinguished strategy development process, organisational structure and product technologies. Notably, intellectual property rights and infrastructure of the firm are seen as the least important factor in internationalisation process (Table 4).

Table 4. Assessment of structural capital

	1st group		2nd group		3rd group	
	Ranking	Weight	Ranking	Weight	Ranking	Weight
Organisational structure	6	0.078	4	0.11	2	0.104
Product technologies	1	0.14	1	0.13	3	0.132
Strategy development process	4	0.092	2	0.12	1	0.118
Customer databases	8	0.084	10	0.07	8	0.068
Organisational culture	3	0.09	12	0.04	7	0.07
Total innovations	2	0.12	5	0.09	9	0.062
Product development processes	5	0.084	9	0.06	11	0.046
Marketing processes	7	0.07	3	0.11	5	0.106
Service processes	9	0.066	6	0.08	6	0.078
Intellectual property rights	10	0.064	11	0.04	10	0.076
Supply processes	11	0.056	7	0.08	4	0.116
Infrastructure of the firm	12	0.056	8	0.07	12	0.024

Source: own

The responses of experts have led to the calculation of the consistency of experts' opinions. Considering formulas (1-5) the following data were obtained. The responses of the 1st group have led to: $\bar{e} = 32.7$; $S_f = 1453.7$; $W_f = 0.407$; $\chi^2 = 22.365$; $\chi^2_{kr} = 19.675$; $S_{max} = 3575$. The responses of the 2nd group have led to: $\bar{e} = 32.5$; $S_f = 1379.5$; $W_f = 0.386$; $\chi^2 = 21.223$; $\chi^2_{kr} = 19.675$; $S_{max} = 3575$. Finally, the responses of the 3rd group have led to: $\bar{e} = 32.5$; $S_f = 1397.0$; $W_f = 0.391$; $\chi^2 = 21.492$; $\chi^2_{kr} = 19.675$; $S_{max} = 3575$. The obtained data let us observe that the calculated value χ^2 is higher than critical value, i.e. $\chi^2 > \chi^2_{kr}$. Based on previous investigations (Podvezko 2005), we conclude that the opinions of experts are consistent.

The investigation of relational capital let us disclose that managerial reputation is the most important factor distinguished by all groups of experts (Table 5). The representatives of high education and business firms emphasised financial reputation. Meanwhile, representatives of the bank distinguished relationships with government agencies. While the experts from high education and business firms distinguished distribution channels type as the least important factors, representatives of the bank emphasised financial reputation as the least important in small firms' internationalization.

Table 5. Assessment of relational capital

	1st group		2nd group		3rd group	
	Ranking	Weight	Ranking	Weight	Ranking	Weight
Financial reputation	1	0.18	1	0.19	7	0.09
The direct relationships with end customers	4	0.16	3	0.15	4	0.146
Relationships with partners	3	0.16	5	0.15	3	0.18
Relationships with government agencies	6	0.11	4	0.15	1	0.176
Distribution channels type	7	0.09	7	0.09	6	0.112
Relationships with community	5	0.12	6	0.11	5	0.12
Managerial reputation	2	0.18	2	0.16	2	0.176

Source: own

The responses of experts have led to the calculation of the consistency of experts' opinions. Considering formulas (1-5) the following data were obtained. The responses of the 1st group have led to: $\bar{e} = 20.0$; $S_f = 313.0$; $W_f = 0.447$; $\chi^2 = 13.414$; $\chi^2_{kr} = 12.592$; $S_{max} = 700$. The responses of the 2nd group have led to: $\bar{e} = 20.4$; $S_f = 319.2$; $W_f = 0.456$; $\chi^2 = 13.681$; $\chi^2_{kr} = 12.592$; $S_{max} = 700$. Finally, the responses of the 3rd group have led to: $\bar{e} = 20.3$; $S_f = 388.4$; $W_f = 0.555$; $\chi^2 = 16.647$; $\chi^2_{kr} = 12.592$; $S_{max} = 700$. The obtained data let us observe that the calculated value χ^2 is higher than critical value, i.e. $\chi^2 > \chi^2_{kr}$. Prevailing studies (Podvezko 2005), let us conclude that the opinions of experts are consistent.

Conclusions

Global trends have been forcing small firms to increase productivity, expand into new markets, adopt new technologies, attract and secure workforce. The changing business context requires to focus on the firm's resources as the main factors, contributing to the competitive advantage in both local and international markets. Hence, scientific investigations, adopting resource-based approach, emphasise the significance of intangible resources which contribute to the customers' added value and sustainability of competitive advantage.

Knowledge based economy is driven by knowledge and thus, knowledge is considered as a key asset of businesses and individuals. Though new technologies, patents or strategic positions in the market are important determinants, the ability to manage knowledge which is embodied in human beings is a key success factor of any firm. The studies confirm the significance of knowledge and conclude that success of organisations depends on their abilities to manage human resources (Pfeffer 1995). Hence, knowledge, abilities and skills of the firm's employees drive value of the firm and motivate to innovate. The aspirations to maintain competitive advantage require efficiently apply knowledge and expand the potential to innovate. Consequently, these aspirations lead to the internationalization of the firms' activities. Hence, internationalization of small firms is interrelated with intellectual capital.

Human capital appears to be the most investigated component of intellectual capital in the small firms' context. The investigations confirmed a positive relationship of human capital and internationalization of SMEs (Cerrato, Piva 2012; Colombo, Grilli, 2005; Galabova, McKie 2013). Though some studies investigated social capital (e.g. Johanson, Vahlne 2006), personal and inter-firm networks and the interrelationships with internationalization (e.g. Manolova et al. 2007), relational capital and structural capital are less investigated.

Based on the main components of intellectual capital, we set forth to investigate the significance of some of the factors in internationalization process of small firms. First, the study highlighted the perceptions of managers and consultants about importance of work experience of employees, ability to transmit experience, international orientation of managers and international business skills. These findings are in line with other investigations (e.g. Cerrato, Piva 2012). Though general capital can be applied in different contexts, it appears to be the least important factor for the representatives of business contrary to the representatives of high education institutions. The low importance of educational level could be explained by the fact that economy of the country is predominated by traditional industries and thus, the representatives of business do not differentiate the education of employees. On the other hand, high-tech industries are dependent on the educational level of workforce and thus, the future investigations have to target the experts, representing these business sectors. Secondly, product technologies were distinguished by all expert groups as the important factor in internationalization processes. The up to date product technologies available by SMEs guarantee overseas expansion. The firms have to promote technological knowledge aiming to expand their business. Notably, internationalization of business requires to set the objectives, collect information and deploy internal resources and capabilities and thus, the strategy development process is assumed as the important factor by business representatives and consultants. As it was pointed above, the lower significance of intellectual property rights could be explained by the structure of economy and thus, require more close investigation in the future. Thirdly, the study revealed the significance of managerial reputation in the internationalization process of small firms. Notably, entrepreneurs and managers of small firms play a primary role in the expansion of firms and their reputation among foreign partners becomes a crucial factor contributing to the success.

To conclude, the internationalization of SMEs is driven by work experience of employees, ability to transmit experience and international orientation of managers. These factors contribute to the development of technical knowledge and strategy development processes. Consequently, obtained technical expertise and strategies lead to the higher reputation of managers in international context. The findings are significant for entrepreneurs having strong intentions to expand their businesses and policy makers, concerning about promotion and support of internationalization processes. The limitations of the study lie in the applied method and selected factors of intellectual capital. Thus, the future investigations have to consider other scientific approaches and tools and include other factors of intellectual capital.

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ACQUISITION BASED DYNAMIC CAPABILITIES AND REINVENTION OF BUSINESS MODELS: BRIDGING TWO PERSPECTIVES TOGETHER*

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Abstract. Dynamic capabilities in merger and acquisition are complex events in the process of sustaining competitive advantage of merging business for which we have incomplete understanding. The aim of the paper is to identify the role of dynamic capabilities in reinvention of business model of merging company in related diversification process by means of acquisition. The major contribution of paper is emerging conceptual model of research that connect acquisition based dynamic capabilities frameworks (Capron & Anand, 2007; Teece, 2007) with nine building blocks of business model (Osterwalder & Pigneur, 2009) together and illustration how acquisition based dynamic capabilities foster a reinvention of business models in ICT Industry. Presented methodology is encouraging to analyse importance and strengths of acquisition based dynamic capabilities and their role in changes of business models in M&A processes.

Keywords: dynamic capabilities, innovation, business model, acquisition, information and communication technologies, sustainability

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1. Introduction

Dynamic capabilities in merger and acquisition are complex events in the process of sustain competitive advantage of merging business for which we have incomplete understanding, in part because researches have tended to consider only explanation of them. However, successful innovative ideas can be brought to global market by means of acquisition process. The aim of the paper is to identify the role of dynamic capabilities in reinvention of business model of merging company in related diversification process by means of acquisition that lead to sustained competitive advantages. Current research was organized to test three propositions that differs from traditional methods of studying merger and acquisition. The research argues that acquirer can buy a target

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company's dynamic capabilities, which it would then also fold into its re-invented business model. That's what Facebook did with WhatsApp in mid of 2014.

This case study of WhatsApp acquisition by Facebook was selected due to following reasons. Firstly, the success story of the case company is closely linked to entrepreneurial innovation (Olaniyi and Reidolf, 2015). Secondly, the numbers are in Facebook Inc.'s acquisition of mobile-messaging application WhatsApp Inc. extraordinary. The Facebook paid \$22 billion for a WhatsApp start up that generated \$10.2 million in revenue 2013 year and its net loss for the six months that ended in June 2014 was \$232.5 million. Thirdly, knowledge creation and dissemination, as well as innovation, are keys to promotion of competitiveness (Aleksjeva, 2016). All mentioned above is especially relevant to an Information and Communication Technologies industry, where technologies are developing at the astonishing speed. The research illustrates how organization deals with the commercialization of innovation by means of acquisition of engineering team, technologies and users' base.

The research main contribution is emerging conceptual model of research that connects acquisition based dynamic capabilities frameworks (Capron and Anand, 2007; Teece, 2009) with nine building blocks of business model (Osterwalder and Pigneur, 2009) together and, thereby, illustrates how acquisition based dynamic capabilities underpinning a reinvention of business models in Information and Communication Technologies Industry.

2. Literature review

Strategy is about building dynamic capabilities aimed at responding efficiency to future and existing contingencies (Ambrosini and Bownam, 2009). What's more, sources for competitive advantage lie in companies' ability to alter the resource base: create, integrate, recombine, and release resources. Teece et al. (1997) define dynamic capabilities as "the ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments". Capron and Anand (2007) define dynamic capabilities as "the capacity of an organization to purposefully create, extend, or modify its resource base". For long-term growth and survival of the enterprise, they must be cleverly managed, or orchestrated, by a dynamically capable management team pursuing a good strategy (Teece, 2014). Dynamic capabilities can usefully be thought of as belonging to three clusters of activities and adjustments: identification and assessment of an opportunity (*sensing*); mobilization of resources to address an opportunity and to capture value from doing so (*seizing*); and continued renewal of core competences (*transforming*) (Teece, 2009).

2.1 Acquisition based dynamic capabilities

There are very few researches on specific dynamic capabilities that have been identified and studied involve merger and acquisition. Teece argues it might be "because assets are bundled together often tightly linked inside incumbent firms, it may be difficult to obtain assets in the desired configurations through asset purchase or sale in mergers and acquisitions" (Teece, 2009). However, Capron et al. argue that "entrepreneurs must acquire additional resources, which will be „reconfigured “and „integrated “with existing resources if firms are to grow and successfully innovate technology - based products and services" (Capron et al., 1998). By Eisenhardt and Martin (2000), practice with homogeneous acquisitions (i.e., those in the related markets) was positively associated with the accumulation of tacit and explicit knowledge about how to execute acquisitions and achieve superior acquisition performance.

Important type of dynamic capabilities which enhances firm's potential for growth and underpin competitive advantage are acquisition-based dynamic capabilities (Capron and Anand, 2007). In their research, Capron and Anand (2007) suggest that acquisition-based capabilities consist of three main capabilities which are *selection*, *identification*, and *reconfiguration* which are very similar as *sensing*, *seizing* and *transforming* dynamic

capabilities of Teece (2007). Selection (*sensing*) is capacity to recognize when an acquisition would be the most suitable strategic move for gaining new resources. Identification capacity (*seizing*) is dynamic capability to find and negotiate with the most suitable targets. Reconfiguration (*transforming*) the capacity is about the dynamic capability to reshape resources within the target and acquiring firms (Capron and Anand, 2007). Thus, making strategically important investment choice on M&A involve such managerial activities as a selection (*sensing*), an identification (*seizing*) and a reconfigurations (*transforming*) as well as re-inventing and implementing new business model (Teece, 2007).

Proposition 1. The success of a merger or acquisition is gouged by the degree of similarities and complementarily between dynamic capabilities of two merging business.

2.2 Business model of merging company

Chistensen et al. argue that “we must be able to describe exactly what we are buying. The best way to do that, we’ve found, is to think of the target in terms of its business model” (2011, p.2). In essence, a business model embodies nothing less than the organizational and financial „architecture “of a business (Teece, 2010). The selection/design of business models is a key micro-foundation of dynamic capabilities - the sensing, seizing, and reconfiguring skills that the business enterprise needs if it is to stay in synch with changing market (Teece, 2005). From the point of view of Johnson et al. (2008) a business model consists of four main elements, the synthesis of which delivers value: customer value proposition; profit formula; key resources and key processes. Osterwalder and Pigneur (2009) with real 470 business practitioners from 45 countries extended number of elements and developed Business Model Canvas with nine building blocks: customer segment, value proposition, channels, customer relationship, revenue stream, key resources, key activities, key partners, cost structure. To re-invent a business model, authors recommended to apply “four steps framework: eliminate, reduce, increase and create” of Kim and Mauborgne (2005): to eliminate and reduce an elements of business model in terms of cost structure as well as increase and/or create as a new an elements of business model in terms of revenue stream (Osterwalde and Pigneur, 2009).

What’s more, Chistensen et al. (2011) differentiate between two acquisition types. First one is “leverage my business model” (LBM) acquisitions, where companies are acquired for their resources and are incorporated into the acquirer’s business model. The authors argue that LBM acquisitions often underperform (Christensen et al., 2011). They are frequently priced too high, and they often don’t deliver the promised growth or cost savings (Kaufmann, 2016). Second one is “reinvent my business model” (RBM) acquisitions, where companies are acquired for their business models, generally disruptive business models. Disruptive companies and their business models are those whose initial products are simpler and more affordable than the established players’ offerings. Acquirer can buy another firm’s business model, operate it separately, and use it as a platform for transformative growth (Christensen et al., 2011). According to the authors, there is far more growth potential in purchasing other companies’ business models than in purchasing their resources (Chistensen et al., 2011). Therefore, Christensen et al. (2011) argue that the most reliable sources of unexpected growth in revenues and margins are disruptive products and business models.

However, there are very few examples how to reinvent business model by means of acquisition of disruptive companies and how acquisition based dynamic capabilities foster a reinvention of business model of acquirer and, therefore, underpin competitive advantages of merging company.

Proposition 2. Business models of both acquirer's and the target's disruptive companies can successfully fold into new business model by means of acquisition based dynamic capabilities to create and capture new value proposition.

Proposition 3. Acquisition based dynamic capabilities underpin reconfiguration existing and acquired core competences of acquirer to facilitate new product/service development and, therefore, sustain competitive advantages.

The propositions were tested empirically by exploring illustrative case study of Facebook acquisition of WhatsApp in mid-2014.

3.0 Illustrative case study Facebook acquisition of WhatsApp

3.1 Facebook acquisition of WhatsApp in mid-2014

The numbers are for Facebook Inc.'s acquisition of mobile-messaging application WhatsApp Inc.: the social network paid \$22 billion for a start-up that generated \$10.2 million in revenue 2013 year. The acquisition supports Facebook and WhatsApp's shared vision to make the world more open and connected by delivering core internet services in efficient and affordable manner. In order to evaluate *what* and *how* dynamic capabilities can be transferred in acquisition process to generate a new business model and thus sustain competitive advantage, as well as to test proposed propositions, we apply three steps research.

3.2 Illustration of acquisition based dynamic capabilities and reinvention of business model

Proposition 1. The success of a merger or acquisition is gouged by the degree of similarities and complementarily between dynamic capabilities of two merging business.

The research has explored dynamic capabilities of *selected* target's company and acquirer's company, the research result is presented in table 1 and table 2.

Table 1. Dynamic capabilities of Facebook before acquisition of WhatsApp

Products	Sensing (selection)	Seizing (identification)	Transforming (reconfiguration)	Result in (sustainability)
Facebook	Need to connect the US college students.	Facebook social platform was created as a way for students to keep in touch over the Internet and get to know each other better.	Over time Facebook has developed into global mass platform, adding new features (news feed, more privacy features, Facebook notes, the ability to add images to your blog and comments and more).	Facebook developed social platform providing excellent user experience, and thus reached 1.2 billion active users being the largest social network globally.
Facebook Mobile app	Growing use of mobiles caused the need to enable users to access the social network on their phones.	Developed the Facebook Mobile app for convenience and easy use on the phones.	Launch mobile app platform updates, improve privacy settings, and build apps that integrate with social network.	Facebook success on mobile devices boosts Facebook's profits with mobile app ad revenues accounted more than \$3 million over 2013.
Facebook Messenger	Impressive growth potential for mobile communications industry and users' preferences towards instant messaging services.	Launched Facebook Messenger to give people passionate about messaging a simpler and faster way to communicate with their friends mobile-to-mobile.	Continue to run tests to improve speed and performance as well as add new features to develop in Messenger.	Facebook Messenger is one of the most popular applications on the mobile platform today. However, it <i>failed to achieve the desired widespread</i> and generated a lot of controversy among users.

Source: developed by author

Table 2. Dynamic capabilities of WhatsApp before acquisition

Product	Sensing (selection)	Seizing (identification)	Transforming (reconfiguration)	Result in (sustainability)
WhatsApp	Growing use of mobiles and need to transform personal communications previously dominated by the wireless carriers.	Devised a simple process of connecting mobile users, focusing on clean and fast communication service that works flawlessly.	Continuous improvement resulted in launching updates, new versions for various OSs and new features (group chats, photo sharing, status updates, shared links and audio files).	WhatsApp has audience of 450 million users with <i>the highest level of engagement</i> ever and growth of 1 million users daily.

Source: developed by author

Having compared on tables 1 and 2, it became obviously, that Facebook failed to achieve the desired widespread in mobile communication whereas WhatsApp has got an audience with the highest level of engagement. Thereby, the success of an acquisition of WhatsApp was gouged by the strong similarities and complementarily between dynamic capabilities of Facebook.

Proposition 2. Business models of both acquirer's and the target's companies can successfully fold into new business model by means of acquisition based dynamic capabilities to create and capture new value proposition.

Having analyzed both Facebook and WhatsApp' business models in depth, the research has identified acquisition based dynamic capabilities of Facebook in reinvention of their business model and delivering new customer value propositions.

Table 3. Acquisition based dynamic capabilities of Facebook in reinvention of their business model by acquiring WhatsApp startup

Building blocks of business model	Facebook business model	WhatsApp business model
	Acquisition based dynamic capabilities	
<i>Key partners</i>	Facebook app& games developers Content partners Internet operators Joint project (Internet.org) partners <i>Seizing</i>	App distributors Content partners Internet operators
<i>Key activities</i>	Social platform development and maintenance Apps development <i>Sensing</i>	Apps development Servers maintenance
<i>Key resources</i>	Brand and user base Technology infrastructure Software engineers Facebook platform <i>Seizing</i>	Communication engine Users in emerging economies Engineering team IT infrastructure
<i>Value propositions</i>	Unique value proposition: connecting the world Communicate with friend and share information easily and free Excellent user experience: news, events, voice or video chatting <i>Transforming</i>	Unique value proposition: simple and mobile, no advertising, first year free Communicate with friend from your phonebook Free messages (text, video, photo) Excellent user experience: "No Ads! No Games! No Gimmicks!"
<i>Customer relationship</i>	Long-term and loyal Network effects <i>Transforming</i>	Loyal users Strong emotional connection with app
<i>Channels</i>	Facebook.com Mobile apps Facebook Ads <i>Transforming</i>	Apps market (Google Play, Android Phone)
<i>Customer segments</i>	Internet users of developed countries Mobile users of developed countries Advertisers Developers <i>Sensing</i>	Internet users of emerging economies Mobile users of emerging economies
<i>Revenue streams</i>	Free app Advertising revenues Payments and other fees <i>Result in</i>	"Freemium" model Subscriptions of \$0.99 annually with first year free
<i>Cost structure</i>	Employees, including engineers and developers Marketing, general and administrative expenses - R&D. Technology infrastructure maintenance <i>Result in</i>	Employees, including engineers New technologies and product development Technology infrastructure maintenance

Source: developed by author

Facebook and WhatsApp had divergent business models; the disruptive business model of WhatsApp is simpler and more affordable as well as deliver a unique customer value proposition. However, the two companies had a convergence in their common mission - to provide users with a closer communication with each other, in different corners of the globe.

The acquisition based dynamic capabilities helped Facebook to reinvent of business model as follows. Facebook *sensed new customers' segments* for their business: Internet and mobile users of emerging economies and new *key activities* that should be developed: mobile apps products; Facebook seized *new key (idiosyncratic) resources* by acquiring WhatsApp engineering team and users' base in emerging economies as well as *key partners' network* by acquiring WhatsApp start up partners. Hence, Facebook transformed new *customers' relationship* mode: exploit a strong emotional connection of loyal users with mobile apps. to their business and new promotional *channels* by adding opportunities of apps markets (Google Play, Android Phone).

Therefore, Facebook transformed their *customer value proposition*, delivering new value to the customers and capturing new value for shareholders. As results, Facebook dramatically changed *cost structure* by eliminating CAPEX or reducing their OPEX on the new mobile technologies and apps development as well as potentially increase their *revenue streams* form Internet and mobile users of emerging markets and resulted in competitive advantage. Several comments on reinvention of Facebook business model in WhatsApp acquisition process from dynamic capabilities perspective is given in table 4 that underpinned second proposition.

Table 4. Reinvention of Facebook business model after acquisition of WhatsApp from acquisition based dynamic capabilities perspectives

Acquisition based dynamic capabilities	Reinvention of existing business model of Facebook
<i>Sensing</i> (select) the opportunities to change the business model in terms of <i>new customer segments</i> : to attract additional FB users the	Researches show that there are more than 100 countries found where Facebook is not in the top five most visited websites. For example, Belarus – VK, Brazil – Orkut, China – Qzone, Latvia – Draugiem, Russia – VK, Uzbekistan – Odnoklasniki. However, in most of these countries WhatsApp is well-known app. <i>This might make it easier to create new Facebook users.</i>
<i>Seizing</i> (identify) new <i>partners' relationships</i> and acquire <i>new resources</i> : enlargement in endorsement with WhatsApp	WhatsApp has more than 600 million active users, and reached <i>that number faster than any other company in history</i> . Every day, more than a million people install the app and start chatting, and they remain more engaged with WhatsApp than on any other service. <i>Incredibly, the number of daily active users of WhatsApp (compared to those who log in every month) has climbed to 72%.</i>
<i>Transforming</i> (reconfigure) the business model in terms of <i>new revenues stream</i> and result in by gaining market share in instant messaging	The note on Jan's desk "No Ads! No Games! No Gimmicks!" serves as a daily reminder of their commitment to stay focused on building a pure messaging experience. But, on the other hand, if Facebook starts adding advertising on WhatsApp, there will be additional revenue. Users spend a substantial time on WhatsApp, which means that advertising is likely to have an impact. <i>Facebook should be able to target WhatsApp advertising as efficiently as it does on the Facebook platform.</i>

Source: developed by author

Proposition 3. Acquisition based dynamic capabilities underpin reconfiguration existing and acquired core competences to facilitate new product/service development and, therefore, sustain competitive advantages.

In order to illustrate the *reconfiguration of existing* and acquired core competences that facilitate to sustain competitive advantages, the paper summarized *acquisition based dynamic capabilities* in traditional dynamic capabilities Teece's framework (2009) as shown in table 5.

Table 5. Acquisition based dynamic capabilities of Facebook Inc. by acquiring WhatsApp Inc.

Products	Sensing (selection)	Seizing (identification)	Transforming (reconfiguration)	Result in (sustainability)
Mobile communication application of Facebook	Exciting Facebook Messenger application does not cater growing mobile subscribers market in <i>emerging economies</i> . Competitors messengers are strong in Europe Advantages of continues evolving technology in mobile based messaging. Searching for fast growing mobile communication application in emerging economies.	Acquiring fast growing communication applications in emerging economies. Acquiring engineering team, brand new apps mobile technologies and users' base in emerging economies of WhatsApp	Became the owners of most popular mobile application in emerging markets and Europe. Capture European market development. Target WhatsApp advertising as efficiently as it does on the Facebook platform. Attract additional FB users.	Gaining market share in instant messaging. Predicted user base increased to 1billion by 2015

Source: developed by author

The research has shown that the combination of *acquisition based dynamic capabilities* to reconfigure existing and new core competences helped accelerate Facebook and WhatsApp growths and users' engagement across both companies. Thus, Facebook would be able to achieve leadership in the field of social media and successfully compete with Twitter.

4.0 Discussion and conclusion.

Innovation is a critical weapon for entrepreneurs attempting to find new opportunities of producing better good or services (Pauceanu, 2016). When tested propositions by exploring dynamic capabilities and business models of Facebook and WhatsApp, we found the acquisition enables Facebook to significantly enhance its mobile messaging capabilities and enjoy the opportunities that are opened in a rapidly growing mobile communications industry. Acquisition of unique operating system of WhatsApp is a positive strategic move of Facebook that leads it to sustained competitive advantage. In addition to gaining market share in instant messaging with WhatsApp acquisition, Facebook will also be able to increase market share in online advertising. Therefore, propositions have been confirmed.

Recently published statistic figures show that 1.12 billion mobile monthly active users are using Facebook, while this figure was 600 million for WhatsApp around the world. Besides contributing to dynamic capabilities view on competitive advantages by adding fresh insights about successful acquisition practice, the research core contribution is in emergent theoretical framework for reinvention of business model in merger and acquisition process as shown in Fig. 1.

Acquisition based dynamic capabilities of acquiring organization:	Selection (sensing)	Identification (seizing)	Reconfiguration (transforming)	Sustainability (result in)
Designing new building blocks of business model of acquiring organization:	New key activities New customers' segments	New key resources New key partners	New channels New customers' relationship New customers value propositions	New revenue streams New cost structure New competitive advantages

Fig. 1. Conceptual model of research: bridging together acquisition based dynamic capabilities and reinvention of business models.

Source: developed by author

First acquisition based dynamic capabilities is to sense opportunities to change flowing building blocks: to select new key activities and new customer segments. Second acquisition based dynamic capabilities is to identify new key idiosyncratic resources and new partnership and seize them. Third is acquisition based dynamic capabilities to reconfigure new customer relationships and promotion channels and, thus, to create new customer value proposition. Therefore, an acquiring organization would result in new cost structure by eliminating and reducing some capital expenditure and operating expenses and new revenue streams by increasing and/or creating new activities. Thus, an acquiring organization sustains competitive advantage by means of re-invention of building blocks of new business model.

Presented methodology is encouraging to analyze importance and strengths of acquisition based dynamic capabilities and their role in changes of business models in M&A processes. The author suggests further empirical testing of presented methodology on illustrative case studies and possible further development this conceptual model.

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WORKERS' BUYOUT: THE ITALIAN EXPERIENCE, 1986-2016

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Abstract. Workers' buyout (WBOs) are emerging during the present economic crisis as an alternative tool to maintain employment and production. In Italy, in the last thirty years, 258 cases have been recorded. What are their general characteristics? Why do WBOs develop and who are the main sponsors and financing tools? The present analysis aims at defining the phenomenon and the enabling environment. Moreover, primary sources collected from different actors will explain how WBOs have developed and thrived across Italy saving jobs and productive capacity.

Keywords: cooperatives; cooperative movement; worker cooperatives; employee participation; collective ownership.

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Additional disciplines: law; political sciences; sociology

1. Introduction

The literature on the history of the cooperative movement refers to 1844 as the year when the first basic commodities consumer cooperative in Rochdale started near Manchester (Bernardi, 2007; Solera, 2012). The *Rochdale Society of Equitable Pioneers*, unlike the previous experiences, owes its success to the idea of securing members' loyalty through the mechanism of profit allocation proportionally to purchases, namely to the number of operations carried out with the cooperative (Bernardi, 2005; Memorie Cooperative, 2014). The breakthrough (Hansmann, 1996) and highly innovative concepts have been, and still are, the success of the cooperative movement: for example, the direct production of assets held from sales as well as taking deposits from members in order to capitalize the enterprise (Bernardi, Treu and Tridico, 2011). A few years later, in 1849, we witness the birth of the first cooperative in Italy: the *Società Operaia e Cooperativa di Consumo* (Scalera, 2011). Besides furnishing ordinary subsidies, the cooperative has promoted a number of activities useful to meet members'

essential needs including night schools, a social store and a bakery (Gera and Robotti, 1989). As far as self-management of a production site is concerned, Humberto Miranda reports the first international case when workers decided, in 1819, to occupy the English tobacco factory where they were working in order to start producing independently (Humberto Miranda, 2011). In Italy, the acquisition of a business by the employees can be traced back to 1874 when workers of a crockery and majolica factory created the *Cooperativa Ceramica d'Imola*, which is the oldest Italian production and worker cooperative (Brignanti, 1976; Reggi 1974).

The paper aims to present the workers' buyout model in Italy basing the analysis on primary sources acquired thanks to the collaboration with the *Alleanza delle Cooperative Italiane* – the Italian cooperative federation, the mutualistic funds and *Cooperazione Finanza Impresa* (CFI), which is one of the key financial actors involved in WBOs. The first part will lay out the ground in order to understand clearly what WBOs are, what kind of processes they are and the differences with other experiences in the world as, for instance, the recuperated factories in Argentina. Secondly, the study will focus the attention on the Italian cases, the importance of the cooperative model for WBOs and the enabling environment. Finally, the article shows up-to-date facts and data on the Italian WBOs from 1986 to 2016.

2. From employees to owners

The *workers' buyout* (WBO) model is part of the Mergers & Acquisitions (M&A) macro-category and it refers to the purchase of capital stock by its own workers (Cataudella, 2016, p. 437). A more organic and detailed definition describes the WBO process as a business restructuring or reconversion where employees buy the majority share of the whole firm, a division or a subsidiary, and it is often characterized by an active participation of the workers in the management control (Bernardi and Monni, 2016; CECOP-CICOPA Europe, 2013; Vieta, 2014, 2015, p. 5). Lastly, in an interview published online on the Euricse website, the anthropologist Andrés Ruggeri describes WBO as “economic units that go through a process of transition from the private management and ownership to a collective business form” (Ruggeri, 2016b).

Historically, two main scenarios determine the beginning of the WBO process and researchers have studied and analyzed both of them: the lack of a successor in guiding the firm or the risk of failure and bankruptcy (CECOP-CICOPA Europe, 2013). In the first case, the owner decides to leave the business to the workers since there are no other viable options. Employees, then, transform the business type to a worker cooperative. In the second case, workers face the possibility that their workplace would close and, through an institutional path, they decide to save it as a cooperative (CECOP-CICOPA Europe, 2013).

There are several kinds of buyouts, all depending on the key actor who completes the operation. The main typologies are:

- The *Management buyout* (MBO) describes the action of a group of managers who acquires the company employing them, becoming manager/entrepreneurs. Usually, the success of the operation depends on the actors' knowledge of the target firm (Cataudella, 2016).
- The *Leveraged buyout* (LBO), where a group of professional investors (venture capital or private equity funds) buys the target firm with the idea of selling it when the value has increased in order to gain a financial surplus (Montalenti, 1991). Friendly and hostile LBOs can take place depending if the target approves or rejects the proposal of acquisition. Moreover, MBOs can be converted in *Leveraged Management buyouts* if managers deeply use the financial leverage in order to put in place the business acquisition (Morano, 1989).
- *Family buyout* are largely used as a successful generational tool in family businesses. The person interested in acquiring the ownership can find inside the firm itself the financial means to buy stakes from other family members (Bausilio, 2014).

- *Workers buyout* (WBO) are promoted, as said, by the employees of the target company who take on the acquisition and assume a managerial role.

MBOs and WBOs concern a specific reality: the crisis afflicting the target firm leads to a complete managerial and ownership restructuring with the aim of balancing the financial situation. The first difference occurring between these two measures, which emerges straight from their names, is the actor involved in the operation: workers in the WBO and the managers in the MBO. Secondly, WBOs are characterized by a low use of financial leverage since, in most cases, the structural issue of the firm is an excessive debt level. Moreover, leverage uses can be avoided thanks to the intervention of specialized intermediaries like institutional investors and cooperative sponsors that, as explained for the Italian case, finance selected WBO projects.

In addition, another form of acquisition and business conversion was born in the last decades, proliferating notably in South America: the “*recuperated factories*” (Petrovic and Cvejic, 2015; Ruggeri, 2016a; Ruggeri and Vieta, 2014; Vieta, 2013, 2014, 2016; Vigliarolo, 2011, 2016). First born in Argentina, these companies have increased in numbers after the economic crisis in 2001 but they are substantially different from the WBOs since workers replace the owners through the occupation of the industrial area of the enterprise. It is a process that can last weeks, even months, until the day when production restarts and the business takes the cooperative vest (Vieta, 2013, p. 7). Even if WBOs are not studied as their South American equivalents, nevertheless, they save jobs, businesses and local communities. There are different paths in order to acquire the ownership of closing factories by the workers. WBOs and, generally speaking, acquisitions are affected by many factors: the regional and national economic context, the strong presence of a workers union or a cooperative movement, public support through economic benefits such as tax reliefs and a legal framework (Borzaga, 2015). Generally, WBOs can be divided into categories based on the method used to buy the target company:

- Cooperatives born from workplace conflicts;
- Cooperatives born from negotiated plans;
- Using the so-called Employee Share Ownership Plan (ESOP).

The first option is gaining momentum as recent cases are arising in those communities more damaged by the economic crisis. This particular WBO model emerges from situations characterized by a certain degree of conflict between capital and labor such as in South America with the recuperated factories or due to deteriorated relationships between workers, managers and local or regional authorities (Vieta, 2015, 2016; Vieta and Depredri, 2015). Activists, local worker unions and social movements often back the process to help workers with an extensive support leading to the company rescue and job saves. Usually, the transformation of the business in the cooperative form ends all workplace conflicts. In this first scenario, the WBO starts after the physical occupation of the plant by the employees. Secondly, a negotiation phase takes place in order to gain control of the firm between the workers, the local authorities and the court (Vieta, 2015, 2016).

On the contrary, negotiated WBOs have a clear legislation like the framework created by the Marcora Law* in Italy. At the same level, there are examples from other European countries: the “only payment” system (*pago unico*, in Spanish) in Spain as well as the French, Swedish and Belgian legislations over the “employment and enterprise cooperatives” (European Parliament, 2013). First, the negotiated plan needs a strong mediation from political authorities. Usually, workers of the company in crisis create a new cooperative and, at the end of the negotiation, members have the chance to participate in the management due to the deal reached with former administrators and owners (Lanzavecchia and D’Aurizio, 2013).

Lastly, WBOs following the ESOP model were born in the United States in the 1950s and, in these last years, the process is reappearing in the entire Anglo-Saxon world (Caragnano and Caruso, 2010). The plan moves from the

* Law n.49/1985 – so called Marcora Law – is the Italian national law that has recognized the important role of the economic partner in the WBOs and it has promoted their birth posing an organic system of benefits to the cooperatives.

acquisition of the target company by its own workers through a trust. Tax benefits are granted to the former owner while liquidating the activity and, differently from the other kinds of WBO models, the new property is divided between workers and other more “traditional” investors. As a result, the new cooperative is not configuring itself as a worker cooperative since the governance and the assets of the firm are not in employees’ hands (Delgado et al., 2014). A clear and famous example of ESOP is the acquisition in 1994 of United Airlines by its workers due to the prolonged crisis of the company and the complete failure of all bailout efforts (Rosen, Case and Staubus, 2005).

Workers’ participation in the management could represent a valid entrepreneurial tool in order to face future challenges (Stiglitz, 2009) as well as to maintain employment levels and, as shown in several experiences, at European and global stages (Bernardi, Treu and Tridico, 2011). Moreover, it could contribute to a more sustainable development of societies and the economy (Caragnano and Caruso, 2010).

3. The Italian experience and the role of the cooperative model

In Italy, similarly to other European and American countries, WBOs use the cooperative form for several reasons. First, cooperatives bring people to the very center of the business model putting them before profit (Zevi, Zanotti, Soulage and Zelaia, 2011). The distinctive element of the cooperative firm, as highlighted by many authors (Mazzotta and Sicoli, 2013; Minardi, Dell’Aquila and Zamagni, 2015), is the economic purpose pursued which lays on the concept of mutuality whereas, for all the other capitalistic firms, the aim is to maximize profits in order to split them between investors (Zamagni and Zamagni, 2008). As the Italian Civil Code notes, cooperatives develop main economic activities towards their own members (art. 2512 c.c.) and at most favorable terms in respect to market standards due to the elimination, in production and distribution processes, by the intermediation of other business actors. Additionally, these principles can be found in the Italian Constitution. While recognizing the social function of cooperatives, article 45 promotes “the increase [of cooperation] with adequate means and ensures, through effective controls, its nature and purposes”. Article 46 underlines the importance of democratic participation in workplaces and states that “in order to achieve economic and social growth bearing in mind the needs of production, the Republic recognizes the workers’ right to collaborate, under the terms and conditions established by the law, in managing firms” (Italian Constitution, 1948).

The *favor legis* towards the cooperative movement can be traced also in the Civil Code (c.c.). In fact, the cooperative firm is a variable capital company with no minimum social capital needed with the exception of those cooperatives involved in lending or insurance sectors (art. 251 and 2524 c.c.). Furthermore, each member counts for one vote while taking business decisions in the members’ meetings, granting equal rights regardless of stocks owned by each member (art. 2538, par. 1 c.c.). The possibility to nominate the board of statutory auditors only in particular cases (art. 2543 and art. 2477, par. 2-3 c.c.) as well as introducing the figure of the financing member in the company structure (art. 2526) help the cooperative born from a WBO process. This last possibility comes into play when states support public funding through financial companies. The European Union itself positively evaluates the role of the financing member in the already quoted 2013 Resolution that identifies among the positive points of a cooperative the “dispositions for the contribution of risk capitals, with or without voting rights, from third parties” (European Parliament, 2013). From the management point of view, the financing member’s stake cannot be higher than a third of the total, preventing any excessive interference in the life of the cooperative (art. 2526 c.c.). Lastly, tax benefits are granted for all cooperatives recognized by the law as “mutually prevalent” in the production sector – regulated under articles 2512 and ensuing of the c.c. (Cataudella, 2016).

3.1. Three decades of workers' buyouts in Italy: 1986-2016

Marcora Law has created a special fund to intervene against unemployment and a rotation fund for the promotion and the development of cooperation called Foncooper (Vieta and Depedri, 2015). In fact, the Italian state does not intervene directly in WBOs. Several financial agents finance these cooperatives. Among others, the most important ones are:

- *Mutualistic funds* of the three main cooperative centrals: Coopfond, Fondosviluppo and General Fond are the expression, respectively, of Legacoop Nazionale, Confcooperative Nazionale and AGCI. In 1992, Law n. 59 has created these funds with the aim to develop and promote the financial and economic growth of the cooperative movement through resources generated internally. In fact, resources come from the 3% of all cooperatives' profits, from the wealth of all cooperatives put in liquidation and, lastly, from the profits made by the different funds (Fossat, 2013).
- *Cooperazione Finanza Impresa* (CFI), born in 1986, is a second level cooperative and mutualistic funds together with the Minister for the Economic Development held its capital. CFI aims at analysing the feasibility and the competitiveness of WBOs projects and, lastly, at financing the approved ones. Between 2012 and 2015, last boards of directors sustained 138 interventions – 36,5% of which to finance WBOs – for a total allocation of 35,6 million euros and more than 6.000 workplaces saved all over Italy (De Berardinis, 2016). Industrially speaking, more than two thirds of the funds have been addressed to save factories and to help in the social sector, both strong sectors of the Italian system (CFI, 2016).
- *Banking institutions*, such as Banca Popolare Etica, Banca Prossima, Gruppo Bancario Iccrea and Unipol Banca. The role in the acquisition process is clear: support the financing of a WBO project earlier accepted by the other partners. If there are multiple banks involved in a single financing scheme, the effective financial advantage will increase (CFI, 2015).
- *Financial institutions* like Cooperfidi, Cooperfactor or the Consorzio Cooperativo Finanziario per lo Sviluppo (CCFS). The key action lies in granting immediate credit guarantees to the banks in order to unlock fast enough new resources needed to successfully finance the new-born WBOs (CFI, 2015). Moreover, they can support day-to-day financial activities and market prices.

The research focuses on the WBOs created in the last 30 years, from 1986 to 2016. The overall period was divided into three main stages: a first stage from 1986, when the Marcora Law established CFI, until 1993, a second phase starting from 1994 when the three main cooperative federations created the mutualistic funds due to law 59/1992 and, lastly, the period between 2008 onwards. Data most-likely represent the overall WBO phenomenon since all the information acquired come from different sources, each one with a different filing system. A deeper analysis could increase the number and the validity of all the information, especially those concerning the number of members, the WBOs lifespan and the financing actors. In any case, several considerations emerge about the Italian WBOs.

In the first period, between 1986 and 1993, CFI alone financed 107 WBOs. Keeping in mind the fact that CFI started financing workers' buyouts only in 1987, one year after being established, and a first comment arises: 15 WBOs were financed yearly in this first stage, resulting in the highest average overall. Between 1994 and 2007, only 67 new WBOs were created, less than five cooperatives each year, while in the last period the yearly average increases up to 10 WBOs with 82 cases between 2008 and 2016 (Table 1). The legislation changed during the second period due to the intervention of the European Commission that launched in 1993 an infringement proceeding towards the law regulating Italian WBOs, considering some of the measures as a distortion to competition (Vieta, 2015). Italy removed the obstacle only with law 57/2001 that adapted the internal discipline going beyond the safeguard of employment promoting the capital strength of all cooperatives (Simone, 2014). Another important element in the so-called second Marcora law was the transformation of the Minister for the

Economic Development that has become a proper member of the financing partners involved in WBO creation by intervening in the social capital (Cataudella, 2016). Finally, all cooperatives already established, including social cooperatives, can receive funding (Cataudella, 2016). As a result, the low number of WBO creations in the second period comes from the transition towards a new legal framework. Furthermore, the macroeconomic situation until the end of 2006 did not present particular challenges to firms in order to access credit. CFI as well as the mutualistic funds started to provide financing opportunities in 2010 and onwards, when the Italian economy and the industrial sector both started to show the consequences of the crisis started in 2008.

Another key issue to underline is the geographical distribution of WBOs in the last 30 years. In the first stage, central Italy records the highest number of cooperatives emerged from a WBO process: 57 out of 107, more than 53% of the total (Table 1). While Tuscany keeps a strong presence in all periods, Marche presents an incredibly positive record with 21 WBOs. At the same time, in Umbria 12 cooperatives opened up thanks to the WBO process, numbers much higher than the other two periods. In the North, Emilia Romagna, Veneto and Lombardy are the regions with more WBOs, respectively 14, 10 and 8 (Table 1). On the contrary, the South did not receive the same amount of financing: only 10 WBOs in all eight regions (including the two main islands – Sardinia and Sicily). In the second stage, central Italy remains the area with more WBOs thanks to Tuscany where 22 new cooperatives were created. Marche, as briefly mentioned before, dropped sharply together with all the other regions except for very few cases. The two main islands, as in the first period, do not show processes of WBO creation. In the final period, many important developments have occurred. First, WBOs opened in Sardinia and Sicily (respectively two and six new cooperatives), about 10% of the total for the period. Secondly, Northeast records more WBOs than central Italy: Emilia Romagna is the home for 32 new WBOs, more than all the cooperative firms established in central regions (27). Basilicata and Molise confirm to be indifferent to WBO creation while, on the opposite hand, Tuscany and Emilia Romagna have the lead: overall, on 256 cases from 1986 to now, these two regions record 107 WBOs, more than 40%. Both territories have always had a strong cooperative movement and linking the two could prove useful, but looking at data, other regions with a strong presence of cooperative firms are not in the highest positions for WBOs creation (i.e. Trentino-Alto Adige).

Table 1. Geographical distribution of WBOs per Italian regions, 1986-2016 [†].

[†] Table 1 follows three main timelines: the first period starts from CFI's birth after 1985 Marcora Law; the second stage starts when the mutualistic funds of the three cooperative centrals begin to operate in 1993; lastly, the period between 2008 onwards follows the path of the recent economic crisis.

Region	1986-1993		1994-2007		2008-2016		WBO Total	
	n.	%	n.	%	n.	%	n.	%
North-East								
Emilia Romagna	14	5.43%	6	2.33%	32	12.40%	52	20.16%
Friuli-Venezia-Giulia	1	0.39%	2	0.78%	1	0.39%	4	1.55%
Trentino-Alto Adige	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Veneto	10	3.88%	6	2.33%	5	1.94%	21	8.14%
NorthWest								
Liguria	3	1.16%	4	1.55%	0	0.00%	7	2.71%
Lombardy	8	3.10%	3	1.16%	4	1.55%	15	5.81%
Piedmont	4	1.55%	5	1.94%	1	0.39%	10	3.88%
Aosta Valley	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Center								
Latium	4	1.55%	6	2.33%	5	1.94%	15	5.81%
Marche	22	8.53%	0	0.00%	4	1.55%	26	10.08%
Tuscany	20	7.75%	22	8.53%	13	5.04%	55	21.32%
Umbria	12	4.65%	4	1.55%	5	1.94%	21	8.14%
South								
Abruzzo	3	1.16%	0	0.00%	1	0.39%	4	1.55%
Basilicata	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Calabria	2	0.78%	2	0.78%	0	0.00%	4	1.55%
Campania	2	0.78%	3	1.16%	3	1.16%	8	3.10%
Molise	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Apulia	3	1.16%	4	1.55%	1	0.39%	8	3.10%
Islands								
Sardinia	0	0.00%	0	0.00%	2	0.78%	2	0.78%
Sicily	0	0.00%	0	0.00%	6	2.33%	6	2.33%
Italy	108	41.86%	67	25.97%	83	32.17%	258	100.00%

Source: our elaboration based on data acquired from CFI, Coopfond, Fondosviluppo and General Fond.

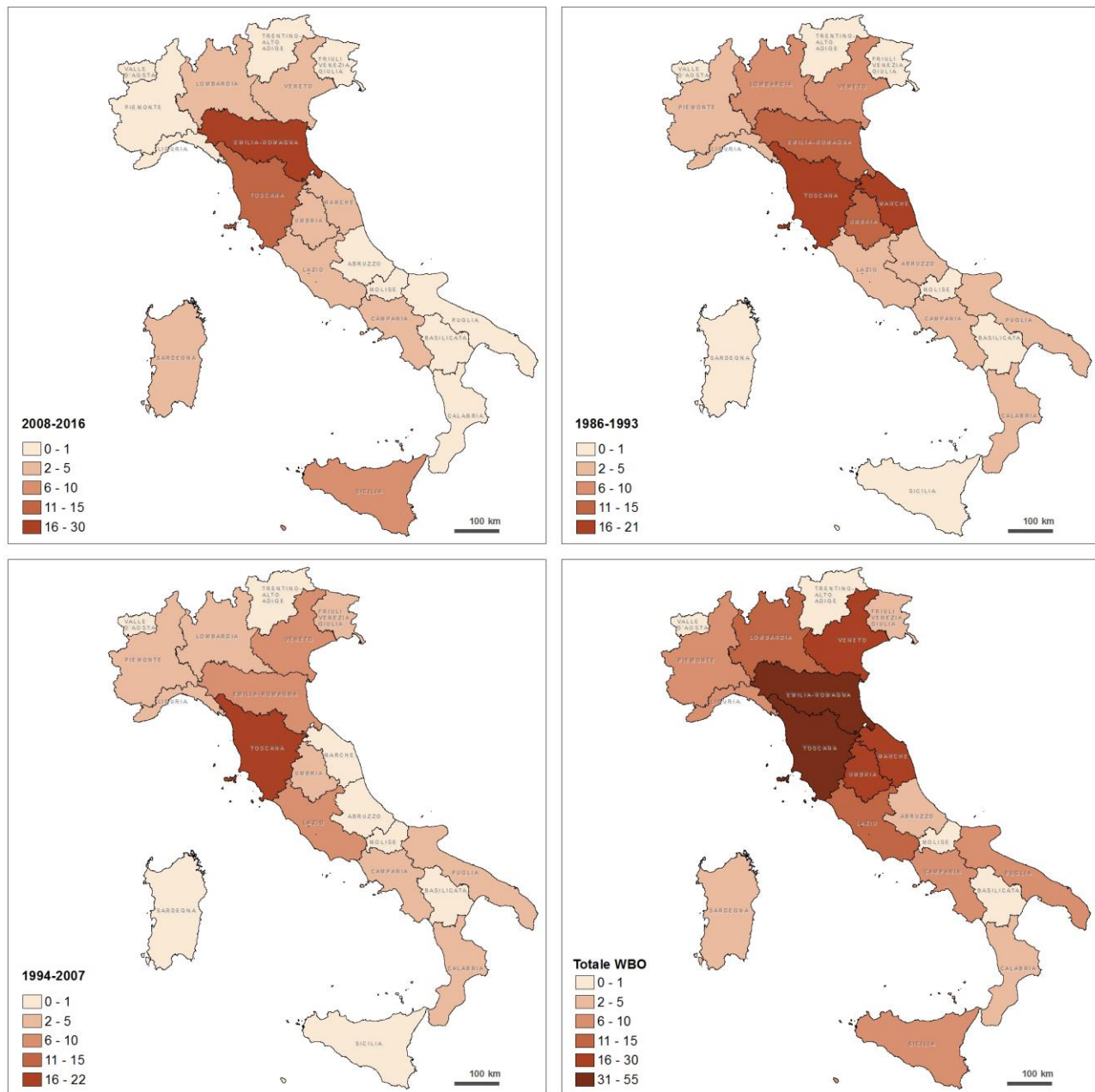


Figure 1. Geographical distribution of WBOs per Italian regions, 1986-2016.

Source: our elaboration based on data acquired from CFI, Coopfond, Fondosviluppo and General Fond.

Table 2. WBO dimension per workers (members and non-members), 1986-2016.

Workers	1986-1993		1994-2007		2008-2016		WBO Total	
	n.	%	n.	%	n.	%	n.	%
<10	5	1.94%	5	1.94%	25	9.69%	35	13.57%
10-49	79	30.62%	48	18.60%	49	18.99%	176	68.22%
50-249	23	8.91%	14	5.43%	9	3.49%	46	17.83%
> 250	1	0.39%	0	0.00%	0	0.00%	1	0.39%
Total	108	41.86%	67	25.97%	83	32.17%	258	100.00%

Source: our elaboration on CFI, Coopfond, Fondosviluppo e General Fond data.

As far as WBO dimensions are concerned, in all stages between 1986 and 2016, financing was primarily directed towards small cooperatives. Looking at Table 2, 176 WBOs out of 258 (68% of the total) have 10 to 49 workers. In the last period, between 2008 to the present, the trend concerning micro (less than 10 workers) and medium (50-250 workers) cooperatives has changed. The creation of 25 new WBOs with less than 10 workers has marked a stunning 500% increase in comparison with the other two phases where only five micro cooperatives were established. On the other hand, medium dimension cooperatives continue to show a declining trend recording only eight cases in the last period. The only large experience born from a WBO process with more than 250 workers is the cooperative Cometha, created in 1989 in Emilia Romagna that employs 377 workers. Overall, WBOs average dimensions reflect the Italian industrial model based on the small and medium enterprise. It must be said that CFI and the mutualistic funds cannot grant financing to large cooperatives without breaking the European legislation on State aids.

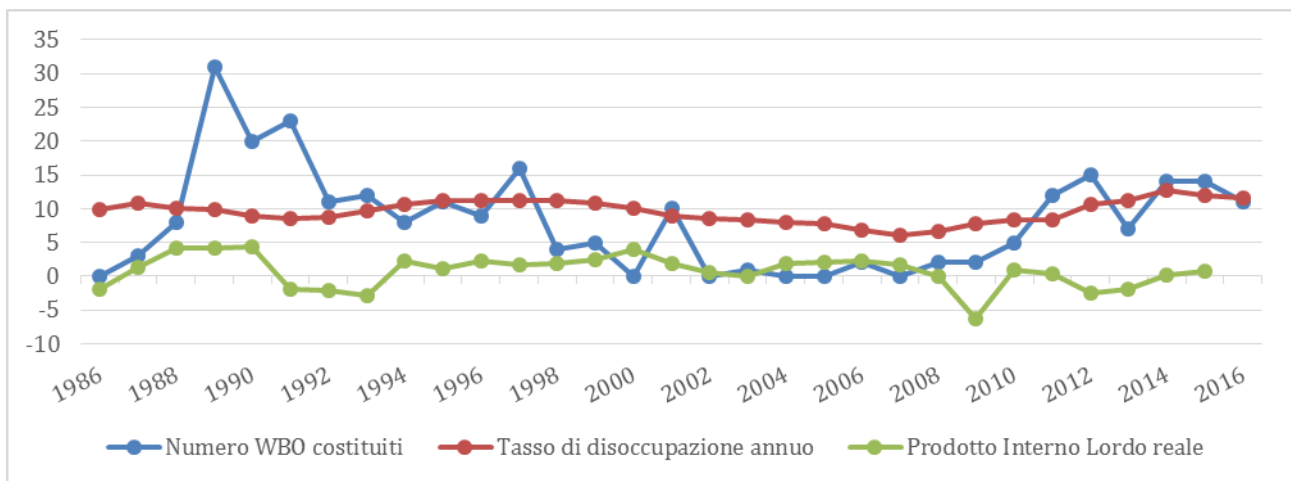


Figure 2. Evolution of WBOs, real GDP and unemployment rates (1986-2016).

Source: our elaboration on ISTAT, CFI, Coopfond, Fondosviluppo and General Fond data.

Some final considerations concerning a possible link between WBO creation and the overall performance of the Italian economy before the conclusion. Confronting both the number of WBOs established annually and the yearly unemployment rate between 1986 and 2016 (Figure 2), a similar trend might be observed. The moment

when the link became more evident occurred during the last economic crisis started in 2007-2008 when the two indicators started to increase proportionally. The WBO process, therefore, might be described as a tool used especially during an economic slowdown when standard business models cannot fully guarantee the stability of the national productive system.

Conclusions

In Italy, the workers' buyout model has small numbers but, at the same time, it has an important social and cultural value, granting job opportunities to thousands of workers and the survival of parts of the Italian industry. Between 2010 and 2011, as showed in the data, the process started to accelerate thanks to the bigger role played by CFI and the mutualistic funds that, in a difficult socio-economic moment, financed an increasing number of viable WBO projects. In the last years, taking into account CFI estimation, only 5% of the production value, 7% of the investment and job places were lost on the overall total of WBOs approved (CFI, 2016). WBOs take time to implement and workers find themselves in the role of managers while financing partners often play the role of tutors in order to save the cooperative from bankruptcy. There is not only the transformation of a business but also, and most importantly, a strong social and cultural transformation of actors involved who decide to hold their future in their own hands even in a difficult economic period (Birchall, 2011, 2014). WBOs are mainly labor-intensive cooperatives that can compete in different sectors since their main goal, the mutualistic purpose, does not aim at maximizing profits and investments made, but it focuses on maintaining job places, steady incomes and profits to be reinvested in innovation and in the enhancement of the cooperative. In conclusion, WBOs are created usually in stable and homogeneous contexts both from a sectorial and a geographical points of view due to workers' low willingness to move as well as the strong ties the cooperative has with the territory and the existing social relations (Vieta, 2015; Vieta and Depedri, 2015). Workers cooperatives arising from WBO processes save not only jobs, acting as economic shock absorbers, but they safeguard workers' productive capacity strengthening the economy of different territories and creating social capital.

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Publisher

THE COMPARATIVE ANALYSIS OF TECHNOLOGY TRANSFER MODELS*

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Abstract. The evolution of technology transfer models is considered in this article with the aim to compare different historical technology transfer models and to analyze main driven factors of technology transfer models evolution. From business administration point of view, technology transfer is process, which involves inhomogeneous participants from academia, government and business. The necessity to balance interests of many different participants with different goals, value systems and resources makes the administration of technology transfer as a very complicated task. In different times this task was solved by different ways and we consider the process of technology transfer models evolution from 1945-1950s until present time trying to identify main reasons, which forced the transformation of technology transfer models. We start consideration from identifying the main reason of varieties in terminology, which is important to create the basic frame for further consideration, after that we consider main classes of technology transfer models – linear, parallel sequential non-linear and back feed nonlinear – and make some forecasting about technology transfer models evolution in future.

Keywords: technology transfer, technology transfer models

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1. Introduction

In this article we consider the evolution of the technology transfer models. Technology transfer is complicated process, which involves participants from academia, government and business with different goals, value systems and resources. (European Commission: Improving knowledge transfer between research institutions and industry across Europe). Technology transfer (TT) is important for innovative business development and by this way for country technological and economic development. During last 30 years three generations of TT models have changed - linear models, non-linear parallel-sequential models, non-linear back feed models. The growth of TT

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models complexity corresponds to the growth of complexity of business, academic and cultural environment. The critical success factor for TT efficiency is the time interval between university scientists makes a discovery until business adapt and use the appropriate technology suggesting on the market new goods and services. (O'Shea, Allen et al. 2004) We will start the consideration of the evolution of technology transfer models from technology transfer definitions.

2. Technology transfer definitions

Using search engines it is possible to find in Internet more than hundred definitions of technology transfer. Let us consider several of them:

1. Technology transfer is the process of sharing of skills, knowledge, technologies, methods of manufacturing, samples of manufacturing and facilities among governments and other institutions to ensure that scientific and technological developments are accessible to a wider range of users. http://en.wikipedia.org/wiki/Technology_transfer
2. The sharing of technological information through education and training. The use of a concept or product from one technology to solve a problem in an unrelated one. http://en.wiktionary.org/wiki/technology_transfer
3. The communication or transmission of a technology from one country to another. This may be accomplished in a variety of ways, ranging from deliberate licensing to reverse engineering. <http://www-personal.umich.edu/~alandear/glossary/t.html>
4. The ability to take a concept from outside the organization (typically from a government or university research programs) and create a product from it. <<http://ccs.mit.edu/21c/iokey.html>>
5. Exchange or sharing of knowledge, skills, processes, or technologies across different organizations. <http://www.nsf.gov/statistics/seind06/c4/c4g.htm>
6. Technology transfer is the process of transferring scientific findings from research laboratories to the commercial sector. <http://www.insme.org/page.asp>
7. The transfer of technology or know-how between organizations through licensing or marketing agreements, co-development arrangements, training or the exchange of personnel. <http://www.et.teiath.gr/tempus/glossary.asp>
8. This term is used to characterize "the transfer of knowledge generated and developed in one place to another, where is it is used to achieve some practical end. <http://www.rmauduit.com/glossary-t.html>
9. The transfer of intellectual property between the ERC and the private sector. http://www.erc-assoc.org/manual/bp_ch6_attach6_4.html
10. The process by which energy-efficient or low emission intensive technologies developed by industrialized nations are made available to less industrialized nations. <<http://www.climatephilanthropists.org/basics>>
11. The transfer of discoveries made by basic research institutions? Such as universities and government laboratories? To the commercial sector for development into useful products and services. <http://biotech-u.com/courses/mod/glossary/view.php>
12. Technology transfer is the international communication (sharing) of knowledge, expertise, facilities, equipment, and other resources for application to military and nonmilitary systems. http://www.onr.navy.mil/sci_tech/3t/transition/tech_tran/orta/glossary
13. The diffusion of practical knowledge from one enterprise, institution or country to another. Technology may be transferred by giving it away (e.g. through technical journals or conferences); by theft (e.g. industrial espionage); or by commercial transactions (e.g. patents for industrial processes). http://www.itcdonline.com/introduction/glossary2_q-z.html

14. The movement of modern or scientific methods of production or distribution from one enterprise, institution, or country to another, as through foreign investment, international trade, licensing of patent rights, technical assistance, or training. <http://www.giagroup.com/terms-of-trade-t.cfm>
15. Technology transfer occurs as a result of an offset agreement that may take the form of research and development conducted abroad; technical assistance provided to the subsidiary or joint venture of overseas investment; or other activities under direct commercial arrangement between a manufacturer and a foreign entity. <http://www.tricolom.com/glossary.htm>

The list of technology transfer definitions can be continued and the first question in technology transfer understanding is the question “What we are speaking about having so overwhelming amount of different TT definitions?” The explanation of the large amount of definitions can be found in the proceedings of RAND conference “Technology transfer of federally funded R&D”, December 12, 2002. (Wang et al. 2003). One of the declared tasks of RAND organized forum was to clarify the technology transfer terminology and after discussions it was recognized, that such clarification hardly is possible because of the following reason: three main participants gave three different definitions of technology transfer.

The definition of the National Technology Transfer Center (NTTC) was: “The process of utilizing technology, expertise, know-how or facilities for a purpose not originally intended by the developing organization. Technology transfers can result in commercialization or product/process improvement”.

The definition of the Federal Laboratory Consortium (FLC) was: “The process by which existing knowledge, facilities, or capabilities developed under federal R&D funding are utilized to fulfill public and private needs”.

The definition of the Association of University Technology Managers (AUTM) was: “The formal transfer of new discoveries and innovations resulting from scientific research conducted at universities and nonprofit research institutions to the commercial sector for public benefit”.

Although these three definitions have similarities, it is evidently that due to many reasons technology transfer means different things to different participating organizations. For governmental institutions, the most important thing in TT is to ensure transparent use of public money, for business most important in TT is profit, for academia most important in TT is scientific publications, reports on conferences, quotation indexes. Due to different systems of values of different TT process participants, they consider as most important for them different sides of the same process and following to their own opinions give different definitions of TT process.

The general conclusion of the RAND conference was that it is necessary to treat the technology transfer process very broadly, allowing individual and organizational differences even in definitions. Similarly, the metrics for technology transfer success and best practice are left open for interpretation and discussion. Considering technology transfer models it is necessary to take into account that TT processes should be considered from at least three different points of view (government, business, academia) and not always success metrics and opinions about what is good and what is bad coincide. This situation is not usual from the business administration point of view, where normally more strict definitions and methods are used, but technology transfer is generally accepted to be beneficial for society, even if specific definitions may not necessarily be agreed upon. (Sazali et al. 2009). Technology transfer peculiarities remain to keep focuss of scientists, practitioners and other stakeholders (Tvaronavičienė, Černevičiūtė 2015; Ignatavičius et al. 2015; Fuschi, Tvaronavičienė 2016; Zemlickiene et al. 2017).

3. Linear models of Technology Transfer

It is difficult to draw the starting line for linear technology transfer model consideration - apparently the first commonly accepted linear model of technology transfer was so called Appropriability Model, which was developed in 1945-1950s. Based on Keynes type ideas of demand driven economy, Appropriability Model considered that “technology transfer occurs when technology has found users”. (Hee Jun Choi. 2009) It was supposed in this model that the only one active agent in technology transfer chain is the private company as user of technology, but universities and government are relatively passive participants of process.

The next step in the technology transfer model development was done in Dissemination Model, which was developed in 1960 – 1970s. It was observed that in those cases, when university researches participated in potential technology users search, process was more successful. In addition to technology user as the only active agent in Appropriability Model of technology transfer, the expert, as mediator between researcher and non-expert technology user, start to play important role in Dissemination Model.

The next significant TT model was the Knowledge Utilization Model, which was developed in 1980s. This model was based on more detailed consideration of technology transfer process that it was done in previous models and on the concentration on critical success factors of technology transfer. There were two main critical success factors, which were identified in the Knowledge Utilization model – communication barriers on interpersonal level and organizational barriers on structural units level. Since 1980s it was considered that the success of technology transfer depends mostly on ability of management to break these barriers.

From the beginning of 1990s so called Communication Model of technology transfer became popular. It was the time when computer technologies made revolutionary changes in information transfer and processing and focus of attention in technology transfer was shifted towards information and communication processes. At this time the first attempts to combine linear models with simplest non-linear models were done. There is deep analogy between the main idea of structural programming - to organize all data flows into system of parallel and sequential flows - and new approach to technology transfer processes management in first non-linear TT models with attempt to organize activities in parallel and sequential flows also. The set of parallel and sequential processes from one side was simple enough to be good controlled, but from another side allowed to perform several tasks simultaneously, which was impossible in linear models.

It is important to underline, that from organizational point of view the development of linear technology transfer models was very closely related with the Bayh-Dole Act, developed and adopted in the USA in 1980. Bayh-Dole was originally designed to facilitate commercialization by making it easier for universities to approve legal rights to innovations developed by faculty using Federal funding. This Act appeared as the result of the understanding of the significant role of technology transfer in scientific and technical progress and the need to accelerate scientific and technological progress by new technologies development. Presently it is clear that since Bayh-Dole Act the number of research related patents has noticeably increased. Bayh-Dole Act established rules that regulated relationships between universities, industry and government. The Bayh-Dole Act has led to rapid growth of activity in science and technology implementation for the new goods and services production and to the emergence of the new models of technology transfer. Bayh-Dole Act was implicitly based on an assumption of "linear model" of innovation, so the first models of technology transfer were linear models. According to linear model universities perform basic research with little concern for application and private firms invest in applied research and commercialization. The traditional linear model of university technology transfer consists of the following consequent steps:

1. University Scientist makes a discovery.
2. Scientist discloses invention to Technology Transfer Office.

3. TTO evaluates invention, decides whether to patent.
4. TTO makes the patent applications.
5. TTO markets technology to firms/entrepreneurs.
6. TTO negotiate licensing agreements/royalties/equity stake etc.
7. Technology license.
8. Existing firms adapt and use technology.
9. Spinoffs & Startup companies are created.

The flowchart of technology transfer process looks as follows:

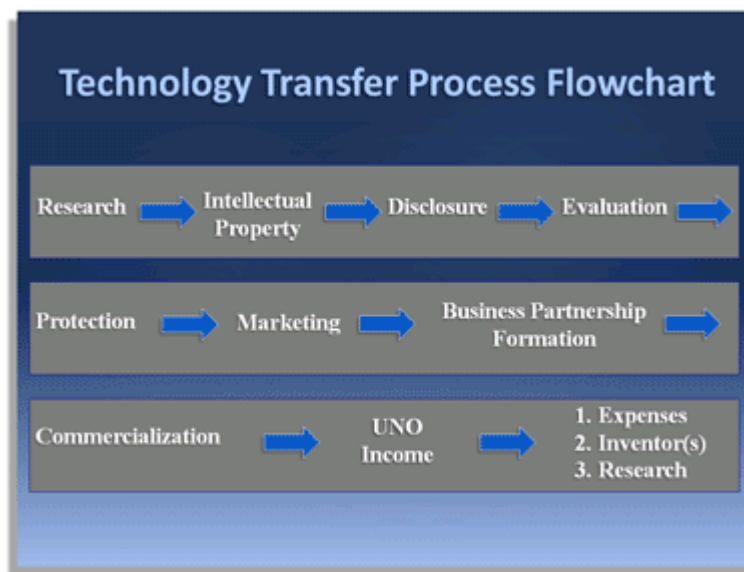


Fig. 1. Technology transfer flowchart in linear model. Presented in “Technology Transfer Process”

Source: http://www.uno.edu/otmc/technology_transfer_process.aspx

First technology transfer models were linear and the main difference between them was the amount of steps from the scientific discovery at university to adaptation and use of new technology in industry. The common idea that lies under all such models independently from the amount of steps is the idea of barriers overcoming.

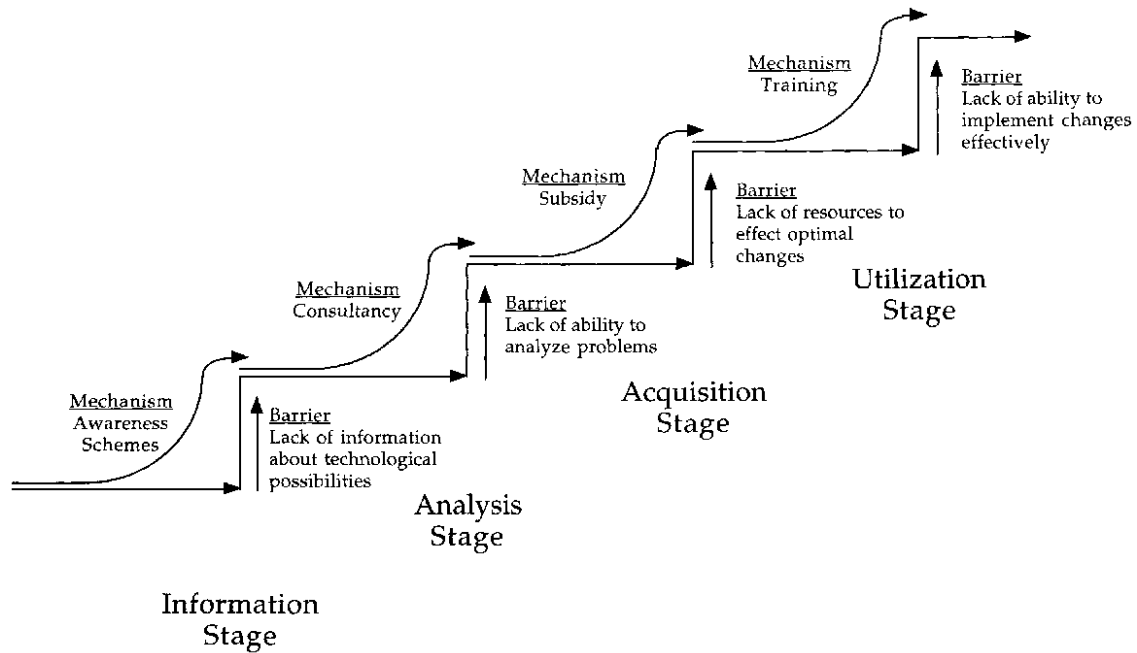


Fig. 2. Barriers overcoming. Presented in “Diffusion of Information Technology”

Source: <http://collections.infocollections.org/ukedu/en/d/Jwb42de/7.2.html>

The main reason of barriers is the inhomogeneous structure of technology transfer process participants - government, academia and industry have different point of views about the significance of different TT process parts as it was mentioned above.

Farinha and Ferreira's Triple Helix Triangulation model

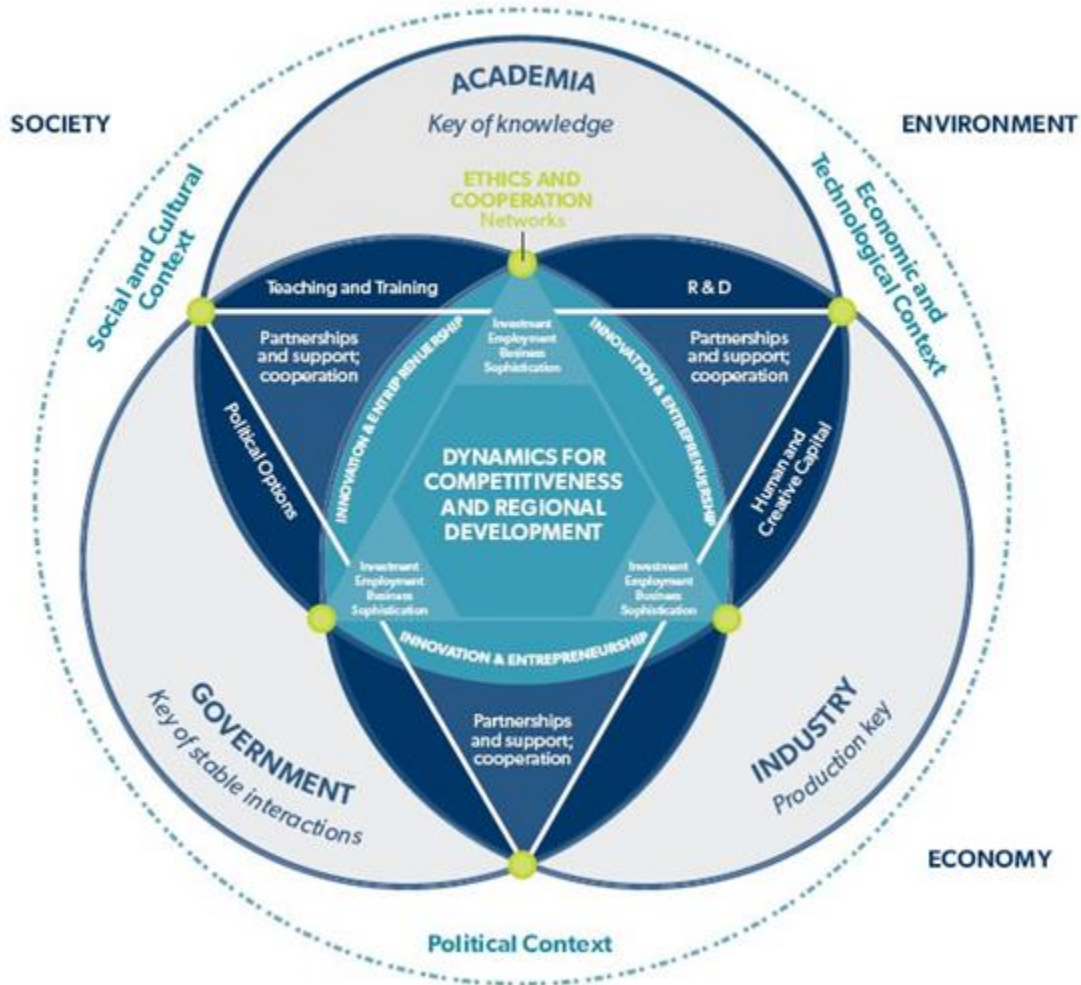


Fig.3. Technology transfer participants. Presented in “The Organization of Power”

Source: http://www.channelingreality.com/Corporations/organization_of_power.htm

Depending on the character of interaction between participants of technology transfer process, many different linear models were created for technology transfer description.



Fig. 4. Typical linear six step technology transfer model.

Source: <http://www.ec21.com/co/e/eurastech/upimg/img2.jpg>

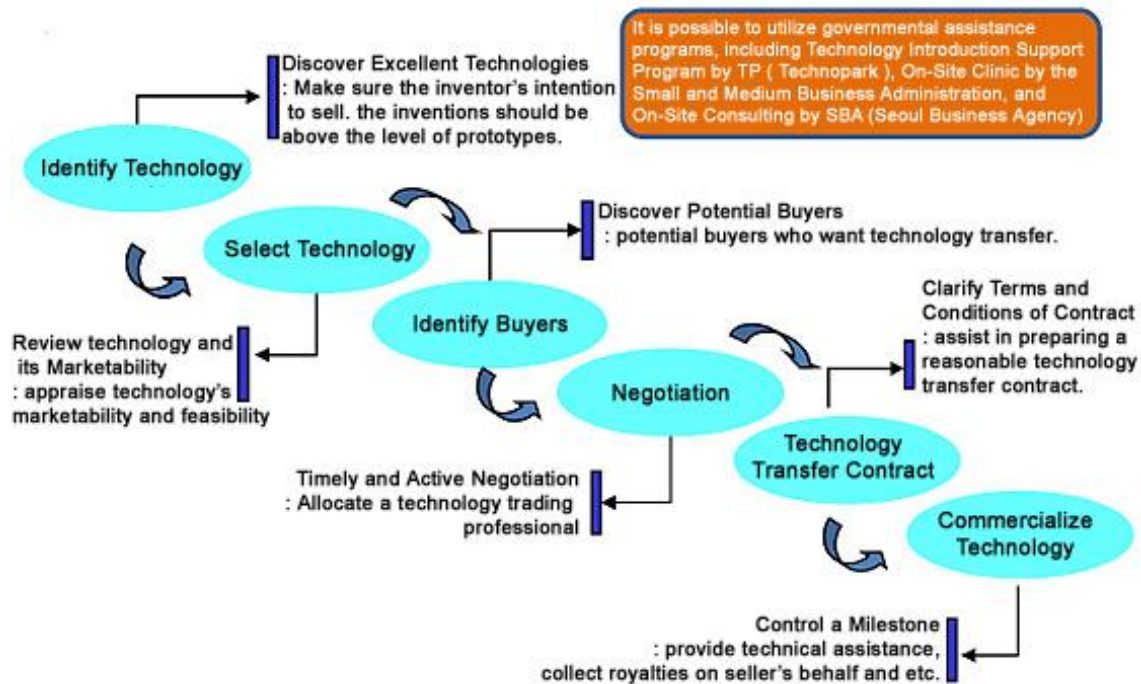


Fig. 5. Another six step linear technology transfer model.

Source: <http://www.nickdavesassociates.com/consulting-services/developing-and-implementing-supply-chain-strategies/technology-transfer>

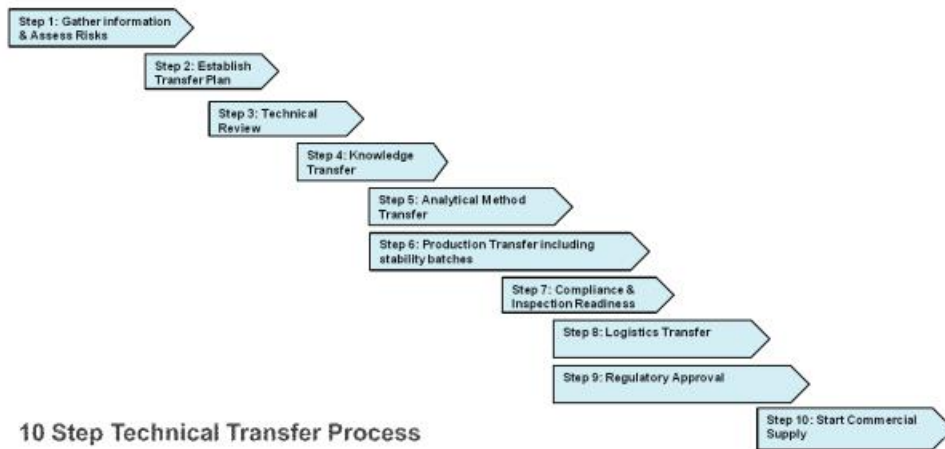


Fig. 6. Ten step linear technology transfer model.

Source: <http://www.nickdavesassociates.com/consulting-services/developing-and-implementing-supply-chain-strategies/technology-transfer>

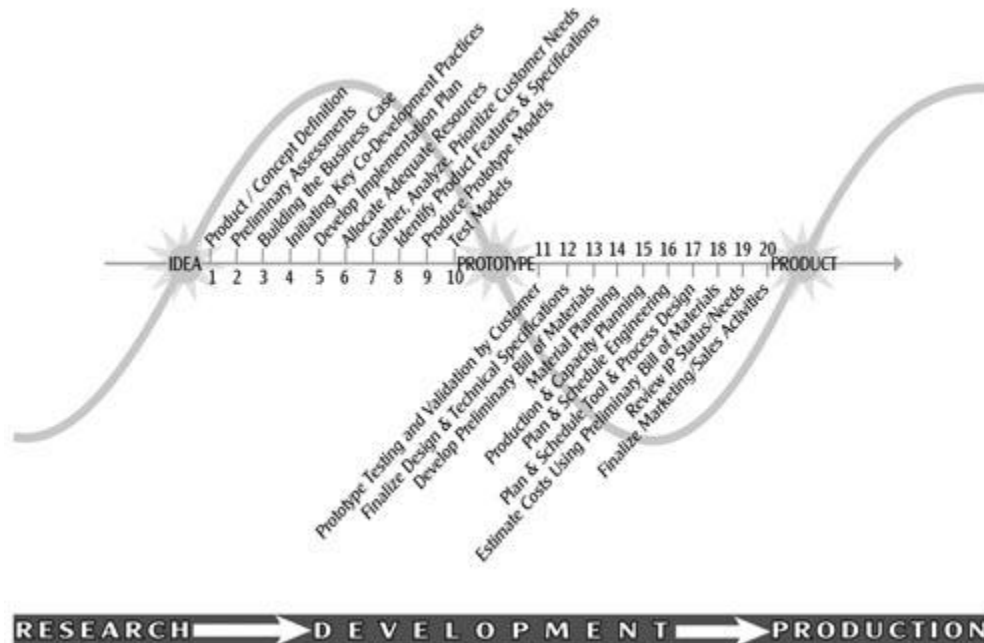


Fig. 7. Twenty step technology transfer model.

Source: "Facilitating Technology-Based Knowledge Utilization"
http://ktdrr.org/ktlibrary/articles_pubs/ncddrwork/focus/focus26

Linear models in a relatively short time identified the main problem of technology transfer process – the existence of the such stage of technology transfer process, when the idea is already not interesting for academia, but still not interesting for business. This stage was called as “Valley of Death” and efforts to improve the process concentrated on this stage analysis.

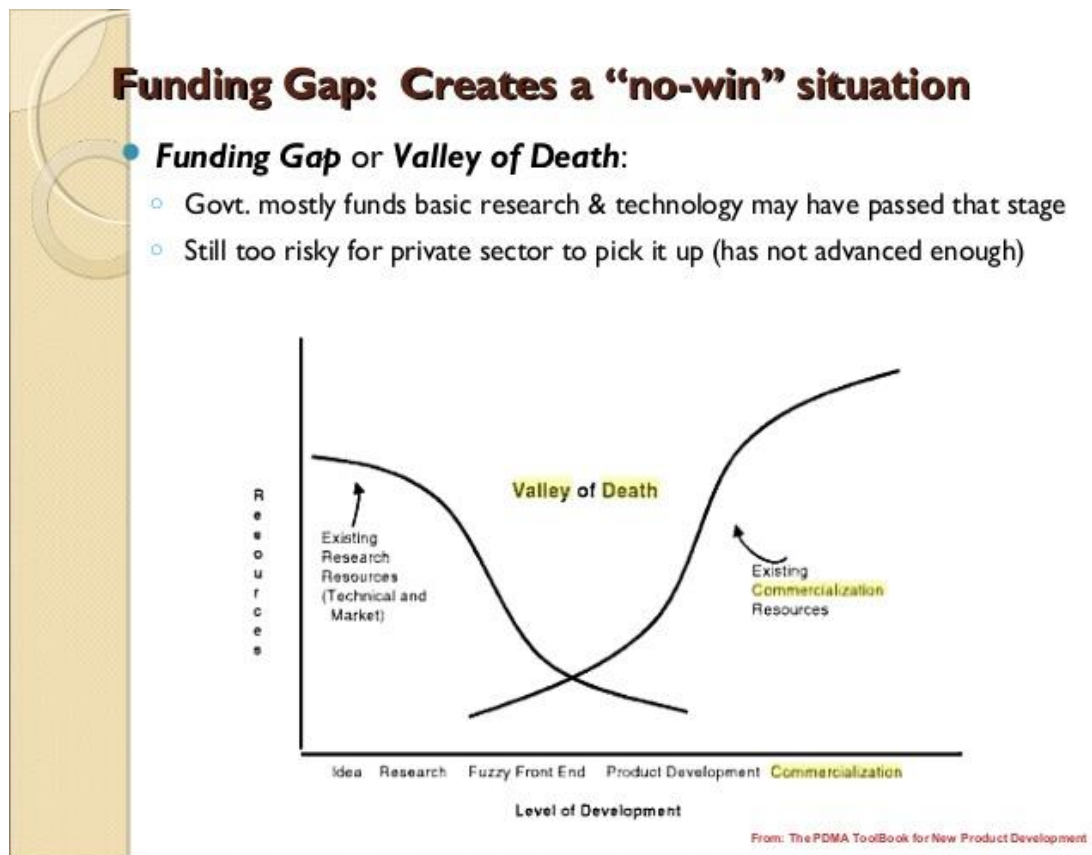


Fig 8. Valley of Death.

Source: “Leading Molecules from Bench to Bedside in Academic World.”

<http://www.slideshare.net/Brainleague/101520114-leadingmoleculiestomarketanoverviewonlicensing>

Looking into details, it is possible to understand the structure of technology transfer problems during the “Valley of Death” stage.

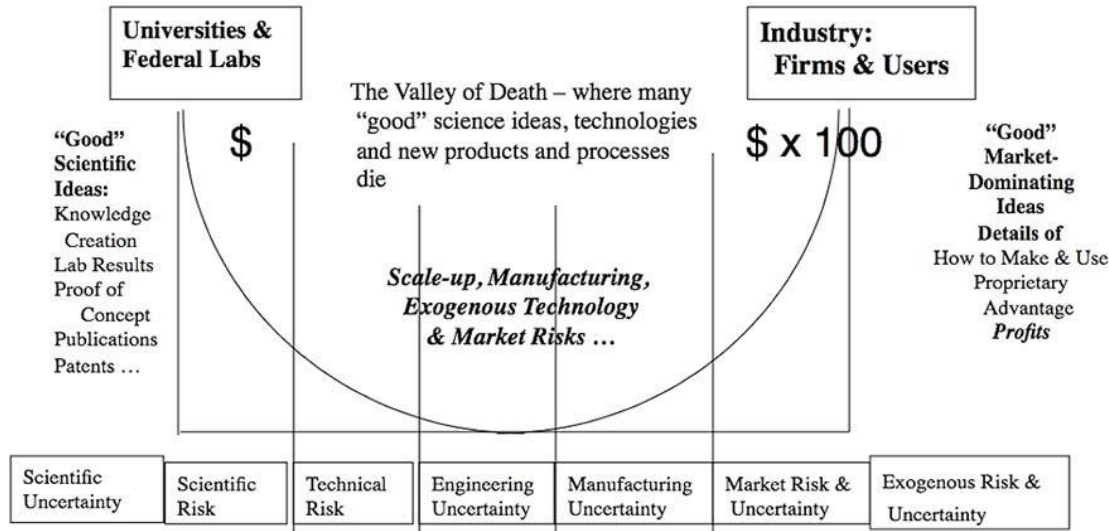


Fig. 9. Valley of Death structure.

Source: "Lessons Learned in Technology Transfer from Dr. Gregg Vanderheiden and the Trace Research & Development Center"

http://ktdrr.org/ktlibrary/articles_pubs/focus37

It is necessary to underline, that depending on industry the structure of the Valley of Death can be different – e.g. in the biomedicine there can be two Valleys of Death.

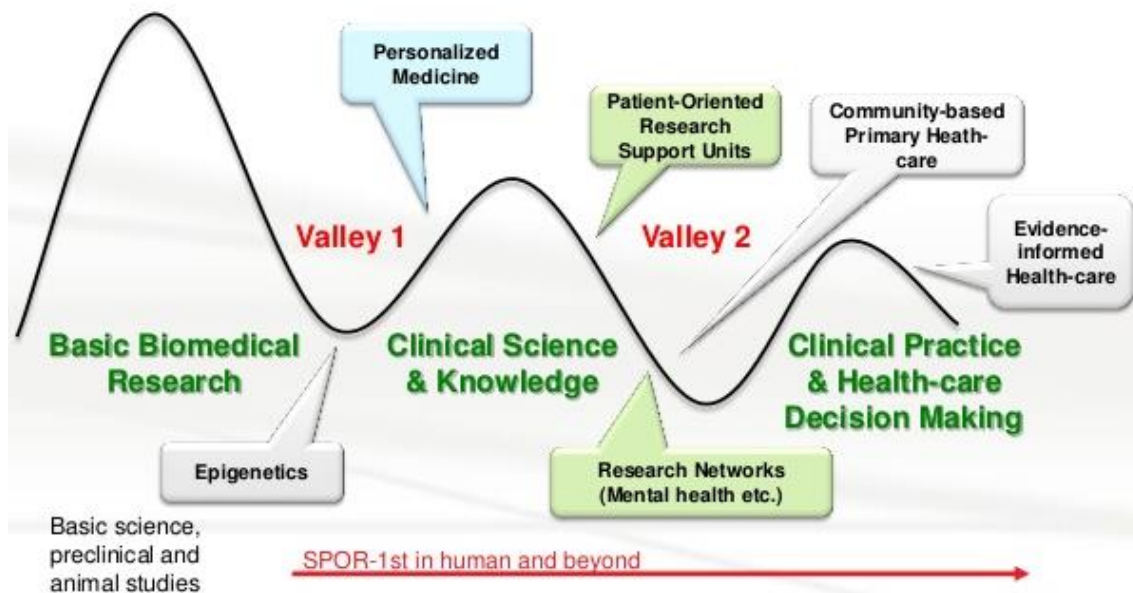


Fig. 10. Two Valleys of Death.

Source: "SPOR - Patient Engagement and Knowledge Translation"

<http://www.slideshare.net/NeuroDevNet/cihr-jeff-latimer-ppt-presentation>

After certain period, the ways to solve the “Valley of Death” problem were found and it became clear, that new additional sources and forms of financing should be used at this stage of process. In the USA the attraction of governmental financing became a main tool for further technology transfer process development.

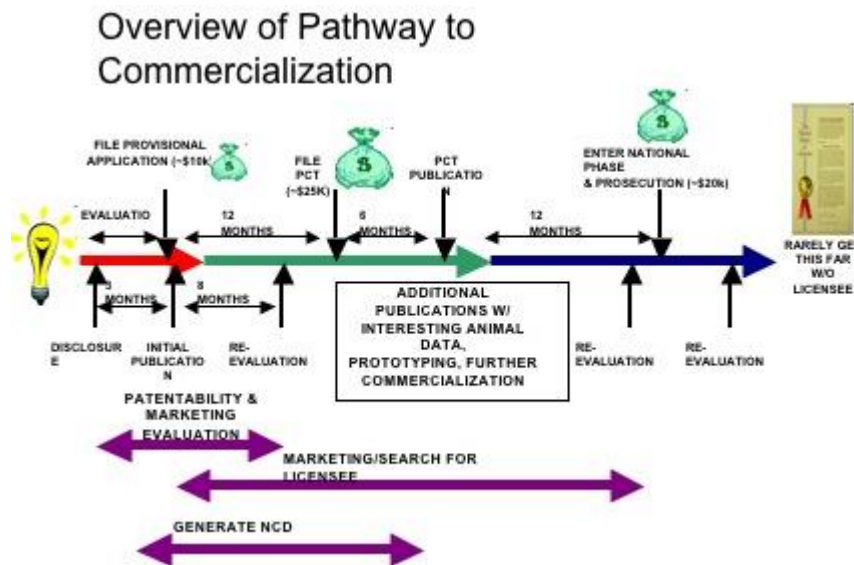


Fig. 11. Different financing sources for different technology transfer stages.

Source: “Overview of Pathway to Commercialization” <https://www.bc.edu/research/otl/faculty-and-staff/marketing.html>

After the identification of Valley of Death as the most important problem of linear models and its solution using financial sources diversification, the period of more complicated, than linear technology transfer models, started. First such more complicated models became parallel-sequential models.

4. Non-linear parallel-sequential models

It is easy to understand the origin of non-linear parallel-sequential models from the Figure 12. If we deal with the single technology transfer, we can follow to linear model, but when we try to attract financing for different stages of many separate technology transfers, we should use some kind of industrial approach that is oriented on mass production. Mass production processes are cyclical. On the level of separate technology transfer model is linear, but on the level of whole program, which consists of many processes, TT model should be cyclical.

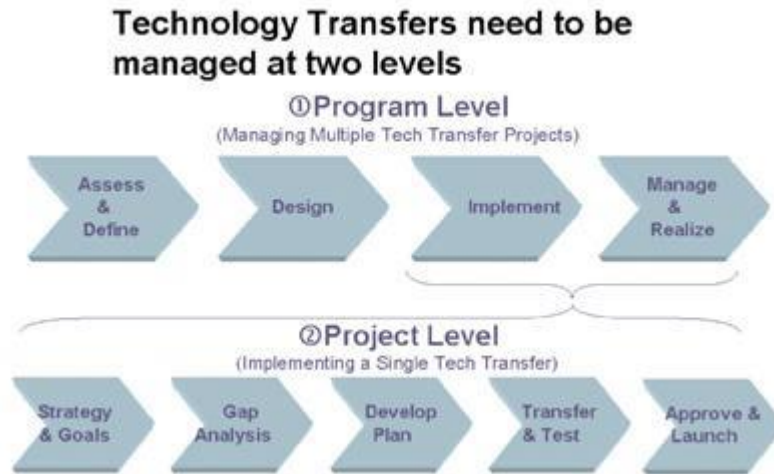


Fig. 12. Two level technology transfer model.

Source: “Technology Transfer by Design”.
http://www.contractpharma.com/issues/2007-06/view_features/technology-transfer-by-design

At the first stage of cyclical models development and implementation, many different cycles with different numbers of stages were suggested in the similar way as we saw before with linear models.

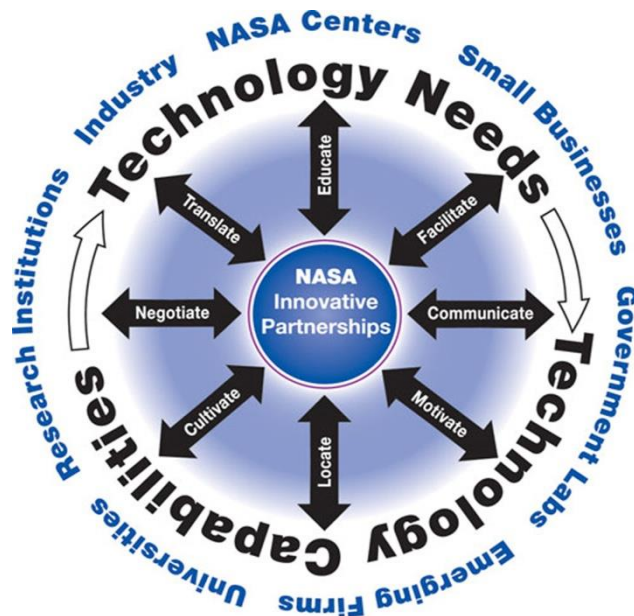


Fig. 13. NASA 8 steps cyclical model.

Source: “NASA's Legacy of Technology Transfer and Prospects for Future Benefits” https://spinoff.nasa.gov/hist_techtransfer.pdf

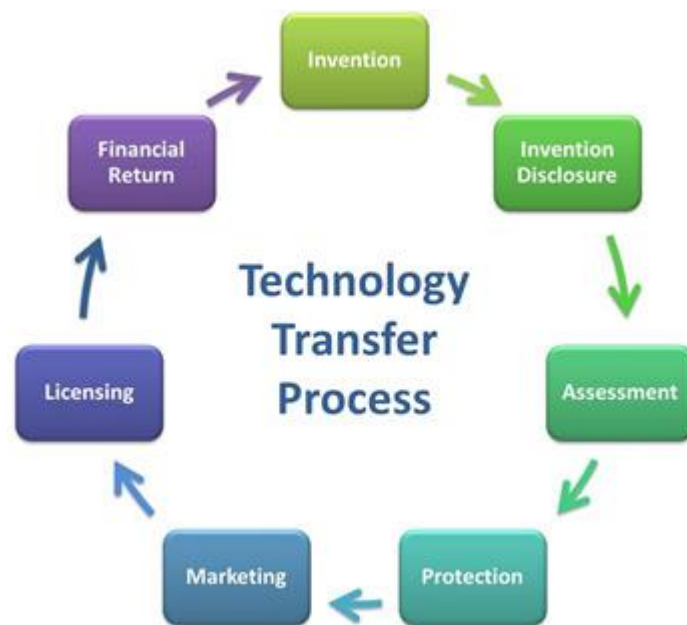


Fig. 14. Cyclical 7 steps model.

Source: "What is the Process of Technology Transfer?"
<http://www.cdc.gov/od/science/technology/techtransfer/technology-transfer-process.htm>



Fig. 15. Pharmaceutical 8 steps cyclical model.

Source: “Technology Transfer in Pharmaceuticals” www.pharmaguideline.com/2015/07/technology-transfer-in-pharmaceuticals.html

At the second stage of cyclical models development and combination with linear models the approach based on alternatives and appropriate parallel-sequential models were created. The main advantage of such models comparing with linear models is the possibility to perform certain activities simultaneously, decreasing the total time of the process. During the further development parallel-sequential models were transformed into models with back feeds.

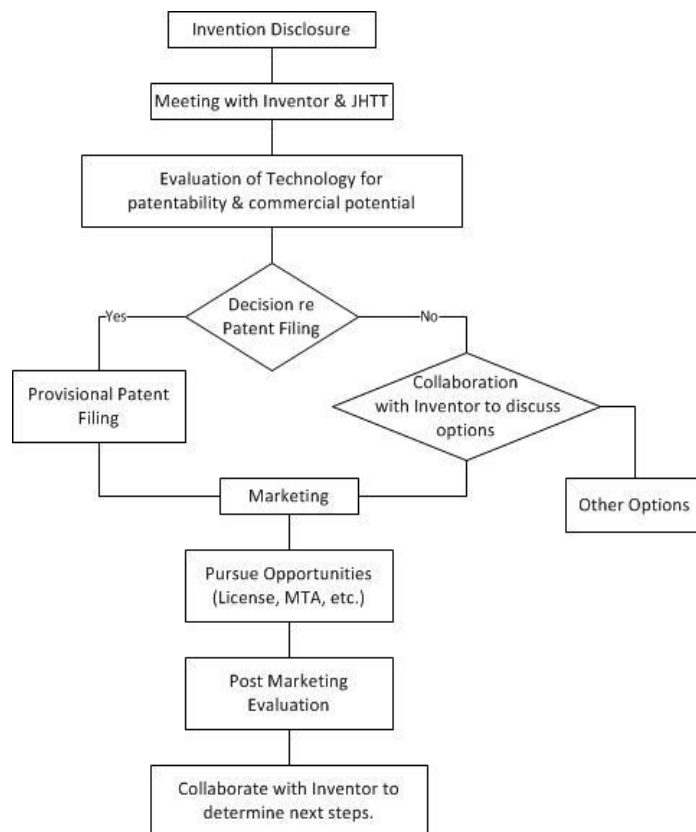


Fig. 16. Model with alternatives.

Source: “Invention Process Workflow”
<http://ventures.jhu.edu/invention-process-workflow>

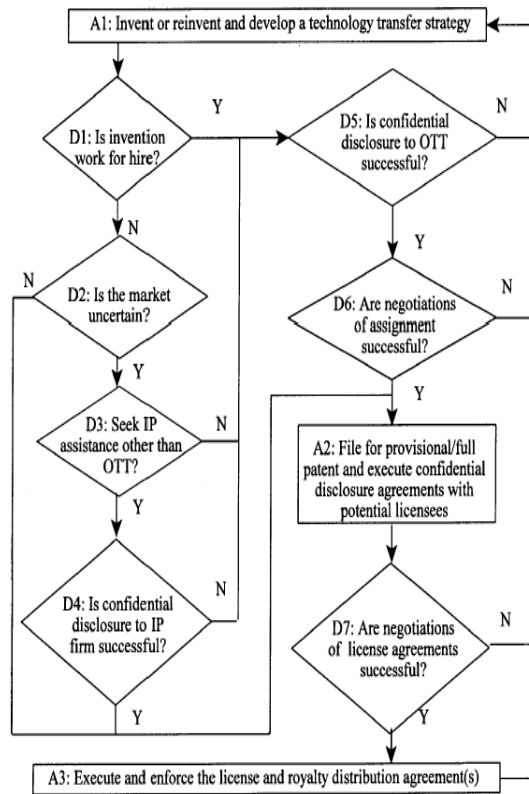


Fig. 17. Model with alternatives.

Source: “The Process and “Curriculum of Technology Transfer ”

<https://scholar.lib.vt.edu/ejournals/JOTS/Winter-Spring-2001/song.html>

5. Non-linear back feed models

The transformation of parallel-sequential models into back feed models happened in a very natural way (Fig. 18). Let us consider, for example, the flow of the technology transfer documentation. It is normal for administrative processes when there are many returns of documents from responsible institution to previous institutions for further development. This is the simplest form of back feed and it needs to forecast possible objections from technology evaluators and to perform activities in advance to remove obstacles from technology transfer process

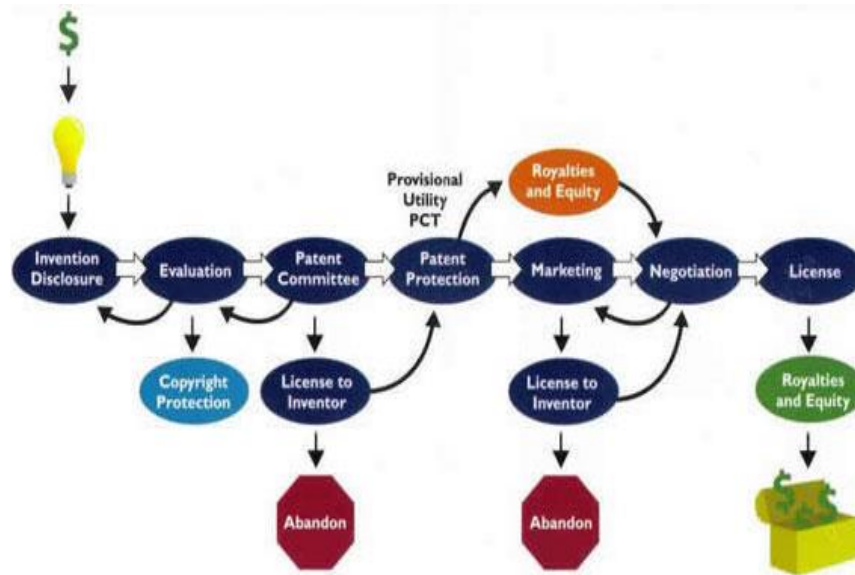


Fig. 18. Back feeds in technology transfer.

Source: "The Technology Transfer Process"
<http://www.gdrc.org/techtran/tt-process.html>

Back feed processes can be more complicated and include not only closest stages in linear model, but far stages also. This makes technology transfer model similar to set of parallel processes with links between different branches. This is more complicated construction than non-linear parallel-sequential model and needs more flexible methods of administration.

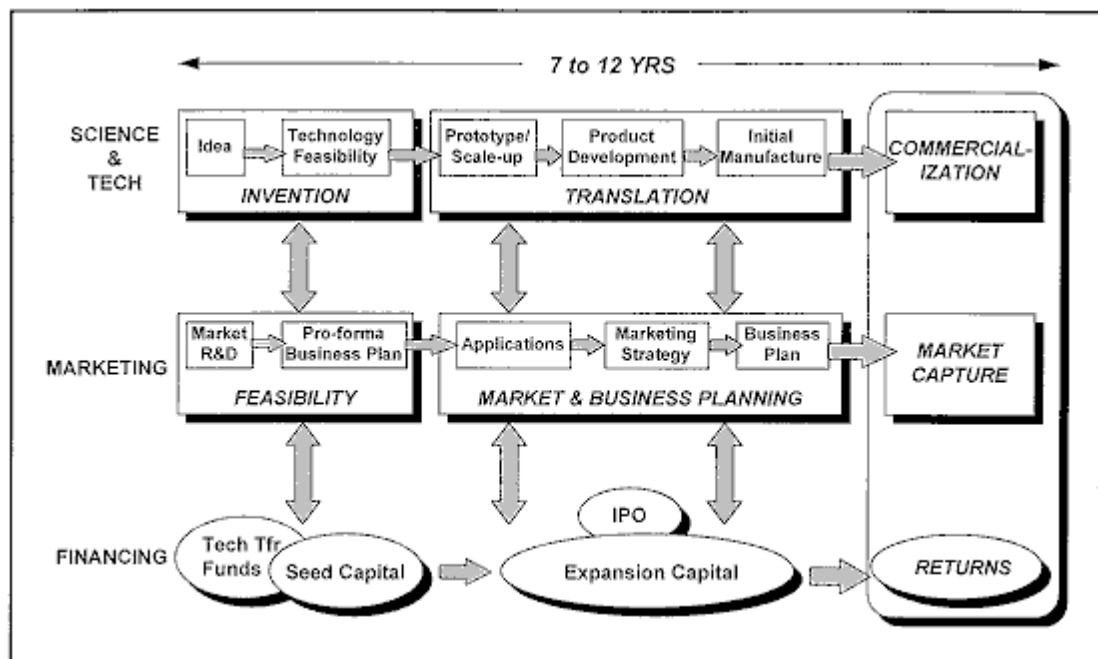


Fig. 19. Complicated back feeds in technology transfer

Source: "The Technology Transfer Process"
<http://www.gdrc.org/techtran/tt-process.html>

Conclusions

We have considered the evolution of technology transfer models from linear to non-linear parallel-sequential and further to non-linear backfeeds models. It is necessary to underline, that there are no "bad" and "good" models - from theoretical point of view, models of all kinds can be used successfully at present time depending on industry and conditions of implementation. From the practical point of view, the critical success factor for TT efficiency is the time and here TT models are not equivalent.

Linear models are good when dominant role in TT process play universities. Universities are big and conservative structures and therefore linear TT models are relatively slow.

Non-linear parallel sequential models are good when dominant role in TT process play the stable old companies. Stable old companies are more flexible then universities and therefore parallel sequential TT models are faster then linear TT models.

Back-feed models are good when dominant role in TT process play new created companies - spinoffs and startups. New created companies are even more flexible then existing companies and therefore backfeed TT models are faster then parallel sequential TT models, but the implementation of such models is related with higher risks.

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CYBER SECURITY MANAGEMENT MODEL FOR CRITICAL INFRASTRUCTURE

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Abstract. Cyber security is the most critical aspect nowadays of our technologically based lives. Government institutions, banking sectors, public and private services, nuclear power plants, power grid operators, water suppliers or waste water treatment companies use information technologies in their day-to-day operations. Everything that uses technologies are based on communication and information systems and that means that it depends on cyber security. The public and private sector each year spend millions of dollars on technologies, security software and hardware devices that will increase the cyber security inside their companies, but they are still vulnerable. The main problem of this situation is that cyber security is still usually treated as a technical aspect or technology which can be easily implemented inside the organization and this implementation will guarantee cyber security. This attitude must change, because cyber security nowadays is something more than just the technology. This article presents the taxonomy of the critical infrastructure attacks, analyzes attack vectors and attack methods used to damage critical infrastructure as well as the most common cyber security mistakes which organizations make in the cyber security field when trying to make themselves safer from vulnerabilities. The main aim of this article is to provide theoretical aspects of the cyber security management model which can be used to ensure security of critical infrastructure in an organization or company. The cyber security management model that is presented in this article is analyzed from management perspectives and is not concerned with technological aspects and products that are used to protect critical infrastructure from cyber security attacks and vulnerabilities.

Keywords: cyber security, management, critical infrastructure, cyber attacks

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JEL Classifications: D80; M15; O33

Additional disciplines: Information and Communication; Energetics and Thermoenergetics; Informatics

1. Introduction

Nowadays in our interconnected world cyber security has become the most important thing that influences every part of our life, especially regarding critical infrastructure. There are a lot of definitions of critical infrastructure. In 1996 The President of the United States issued an Executive Order (EO) which listed seven areas of critical infrastructure of the US (Johnson, 2015). The EO also stated that the most important areas are: the system of electrical grids, transportation and telecommunications. Damage to any of these will have impact on the viability

of all other critical infrastructure. The main aim of this article is to provide theoretical aspects of the cyber security management model which can be used to ensure security of critical infrastructure in an organization or company.

It should be emphasized that cyber security nowadays is not just a technical issue. Lithuanian Cybersecurity law defines cyber security as a set of legal, information dissemination, organizational and technical measures which are needed to be taken to prevent, detect, analyze and respond to cyber incidents, which are described as the event or activity that causes or may cause or allow: unauthorized access to communication and information systems (CIS), electronic communications networks or industrial process control systems; can disrupt or change information systems, including the management takeover; electronic communications networks or industrial process control operations to destroy, damage, delete or modify electronic information, withdraw or restrict access to electronic information, as well as enable to absorb or otherwise use non-public information in electronic format by unauthorized persons (Law on Cyber Security of the Republic of Lithuania, 2014). The main purpose of the mentioned actions is to provide fast recovery of electronic communications networks, information systems or industrial process control system in case of cyber incidents or cyber attacks.

Based on the approved cyber security and cyber incident definitions, it is possible to identify the most important objectives in order to ensure cyber security. The first objective is confidentiality which ensures that only authorized individuals can receive, change or manage information. The second objective is integrity, which ensures that only authorized persons or processes are able to carry any changes in the system. Thirdly – the availability of system and information which is managed by the system and its operators. This objective ensures that only authorized entities will have access to the information or resources stored or used in the organizations infrastructure. Law-based regulation clearly indicates that cyber-security and management are closely related and very important aspects of each organization. In order to ensure the security of critical infrastructure, it is recognized that cyber security is as important as the physical security (Ten, Manimaran, Liu, 2010).

CIS security and security tools were analyzed by a lot of commercial companies and scientists. A lot of security tools and technical standards were provided to the market to improve the security of CIS, but in last two decades there has been a significant interest in providing universal security tools to critical infrastructure protection.

Nowadays the meaning of cyber security is maturing, because of the rapid spread of communication and information technology to all parts of our life, more convenient and more efficient service delivery (Limba et al., 2016) as well as the increase in the energy infrastructure integrity (Wang, Lu, 2013). It can be argued that the vulnerabilities in critical infrastructure are also maturing rapidly and this process influences the security of systems.

The main problem of the increasing vulnerability can be associated with the complexity of the system and integration process: the small elements of the systems or small systems are integrated into larger systems which increases the system complexity and creates conditions for vulnerabilities to arise not only in domestic but also in countries interconnected systems; new modern technology usage is usually motivated by the increasing need for efficiency, but it is not considered from the security and especially cyber security position due to a lack of proper understanding of the vulnerable areas and limitations as well as a lack of possibilities to enforce the responsibility of private sector players to reduce the effect of their negligence on society or some part of society (Kroger, 2008).

One thing that each country and each scientist agrees on is that a cyber security management model is necessary if you want to secure your critical infrastructure (e.g. internet voting systems or banking systems) or critical energy infrastructure. However, although there is no single cyber security management model, all countries of the world are aware of the need to carefully manage and protect their critical resources. Governments and organizations of

the world understand that the main efforts should be taken to provide security for their critical infrastructure because only this can ensure the wellbeing of the country and its people, especially when critical infrastructure and energy security has become an argument for political decisions making (Tvaronavičienė, 2012). The United States already pointed out in 2000 that cyber security must be managed holistically, rather than in separate state information systems (US GAO, 2007; Council of Europe, 2008; NATO, 2010; Lithuania National Security Strategy, 2012; Johnson, 2015).

Researchers from different countries have attempted to look for an effective cyber-security model. In their view, ensuring cooperation on critical infrastructure cyber security is crucial both at domestic and international level. It is noted that since the critical infrastructure elements are very closely linked, a cyber attack can spread very widely and damage other systems as a breach in one area can easily spread to the other (Bulakh, 2016). It is essential to strengthen public-private partnerships in securing critical infrastructure resources, usually because the public sector is the owner of some part of the critical infrastructure systems or communication systems which is usually managed by private operators. It should be noted that one of the public - private partnership initiatives is organized by the European Commission – they have created the critical infrastructure protection information dissemination network. This network allows the public authorities, private sector representatives and experts to exchange and share information and best practices (European Commission).

However, it is noted that the private sector is much less inclined to share information about specific attacks even though such information could significantly contribute to the strengthening of cybersecurity. It is assumed that it is unlikely for the private sector to share the information about cyber security attacks and vulnerabilities they have identified in their infrastructure because this information can ruin their reputation and make society or business partners rethink the attractiveness of collaboration (European Commission; Rosner, 2013).

Many cyber security studies have been focused on technical solutions which can be accepted in the cyber security protection field: much attention is given to ensuring the security of Supervisory Control and Data Acquisition (SCADA) systems that are used to monitor and control features in the industrial sector and energy transit infrastructure. The security of the SCADA system consists of four major elements: real-time monitoring, detection of anomalies, impact analysis and mitigation strategies (Ten, Manimaran, Liu, 2010). Cyber security in this case is analyzed only from a technological aspect, but this view is not fully correct. Technological solutions to strengthen cyber security are very important but, in reality, today you need a wider and more nuanced view regarding the cyber security model.

When developing the country's critical infrastructures cyber security model it is also recommended to involve public institutions, national regulators and the private sector. It is important to look for the most effective regulation and international practices (US Department of energy, US Department of Homeland Security, 2006; Organization for Security and Cooperation in Europe, 2013).

The authors of this article will not concentrate on CIS security technology aspects, because as has been mentioned earlier, cyber security is not just technological, authors will try to provide a theoretical model that can be used for cyber security management to also secure critical infrastructure because cyber security is concurrent with critical infrastructure security and is the main part of it (Fuschi, Tvaronavičienė, 2014).

2. Taxonomy of Critical Infrastructure Attacks

Cyber criminals concentrate their attention on critical infrastructure because in case of a successful attack you can get financial or political profit. The biggest vulnerability of this situation is that the systems use commercial products and with some technical knowledge the attacker can exploit vulnerabilities that exist in those products,

telecommunication methods, and common operating systems (US Department of energy, US Department of Homeland Security, 2006).

This situation evolves because of deep trust in the CIS and technologies. Cyber-attacks on critical sectors usually have a big influence to the government and private sector. As an example, in December 2015 an attack on the Ukrainian power supply system cut off 225,000 users. The US Department of Homeland Security stated that a cyber-attack was executed through malicious software. This incident is probably the first known incident that was a successful cyber intrusion in interrupting the power supply chain. There have been a lot of attempts to find the initiators of the cyber-attack, but with incidents in cyber-space, you are always faced with the problem of attributing responsibility – it is extremely difficult to trace the perpetrators of the incident (Volz, 2016). In order to prevent cyber-incidents, the best response is the improvement of cyber security. It is important to note that cyber threats are particularly difficult to predict, anticipate and take timely preventive measures, so the risk that cyber attacks will be successfully implemented is increasing.

A lot of countries have not developed a strategy on how to respond to cyber attacks and unexpected scenarios and underestimate their vulnerabilities. It is extremely important and relevant to exam cyber-security aspects in a critical infrastructure context in order to ensure protection of vital national interests. It should be noted that the mere technological solutions do not solve all the problems and the cyber security management model of critical infrastructure should be improved along with the rapidly evolving technology, legal aspects and etc. (Limba, Agafonov, Damkus, 2016).

Government organizations (US Department of energy, US Department of Homeland Security) and researchers (Tranchita, Hadjsaid, Viziteu, Rozel, Caire, 2010) make attention to the main type of attacks on critical infrastructure or industrial control systems (ICS). Attacks can be described by five major groups which vary according to the objectives pursued by the attacker of the system:

- Corruption of information – when data on a system or communications channel suffers improper modification.
- Denial-of-service (DoS) – when access to the system is denied for authorized users.
- Disclosure of information – when critical information is disclosed to unauthorized persons or systems.
- Theft of resources – when system resources are used by unauthorized entities.
- Physical destruction – when physical harm or destruction is achieved through the use of ICS.

US Department of energy and Department of Homeland Security also predicted that the cyber environment will change and therefore attack vectors to the critical infrastructure will change as well meaning owners and operators will need to combat new threats. The security posture of critical infrastructure will be increasingly challenged as technologies, business practices (Kiškis, Limba, Gulevičiutė, 2016), and market trends (Kiškis, Limba, 2016) continue to reshape the security landscape. Changes of technology (Vlasenko et al., 2016) will mean big changes in the field of system management and resistance to vulnerabilities.

Barnes and others identified that ICS cyber vulnerabilities originate from the point where connectivity is the greatest and access control is the weakest (Barnes, Johnson, Nickelson, 2004). They identify 4 domains of cyber vulnerabilities (each domain has its own attack vectors that are used by cyber criminals to achieve their goals):

- IT Domain.
- ICS Domain.
- Communications Domain.
- Physical Domain.

Nowadays the ICS and IT domains can't be separated. Marcelo indicates that modern infrastructures, and especially power infrastructure, integrate ICS components with IT components and the biggest argument for this situation is technological evolution and progress (Marcelo, 2010).

US Government Accountability Office identify cyber attacker groups by the goals that the attacker is trying to reach by his activity: Bot-network operators, Criminal groups, Foreign intelligence services, Hackers, Insiders, Phishers, Spammers, Spyware/malware authors, Terrorists. All these groups are targeting critical infrastructure or other information technology assets for the different purposes, but all of them are really dangerous and any group can be identified as innocuous (GAO, 2005).

Each attacker usually will try to exploit system vulnerabilities and use a few attack vectors to take the control of the system that he is trying to damage or exploit. In most cases attackers will study vulnerabilities in order to achieve their objectives (Stouffer, Falco, Kent, 2013). A cyber attack frequently develops in five different stages: finding a vulnerability of the system, taking control of the system or part of it, inserting malicious software into the system, infecting other system components and making an attack to all of the system or to special part of it. All these stages are shown in Fig. 1.

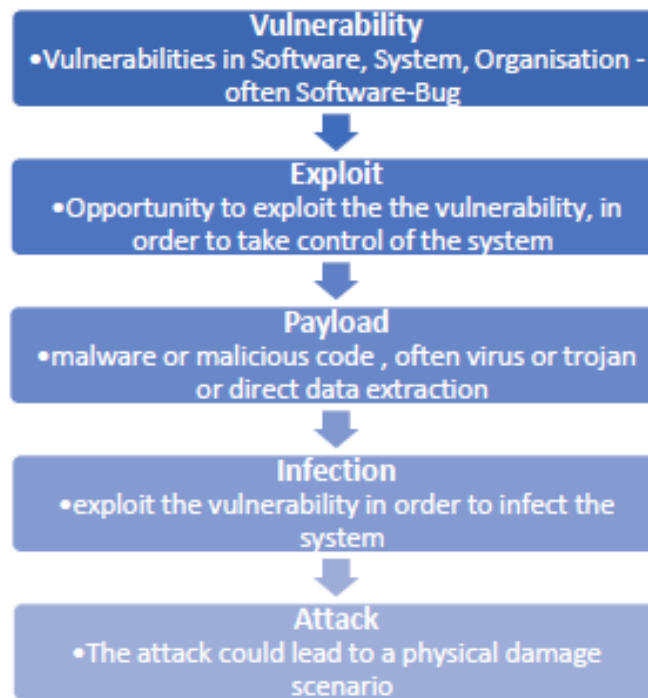


Fig. 1. Cyber attack development stages

Source: IMIA Working Group, 2016

Gaps in cyber security cause big issues to each system owner or operator, but they may not be perceived to be as critical as gaps in critical infrastructure systems, because the impact of attacking them will be mostly invisible.

The attack on the system may have various impacts. Some attacks on critical infrastructures are described below. Whilst these are the most common attack types the reader must understand that this is not a finite list and the attackers can have other aims when attacking not just critical infrastructure:

- Some attacks on the infrastructure seek to cause panic in the population and disrupt usual life. The examples of these attacks are the Los Angeles traffic lights 2006 attack (GAO, 2007), Volgodonsk 2007 and St. Petersburg 2008 nuclear power plant attacks (Butrimas, Bruzga, 2012; sputniknews.com, 2008) and others.
- Espionage attacks like 2006/2013 US energy facilities attacks (Umbach, 2013), Red October 2012 (securelist.com, 2013), Gauss 2012 (kasperskylabs.com, 2012), Careto (the Mask) 2014 (kasperskylabs.com, 2014) and others.
- Attacks whose main aim is to destroy or disrupt the normal work of system equipment. F. e. 1982 USSR SCADA attack (Radziwill, 2015), 2000 Australian Sewage spill (Crawford, 2006), probably the most known nuclear power plant attack – STUXNET 2010 (Karnouskos, 2011; langner, 2013) and others.

Today we can't imagine the power supply backbone or other critical infrastructure without ICS control environment. The field of critical infrastructure management nowadays is impossible without modern technology, which simplifies and reduces operating costs but at the same time this technology has formed security gaps and created gates to exploit cyber vulnerabilities. The technology companies are trying to increase the resistance of the critical energy infrastructure and eliminate cyber threats by creating a centralized system management model that protects critical infrastructure from cyber vulnerabilities, but sometimes new technologies just open new possibilities to attackers (Wei, Lu, Jafari, Skare, Rohde, 2010) and they will attack if the smallest chance is given.

3. Development of Cyber Security Management Model

What is important is that cyber threats are very difficult to predict, anticipate and take preventive measures in time (Craig, Valeriano, 2016), so the risk that cyber attacks will be successfully implemented is increasing. This is particularly true in the case of Lithuania, especially in view of the current geopolitical situation. Currently there is no cyber security management model developed which allows a response to cyber attacks, unexpected scenarios and vulnerabilities, so it is vitally important to deal with cyber security issues in the context of critical infrastructure, in order to safeguard the basic interests of the state. It should be noted that the mere technological issues and solutions do not solve all the problems as a cyber security management model of critical infrastructure should be constantly improved along with the rapidly evolving technology (Water Information Sharing and Analysis Center, 2015).

3.1. Cyber Security Mistakes

There are common mistakes that organizations make when thinking about the cyber security of their assets:

- Falsely thinking that each infrastructure can be made safe from any vulnerability. Each organization that operates infrastructure and especially critical infrastructure should understand that full security is just a dream. The most important aspect of security is to understand what are the most vulnerable areas, what activities you must do to avoid threats, which mechanisms you need to detect abnormal infrastructure activity and have a clear plan which describes how to reduce losses and to restore normal activity of your infrastructure (WISAC, 2015). However, a fundamental aspect which should be the most important to organizations is the *detection* and *response* for critical situations. These things can significantly reduce losses concerned with cyber security breaches (Techrepublic, 2004).
- False opinions that recruiting the best professionals will save you from the cyber threat. Each organization needs to understand that cyber security is not a department but a whole organization's approach (WISAC, 2015; Singer, Friedman, 2014). Qualifying cyber security as one of the department and professional

association form deceptive sense of invulnerability. This approach is flawed. Cyber security must be a fundamental objective and must become a key aim of each organization's team member, because the human factor is the most vulnerable part in cyber security (Techrepublic, 2004; Wei, Lu, Jafari, Skare, Rohde, 2010). This means that, for example, cyber security should become one of the organization's policies, which can influence earnings.

- False thinking about security technologies and tools that are used to ensure the security. Companies that produce technical equipment and software will never guarantee that their products will defend you from 100 percent of cyber attacks. Technology and equipment used in the modern world to the fulfillment of certain security features such as detecting an intruder or etc. These measures and tools are very important and must be used in the technological infrastructure, but it is just technology and it can't grant you total cyber security (Techrepublic, 2004; Wei, Lu, Jafari, Skare, Rohde, 2010). Tools have to be a certain product, which occurs after the time when good and strong cyber defense capability is deployed. But products alone don't make the IT department, everyone is responsible for cyber security and the human factor remains the weakest link in relation to security (WISAC, 2015). Investment in tools is meaningful only when people are aware of their personal responsibility and seek to keep their networks safe. As an example: social engineering, which is still one of the main risks facing an organization taking care of their own security. Technology can help in this regard, but it is very important that managers take responsibility in solving this problem. Organizations need to understand that each person in the company needs to be evolved in education and must understand the threat of cyber attacks.
- False opinion that cyber security is just about effective monitoring. Monitoring in this context has a more broad meaning than just monitoring of equipment and infrastructure assets. Monitoring is not a narrow technical view, which is linked to specific information resources, information systems and network monitoring, but is a broad view, which combines in itself the whole organization of the surrounding environment and modern cybercrime trends tracking. Monitoring is worthless if no one can learn from it (WISAC, 2015). If you understand the external changes and trends in the cyber security you will be able to use these insights, and develop appropriate policies and strategies to be successful in the fight against cybercrime in the long run. Cyber security policy and strategy must be based on continuous learning and development. Organizations need to understand how threats evolve and develop in the future, and what the opportunities to prepare for the upcoming threats are. This approach is ultimately more cost effective because they have certain advantages over a short-term increase in security by building higher and higher walls. Each organization must ensure that the information about the security vulnerability is shared to others, because only the exchange of information may provide a general picture of the actual security situation in the city, state or the world scale (Govindarasu, Hahn, 2017).
- False opinions that security measures that are used by the organization to protect itself from cyber threats are superior. Security should first be determined to achieve its goals. Making effective cyber security and trying to avoid cyber attacks is like running in Olympic marathon, but security is not winning vs. cyber attackers. The attackers develop new methods and techniques, and defenders are always one step behind. It seems that it is useful to invest in increasingly sophisticated security measures to prevent attacks, but the reality is somewhat different. The cyber security policy must prioritize investment in critical infrastructure and resources, rather than the latest technology or systems that can detect any threat (WISAC, 2015). First of all, you need to understand what kind of invaders could be interested in the organization's activities and why. We must understand the value of their assets, to be able to assess and assume some risk because immeasurable cost technologies, as has been said before, do not ensure complete security.

The main aspect of cyber security is that cyber security should be the cornerstone of the development of new IT solutions and systems, and not, as often happens, remembered only at the end of the project like has happened

with the internet architecture which was designed to promote connectivity, not security (Jenab, Moslehpour, 2016).

3.2. Dimensions of Cyber Security Management Model

Further on we will provide the cyber security management module which can be used to ensure security to any critical infrastructure as well as to improve the cyber security of any business company or government organization. However, we will not concentrate on usage of concrete technology equipment or information security management processes that are used for making critical infrastructure safer, but will provide core information about the proposed model. The whole model is presented in Fig. 2.



Fig. 2. Cyber security management model

Source: Designed by the authors

The presented model is constructed from the six core fields that the authors find to be most critical in the process of ensuring cyber security. All these elements have the same importance and need to be developed throughout the whole organization all together, because just the development of the one part of the model will not make any big changes to the security in organization.

As it was shown in the earlier figure, the model consists from the six core sections:

1. Legal regulation. This part of the model is constructed from requirements and legal proceedings and aspects that need to be achieved by the organization which is thinking about the modern cyber security. It must contain the whole vision of all legislation acts which will be used in organizations

- each day life (security instructions for employees, information security officers and network administrators, any standards which are used or are planned to develop in organization and etc.);
2. Good governance. In terms of cyber security achievement, this is maybe the most important part of the cyber security management model. Each modern organizational leader needs to understand the main aims of cyber security in their organization and understand that there are risks that will be never excluded from organizational life. The organization needs to understand that you can't do anything to avoid all cyber risks, but you can minimize the impact of cyber incidents to the organization if they occur. Cyber security must be the first stone in any project pedestal. Any project or activity which is planned within the organization must first be fully reviewed from a security perspective. Only a good understanding that security, and especially cyber security, is the core element of any project will provide success to organization projects and will help to save money and resources.
 3. Risk management. This is the organizations ability to properly identify risks that are growing around the organization and ensuring they have the specialist skills to control the impact of these risks. As was mentioned earlier, organizations can't avoid all risks. Sometimes it is more important to have all risks identified and have a contingency plan than try to avoid all risks. In fact, the organization must learn not only to avoid risks, but also learn to accept them. Sometimes the ability to identify the risks and prepare contingency plans will do more for the organization than attempting to avoid the identified risks. Only after careful consideration of all risks can the question be answered; what is more effective, avoidance or the use of counter-measures?
 4. Security culture. This needs to be integrated in the cyber security management model. This dimension is probably the hardest to implement and control. You can use informatics, mathematics or risk management technologies to attempt to calculate what is more beneficial to organization – buying new security system or accepting the risks of theft, but it is much more difficult to with your personnel, because they are people. This aspect is very important and the organization needs to understand that it is vulnerable as the people who are working there. Security must be understandable for every organization member and each member must have an ability to learn how to defend the organization and themselves from cyber security incidents as mistakes can be critical to the security of the organization. One of the biggest cyber security mistakes in this dimension is usually associated with the opinion of higher managers and IT specialists that they must have more privileges and access on their systems. If you need really to be protected and want to have fewer troubles with cyber security, you need to understand that all security measures must be available to all personnel personnel; otherwise you can lose your struggle for cyber security.
 5. Technology management. As has been mentioned before, cyber security is not just about the technological approach to the organization but you will need to use it to achieve your organizational goals. Try to understand that your knowledge about each component that is controlled by IT can be vulnerable. You will need to know each component that you use for your organization work. This knowledge will let you know if there are some components which are vulnerable and can be the breached. The management of technologies and components will let you decrease the time which is needed to remove the effects of the security incident or prevent the rise of security incident.
 6. Incident management. This dimension is closely attached to legal dimension of the module. You must have special plans regarding the incident consequence management. These plans need to include instructions to organization members which must be applied if any secure incident happens. You need to identify which measures must be implemented when trying to reduce the impact of the incident and how to restore normal operation to your organization.

Each field (dimension) of the proposed cyber security management model must be clearly identified, measured and evaluated and the organization needs to develop a clear plan regarding the problems that are identified in each field of the cyber security management model.

3.3. Levels of Cyber Security Model

Each dimension of the proposed cyber security management model can be divided in to 3 levels: *initial level*, *moderate level* and *full integration level*.

Initial level of all dimensions is associated with the organizations ability to clearly identify which problems can be met by the organization during the implementation of the cyber security model:

- The legal dimension will consist of the deep analysis of the legal framework inside and outside the organization and identification of all the gaps in the legal aspects that can affect the cyber security policies of organization;
- The good governance dimension will include the analysis of the governance system in the organization, with the possibility to identify which department or individual is involved in to the decision making process. Even a small understanding of the governance process in the organization and the governance process cooperation with the cyber security field will make the organization a little bit stronger on cyber security arena;
- The risk management dimension initial level collates all the risks that have any possibility to appear inside or outside the organization and can affect the organizations normal life and operation;
- The security culture dimension needs the clear understanding of the organization and its members about all security measures which can be used inside the organization to try to increase cyber security;
- The technology management dimension must include a clear vision of the all technologies used in the organization on daily working processes. Only a clear view of existing technologies that are used in the organizational life can identify what can be used as attack vectors to these technologies and what measures can be used to prevent or minimize attacks;
- The incident management dimension initial level in the organization must contain the organizational ability to understand that each organization can be damaged through technological or social aspects and this damage can appear at any time from any infrastructure segment (hardware or software) or personnel. Incident management on this level can contain simple instructions to the organization that can be used in the case of abnormal activity against the organization. The understanding of the cyber incident nature is the first, and maybe the main, step to increasing cyber security in the organization.

Moderate level of each of the six cyber security management model dimensions includes the clear plan and visibility of changes, which need to be done in organization:

- The legal aspects need to be clearly identified and all working instructions need to be prepared and introduced to each member of the organization
- The good governance dimension needs to clearly identify the governance chain in the organization with clear borders of responsibility for each department that is involved in organizational life;
- The risk management dimension needs to identify the clear plan of avoiding or accepting the risks which were identified in the initial level of the cyber security management model, because sometimes the better decision is to accept some risks than try to avoid them (it costs more or takes huge resources);
- The security culture dimension in the moderate level needs to include a clear plan of managing the personnel and providing a clear identification of skills that need to be reached by each organization member (you need to plan additional training for your IT security specialists and IT system users because only qualified IT personal should not be the warranty of your cyber security);
- The technology management must include clear and understandable information about the software and technologies that are used in the organization, including the life cycle of used equipment and

software, because most security breaches are hidden inside the systems that are outdated, but still used in organizational working process (this technology audit needs to be done continuously, because it will let you plan financially what upgrades are needed for your existing equipment);

- The incident management dimension in this level needs to contain detailed plans and directions about the organizations recovery plans if any cyber security incidents occur and the normal work of the organization is disrupted. Each department of the organization or organizational member needs to know the disaster recovery plan if a cyber security attack on the organisation is successful.

The moderate level of each dimension in the cyber security management model is like the well trained soldier who has enough knowledge how to accomplish his mission, but doesn't forget that even well trained soldiers sometimes need training to refresh his knowledge. Organizations need to do timely audits of the cyber security management model dimensions and timely updates to all plans. Organizations need to remember that the world is changed by the computer technologies and this change process is still happening. When organizations try to survive in the real world they need to adapt to the changes and play by the rules of today's technologies and technologies that will appear in the future. Otherwise the modern organization will struggle to survive in our interconnected world and each organization needs to understand that it is impossible to create its own Arthur Conan Doyle's Lost world.

The highest level of the cyber security management model is the *full integration* (interoperability) level. It is defined by the full interconnection of all management model dimensions. On this level the organization is operating like a large army of soldiers working on one general mission and each dimension of the cyber security model is an inherent part of the organization.

The integration of the cyber security management model into the organization is a very difficult process which requires substantial understanding, and this knowledge can't be associated with the technology or information security fields. The biggest issue is to link technologies and management together, because often technical and management specialists talk different languages. Your organization will change when you begin to understand cyber security not as a technological discipline but as a real management challenge.

The model which has been presented in this article confers some advantages to organizations which implement it. All the dimensions of the presented model need to be auditable and renewed on a timely basis and this process will give the organization a better understanding of the cybercrime world around it and information about cyber security trends that help the organization make the right decisions and be more resistant to the cyber attacks. It also confers the ability to enable organizational leaders to actively participate in decision making and shaping the cyber security policy as well as an opportunity to properly assess the risks related to security and proper identification of such risks. The ability to learn how to manage incidents and reduce the effects of a successful attack helps all members of the organization understand cyber security threats by knowing what actions need to be done to reduce the ongoing attack symptoms or which actions need to be taken to avoid vulnerabilities. The ability to improve the organization's reputation in the outside environment because the organization really cares about cyber security is more attractive to consumers or business partners including the ability to moderate communication inside the organization, which helps to make organization more resistant to attack.

This knowledge creates security and confidence inside an organization which can easily deal with cyber security threats and perhaps it is time to take a step toward the management model and finally understand that technology and management must walk hand in hand in order to ensure effective cyber security.

Conclusions

The existing literature, which deals with critical energy infrastructure cyber security as well as with cyber security in other dimensions usually consists of two main sections: first, technical analysis, including finding the most effective technical solutions, whilst the second strategic-level analysis attempts to find an effective model for cyber security, ensuring the needs of responsive governance and management. It should be noted that the technical solutions is not the panacea that can improve cyber security for organizations, systems or infrastructures. Nowadays when the threats are increasing rapidly, you need to think about the solutions that have more complex measures. It is time to think about a cyber security management model which has considered all strategic aspects. The main idea of the cyber security management model that has been presented in this article is that cyber security must be pushed to all parts of the organization and each member of the organization must be involved in cyber security. Also it must include the involvement of government, public authorities and private sector organizations cooperating and sharing international best practices, despite the complexity of their interactions.

The proposed cyber security management model includes six dimensions. The implementation of the cyber security management model dimensions in an organization will help to minimize the risks and limit the impact of successful cyber attacks which can be initiated against the organizations infrastructure, have a better understanding of the security situation around the organization and inside it (this will provide necessary knowledge about the vulnerabilities of the organization, cybercrime trends and attacks that could be executed against the organization), provide better communication inside the organization as well as improving the communication with other organizations which makes them more resistant to attacks and improves the organizations reputation.

The implementation of the cyber security management model in an organization could be made by three initial levels. Each level has its own line of achievement. The first and second levels (initial and moderate level) of all dimensions in the proposed cyber security management model can be implemented separately. This means that you can achieve the goals and prepare improvement plans of each dimension separately and these plans need not be connected together. Only after the second level is reached for all dimensions of the model can you step into the *integration* level of the model. This level has full interoperability through all dimensions and each member of the organization has their own role. The achievement of this level means that an organization is able to resist cyber attacks that can be attempted against it and can predict the main attack vectors, but it doesn't mean that everything is done. The cyber security situation in today's interconnected world is changing second by second and organisations need to be prepared and understand that plans that are prepared today and that technology that is used to protect you from cyber vulnerabilities can be rendered obsolete tomorrow. This means that the cyber security management process is very dynamic and organisations need to be prepared for situations that are not in their plans and that need to be covered in the future.

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A NEW APPROACH TO MEASURING GREEN GDP: A CROSS-COUNTRY ANALYSIS

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Abstract. While the gross national/domestic product (GNP/GDP) index is a highly reliable indicator that reflects economic performance of a country, it still largely ignores the depreciation of assets, non-market economy and especially the damages to the environment caused by growth. Environmental sustainability of economic growth has come to be recognized as one of the most important pillars of sustainable growth and development. In order to tackle many challenges of the so-called green growth and sustainable development we try to build a new/alternative Green GDP indicator that should give us a clearer perspective of the consequences of economic progress by offering a new approach in quantifying the cost of ecological and environmental degradation. The indicator reviews economic growth through the environmental prism without speculating on how economic and social trends will evolve and how these developments will guide policy making in the years to come. We are well conscious that this indicator cannot ideally reflect the genuine status and improvement of national output, however, we see it as an attempt to encourage further discussions on the green growth in a diverse range of developing and developed countries. The results reveal a necessity for a new synergy between economic and environmental concepts, hence this study should be seen as an opportunity, not an obstacle for equitable and sustainable growth/development prospects.

Keywords: Green GDP, sustainable economic growth, environment and development

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JEL Classification: E01, O10, Q56

1. Introduction

A frequently asked question lately is whether the traditional measures of a country's level of economic activity and progress, such as gross domestic product (GDP) or gross national product (GNP), fail to account for the environmental issues. There is a general consensus that these indicators, (especially) according to the concepts of sustainable development and green growth, appear to be poor measurements. Some of the common critiques state that these standard measures do not take into account non-valued aspects of income distribution, the depreciation

of assets, the non-market economy and the environmental issues of pollution, ecological degradation and resource depletion. Thus, the GDP, for example, tells us nothing about sustainability and/or equitability of growth and development. It is even worse when we use it as a measure of comparison between countries, since many countries achieve their growth by means detrimental to their environment. *Ditto*, it also becomes a question of ethics. Many would agree that GDP is a bad measure simply because it is an incomplete indicator. However, we have to be objective as well and state that standard measures such as GDP do have an enormous impact on policy goals and regulations, public and academic discourse as well the media since it is a powerful accountability mechanism (Boyd, 2009) that is objective, scientific and rule-driven, politically and institutionally independent and allows us to observe a complex economic system on an aggregate and disaggregate level. Motivated by these questions, throughout history, numerous scholars have tried to evaluate economic growth by proposing alternative measures that would incorporate different aspects of well-being, but none of the proposed indicators have yet captured enough range to dethrone the GDP measure. There are plenty of reasons why this is so, and some of these will be addressed in this paper. However, due to heterogeneous public attitude/opinions, many forms of ecological and environmental groups, an increased attention in the media, the relevance of economic costs of natural resource depletion and pollution, damages to the future growth and development perspectives, a relatively new measure of growth imposed itself as a relevant factor in measuring welfare and well-being i.e. the so-called Green GDP. Green GDP is an alternative indicator of economic growth that incorporates environmental consequences of that growth by including the depletion of natural resources and degradation of the environment. Namely, as the economic growth improves quality of life to a certain point, it usually has a negative effect beyond this point due to the 'threshold effect'. When this point is crossed, further economic growth can deteriorate the quality of life due to the costs associated with an increasing income inequality, loss of leisure time and natural resource depletion. These deficiencies could be detected by using alternative methods of national accounting or by calculating the Green GDP indicator (Vaghefi, Siwar and Aziz, 2015).

The goal of this study is to present the calculation of an environmentally adjusted GDP measure on the cross-country base in order to shed some more light on the relevance of green growth and sustainable development. Hence, we try to build an alternative Green GDP indicator that can give a clearer perspective on the consequences of economic progress by offering a new approach in quantifying the cost of ecological and environmental degradation. Not only will it evaluate the real costs of environmental damage, but it will also process some opportunity costs. We are well aware that this kind of indicator and the result itself cannot ideally reflect the genuine status and improvement of national output across the countries, however, we see it as an attempt to encourage further discussions on the green growth syntagm in a diverse range of countries, institutions, media and academic circles. The general conclusion is that economic growth is largely influenced by environmental factors; therefore, a new synergy between economic and environmental concepts should be achieved in order to make more accurate assessments of true national progress and well-being in the future.

All the data used in the study are on a country level for the year 2014. A sample of 44 countries includes developing countries and developed countries. In that manner, the sample covers some major countries of the world (European Union (EU) countries and its potential members, part of the OECD countries and some selected ones, China being the most eclectic example). Data are collected from Eurostat and World Development Indicators (WDI) database of the World Bank. All the data are thoroughly checked in order to achieve robustness, integrity and compatibility of the results across countries.

The remainder of the paper is organized as follows. Section 2 surveys the theoretical background of the Green GDP concept and offers a short review of the empirical literature. Section 3 contemplates on the challenges and future perspective of the topic. Section 4 gives a full perspective to the analytical part by describing used methodology and data together with the results of the analysis. Section 5 offers some concluding remarks.

2. Theoretical background and literature review

This section presents a short introduction to the development of the concept of Green GDP with introspection into some practical issues, and in addition offers an empirical background on related studies.

2.1. Development of the Green GDP

Since its introduction in 1937*, GDP has been used to measure flows of output and income through the economy; therefore, it became a basis for decision making and economic policy evaluation. However, as we can tell from the way it is being calculated (in any of the three calculating approaches standardized by the System of National Accounts – SNA), traditional GDP answers the questions related to its structure and fluctuations, thereby ignoring many relevant factors that enrich the qualitative aspects of well-being such as human, social and natural components of capital that societies depend upon. It also does not take into account the unobservable part of the economy, i.e. the unofficial economy. As early as 1950s, some scholars began to question the conformity of this indicator as a gauge of progress. Many subsequently pointed out that such a measure can give a highly misleading impression of economic growth – growth sustainability – human development. We must, however, stress that regardless of these shortcomings, the GDP is and will still be a relevant indicator of the economic health of a country, as well as a gauge of a country's standard of living.

The first imperfection is that the GDP indicator does not measure the sustainability of economic growth, for a country can achieve a temporary high GDP by over-exploiting its natural resources (Rauch and Chi, 2010). It can also fail to register economic costs of non-market activities such as crime and unemployment. Generally, GDP can be a misleading economic indicator if we place a disproportionate importance to it because it often reflects the material and static positions, rather than signalling what is wrong in the economy. Namely, a high proportion of household consumption does not always reveal its true source or its impact on savings, trade perspectives, asset bubble etc. Therefore, it can be misleading in terms of macroeconomic management. Some scholars also believe that the GDP does a poor job capturing innovation, because innovation is not necessarily limited or even related to tangible items that the GDP traditionally measures well (Samuelson and Nordhaus, 2014). A second imperfection arises from its limitations; since the GDP does not scale the sustainability of growth (it does not detect the distribution of income, household production and/or the loss of leisure time, volunteering, costs of environment degradation, social and public health costs that are in direct relation to economic activity and etc.), it is *de facto* a bad measure of social welfare. There is a bulk of indicators nowadays that are trying to resolve these issues, for example Green GDP, Index of Sustainable Economic Welfare (ISEW), Human Development Index (HDI), Genuine Progress Indicator (GPI), Adjusted Net Saving (ANS) and an array of environmental asset accounts often related to the 'green' national accounting. The third imperfection can be derived from the previous two. Considering all of the above, the GDP is also a bad measure for international comparison of countries' life standard. Thus, the GDP should be used only for comparison of the productivity (i.e. economic growth) of various countries and not for the comparison of a global well-being.

To be in line with the topic of the paper, at the same time contemplating what has previously been stated, we will focus next on the argumentation of the part human-social-natural component in the assessment of such an important indicator. As a tool for assessing the real impact of economic growth and, ultimately, for estimating the

* The GDP took over 300 years to develop, however, it was introduced as a standard United Nations (UN) measure for the first time in 1956, with major revisions following in 1968 and 1993 (Rauch and Chi, 2010). Means of calculating GDP have evolved continually so as to keep up with evolving measurements of economic activity (for example new forms of intangible assets, changes in industrial activity, statistical requirements, etc.).

sustainability of an economy, some form of environmental accounting is essential (Li and Lang, 2010). There are many technical problems and challenges in producing an aggregated environmental cost account, such as a Green GDP. The 1970s was the era in which awareness of social – environmental accounting began to take its root, but it was only, as Samuelson and Nordhaus (2014) state, on the experimental base, for issues such as sustainability and environmental awareness found no place in business practice or within government policy focus. The idea of Green GDP arose in the early 1990s in response to the imperfections of traditional GDP measure to account for specific types of (environmental) economic costs which influence human well-being. Basically, inspired by various international conferences in the early 1990s, such as the UN Conference on Environment and Development in Rio de Janeiro (1992), and the World Commission on Environment and Development (1993), the concept of sustainable social and economic development was introduced and has received global attention (Li and Lang, 2010).

Ultimately, this way of thinking led to the first international framework for environmental (green) accounting prepared by the UN System of Environmental-Economic Accounting (SEEA). By amending the SNA in 1993, the UN *de facto* paved the way for the development of the Green GDP concept[†]. As of 2012 we have the SEEA – Central Framework, the first international statistical standard for environmental-economic accounting which became a multipurpose conceptual framework for understanding the interaction between the economy and the environment, and for describing stocks and changes in stocks of environmental assets (Abdul Rahim and Noraida, 2015).

Green GDP is today known as a general concept that refers to a wide array of adjusted GDP measures that are corrected for social and environmental costs (for some of these commodities are not traditionally presented in monetary units). In that manner, Green GDP is just an alternative way for the quantification and measurement of the monetary impact of social and environmental damage caused by a country's economic growth. The most common approach to measuring the Green GDP is to deduct social and environmental costs (for example natural resources depletion and pollution damage) from the standard GDP measure. There is an interesting way to explain the (conceptual) purpose of this indicator. If we consider that by adding social features/human capital and environmental features/natural capital to a standard measure of the volume of output, we are in fact relating it to the deterioration in social or environmental capital and reducing it by the amount of capital thus consumed. Some say that we could look the other way around, too. So that any improvement in social and/or environmental capital constitutes in itself a form of output and can, therefore, be added to standard GDP measure. Sustainability criteria are becoming increasingly important for industries, organizations and economies (Zavadskas *et al.*, 2016; Tvaronavičienė, Černevičiūtė, 2015) as well as energy security issues (Tvaronavičienė *et al.*, 2015; Tvaronavičienė, Černevičiūtė, 2015; Strielkowski *et al.*, 2016). Shadow economy is another important aspect to be considered when measuring GDP (Bejaković, 2015; Gasparėnienė *et al.*, 2016).

2.2. Practical issues

Green GDP should not be confused with various social and environmental accounting systems, as a large number of these carry issues and problems related to valuation and calculation. As Alfsen *et al.* (2006) said, a Green GDP will also in many contexts do more to obscure problems than resolve them, however, from its inceptions, this indicator has become a significant factor in the development and implementation of different sustainable

[†] Green GDP was first introduced in 1993 as the concept Environmentally Adjusted Domestic Product (EDP) or Eco Domestic Product in the interim version of Integrated Environmental and Economic Accounting.

strategies in the world. It is important to mention that there is no universally accepted approach to environmental accounting, as we will see in the next section. In the next few lines we will present some practical issues that revolve around the Green GDP.

The first issue relates to the conceptual scope of the indicator. Following the SEEA standards (from 2003), we can derive four basic approaches to environmental accounting that are relevant for the coverage of Green GDP (see Hecht, 2012). The first approach is focused on measuring the relationships between the environment and the economy in both directions, as the key motivation is to determine how closely economic activity is linked to material inputs and pollution outputs. The second approach is based on measuring environmental economic activities as it tries to measure the expenditures on environmental protection and also the impact of economic policies through taxes and subsidies on the reduction of environmental damages. The third approach, called environmental asset accounts approach, collects data on the levels of various types of natural capital and offers different ways of calculating. The last, and probably the most important approach (that can be easily related to the Green GDP concept), is based on the adjustment of existing accounting measures to account for natural capital degradation, seeking to monetize the damage associated with the depletion of natural resources and environmental quality degradation, as well as to identify the so-called defensive expenditures made in response to, or in order to avoid, environmental damages. On the other hand, Veklych and Shlapak (2013) present three methodological approaches to the environmentally adjusted domestic product calculation; (1) includes the consideration of the reduction of natural capital; (2) takes into account the environmental degradation due to the accumulation of pollutants and waste, as they have an effect on both economic activity and natural capital; (3) supposes further deduction of the costs spent on combating environmental degradation because defensive expenditures should be displayed in these adjusted accounts depending on their impact on natural capital. There is no general agreement on how Green GDP should be estimated and we find no consensus either on whether there should be a uniform measure.

The second issue is related to the process of gauging the indicator. In this part, we will mention the stages of development of the Green GDP, as presented by Rauch and Chi (2010). They state that the process of developing the Green GDP can be roughly defined by three stages: (1) environmental accounting, (2) valuation, and (3) metric calculation. Environmental accounting, as the bedrock of the process, should quantify in physical units the amount of pollution, waste and other physical quantities from the environment. Valuation is a part in which monetary values are assigned to these physical quantities by applying various valuation techniques. And consequently, with the assignment of value, the environmentally and if possible, socially adjusted GDP measure, such as Green GDP, can be estimated.

There are many methodological challenges and problems that arise from the calculation, as those seeing little contribution of the Green GDP indicator would argue that the traditional GDP indicator already provides the best account of the progress of an economy, revising the system of national account and therefore, making the Green GDP unwarranted unless a solid imperative can be put forward (Li and Lang, 2010). Few countries tried to establish their own environmental accounting (China, Australia, Norway, Germany, France, and etc.) with only China being capable of fostering detailed analyses of the Green GDP to some extent. Many countries, such as Germany, even opposed the official use of this concept because if it is not statistically correct, it can lead to controversial decisions about the value of environmental assets and the real value of national output. More on this topic can be found in the next section. Now we will focus on empirical evidence.

2.3. Literature review

The number of both theoretical and empirical papers on the Green GDP topic is not very astonishing. As we can see from the above-mentioned complexities that evolve around the Green GDP, we can expect that the empirical part would be rather intriguing, too. This is true, mainly because empirical studies approach the matter from different standpoints that consider different lines of inquiry. In order to mitigate the empirical stroll, in this short review of the literature we will present only papers that are conceptually related to the scope of our study, i.e. how to calculate (more accurately) the Green GDP measure.

An interesting theoretical discussion is provided by Boyd (2006) in his paper on non-market benefits of nature where he evaluated two positions of the SEEA related to the measurement of benefits that arise from environmental public goods. Though the focus of this paper was the measurement of services, Boyd suggested that asset valuation is utterly possible. And that even though SEEA is too pessimistic about the economists' ability to account for ecological public goods, adequate moves can be taken immediately in order to assess what is socially valuable about the common property resource. Another engaging paper was that of Rauch and Chi (2010) who explored the challenges inherent in Green GDP implementation. Their analysis of the implementation of such framework has led to the proposal of specific recommendations that could increase the robustness of sustainability accounting systems. Their appeal is seen through the title of the paper 'The Plight of Green GDP in China and the conclusion that though China aborted initial attempts, it can yet revive its development of Green GDP and/or environmental accounting. They concluded that for the sake of China and the global community, they hope that abandoning the nationwide implementation and use of Green GDP can be a step forward that will provide efforts upon more accurate and comprehensive environmental data collection and accounting as well as additional environmental valuation research. A great evaluation of the GDP vs. Green GDP dilemma was provided by Samuelson and Nordhaus (2014) who concluded that the traditional GDP indicator was never intended to be an all-encompassing proxy for human well-being, for it is a partial measure, one that primarily focuses on a society's material standard of living and how it changes over time. For that, the concept of GDP will retain its value. However, because standards for data collection already exist, countries' environmental performance can be evaluated and compared if they comply with a better understanding of environmental and resource use trends, Green GDP being the one indicator that could help achieve that. For a deeper systematization of the early contributions to this topic, theoretical as well as empirical, see Qi, Xu and Coggins (2001). Let us evaluate now some of the empirical studies.

The already mentioned Veklych and Shlapak (2013) calculated the Green GDP and environmentally adjusted net domestic product for Ukraine (for the period 2001-2010) by taking into account the depletion of natural capital, environmental degradation due to atmospheric pollution and governmental expenditures on environmental protection. The general conclusion was that the economic growth of Ukraine is significantly dependent on natural capital and has substantial environmental drawbacks. Abdul Rahim and Noraida (2015) tried to examine the short-run and long-run causal relationship between the Green GDP, traditional GDP, CO₂ emissions, trade openness and urbanization for Malaysia (for the period of 1971- 2010) by applying auto-regressive distributed lag (ARDL) bounds testing approach. Apart from that, this study also examined the forecasted values of Green GDP and traditional GDP from 2011 to 2050. The forecasted values have revealed that the traditional GDP could grow at higher rates in comparison to the Green GDP until both achieve equal values in the year 2045. Surprisingly, from that year onwards, the Green GDP outweighs the traditional GDP. In that way the authors suggested that Malaysia is serious in implementing its green policies, so that in the long-run, the outcome of the vision can be in fact realized. In a different type of study, Wang (2011) tested the effects of openness to international trade at Chinese provincial level, by applying Comparable Green GDP data from 31 provinces and regions to a variant of the Solow-growth model. The main finding was that there seems to exist a non-linear relationship between the Green GDP and openness, measured both by volume of trade and foreign direct investment, at provincial level. This result coincides with the finding of Talberth and Bohara (2006) at national level.

The most interesting paper for our study is that of Qi, Xu and Coggins (2001) because it is the only comprehensive and extensive research of the Green GDP on a cross-country base. The authors calculated the value of environmental damage as a percentage of GDP and Green GDP for a sample of 103 developed countries and developing countries (for the period 1980-1997). On behalf of environmental damages, they concluded that the values of environmental externalities per unit of GDP in the world increased in the period 1980-1983. It implies that the environmental quality has been sacrificed on some scale to GDP growth in this period. Yet, the world's environmental externalities for producing one unit of GDP have declined steadily since 1992. On the other hand, they calculated the Green GDP indicator by country in selected years (1980, 1992, and 1997) concluding that the growth of GDP and Green GDP coincided in almost all countries, though the growth rates were on some different scales, in regard to developing countries vs. developed countries. The authors finally concluded that most of the countries have not worsened their environmental quality to get the gains of GDP, even if we consider the countries that are in their early development stages. Since the results (in regard to the period observed) of this study are now older than 20 years, it will be interesting to see what the results would be today. The answer will be provided by our study.

3. Green GDP; future perspective

The Green GDP indicator has become a measure of awareness by which public and policy makers are trying to enforce a new, 'environmentally attributed' policy orientation. While the Green GDP accounting is not yet a widely accepted concept, for it is methodologically complex and (socio-economically speaking) a complicated and questionable system, the improvement in theories and methods is still speeding up. As part of the movement towards a new sustainable model of growth and development, many governments have been trying to evaluate, and some of them to establish, Green GDP as one of the key indicators in the assessment of national progress (see Alfsen et al., 2006). Norway has a long history of grasping with sustainable development questions. After ambiguous attempts, pointed towards the development of natural resources and environmental accounts, Norway is today focused on hybrid accounts and indicators. As they see a need for environmental accounts and not just environmental statistics, improvements are visible in the development of adequate environmental accounting framework that would be useful to policy makers. At Statistics Canada, environmental accounts models (asset accounts, energy use, gas emissions, etc.) are updated on a regular basis. The German Federal Statistics office has implemented a number of SESA modules on energy and air emission, physical input-output tables, land accounts, sectoral reporting modules, etc. India established survey methodologies to follow different areas of environmental accounting (waste and wastewater accounts, estimation of the annual cost of environmental degradation, etc.). Other countries that are involved in environmental accounting developments are Australia, Belgium, Denmark, Finland, France, Indonesia, Italy, Japan, Netherlands, New Zealand and Sweden (but there are other countries that are speeding up the process too). The Chinese experience with environmental accounting and Green GDP was fruitful. The most engaging project in the world came to an abrupt end as China's government structure for environmental management, the degree of additional data collection required, and the lack of consistent rules for environmental valuation contributed to the failure of the use of Green GDP indicator in China (Rauch and Chi, 2010).

The reasons for such a limited and generally unsuccessful story regarding the Green GDP concept could be found in its weaknesses. Though Green GDP calculations can raise awareness for sustainable concerns, as Jiang (2007) points out well, the Green GDP (again, in general) faces expected problems when addressing environmental damage in monetary terms; due to estimation problems and data availability, this indicator cannot consider all damage (depletion costs for mines, water, air, forest, wildlife, etc.) to the ecosystem. Hence, social and economic issues (such as the cost of congestion) are also not taken into account. Next, calculations often tend to neglect the overlap between the categories of damage that may exist and could lead to underestimation of the true cost of

environmental damage and resource depletion. On the other hand, Green GDP also fails to account for the potential benefits of the soaring development of an economy that, though causing a rapid growth of exploitation of natural resources, may likewise cause an efficient utilization of natural resources, a competition in investment and thus a rapid economic growth. Countries on higher levels of development tend to have more concern for the environment, ecosystems, high life expectancy, greater health care and all those issues that the Green GDP cannot evaluate and accurately measure. From a standpoint of short-term assessment, the accounting of a complete – comprehensive indicator is impossible (Jinnan, Hongqiang and Fang, 2004), however in the medium to long-term, monitoring of economic progress will require both an indicator of total growth (that can be observed through traditional GDP) and an indicator of how a country's real comprehensive wealth, that includes natural, social and human capital, is changing (could be evaluated through the Green GDP).

As we can conclude, Green GDP is a term much used, but only seldom precisely defined (Alfsen et al., 2006). There are many directions in which the development of the Green GDP indicator can go, as a single or even a set of indicators, nevertheless many authors agree that the future perspective of a greener accounting should be built on several features. These are (Li and Lang, 2010; Rauch and Chi, 2010; Jinnan, Hongqiang and Fang, 2004): improving the communication between the policy makers, academia and professionals for the development of new theories and methods, stimulating public interest and policy debates, developing accurate and robust environmental accounting systems on a world basis or on a country level, accelerating the construction of such systems, strengthening international cooperation on Green GDP accounting, utilizing the knowledge resource to develop more reliable and standardized valuation techniques, and improving data transparency. But, as we already mentioned, the goal of this study is to review economic growth through alternative environmental prism without speculating on how economic and social trends will evolve and how these developments will guide policy making in the years to come. Hence, the focus of the next section is the construction of a new quantitative indicator representing alternative Green GDP measure that will help us in comparing sustainable economic growth between a range of countries.

4. Methodological issues and the results

This section consists of three parts, each a conceptual continuation of the previous. First, we will clarify some methodological issues, then evaluate the dataset and in the end, interpret the results.

4.1. Methodology

In order to derive an alternative approach to the Green GDP measurement, we considered both quantitative and qualitative features that a stable and comprehensive indicator, on a cross-country scale, should possess. So as to keep the common Green GDP accounting framework (a quantitative position), we used a general methodological algorithm that is suitable for the assessment of and comparison between different countries, as well as other surveys. Therefore, the Green GDP indicator is calculated as a traditional GDP indicator minus the cost of natural resource consumption minus the costs of environmental depletion. To secure a high degree of objectivity, the indicator is calculated based on the data that are compiled from officially recognized international sources, such as the World Bank. Additionally, the indicator is presented as a growth rate, which is convenient for the comparison to the traditional GDP measure and a numerical analogy between the countries. On the other hand, we have also considered the importance of economic dimensions that are not sufficiently reflected in the traditional GDP measure, or even in different 'green growth' approaches. Namely, our methodology (a qualitative position) integrates supplementary information by distinguishing the real costs of environmental damage and opportunity costs (that can be easily calculated) of a lost turnover. In that manner, we are in fact addressing certain aspects of social costs.

The goal is to create a single (monetary measurable) indicator, similar to the Green GDP concept that is comprehensible to the general public and can be easily related to the traditional GDP data. Our methodology offers a flexible framework that can be extended to incorporate additional aspects over time, reflecting growing data availability and new political, social and economic concerns, and comparability across nations and/or regions.

Drawbacks of this methodology are mainly related to the usual problems when assessing environmental damage in monetary terms. Some methods of assigning monetary values show a certain degree of arbitrariness, and the data availability and reliability is still a challenge for many countries, especially developing countries, as the required data can suffer from incomplete coverage, measurement errors and biases. At the same time, it can be criticised for not having appropriate consideration of other aspects of human and social, or even natural aspects (for example environmental protection expenditure) of development. However, we see it as an attempt that can still provide a good example for constructing and developing a new indicator that can attract widespread public attention.

Thus, a general scheme of calculation is $\text{Green GDP} = \text{GDP} - (\text{CO}_2 \text{ emissions in kt} \times \text{total CDM in average prices for kt}) - (\text{t of waste} \times 74 \text{ kWh of electrical energy} \times \text{price for 1 kWh of electrical energy}) - (\text{GNI}/100 \times \text{natural resources depletion \% of GNI})$; or expressed simplified as:

$$\text{Green GDP} = \text{GDP} - (\text{KtCO}_2 \times \text{PCDM}) - (\text{Twaste} \times 74\text{kWh} \times \text{Pelect}) - \left(\frac{\text{GNI}}{100} \times \% \text{NRD}\right)$$

(1)

where the first deduction presents the costs of CO₂ pollution (as CO₂ emissions times carbon market price), second the opportunity costs of one tonne of waste that could be used in the production of electrical energy), and a third is the adjusted savings of natural resource depletion as a percentage of the gross national income per country.

4.2. Data

Data for a sample of 44 countries, that includes both developing and developed countries, has been collected from Eurostat and World Development Indicators (WDI) [‡]database of the World Bank (with some specific indices from other sources; see Appendix). The sample covers 44 countries of the world (EU countries and potential members, part of the OECD countries and some selected countries plus two specific regions EU-28 total and Euro area total) for the year 2014. Data (un)availability is a major obstacle in achieving more extensive research on a cross-country base for most of the data on, for example CO₂ emissions (biennially published by WDI) or tonnes of waste (published by Eurostat every five years), is published irregularly. In such manner, this is a rather static indicator, but with a possibility of publication in regular terms. Nonetheless, in order to achieve adequate robustness and integrity as well as compatibility of the Green GDP indicator across countries, all the data are thoroughly checked, compiled and verified. Finally, both traditional GDP indicator and derived Green GDP are measured in current U.S. dollars (USD).

[‡] WDI is the primary World Bank collection of development indicators, compiled from officially recognized international sources. It presents the most current and accurate global development data available, and includes national, regional and global estimates.

GDP (in PPP) was obtained as the sum of gross value added by all resident producers in one economy plus any product taxes minus any subsidies not included in the value of the products. It has been calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources (WDI, 2017)[§]. Carbon dioxide emissions (CO₂)^{**} are expressed as kilotonnes and were obtained from the same source. Total CDM in average prices for kilotonne, is a carbon market price^{††}. Total (commercial and industrial) waste is presented in tonnes and data were partially collected from the Eurostat^{‡‡} and from the World Bank database. In order to evaluate opportunity costs related to waste problems, knowing that the amount of waste nations produce annually is huge, we introduced a waste-to-energy conversion principle. Hence, kilowatts of energy in one tonne of waste present an amount of electrical energy that can be obtained from a waste^{§§}. The price for 1 kilowatt-hour is calculated as a mean of commercial and industrial price for each country^{***}. Gross national income^{†††} or GNI (in current U.S. dollars) is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad (WDI, 2017). Finally, variable adjusted savings of natural resource depletion (NRD), as a percentage of the GNI per country, presents natural resource depletion as a sum of net forest depletion, energy depletion, and mineral depletion^{†††}.

4.3. The results

Here we present a detailed overview of the differences between the traditional GDP annual growth rates and calculated Green GDP annual growth rates for the year 2014^{§§§} for the observed countries (see *Table 1*). So as to ensure robustness within the comparison, we will also evaluate different categorizations of countries, for example,

[§] Dollars for the GDP are converted from domestic currencies using single year official exchange rates.

^{**} Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

^{††} The average volume-weighted price for CDM in 2006 was around USD 11.07 per tonne CO₂ (Capoor and Ambrosi, 2007). Price in 2006 was then transformed into a price in 2014 by adjusting it with the cumulative rate of inflation, so we obtained a total price of USD 12.64 per tonne CO₂.

^{‡‡} On the basis of the Regulation on waste statistics (EC) No. 2150/2002, amended by Commission Regulation (EU) No. 849/2010, data on the generation and treatment of waste is collected from the EU Member States. The information on waste treatment is divided in five treatment types (recovery, incineration with energy recovery, other incineration, disposal on land and land treatment) and in waste categories. All values are measured in tonnes of waste and in kg per capita, based on the annual average of the population (Eurostat, 2017).

^{§§} Based on the researches made by the Australian Energy Regulator; Department of Environment of Australia (2015), and some others (Waste to energy in Denmark, 2006), depending on the type of waste (our calculation uses an average waste i.e. waste composite), we came to the conclusion that a tonne of waste translates into 74 kilowatt-hours per tonne of electrical energy.

^{***} Prices were given in Euros so we had to transform them to U.S. dollars (Eurostat, 2017).

^{†††} Formerly gross national product (GNP).

^{†††} Net forest depletion is unit resource rents times the excess of roundwood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate (WDI, 2017).

^{§§§} The change in 2014 for Green GDP reflects the change in growth rates of GDP in 2014 compared to 2013.

developed countries vs. developing countries, ex-communist countries, the Euro area countries vs. EU-28 countries, etc.

In 2014, the growth rates of GDP (see also *Graph 1*) for the whole sample were ranging from -6.99% (Australia) to 10.79% (Iceland), whereas the values of environmentally corrected GDP i.e. Green GDP were ranging from -14.83% (Chile) to 9.94% (Iceland). Average GDP growth for all the countries was 1.92%, however, we have negative values for Green GDP growth of -0.06%, meaning that we have a difference of almost 2%. This implies that growth in these countries in 2014 was not satisfactory in terms of economic development. The most satisfactory results, hence the smallest difference (<0.60%) between the GDP and Green GDP growth was found in Belgium (0.51%), Germany (0.57%), Ireland (0.35%), Spain (0.46%), France (0.39%), Italy (0.45%), Luxemburg (0.40%), Austria (0.47%), Portugal (0.49%), Japan (0.46%), Israel (0.51%) and Switzerland (0.18%). On the other hand, the worst results, in terms of differences (>5.00%), were found in Bulgaria (5.08%), Norway (5.20%), Macedonia (6.42%), Albania (9.60%), Serbia (6.77%), Chile (8.21%) and Mexico (5.79%).

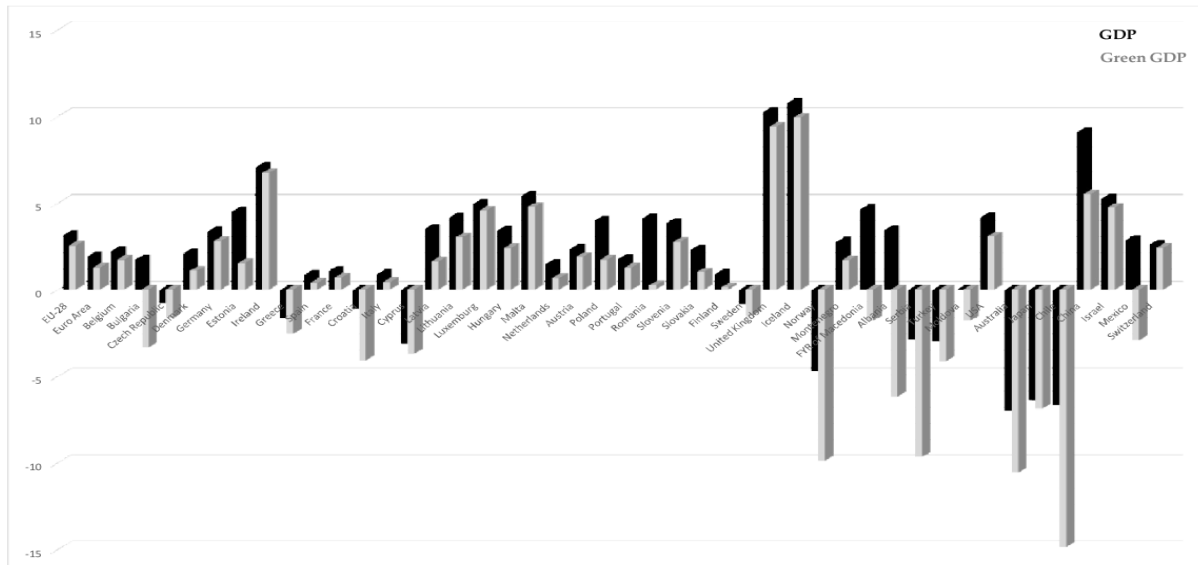
Next, we can categorize countries into three standard groups****: developed countries (Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, Cyprus, Luxemburg, Malta, Netherlands, Austria, Portugal, Finland, Sweden, UK, Iceland, Norway, USA, Australia, Japan, Israel, Switzerland (24)), developing countries (Bulgaria, Czech Rep., Estonia, Croatia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia, Montenegro, Serbia, Turkey, Moldova, Chile, China, Mexico (18)) and underdeveloped countries (Macedonia, Albania (2)). The sample was randomly selected, however, the results will show their integrity when compared to other similar groupings. The average GDP growth and Green GDP growth for the developed countries was 1.85% and 0.92% (difference 0.93%), then 1.78% and -1.15% (difference 2.93%) for the developing countries, and 4.03% and -3.98% (difference 8.01%) for the underdeveloped countries. This implies that environmental quality and the process of economic development grows with the development stages or, on the other hand, that the countries on the lower development stages tend to go in favour of higher (current) growth rates against sustainable human-social-natural growth and development. A direct argument for such a statement could be found when observing the results for the EU countries. Namely, the average GDP growth and Green GDP growth for the EU-28 was 3.16% and 2.56% (difference of only 0.60%), and 1.93% and 1.30% (difference of only 0.63%) for the Euro area countries. We can conclude that the most satisfactory countries, by the standard of sustainable development (seen through the smallest difference in GDP vs. Green GDP growth), are in fact coming from one of the most developed areas in the world, the EU. Further systematization will help us in confirming some of the previous results.

Table 1. GDP growth rates vs. Green GDP growth rates (year 2014)

**** Such categorization is made purely for comparison purposes, and is in no way made to be in contrariety to the initial systematization (in 4.2.) on developed countries and developing countries.

Country	% GDP	% Green GDP	Country	% GDP	% Green GDP
Belgium	2.24	1.73	Slovenia	3.86	2.75
Bulgaria	1.75	-3.33	Slovakia	2.32	1.03
Czech Rep.	-0.76	-1.63	Finland	0.92	0.14
Denmark	2.12	1.09	Sweden	-0.85	-1.49
Germany	3.38	2.81	UK	10.27	9.43
Estonia	4.52	1.54	Iceland	10.79	9.94
Ireland	7.10	6.76	Norway	-4.67	-9.86
Greece	-1.58	-2.52	Montenegro	2.76	1.72
Spain	0.88	0.42	Macedonia	4.63	-1.79
France	1.09	0.70	Albania	3.43	-6.16
Croatia	-1.10	-4.08	Serbia	-2.88	-9.65
Italy	0.91	0.45	Turkey	-2.97	-4.13
Cyprus	-3.10	-3.71	Moldova	-0.03	-1.80
Latvia	3.52	1.64	EU-28	3.16	2.56
Lithuania	4.18	3.03	Euro area	1.93	1.30
Luxemburg	4.98	4.58	USA	4.20	3.10
Hungary	3.43	2.42	Australia	-6.99	-10.54
Malta	5.43	4.80	Japan	-6.37	-6.83
Netherlands	1.49	0.67	Chile	-6.62	-14.83
Austria	2.36	1.90	China	9.11	5.53
Poland	4.00	1.74	Israel	5.27	4.76
Portugal	1.79	1.30	Mexico	2.87	-2.93
Romania	4.15	0.26	Switzerland	2.61	2.43

Source: Authors' calculation



Graph 1. GDP (%) vs. Green GDP (%) in 2014

Source: Authors' calculation

Let us evaluate developed countries first. If we observe developed countries (in total) as those represented as 'High income OECD members' (as determined by the World Bank), we notice that the difference between the average GDP growth (1.87%) and Green GDP growth (0.52%) is 1.35%. When we take into account so-called 'IMF advanced economies' (according to the International Monetary Fund) we find the difference between the two indicators (2.06% against 1.01%) of 1.05%. If we eventually take into consideration the 'HDI top 25 countries' (ranked by the United Nations), there is a difference between the average GDP growth rate (2.31%) and the Green GDP growth (1.27%) of 1.04%. This is consistent with the previous, as the average values of the differences in the developed countries are below the average of the sample (1.98%). It suggests that the environmental quality tends to improve as the economy grows towards higher income levels. As Qi, Xu and Coggins (2001) put it well, such a conclusion could indicate the existence of the inverted U-curve i.e. environmental Kuznets curve on high income levels.

As for the developing countries, we notice significant differences. In the analysis of former socialist countries (Czech Rep., Bulgaria, Estonia, Croatia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia, Montenegro, Macedonia, Serbia and Moldova (15)) we find a huge difference between the average growth of GDP (2.29%) and the average Green GDP growth (-0.41%) of 2.70%. This difference (3.67%) gets even bigger when we focus on the ex-Yugoslavia countries (Croatia, Slovenia, Montenegro, Macedonia and Serbia), with the average GDP growth of 1.46% and a negative Green GDP growth of -2.21%. When Albania is considered, the huge difference between the indicators (3.43% against -6.16) gets to an enormous 9.59%. All the values for these countries are above the sample average, suggesting that their annual Green GDP growth rates are actually unsatisfactory.

Overall, we find that the growth rates of GDP and the growth rates of Green GDP in 2014, differ significantly in almost all countries, equally between the countries in the same grouping and in between different categories of countries. We may conclude that in most of the countries, environmental quality has been sacrificed to achieve

higher growth rates and higher benefits of standard economic features. Finally, we have to be very careful in the interpretation, manipulation and usage of these results for they correspond to a specific period and are part of a static analysis.

Beyond conclusion

We see this paper as a step forward for a growing academic platform on ‘green economy topics’, a step pointed towards improving, amending, evolving and promoting further development of green growth measurements and indicators. By stating that there is a need for a new synergy between economic and environmental concepts so that more accurate assessments of true national progress and well-being in the future could be made, we are in fact raising many questions such as: Why do we need to measure Green GDP? How to measure it? Should we forecast green growth? Who are the potential users of the Green GDP indicator? How to make it an accounting rule? There is no strict answer(s) to these questions, but a pragmatic epilogue in a question form: if a century ago, a GDP indicator was a kind of anathema, yet it became the most important economic measure of economic progress; why should we not put our intellectual capacity into the development of a new indicator, that could one day become (at least) an equally important measure of a broader aspect i.e. socio-economic progress. The objective of this study was to evaluate economic growth through an alternative environmental prism without speculating on how economic and social trends will evolve and how these developments will guide economic policies in the future. Therefore, we have offered an alternative approach in quantifying the Green GDP indicator that could be used for a comparison of sustainable economic growth on a cross-country base. First, so far, no systematic attempt has been made for measuring Green GDP on a global scale or on the European level (with few exceptions). Second, by promoting an alternative indicator of socio-economic progress we are addressing a wide audience: academic circles, public groups, national policy makers but also policy analysts in important international organizations. The structural similarity to the traditional GDP measure could offer the opportunity to create public perception/awareness, thus linking it to concrete policy agendas. And third, due to its methodological limitations and interpretation scantiness, Green GDP cannot replace the traditional GDP measure, nor will it substitute other measures of sustainable development, but should be seen as an attempt in contemplating an unavoidable feature of economic progress - sustainability.

In deriving this alternative Green GDP measure, we considered both quantitative (common methodological algorithm) and qualitative (opportunity costs) features. The major distinction from other approaches is visible in this qualitative attribution. Our methodology, from a qualitative position, integrates supplementary information by distinguishing the real costs of environmental damage and opportunity costs of a lost turnover. Additionally, our methodology offers a flexible framework that can be extended to incorporate additional aspects over time (growing data availability, new international concerns, and comparability across nations and/or regions). This brings us to two major shortcomings of the study that we as authors would like to emphasize. The first is data availability and the scope (providing rather static analysis) of the research. Second is the partiality of some conclusions (resulting from *rule-of thumb* scaling and generalization). Both can impose a certain narrowness in economic reasoning (since we cannot comprehend a larger picture within a specific time domain); however, we find this argument as an incentive for further research that could include different (but analogous) set of data and broader time horizons.

Results suggest that the growth rates of GDP and the growth rates of Green GDP in the year 2014, differed significantly in almost all countries, equally between the countries in the same groupings and in between different categories of countries. We noticed that the difference between the average GDP growth and Green GDP growth, in the developed countries, is roughly 1%. This difference is even higher, when developing nations are considered. It stands around 3%. If we focus on undeveloped countries, this difference becomes enormous. Interestingly, the average GDP growth and Green GDP growth for the EU-28 was 3.16% and 2.56% (difference

of only 0.60%), and 1.93% and 1.30% (difference of only 0.63%) for the Euro area countries. Generally, the lowest difference between these two indicators was found within developed European countries, Israel and Japan, and the highest for developing nations such as Albania, Bulgaria, Serbia, Chile and Mexico. The regularly emphasized example for the (obvious) lack of environmental awareness is China, however we found a relatively coherent result, similar to other developing nations. Finally, we conclude by stating that most of the countries' environmental quality in 2014 was sacrificed to achieve higher growth rates and higher benefits of standard economic features.

In the end, we hope that we gave a small contribution to the comprehension of methodological, as well as theoretical, vagueness within the Green GDP measurement. Our approach and deductions made above are just our opinion and could/should be subject to revision in the future.

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Appendix

Variable	Description	Source
GDP	Obtained as the sum of gross value added by all resident producers in one economy plus any product taxes minus any subsidies not included in the value of the products. It has been calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. (in PPP)	WDI (2017)
CO₂	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring (expressed as kilotonnes).	WDI (2017)
CDM	The average volume-weighted price for carbon (in PPP)	Capoor and Ambrosi (2007)

<i>Twaste</i>	Total (commercial and industrial) waste (expressed in tonnes).	WDI (2017) and Eurostat (2017)
<i>74 kWh</i>	Kilowatts of energy in one tonne of waste present an amount of electrical energy that can be obtained from a waste.	Australian Energy Regulator (2015), Waste to energy in Denmark (2006)
<i>Pelect</i>	Price for 1 kilowatt-hour is calculated as a mean of commercial and industrial price for each country. (in PPP)	Eurostat (2017)
<i>GNI</i>	Gross national income is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. (in PPP)	WDI (2017)
<i>NRD</i>	Adjusted savings of natural resource depletion as a percentage of the GNI per country, presents natural resource depletion as a sum of net forest depletion, energy depletion, and mineral depletion.	WDI (2017)

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ECONOMIC SUSTAINABILITY OF ENERGY SYSTEMS AND PRICES IN THE EU

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Abstract. Economic sustainability of energy system and energy prices in the European Union (EU) constitutes an important issue that includes many multidimensional perspectives and calls for non-trivial solutions. Our paper tackles these issues in a critical manner attempting to analyse the interdependence between the economic growth and the energy prices.

We employ an empirical analysis of energy prices and economic growth in the European Union (EU-28 Member States) and make conclusions based on the results of this analysis. Our conclusions can be used by the relevant stakeholders and policy-makers who are responsible for the regulation of energy systems or setting up the energy tariffs and the prices of energy.

Keywords: economic development, energy systems, sustainability, energy pricing, security, European Union

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JEL Classifications: F50, Q40, P18

1. Introduction

Sustainability and energy economic security are based on the smooth and uninterrupted supply and demand mechanisms of energy sources. In the recent decades the governments of many countries have shifted towards climate and energy policy that favors renewable energy sources (RES), implementation of green technologies (Traversari et al. 2017; Passerini et al. 2017; Gandini et al. 2017; García-Fuentes, de Torre 2017; Zemlickiene et al. 2017) and change of consumption patterns (Tvaronavičienė 2016).

Alas, traditional carbon fuels represented by mostly oil, natural gas and coal still play an important role in the world economy (Lisin et al. 2015).

It is apparent that long-term development of any country's economy is impossible without the extensive use of carbon fuels and a respectful attitude toward the environment that should go together hand in hand. Everyday's management applied to the national economy should not only be aligned with the demands of contemporary society but should also seek ways to secure the fair living conditions for future generations to come (Balitskiy et al. 2014).

According to *Limits to Growth*, a study published by the Club of Rome in 1972, population growth coupled with production growth and the resulting environmental strain will ultimately lead to one of the two possible outcomes (Gómez-Baggethun and Naredo, 2015). The exponential population growth will eventually result either in a complete crash of the existing consumer-driven economy, or a severe crisis with consequences that can be mitigated by adjusting the social production structure to reach an agreement between social, environmental, and economic indicators of national welfare.

Population growth brings about increased needs that can only be satisfied if there is a steady production process, which in turn depends on the sufficiency and availability of carbon fuels extracted from the environment. Moreover, the production process is always associated with generation of waste that pollutes the environment. Experts in global environment issues and energy policy cite different projections of the limit to population growth and pollution rate; however, all of them agree that such a limit does exist and has been approached quite closely by mankind.

Avoiding collapse at the national level requires adjusting national economies to prioritize qualitative development – balancing consumption with the environment's capability for recovery of resources expended on the production of economic assets.

Power industry is a key industry of the national country's economy from the standpoint of ensuring economic stability. National security hinges on the efficiency and reliability of the energy sector. The energy sector necessarily leads the development of other sectors of the economy to accommodate the ever-growing demand for electricity.

2. Literature review

Evaluation of world data on construction of all kinds of generating facilities allows for the conclusion about considerable energy consumption growth over the last 30 years. Figure 1 that follows shows the distribution of plant capacity global type in the world according to the types of energy sources.

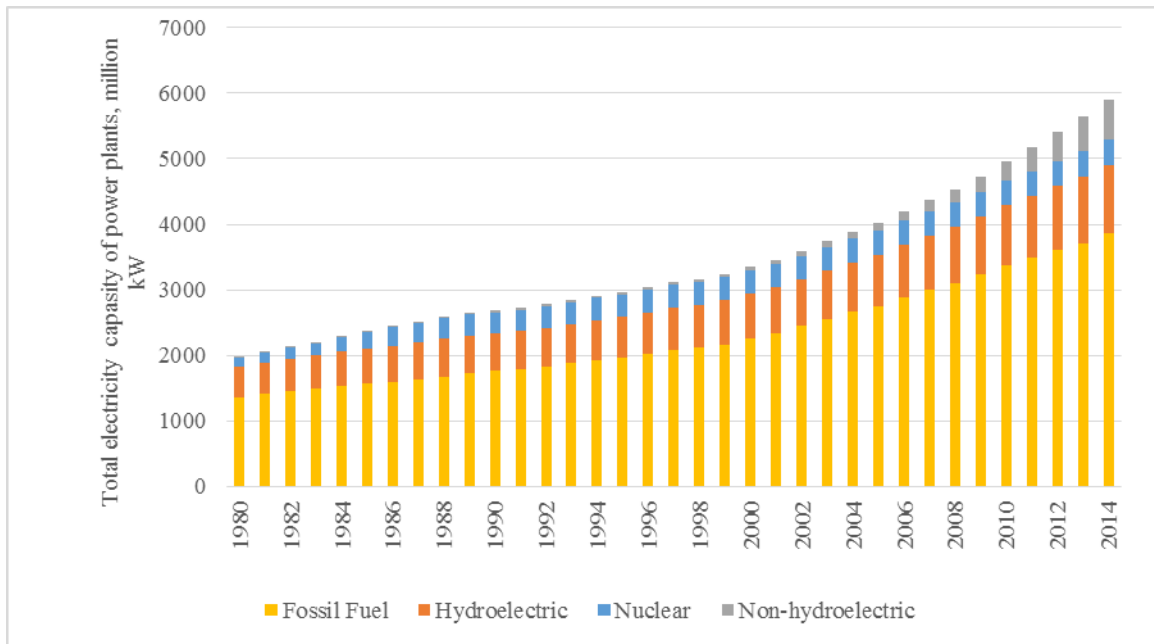


Figure 1. Plant capacity global change according to types of energy sources

Source: U.S. Energy Information Administration: International Energy Statistics (2016), own compilations

Figure 2 that follows shows complete energy balances for the the EU-28 countries: one can clearly see that the share of solid fuels and total petroleum products is giving way to te renewables with roughly the same share of nuclear heat that remains unchanged over the past 25 years (see Figure 2).

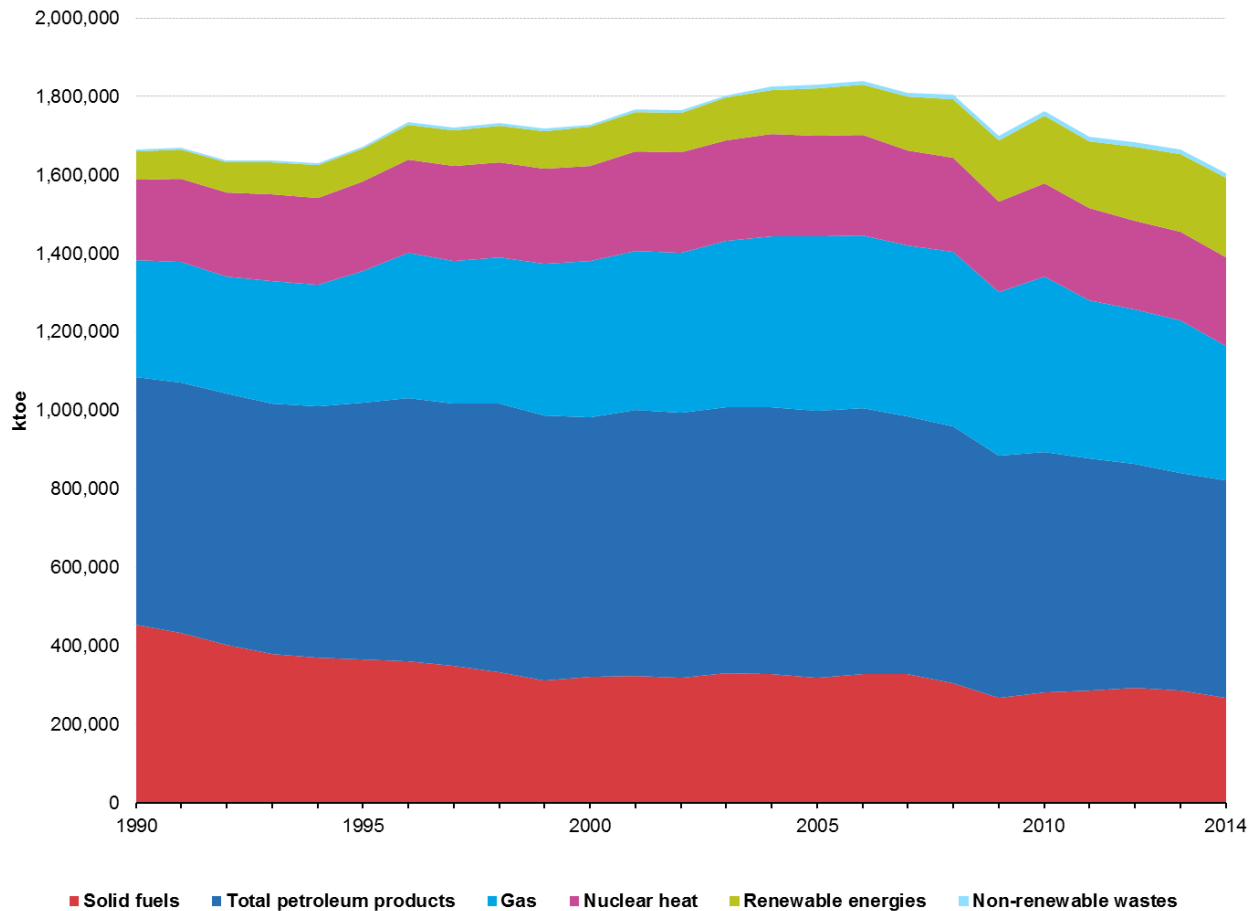


Figure 2. Complete energy balances for the EU-28 countries
Source: Eurostat (2016)

Despite the achieved capacity gain of alternative and renewable energy sources over the past decade, the increase of typical fuel and energy resources (oil, gas, coal) consumption is observed, and traditional thermal power industry based on chemical transformation of carbon fuel still dominates.

A thermal power plant (TPP) is the basic generating unit in the traditional thermal generation field. Intense use of carbon fuels at TPPs to meet the demand for electric energy, coupled with the scarcity of this resource, is a major driver behind the development of efficient energy transformation technologies. According to a global forecast for power utilities development, classical thermal power plants will retain their dominating role in supplying the electricity needs of national economies. A gradual transition from natural gas to coal as the primary fuel will take place at the same time.

Today from oil is produced about 7% of world electricity. This is a significant share, and in the context of lowering prices for this energy carrier, it is projected to increase its use in the energy sector. At the same time, it is advisable to use oil in areas where natural gas and coal are more difficult to deliver.

Thermal power plants use a fuel oil as fuel, which is a heavy fraction of oil. Most often, fuel oil is used as a backup fuel for TPPs using gas as the main fuel. At the same time, fuel oil is not the only petroleum product,

which uses to produce the electricity. To drive electric generators, gasoline or diesel internal combustion engines are used. Their low power and low efficiency are compensated by the compact size of the station and low installation and maintenance costs.

The use of fuel oil as fuel for power plants is gradually declining. This is largely due to the global modernization of the refinery in order to increase the production of light petroleum products, respectively, to reduce the output of heavy oil. In the future, oil will be used more actively as a valuable raw material for the chemical industry. And the electric power industry will rely on renewable energy sources.

The sustainable development concept specifies three stability conditions for an energy system:

Renewable resources should not be depleted faster than their recovery rate;

The rate of depletion of nonrenewable resources must not exceed the pace at which substitutes based on other renewable resources are developed to replace the nonrenewable resource;

The pollution rate should not be faster than the rate at which the environment is able to assimilate such pollution.

This allows for increased rates of resource consumption provided that the energy system remain stable there is a commensurate increase in the rate of resource recovery or the pace of substitute development. The logical corollary to these sustainable development considerations is that the national economy growth rate will be capped by the rate of recovery of consumed resources, with either nature or state-of-the art technology determining the latter. Development and introduction of efficient technologies will ensure reduction in the consumption of nonrenewable resources together with faster recovery of renewable resources, thus increasing the consumption of goods without compromising the stability of the energy system.

The environmental aspect of energy sector development is specified in terms of exposure limits for various types of emitted pollutants. Thermal power plant operation is associated with direct environmental impact in the form of pollutant emissions such as sulfur oxides (SO_x) and nitrogen oxides (NO_x). Maximum permitted concentrations of harmful pollutants are specified for different countries at every stage of implementation of the energy strategies. Exceeding specified thresholds makes the power plants liable for a fine.

Technological methods of nitrogen oxides NO_x suppression, particularly three-stage combustion, are the most mastered ways for improvement of environmental characteristics of power plant units. Also, the concentration of NO_x in the flue gases may be reduced by 30–65% by using the selective non-catalytic reduction technology which is widely applied in the EU, USA and Japan.

Table 1 represents the data on pollutant emissions by thermal power plants in EU and abroad.

Table 1. Comparative data on environmental performance of high-capacity thermal power plants in EU and abroad

Emissions of flue gases		EU standard emissions	Active thermal power plants in Russia	Japan emissions
NO_x	mg/m^3	200	300-570	80-100
SO_2	mg/m^3	200	700	70-100
Ashy particles	mg/m^3	30	50	10-20

Source: Own results

The urgency of the climate crisis necessitates swift action on the part of governments to reduce emissions from the energy sector. Climate scientists warn that in order to avoid the worst effects of rising global temperatures, greenhouse gas emissions must peak between 2015 and 2020 and fall dramatically thereafter.

Approximately 39% of CO₂ emissions in the EU are generated by the electricity sector. By mandating an emission limit CO₂ of 350 g/kWh of for carbon fossil energy, EU policymakers have sent a clear signal to power plants that only the cleanest fossil fuel power stations can have a place in the future.

The EU's main policy in the field of climate is the development of an emissions trading system. Currently, there are about 10,000 power plants in the energy and industrial sectors, which together are responsible for almost half of CO₂ emissions in the EU, and for 40% of all greenhouse gas emissions. CO₂ emissions quotas traded at ICE Futures Europe in London at an average price of 6 €/t CO₂ in 2016.

In many key world countries, such as China, Russia or the United States, the majority of energy systems is quite obsolete and requires modernization and innovation. In spite of the recent focus on RES, they are still dependent on the traditional sources of energy and have to set their energy pricing mechanisms based on the existing prices of energy sources on the market. Due to their position on the world geopolitical arena, the rest of the world has to take this into account. It is hard to imagine fulfilling the declared goals of decarbonization and sustainable development without these global players helping along.

Economic subjects try to optimize regardless of ecological or sustainability concerns. Paradoxically, when the oil prices plunged once again in 2016, many energy companies in the EU Member States shifted from the renewables to the traditional carbon fuels (mostly coal) due to the economical reasons. The market force takes the advantage over the policies of implementing RES in order for reaching ultimate decarbonization in the nearest decades.

The price of oil has a particular importance and impact on the world economic relations and international trade. When the breakdown of the Bretton Woods regime occurred in 1971 and the primary oil shocks first appeared in 1973, they challenged classical macroeconomic schema represented by the transmission mechanism. The rise in oil prices in 1973 that was caused by the oil embargo deliberately imposed by the Organisation of the Petroleum Exporting Countries (OPEC) led to the worldwide global recession.

The European Union also faces issues with energy systems and prices. European energy security represents a multidimensional dilemma with multiple facets impersonated by the dependence on Russian gas and its energy policy strategy that has to satisfy all EU Member States. Furthermore, changes to the existing energy and climate strategies are envisaged due to Brexit which shifted the balance of power and the stability of the EU in many ways.

In general, there is a plethora of studies on the relationship or correlation between oil prices or oil price shocks and the economic activity or economic growth (see e.g. Rasche and Tatom, 1981; Darby, 1982; Hamilton, 1983; Kilian and Vigfusson, 2013; Kilian and Hicks, 2013; Dezellus et al. 2015; Arezki et al. 2017).

3. Dynamic panel data model and its estimations

The main objective of our empirical study is to test if crude oil price had any impact on real GDP rate in the EU-28 countries in the period 2011-2015. The data for real GDP rate were provided by Eurostat, while crude oil price data are taken from World Bank database. Some dynamic panel data models are built using these two variables.

In total, we estimated three types of system dynamic panel data models: i) usual standard model, ii) models with robust errors, and iii) general method of moments (GMM) estimation. All these models in question indicated that GDP rates had an average tendency of increase in the EU-28 from a year to another. The GDP rate in the previous year had a positive impact on the current GDP rate. However, the oil price had a negative influence on economic growth. An increase in the oil prices generated a decrease in the real GDP.

Table 2. System dynamic panel data for explaining the impact of oil price on real economic growth in EU-28 (2011-2015)

	Coef.	Std. Error	z	P>[z]	95% conf. interval	
GDP rate						
L1	0.588	0.133	6.01	0.000	0.463	0.912
Oil price	- 0.167	0.039	-4.27	0.000	-0.243	-0.090
Constant	18.314	4.206	4.35	0.000	10.070	26.558
Wald chi2(2)	46.08					
Prob > chi2	0.0000					
N of groups	28					
N	111					

Source: Own results

The moment conditions in case of GMM estimators require the test of independence for the idiosyncratic errors. In this case, the first difference of white noise is automatically auto-correlated and the second and higher autocorrelation should be checked.

Let us introduce the estimation with robust errors (RE) for cross-checking our results from the previous model. Table 3 that follows reports the results of the estimations of system dynamic panel data with robust errors for explaining the impact of oil price on real economic growth in EU-28 (2011-2015).

Table 3. System dynamic panel data with robust errors: oil price on real economic growth in EU-28 (2011-2015)

	Coef.	Std. Error	z	P>[z]	95% conf. interval	
GDP rate						
L1	0.688	0.114	5.16	0.000	0.426	0.948
Oil price	- 0.167	0.027	-6.08	0.000	-0.221	-0.113
Constant	18.314	2.921	6.27	0.000	12.588	24.041
Wald chi2(2)	53.97					
Prob > chi2	0.0000					
N of groups	28					
N	111					

Source: Own results

Our results confirm that this model is valid, because the errors at second order are not serial correlated at 5% level of significance. In addition, we performed the Arellano-Bond test for zero autocorrelation in first-differenced errors. The results can be presented in the following manner (see Table 4 that follows).

Table 4. Arellano-Bond test for zero autocorrelation in first differenced errors

Order	z	Prob > z
1	-3.311	0.0009
2	1.524	0.125
H0	No autocorrelation	

Source: Own results

Moreover, Table 5 that follows employs the generalized method of moments (GMM) for explaining the impact of oil price on real economic growth in EU-28 via the system dynamic panel data.

Table 5. System dynamic panel data (generalized method of moments) for explaining the impact of oil price on real economic growth in EU-28 (2011-2015)

	Coef.	Std. Error	z	P> z	95% conf. interval	
GDP rate						
L1	0.688	0.114	6.01	0.000	0.463	0.912
Oil price	- 0.167	0.039	-4.27	0.000	-0.243	-0.090
Constant	18.314	4.206	4.35	0.000	10.070	26.558
Wald chi2(2)	46.08					
Prob > chi2	0.0000					
N of groups	28					
N	111					

Source: Own results

4. Discussion of results

Our results for EU-28 are consistent with the study of Ftiti et al. (2016) for some OPEC countries. Indeed, if the oil prices increase, then aggregate supply reduces, because companies purchase less energy at higher energy prices.

The results show that the GDP rate in the EU-28 increases with an average stable tendency. There is a lag in the GDP rate, since the value of the GDP in the previous year has a positive impact on the current GDP rate. Moreover, the results show that the oil price had a negative influence on economic growth meaning that an increase in the price of oil should result in a subsequent decrease in the real GDP and therefore economic growth and economic performance.

The results of all three models (system dynamic panel data model, panel data model with robust errors, and panel data with generalized method of moments) seem to be consistent and tell the same and consistent story. Raising prices of energy sources impact the economic growth making it to slow down and therefore hampering the economic security and stability of energy systems.

Conclusions and policy estimations

All in all, it appears that energy systems and energy prices in the European Union are going through many structural and existential changes. The EU-28 countries have to deal with the changing prices of energy, as well as with the alternative sources of energy represented by the renewable energy sources (RES) that include, above

all, solar, wind, and hydro power. The shift from the traditional sources of energy might lead to the distortion of the current market mechanisms and lead to the changing prices of energy that, in turn, might result in the structural shifts in the energy systems and their balance.

We conducted an empirical analysis of the correlation between the traditional carbon energy prices represented by the prices of crude oil and the economic growth in the EU-28 Member States. The analysis was based on the similar studies conducted around the world, most notably in the United States and employing the data for the U.S. economy.

Our analysis of the available data demonstrates that the increase in the prices of the traditional energy resources results in the worsening of the economic well-being. These results are quite informative and might be important for the economic and energy security of the European Union. The recent decrease in the price of oil that worsened the economic situation in Russia, might have also resulted in the increase of economic performance across the EU states. Moreover, the shift from the traditional energy sources represented by oil, gas and coal, towards the renewable sources of energy, would also increase the economic performance of the energy systems without threatening the life standards of the population. Economic and energy sustainability of the energy systems in the European Union as well as in the rest of the world rests upon the wise selection of the energy sources and prices that are paid for those sources. Stakeholders and policy-makers need to take this into account when designing the optimal energy strategies and selecting the mix of energy sources for achieving the sustainable economic development and growth.

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PERFORMANCE IMPLICATIONS OF ENTREPRENEURIAL ORIENTATION AT PUBLIC RESEARCH AND TECHNOLOGY INSTITUTIONS

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Abstract: This paper presents the results of a study on the Performance implications of Entrepreneurial Orientation (EO) at fifteen research centers within three public research and technology institutions (RTIs) in energy industry of Iran. Considering the sensitivity of EO construct to specific contexts, we initially developed a new scale to measure the EO of research centers; and then, investigated its consequences. Different latent interaction and multiple regression techniques were employed to investigate the effects of EO on performance indices of research centers from universalistic and contingency perspectives. It was concluded that EO has the strongest positive effect on financial performance of research centers, when they are dealing with unfavorable environmental conditions.

Keywords: Entrepreneurial Orientation, Public RTIs, Contingency/Situational Approach, Academic Entrepreneurship

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JEL Classifications: O32, L26, O31

1. Introduction

The essential role of knowledge in economic development of societies, especially in developing countries, has brought different types of academic and knowledge-based entrepreneurship into the attention. Nowadays, the authorities expect Universities and Public Research & Technology Institutions (RTIs) to contribute in development of country by commercializing the results of publicly funded research. Therefore, RTIs are being encouraged to be more entrepreneurial, requiring inevitable changes in their governance structure (Todorovic et al., 2011). Despite the fact that everybody expects RTIs to be more entrepreneurial, very little is known about the appropriate strategies to achieve this objective; and the consequences thereafter.

In this study, we have utilized the renowned and widely-used construct of Entrepreneurial Orientation (EO) from corporate entrepreneurship to shed some light on benefits and consequences of being entrepreneurial at RTIs. By employing a mixed explorative research design, we first developed a contextualized variant of EO scale to measure the EO of 15 research centers within 3 public RTIs in Iran's energy industry. Later on, the predictive ability of this scale against the performance indices of research centers was deliberated from universalistic and

contingency perspectives, considering different organizational and environmental factors that moderate the relationship.

2. Literature Review

The concept of Entrepreneurial Orientation (EO) is one of the widely used constructs in corporate entrepreneurship literature. Since its introduction to the scholarly community by Miller (1983), and subsequent development of its original measurement scale by Covin and Slevin (1989), this construct/scale has been used in many empirical studies by numerous scholars. According to the literature, the concept of EO is significant because it fills an important gap in entrepreneurship literature by denoting the characteristics of an entrepreneurial firm (Covin and Lumpkin, 2011), in three dimensions of "Proactiveness", "Risk taking", and "Innovation". A decade after its introduction, Lumpkin and Dess (1996) augmented the scale with two dimensions of "Competitive Aggressiveness" and "Autonomy".

EO encompasses entrepreneurial strategy-making policies, practices and processes aimed at developing opportunities for the organization (Muchiri and McMurray, 2015); and some authors have presented EO consisting of processes, structures, or behaviors that can be described as aggressive, innovative, proactive, risk taking, or autonomy seeking. In a nutshell, EO is a behavioral construct which could be viewed as a set of policies (practices), processes (procedures) as well as activities (behaviors) which form the basis of an organization's engagement in entrepreneurial activities. For the purpose of this research, EO construct and its relationship with Performance have some subtle properties which had to be noted while planning and performing the research, and henceforward we will briefly mention these significant issues:

2.1. Organizational Context: It is vital to memo that EO scale has been developed and used for private firms; and thus, its measurement scales have limited applicability in other organizational contexts. It is almost intuitive that meaning of being "Entrepreneurially Oriented" must be different within public or non-profit sectors, due to inevitable differences in their objectives, structure, and governance structure (Todorovic et al., 2011; Zahra et al., 2014). As an instance, a specific unidimensional measurement scale for university departments has been developed by Todorovic et al. (2011). This contemplation led us to the idea that for the purpose of measuring the EO of research centers within public RTIs, we need to first develop a context-specific measurement scale. In our study, we first developed a new measurement scale, measured by 25 items, demonstrating the propensity of research centers to engage in academic entrepreneurship; which proved to have a relatively strong positive effect on their financial performance.

2.2. Relationship with Performance: While many empirical studies have concluded that EO has a positive impact on performance of the firms (Rauch et al., 2009) especially in hostile environments (Covin and Slevin, 1989), there has been a long debate on whether EO is always an appropriate strategic orientation? Initially, the EO studies were founded on the universal effect approach, assuming that EO is universally beneficial. Later on, based on premises of Contingency theory, EO literature discussed many variables moderating the EO–performance relationship (Linton, 2016; García-Villaverde et al., 2013; De Clercq et al., 2010). Empirical research has found that the effect of EO on performance varies in dissimilar environments and internal settings, highlighting the importance of a contingent approach (two-way interaction). Moreover, it is crucial to recognize the multidimensional nature of the Performance construct. Employing Entrepreneurial strategy and EO may, at times, lead to favorable outcomes on one performance dimension and unfavorable outcomes on a different performance dimension. Therefore, it is essential to memo that the conceptual argument of the EO–performance

relationship focuses mainly on financial aspects of performance and the relationship between the EO construct and nonfinancial goals is less straightforward and expected to be weak, due to tenuous nature of the relationship.

2.3. Entrepreneurship at Public RTIs: Research and Technology Institutions (RTIs), and the specialized Research Centers therein, should be considered as hybrid organizations along two dimensions. They often occupy an intermediary position between public and private organizations when it comes to outputs, governance, ownership, and other issues. In an ideal world, the hybrid nature of research Institutions/centers can create opportunities for combinations of academic work and practical problem-solving (Gulbrandsen, 2011). As an essential part of national innovation system, RTIs are expected to involve in knowledge-intensive entrepreneurship, and consequently, play a role in innovation, transformation of industrial system and economic growth. In the broad sense, knowledge-intensive entrepreneurship may take place in various ways: through the foundation of new firms, or through the display of entrepreneurial spirit within existing firms, or through the actions within public research organizations such as universities or RTIs. The latter form is commonly known as Academic Entrepreneurship, and could be defined as the involvement of academic scientists and organizations in commercially relevant activities in different forms, including industry-university collaborations, university-based venture funds, university-based incubator firms, start-ups by academics, and double appointments of faculty members in firms and academic departments.

3. Conceptual framework & Hypotheses

The conceptual framework of study has been depicted in Figure 1. It is a contextualized version of the proposed framework by Lumpkin and Dess (1996) which relates EO of organization to its Performance. Consistent with EO literature, the following hypotheses were developed for investigation:

H₁: EO has a positive effect on financial performance of research centers

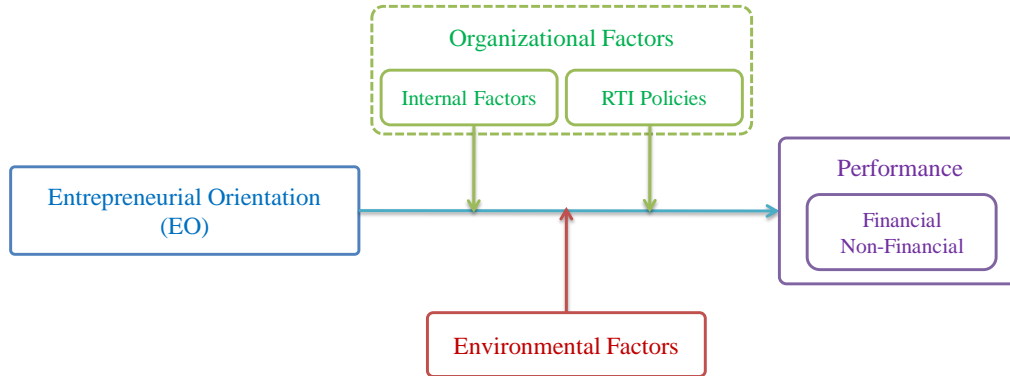
H₂: EO has a positive effect (weaker than H₁) on non-financial indices of research centers

H₃: The relationship between EO and financial performance is moderated by RTI policies. Favorable policies of RTI regarding entrepreneurship, strengthens the relationship

H₄: The relationship between EO and financial performance is moderated by environmental factors. Favorable environmental conditions dampen the positive relationship between EO and financial performance.

H₅: The relationship between EO and financial performance is moderated by internal factors. Favorable internal conditions strengthen the positive relationship between EO and financial performance.

Figure 1: Conceptual framework of research



3.1. Operationalization of Constructs: Historically, the construct of EO and its related measurement scales in the corporate entrepreneurship literature have been developed and validated for private firms (Covin and Slevin, 1989; Lumpkin and Dess, 1996). In recent years, several scholars have questioned the applicability of EO scales in organizational contexts other than private firms, such as governmental and non-profit organizations, and thus, it has been suggested that contextualized variations of EO scale must be developed to be used in specific organizations (Todorovic et al., 2005; Zahra et al., 2014). With this premise, we employed exploratory sequential (Qualitative - Quantitative) design (Creswell and Clark, 2007), to first develop an scale to measure EO within our specific context, as well as other constructs within our conceptual framework.

Consistent with scale development literature by (Hinkin, 1995; Worthington and Whittaker, 2006; Stratman and Roth, 2002), Phase 1 (qualitative) was designed to generate the items related to constructs in the conceptual framework. We performed semi-organized extensive interviews with top and middle managers of 15 research centers within three RTIs, using an interview protocol which was the results of a thorough review of EO literature. The interviews were recorded and then transcribed to be used in open and axial coding (theme analysis).

After generating the potential items for each construct, and for reducing the number of potential items (Item purification), we initially performed a pilot survey in two research centers; and by help of a focus group and factor analysis, the final instrument was developed in which 25 items were meant to measure the EO of research centers. Furthermore, a total of 18 items were selected (based on the discrimination they brought to the instrument) to represent other constructs - environmental factors (6), internal factors (5), and RTI policies (7) – in the final instrument. By adding four questions to assess the financial and scientific performance of research centers (monetary performance, granted patents, published papers and published books), the final questionnaire was formed with 47 questions in likert scale for the final survey.

The organizational survey was performed in 15 research centers of three RTIs in Energy Industry of Iran. Equal number of 23 questionnaires was distributed among the target population of each research center (middle managers); which resulted in 181 responses (representative of about %51 of the target population). The gathered data was then used to investigate the research hypotheses.

4. Performance Implications

In this section, we utilized Structural Equation Modeling (SEM) & Multiple Regression techniques to investigate the EO-performance relationship from various perspectives, by examining the 6 research hypotheses as described before. We used IBM AMOS v₂₄ to build measurement models of all constructs within our conceptual framework (Figure 1), and then investigated reliability, convergent validity, & discriminant validity of constructs (Table 1). It was concluded that measurement models are in good fit with data (181 cases), the constructs are reliable, and validity criteria is fulfilled.

Table 1: Reliability, Convergent validity and Discriminant validity analysis

Reliability	Convergent & Discriminant Validity						
$\alpha > 0.7$	Constructs	CR	AVE	MSV	Int. Factors	EO	Env. Factors
0.917	Int. Factors	0.963	0.838	0.187	0.915		
0.961	EO	0.894	0.678	0.340	0.432	0.823	
0.945	Env. Factors	0.940	0.727	0.340	0.320	0.583	0.853

4.1. Universalistic Perspective: This perspective simply assumes that EO is always beneficial, mainly for financial performance. In order to examine the H₁ and H₂ hypotheses, we fitted five structural models to dataset with EO as independent variable (predictor) and different performance indices as dependent variable. Table 2 reports the results, which indicate that EO has a substantial positive relationship with financial performance ($R^2 = 39\%$), and the relationship is weaker for other performance indices.

Accordingly, it can be concluded that H₁ and H₂ are correct. It is remarkable that the strongest relationship among non-financial indices is for patents, showing that EO is able to explain %11 of variance in patenting activities by a research center. This is due to a relatively close relationship between patenting and technology commercialization, which is consistent with the findings of Todorovic et al. (2011). Furthermore, the goodness of fit indices for five structural models were investigated and it was concluded that they are all within acceptable range and the relationships are statistically significant, except for Sp₃ (books) denoting that there is no significant relationship between EO and publication of books.

Table 2: SEM regression results on different independent variables

Structural Model \ Index	Standardized regression weight p-value	Variance explained (R ²)
EO → Fp (Financial Performance)	0.63 ***	% 39
EO → Sp ₁ (Research Papers)	0.24 **	% 6
EO → Sp ₂ (Patents)	0.33 ***	% 11
EO → Sp ₃ (Published Books)	0.10 p=0.194	% 1
EO → SP (Mean of Sp _n)	0.29 ***	% 8

4.2. Contingency Perspective: The contingency approach simply acknowledges the fact that the effect of EO on financial performance is under the influence of other issues as well. Corresponding to our conceptual framework, we separately investigated the moderating effect of three constructs (RTI policies, Environmental factors, and Internal factors) on EO-financial performance relationship to examine hypotheses H₃, H₄, and H₅ respectively:

4.2.1. RTI policies (H₃): In our survey, 7 items were intended to measure this construct which belongs to a higher level of analysis. For all research centers within the same RTI, this construct plays the role of a constant (i.e. control variable). Thus, the variations in this construct are meant to differentiate RTIs in terms of their encouraging policies regarding academic entrepreneurship. Noting that our sample is drawn from three different RTIs, we used multi-group moderation technique to examine H₃ hypothesis. By interpreting "RTI policies" as a categorical variable, we calculated the un-weighted mean of seven related items to generate a score for each RTI. A multi-group moderation analysis was then conducted to see the chi-square difference in fully constrained and un-constrained models. For one of RTIs with a very low number of samples, the EO-performance relationship was not significant, and for other two RTIs, the results have been reported in Table 3.

As the chi-square difference between the two groups is more than the calculated threshold (4.61 for %90 confidence), it can be concluded that favorable RTI policies will strengthen the positive effect of EO on financial performance of research centers, as evident by the differences between RTIs I & II in the Table 5 (higher RTI score is consistent with better performance and stronger relationship); therefore, we can conclude that H₃ is approved (with %90 confidence).

Table 3: Multi-group Moderation analysis results (*chi-square difference = 4.9*)

RTI	Standardized regression weight p-value	Variance explained (R ²)	RTI Policy (Score)	Performance (Score)
I	0.596 ***	% 35	1.35	2.51
II	0.414 **	% 17	1.15	2.44

4.2.2. Environmental and Internal factors (H₄ & H₅): The "Environmental Factors" construct represents the influencing factors from the research center's close environment which is beyond the control of both RTI and research center. In order to operationalize this construct, the related codes were separated in interviews and by a frequency-based approach, six items with the highest frequency were selected to be included in instrument in conceptual categories of "Industry Characteristics" and "Environment Munificence" which are both consistent with the suggestions of EO literature (Covin and Lumpkin, 2011). The "Internal factors" construct corresponds to some internal organizational characteristics which influence all activities within the research center (including entrepreneurial activities). A number of these characteristics are the inevitable results of some historic pathway, social values, etc. Although these factors are not completely under control of the management, it does make sense to assume that the management policies can influence these factors (at least in mid-term); and consequently, providing a better environment for entrepreneurial activities. Same as the environmental factors, in order to operationalize this construct, the related codes were separated in interviews and by a frequency-based approach (inductive), and five items with the highest frequency (mentioned by more than 10 interviewees) were selected to be included in the final instrument in two conceptual categories of "Management Style" and "Organizational Culture" which are both consistent with the suggestions of EO literature (Leyerer, 2012).

In order to carefully examine H₄ & H₅, we decided to employ a combination of multiple regression techniques and SEM. In multiple-regression, an interaction term is expected to be uncorrelated with the predictor variables to avoid the problem of collinearity. In reality, the product term always has some degree of correlation with predictor variables which leads to problems of instability of estimated regression weights. To overcome this

challenge, we employed prior mean-centering of variables (Hayes, 2013), and a two step technique called residual-centering has been proposed to ensure the orthogonality of the product term and its constituents (Little et al., 2007). Although multiple regression techniques are vastly popular and rather easy to implement, we decided to additionally utilize a latent-variable interaction technique with SEM, known as Moderated Structural Equation Modeling (MSEM), to enhance the robustness of the results. Among many available MSEM methods, we used a method proposed and enhanced by Ping (1995 - 2011) in which only one interaction term is being calculated in a two-stage process to be included in the MSEM. The main advantage of Ping method is that it does not increase the model's degrees of freedom. Details of this technique have been described at (Foguet et al., 2008; Convey et al., 2015; Ping, 1995; Ping, 2001). Tables 4 and 5 have reported the results of applying three techniques on data with different moderators. As evident in Tables 4 and 5, it can be concluded that:

✎ *Environmental factors* negatively moderates the EO-financial performance relationship (i.e. damps the relationship by reducing the slope). The results of three techniques are similar; all indicating a statistically significant negative moderating effect on relationship. Adding the moderator and interaction clearly have increased the predictive capability of model and the full model is able to explain %45 ~ %48 of variance in financial performance, of which, %2.6 ~ %3 is on behalf of the interaction term. This last observation is of particular importance since the interaction term is proved to be able to explain a unique and statistically significant share of variance. In conclusion, it is evident that EO effect on financial performance of research centers is contingent upon different environmental conditions, and interaction of these variables has a meaningful effect of the dependent variable. The direction of this effect has been depicted in Figure 2 by plotting the conditional effect of EO on financial performance in different values of moderator. Obviously, higher level of moderator dampens the relationship and the maximum effect of EO on financial performance is within lower values of moderator (i.e. bad environmental conditions). Consequently, the results approve H_4 in the context of study. Moreover, we employed the Johnson-Neyman technique (Hayes, 2013) to identify the significance range of moderating effect. It was showed that significance region covers % 87.7 of moderator values; and, the moderation is NOT significant at highest levels of Environmental factors (% 12.3). It can be concluded that in very favorable environmental conditions, the effect of EO on financial performance will probably vanish.

✎ *Internal factors* may positively moderate the EO-financial performance relationship (i.e. strengthen the relationship by reducing the slope). In all three techniques, the moderating effect is NOT statistically significant, although the direction of effect is positive. Adding the moderator and interaction to model enhances the predictive capability up to 55 ~ 59 percent, but the variance explained by the interaction term is less than 1 percent and statistically insignificant. For conceptual purposes, The direction of this insignificant effect has been depicted in Figure 2 by plotting the conditional effect of EO on financial performance in different values of moderator, implying that the better internal conditions, the stronger the relationship between EO and financial performance. Consequently, the results can NOT approve the hypothesis H_5 .

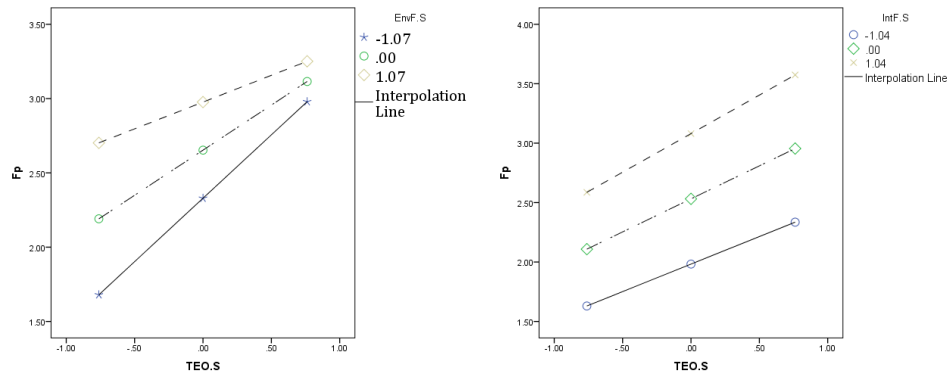
Table 4: Un-standardized Regression Coefficients for different predictors (A: Environmental factors, B: Internal factors)

Predictors \ Method	Ping MSEM		Residual Centering		Mean-Centering	
	A	B	A	B	A	B
Independent Variable (EO)	0.66 ***	0.57 ***	0.59 ***	0.55 ***	0.61 ***	0.56 ***
Moderator (A or B)	0.24 ***	0.51 ***	0.34 ***	0.52 ***	0.30 ***	0.53 ***
Interaction (EO × Moderator)	-0.18 ***	0.07 p=0.167	-0.23 ***	0.089 p=0.186	-0.23 **	0.088 p=0.143

Table 5: Variance Explained (R^2) for different predictors (A: Environmental factors, B: Internal factors)

Predictors	Method	Ping MSEM		Residual Centering		Mean-Centering	
		A	B	A	B	A	B
Independent Variable (EO)		0.39 ***	0.39 ***	0.34 ***	0.34 ***	0.34 ***	0.34 ***
Moderator (A & B)		0.31 ***	0.44 ***	0.30 ***	0.42 ***	0.30 ***	0.42 ***
EO, Moderator		0.45 ***	0.58 ***	0.42 ***	0.55 ***	0.42 ***	0.55 ***
EO, Moderator, Interaction		0.48 ***	0.59 ***	0.45 ***	0.56 ***	0.45 ***	0.56 ***
ΔR^2 for Interaction		0.03 ***	0.009 p=0.167	0.026 ***	0.004 p=0.186	0.026 **	0.004 p=0.143

Figure 2: Graphical depiction of moderating effect on EO-performance relationship
Left: Environmental factors (significant), Right: Internal factors (insignificant)



5. Discussion

In this research, by developing a contextualized variant of EO scale to measure the Entrepreneurial Orientation of public research centers, we used SEM and multiple-regression techniques to investigate the EO-Performance relationship by examining six research hypotheses. Regarding EO-Financial Performance relationship, while positive effect of "internal factors" does make sense, the negative effect of "environmental factors" seems to be odd, and needs some explanation. This phenomenon, which is in fit with previous empirical studies in EO literature (Wiklund and Shepherd, 2005; Covin and Slevin, 1989), could be described from both practical and theoretical points of view:

From practical perspective, the research center working in an environment so favorable, in which many opportunities are available to be exploited, does not need to employ an entrepreneurial strategy to get a project. When industry conditions are favorable for technological activities and environment munificence is at high levels, the ability to discover or create new opportunities is not of use, and research center (more or less) will benefit from the positive conditions. In such circumstances, the organization can improve its financial performance just by focusing on its internal conditions to increase the efficiency in opportunity exploitation. *From theoretical viewpoint*, we rely on resource-based theory of the firm which suggests that each organization is a unique bundle of resources, capabilities, and competencies; and the competitive advantage is the result of difference in this unique bundle. EO is a source of discrimination and competitive advantage, in the sense that high levels of EO enable the research center to discover or create new technological opportunities to be exploited. The point is, the EO-induced discrimination is of more importance in unfavorable environmental conditions; and thus, EO is a discrimination mechanism for harsh conditions, in which the industry (for any reason) is not eager for technological collaboration.

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