

ISSN 2669-0195 ONLINE

<http://doi.org/10.9770/IRD.2022.4.2>

INSIGHTS INTO REGIONAL DEVELOPMENT

Volume 4 Number 2
June 2022



ENTREPRENEURSHIP AND
SUSTAINABILITY CENTER

INSIGHTS INTO REGIONAL DEVELOPMENT

ISSN 2669-0195 (online) <http://jssidoi.org/IRD/>

2022 Volume 4 Number 2 (June)

<http://doi.org/10.9770/IRD.2022.4.2>



ENTREPRENEURSHIP AND
SUSTAINABILITY CENTER

Publisher

<http://jssidoi.org/esc/home>

Volume 4 Number 2 June 2022

INSIGHTS INTO REGIONAL DEVELOPMENT*

** The journal was launched as a platform for dissemination of the project results, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEVMED (2015-2019) Grant Agreement Number 645730730*



European Research Council
Established by the European Commission

INSIGHTS INTO REGIONAL DEVELOPMENT ISSN 2669-0195 (online) is a peer-reviewed journal, which publishes original research papers and case studies. It is international journal published cooperating with universities, social companies, consultancies and associations. It is published quarterly.

Scope of research includes but is not limited to the following:

- Conceptual/Practical Approaches and Methodologies towards Sustainable Regional Development
- Globalization, Internationalization and Solutions for Low-Carbon Economies of Scope or Scale
- Innovations and Technology Transfer Pilot Results Advancing Regional Development
- Information Technologies (IT) and Information Communication Technologies (ICT) for Regional Development, and Socio-Economic Innovations
- Environmental Engineering for Sustainability and Regional Development
- Smart Electricity Grid Solutions for Sustainable Regional Development
- Entrepreneurship for Regional Development
- Safety and Regional Development
- Threats to Society, Entrepreneurship and Regional Development
- Security and Safety of Countries, Regions and Society as Precondition of Sustainable Regional Development
- Boarder Guard Issues and Regional Development
- Migration and Sustainable Regional Development
- Terrorism, International Crime and Secure Regional Development
- Security and Safety Models for Sustainable Regional Development
- Emerging Business Drivers, Opportunities, or Constraints in Future Sectors of Current Markets
- Retrofitting Techniques and Technologies Near-Zero Energy Demand Buildings and Regional Development
- Urban Planning and Advanced Construction Materials for Energy-Efficiency or Smart Cities
- Contemporary Regional Development in the Context of Security, Comfort, or Legislation
- PPPs for Developments in Sustainable Entrepreneurship, Finance, and Investments
- Accounting for Sustainable Regional Development
- Sustainable Regional Development in the Context of Management or Life-Long Learning
- Strategic Management Practices and Creative Marketing Techniques for Sustainable Regional Development
- Organizational Studies and Sustainable Regional Development
- Regional Development in the Context of Marketing, ICT, and Creative Industries
- Intercultural Communication for Sustainable Regional Development
- Institutions and Regional Development
- Case Studies on Entrepreneurship and Sustainable Regional Development
- Social Cohesion and Social Innovations for Regional Development
- Business Models and Strategic Management for Sustainable, Secure and Safe Futures
- Corporate Social Responsibility and Sustainable Regional Development
- Regional Development in the Context of Psychology, Education, or Women
- Intuitions about Emerging Phenomena in Regional Development
- Start-Ups, Spin-Offs, SMEs in the Context of Market Growth and Regional Development
- Global Value Chain Management for Sustainable Regional Development
- Knowledge Management for Sustainable and Safe Regional Development
- Legal Regulation Peculiarities Affecting Regional Development













Editorial correspondence:










E-mail: submissions@jssidoi.org

Editor-in-Chief

[Prof. Salvatore Monni](#) , Roma Tre University, Italy

Editors

- [Prof. Manuela Tvaronavičienė](#) , Vilnius Gediminas Technical University, Lithuania
- [Prof. Wadim Strielkowski](#) , Prague Business School, Czech Republic
- [Prof. Dalia Štreimikienė](#), Vilnius University, Lithuania
- [Dr. Waleed Mugahed Al-Rahmi](#) , Faculty of Social Sciences & Humanities, School of Education, Universiti Teknologi Malaysia, Malaysia
- [Prof. Gil Vieira](#) , Instituto Nacional de Pesquisas da Amazônia, Brazil
- [Dr. Ketil Lelo](#) , Università degli Studi Roma Tre, Italy
- [Prof. Sebastian Kot](#) , Czestochowa University of Technology, Poland
- [Ms. Elisa Natola](#), Brazilian National Council for the State Funding Agencies (CONFAP), Brazil
- [Dr. Rasmus Bøgh Holmen](#) , Institute of Transport Economics, Norway
- [Dr. Throstur Olaf Sigurjonsson](#) , School of Business, Reykjavik University, Iceland
- [Prof. Abel Femi Adekola](#) , Wilkes University, USA
- [Prof. Fan Lü](#) , Tongji University, China
- [Prof. Gilberto de Miranda Rocha](#) , Federal University of Pará, Brazil
- [Prof. Dr. Sibylle Heilbrunn](#) , Kinneret Academic College on the Sea of Galilee, Israel
- [Dr. Amr Radwan](#) , Academy of Scientific Research and Technology, Egypt
- [Prof. Armenia Androniceanu](#) , The Bucharest University of Economic Studies, Romania
- [Prof. Najiba El Amrani](#) , University Sidi Mohamed bin Abdellah, Morocco
- [Prof. Bora Aktan](#) , University of Bahrain, the Kingdom of Bahrain
- [Prof. Gunnar Prause](#) , Tallinn University of Technology, Estonia
- [Prof. Vera Komarova](#) , Daugavpils University, Latvia
- [Prof. Fernando García](#) , Polytechnic university of Valencia, Spain

- [Prof. Michal Fabuš](#) , School of Economics and Management in Public Administration in Bratislava, Slovak Republic
- [Prof. Sulphery, M. M.](#) , Prince Sattam Bin Abdulaziz Universtiy, Saudi Arabia
- [Prof. Mirjana Radović Marković](#) , Institute of Economic Sciences, Serbia
- [Prof. Ronaldo Lopes Rodrigues Mendes](#) , Federal University of Pará, Brazil
- [Dr. Andrea Bernardi](#) , Oxford Brookes University, UK
- [Prof. Francesco Vigliarolo](#), Universidad Católica de La Plata, Argentina
- [Dr. Laima Gerlitz](#) , Wismar University of Applied Sciences, Germany
- [Dr. Federico Tomassi](#) , Agenzia per la Coesione Territoriale, Italy
- [Prof. Maria da Gloria Gonçalves de Melo](#) , Universidade do Estado do Amazonas, Brazil
- [Prof. Mykola Sidak](#) , University of Economics and Management in Public Administration in Bratislava, Slovak Republic



Publisher

<http://jssidoi.org/esc/home>



Volume 4 Number 2 June 2022

CONTENTS

János Besenyő, András Málnácssy. FUTURE EXPANSION AND PROSPECTS OF TURKISH DEFENSE INDUSTRY	10
Mohammed R. Chehabeddine, Sabina Grabowska, Abel Femi Adekola. BUILDING A MODEL FOR SECURING REGIONAL DEVELOPMENT FROM ECOLOGICAL THREATS	22
Julija Moskvina. WORK AFTER RETIREMENT: THE EVIDENCE OF SUSTAINABLE EMPLOYMENT FROM LITHUANIAN ENTERPRISE	52
Milica Sikimić. SECURITY OF EUROPEAN CRITICAL INFRASTRUCTURES OUTSIDE THE EUROPEAN UNION: A REVIEW OF THE WESTERN BALKANS NATIONAL LAWS	63
Benedict Ogheneakpoje Ighoshemu, Ufuoma Benson Ogidiagba. POOR GOVERNANCE AND MASSIVE UNEMPLOYMENT IN NIGERIA: AS CAUSES OF BRAIN DRAIN IN THE BUHARI ADMINISTRATION (2015-2020)	73
Ali Maalej. THE ROLE OF ENTREPRENEURSHIP AND INNOVATION IN THE ENVIRONMENTAL AND ECONOMIC DIMENSIONS OF GROWTH	85
Attila Máté Kovács. RANSOMWARE: A COMPREHENSIVE STUDY OF THE EXPONENTIALLY INCREASING CYBERSECURITY THREAT	96

**Publisher**<http://jssidoi.org/esc/home>

FUTURE EXPANSION AND PROSPECTS OF TURKISH DEFENSE INDUSTRY*

János Besenyő¹, András Málnássy²¹ *Doctoral School for Safety and Security Sciences and African Research Institute, Óbuda University, Bécsi út 96/B, 1034, Budapest, Hungary*² *Doctoral School of Earth Sciences, University of Pécs, 7633 Szántó K. J., Pécs, Hungary**E-mails:*¹ besenyo.janos@uni-obuda.hu; ² malnassy.andras@gmail.com*Received 25 March 2022; accepted 10 May 2022; published 30 June 2022*

Abstract. The global military industry, like the Turkish military industry, has undergone and is undergoing a major transformation in the 21st century. The faster and faster coming-out of new technologies and economic ecosystems are transforming the military industry as well while the latter used to make slow responses and changes otherwise. New players and companies are emerging and expected to become increasingly important. In this changing environment, the Turkish military industry needs to produce tools and systems that meet the requirements of them: to be technologically of high quality, to be competitive in terms of prices, and to have security of supply in the event of a crisis. A changing global field and security environment, where the interdependence of national economies is increasing, make increasingly difficult to meet these three expectations simultaneously.

Keywords: Turkey; defense industry; security and defense policy; geopolitics; military force projection; drones

Reference to this paper should be made as follows: Besenyő, J., András Málnássy, A. 2022. Future expansion and prospects of Turkish defense industry. *Insights into Regional Development*, 4(2), 10-21. [https://doi.org/10.9770/IRD.2021.4.2\(1\)](https://doi.org/10.9770/IRD.2021.4.2(1))

JEL Classifications: F50, F51, F52

1. Introduction

The Turkish defense industry has a significant historical background. There is a long-standing position in the Turkish approach to security and support for the development and maintenance of a robust defense industry. Until recently, Turkey was not a major arms producer and exporter (Cannon, 2021). However, in the 2010 decade, the battlefield successes of Turkish-made drones helped the Turkish defense industry and companies make significant sales (Bakir, 2021). In addition, sales of Turkish armored vehicles manufactured by Turkish companies have boomed, with Kenya, Tunisia and several West African states placing large orders for Turkey. The increase in sales can also be interpreted as the success of Turkish weapons in the battlefields in Syria, Libya and the Caucasus (Bağcı and Kurç, 2017).

* The research was partly financed by, Óbuda University (Hungary), and University of Pécs (Hungary)

This study attempts to present a slice of the process of how Turkey has become a factor in the world of highly lucrative arms production and sales. The first part presents the role of the defense industry in Turkish security and defense policy. The second presents the development of the Turkish military industry and its geopolitical aspects in recent decades. The third deals with the primary markets for Turkish military products and the development of Turkish drone capabilities. The study concludes with the potential of strengthening Hungarian-Turkish defense relations.

2. Theoretical background

In the contemporary world security enhancement has become precondition of sustainable development including military development as well (Chehabeddine and Tvaronavičienė, 2020); various security facts and views are being continuously revealed and analyzed in scientific literature (e.g. Limba et al. 2017; Mikhaylov et al. 2018; Tvaronavičienė 2018; Lisin et al. 2018). International Security Studies (ISS), also known as Security Studies, is among the most respected theoretical frameworks for security today, arguably surpassing even the popularity of the neorealist school, or ‘national security’ based classical realist schools, particularly in the UK and in much of continental Europe (Besenyő, 2019).

The security approaches developed by Buzan and the Copenhagen School have appeared in a number of studies, the most important of which is *Security: A New Framework for Analysis* (Buzan et al. 1998). Based on an analysis of the new security challenges, it proposes to broaden the concept of security and distinguish five sectors (sector theory). In addition to the military (including defense industry), this new concept of security includes the political, economic, societal, and environmental sectors. A significant advance in the theory is the recognition that, according to the authors, the security sectors can only be separated in theory, but in practice, they are closely interconnected, and the processes taking place in them interact with each other. In the theory, however, in addition to sectoral relationships, it is also necessary to examine the levels of each sector (level theory). Security issues in each sector can be attached to four levels: global, inter-regional (interaction between a region and its neighbouring regions), intra-regional (state-to-state relations), and sub-state levels (domestically within the states of the region). Security problems in the economic and environmental sectors tend to occur primarily on a global scale. At the same time, security problems in the military, political, and societal sectors typically occur at the regional level.

Security has always been an important goal for states. Historical experience shows that protecting the territory of communities and the boundaries of the territory was a vital interest in survival. In this context, the main tools of security are the military force and the defense industry. According to Barry Buzan, military force and the economic potential needed for the purpose formed the basis of power, and as to the basics of the theory of international relations, the security of states is built on these factors (Buzan, 1991).

Turkey as a middle power has a strategic role in current international relations. In Regional Security Complex Theory (RSCT), Turkey is an insulator state, as it is situated at the intersection of three different regional security complexes (RSCs): Europe (including the sub-complex of the Balkans); the Middle East (including the sub-complexes of the Levant, the Gulf, and Maghreb); and the former Soviet Union (including the Baltic; Belarus, Ukraine, and Moldova; the Caucasus; and Central Asia) (Kazan, 2003, p. 90–91). Even though Turkey is a part of all three RSCs as an active participant, according to the Copenhagen School, it is from the position of an ‘outsider’ (Barrinha, 2014, p. 166). The Regional Security Complex Theory also states that Turkey can only be promoted to a great or superpower status if it first becomes a regional power, and to this end, it needs to belong to an RSC. This means that the country would have to intensify its security relations with one of the RSCs around its borders, shifting its position from a peripheral security role to a central one especially in military terms (Barrinha, 2014). This paper examines to what extent Turkey can be considered a dominant international player in terms of military interdependence and to what extent it seeks to play such a role in its broader security region.

3. The role of the defense industry in Turkish security and defense policy

The defense industry in each state has essentially three comprehensive and mutually supportive roles, namely, the: military, political, and economic ones. The military role is the main *raison d'être* of building a state's defense-industrial base. In the case of national armed forces, it means arming them with weapons systems and military equipment that will enable them to achieve the tactical, operational and strategic military objectives assigned to them in both peacetime and war. The development of military techniques involves a complex process and consists of several distinct stages, including research and development, the development of new technologies, end products, the production of platforms and systems, and the building of service and dismantling capabilities. Companies operating within the defense industry have a role to play in each step of the former process. As a result, these companies have a strategic role to play in maintaining and developing national military capabilities (Wiśniewski, 2015).

For Turkey, the military role of the defense industry is determined by three specific factors. First, it must support the Turkish Armed Forces, the 9th largest army in the world and the 2nd largest in NATO (The Military Balance 2021). Such a large army almost always generates significant demand for defense products, including precision weapons. Second, for more than half a century, Turkey has fought an arms race against Greece. Although relations between Turkey and Greece have improved significantly over the last two decades, their defense procurement programs are still significant and there is competition between the two countries in the military field as well (Dunne, Nikolaidou and Smith, 2005). Third, the current Turkish military doctrine of advanced defense and growing aspirations for regional power status prioritize force projection capabilities. According to Turkish defense doctrine, threats to national security must be stopped before they reach national borders. And this goal can be achieved with an advanced defense industry and military equipment (Karaosmanoglu and Kibaroglu, 2003).

In the case of the Turkish security environment, the MENA region is one of the most unstable regions in the world, and there are serious armed conflicts in Iraq and Syria in the immediate vicinity of Turkey. Iran's nuclear ambitions and broader regional policy objectives create a threatened security environment that requires the maintenance of effective military force and potential for other Member States. Taking all of the factors above into account, it seems clear that the demand for military functions in the Turkish defense industry is strong and will remain so for the foreseeable future. The political role of the defense industry primarily concerns the role of the state in international politics. Arms exports are not only a profitable business, but can also be used to exert political influence. Few states in the world are capable of developing and manufacturing the most sophisticated weapons systems. In the foreign and defense policy of a sovereign country, it seeks a level of independence to assemble and operate its own armed forces independently, without the constraints imposed by a foreign supplier. Exports of military equipment can strengthen political and military alliances and gain political influence in importing states. In the case of Turkey, the development of the defense industry is also seen as a kind of prestige (Defence and Security Policy of the Turkish Republic, 2011).

The ability of the defense industry to develop and manufacture advanced, high-tech weapons systems is a widely recognized symbol of technological and industrial capabilities as well as an attribute of superpower status. The Turkish government is clearly of the view that the development of a national defense industrial base could help lay the foundations for a more independent foreign policy. Thirdly, the defense industry is also an important sector of the national economy (Wiśniewski, 2015). The revenues provided by the defense industry and the employment created generate significant revenues for the economy (Andryeyeva et al. 2021). Companies operating in this sector typically generate significant profits, invest significant sums in the development of

advanced technologies, and employ a large number of skilled workers. They also contribute to economic growth, industrial and technological development and social well-being through all these channels (Ilchenko et al. 2021).

4. The development of the Turkish military industry and its geopolitical aspects in recent decades

Turkey has allocated significant resources to the development of its national defense industry over the past two decades. Progress has been made in the context of the *Turkey's Strategic Vision 2023 Project (TASAM)*, which has strengthened the existing military base and created more and more value-added industrial players, making it a world leader in many sectors, with significant export capacities in many cases. Turkey has set three main goals for the development of the military industry: to stimulate the economy; maintaining force capabilities and acquiring new capabilities; achieving military self-sufficiency by 2023 (Turkey's Strategic Vision 2023 Project, TASAM, 2012).

The Turkish military industry has a significant history, with continuous developments in the sector since the 1980s. The Presidency of Defense Industries (SSB) was set up in 1985 as an umbrella organization to represent state aid to the defense industry and coordinate procurement, and in 1987 the Turkish Armed Forces Foundation (TSKGV) was established, which has become a famous player in the sector for many decades (Demir, 2020). TSKGV has since owned a number of key public and private companies. In the midst of the particularly changing conditions of political life and the army, like many other developing countries, purchases have been made from traditional arms-exporting states, primarily the United States and Germany. In the first phase of the development of the defense industry, strong transatlantic and European military relations developed at the level of both political and defense industry actors (Côte Réal-Pinto, 2017).

According to the Stockholm International Peace Research Institute (SIPRI), Turkish arms exports increased by 170% between 2014 and 2018, an outstanding result among major arms-exporting states. Such an increase in exports also presupposes the development of the underlying military industry. Turkish companies were initially involved in the import of foreign weapons, mainly Western weapons as members of NATO, followed by the domestic assembly of individual components and then domestic production under foreign licenses, even for complete weapons. The successful and reliable assembly and supplier activities of the largest Turkish companies have paved the way for the quality development of defense capabilities. From the late 1990s onwards, there was a need to create as independent a Turkish defense industrial capacity as possible, mainly to reduce import dependence. This goal has been included in the official goals since the mid-2000s, with the emphasis on allocating adequate budgetary resources (TRT World, 2018).

One of the strongest segments of the Turkish military industry is land vehicles and weapons systems, and the armed forces and internal security forces use almost entirely domestic assets in this area. The customer base was initially represented by the Middle East and Southeast Asia, and was later joined by European NATO members. The development of the Turkish military industry in the 2010s became more tangible in new areas, especially in the aerospace and electronics industries, as well as artillery equipment. According to SIPRI, seven of the Turkish companies are now among the world's 100 largest players in the defense industry, compared to just one in 2010. Turkey has become the 14th largest arms exporter globally. More and more countries and customers are discovering the offerings of Turkish companies, Turkish industry can produce more and more equipment and weapons systems, and what is a significant step forward: these products also represent more and more domestic added value in areas previously dominated by Western companies (e.g. guided artillery shells, avionics). Turkey, for example, is participating in the US Lockheed Martin F-35 aircraft development program (TRT World, 2019). Key players of the Turkish defense industry are presented below in Table 1.

Table 1. Key players of the Turkish defense industry

Company/organization name	Scope of activity
ASELSAN	Primarily active in the integration and modernization of land weapons systems and in the field of C4ISR14.
TÜBİTAK	The Scientific and Technological Research Council of Turkey.
Baykar	Turkey's leading UAV and AI Company.
ANASAYFA - TUSAS	Turkish Aerospace Company.
FNSS Defense Systems	Major supplier of tracked and wheeled armored vehicles and weapon systems for the Turkish Armed Forces and Allied Armed Forces.
ROKETSAN	Develops unguided and guided artillery ammunition, missile systems and ballistic equipment.
HAVELSAN	Software, simulator development, system integration.
ASPILSAN and İşbir	Operating in the defense energy sector.
TUSAŞ	Aircraft industry.
BMC Otomotiv	Inland vehicles.
STM	Engineering, technology and consultancy.
MKEK	Ammunition manufacturing.
Kale, Sarsılmaz, YDS	Aircraft engine, small arms manufacturing, clothing and footwear.

Source: Compiled by the authors

The defense sector has been key in recent years, in political terms as well, serving as one of the pillars of the Erdoğan administration. This is especially true today, when the country's economic problems are at least partially masked by the positive economic performance of the defense sector. However, the trajectory outlined above does not appear to be continuing unbroken. As early as 2019, there were signs of a decline in arms exports (Nordic Monitor, 2020). The reasons for this are quite complex. Above all, import dependence is a limiting factor. Although the Turkish defense sector has made significant progress in reducing its dependence on imports, it is not possible to implement fully domestic production of the increasingly complex weapons systems, which have recently come to the fore, in terms of the whole supply chain. For each such product, there is a sub-component, part, component that comes from a foreign supplier, in many cases from abroad.

In addition to export successes, a very important result is that Turkey has reduced its share of imports from around 70% to 30% (Gurini, 2020). In addition, the Turkish defense industry is said to belong to the relatively narrow group of countries capable of producing high-level reconnaissance and armed unmanned aerial vehicles. This fact has played a role in all major Turkish operations in recent years. Turkey's military industry has thus come a very long way in the last two or three decades and has now become a high-level and high-value-added sector that contributes significantly to the growth of the national economy. Its customers include both developing and developed states for almost all military forces (Kasapoglu, 2022).

5. Primary markets for Turkish military products

After Turkey joined NATO in 1952, the modernization of the members' forces and defense industry became a generally accepted aspect. In line with this purpose, Turkey has sought to reduce its dependence on foreign arms manufacturers by strengthening its domestic arms production. We can talk about two types of markets for the

products of Turkish military companies, one of which, as we have already mentioned, is the Turkish National Security Forces, which includes the police force and the army, and the other is the market of foreign states. The Turkish defense industry also provides technology transfer to many foreign countries. Kazakhstan, Saudi Arabia, Malaysia, the United Arab Emirates, Azerbaijan and Indonesia are considered to be the most important partners for Turkey in terms of military products produced by technology transfer and joint production (Turkish Defence & Aerospace, 2020).

Turkish companies have made significant progress in recent years in the production of drone, ship, military electronics and armored combat vehicle technologies. For these products, high technological features and competitive prices are the parameters that attract the attention of foreign buyers the most. In addition, of course, the quality of political relations can also affect cooperation, significantly increasing the competitive advantage of friendly countries. The most important markets for Turkish military products are Qatar, some African countries (e.g. Libya, Tunisia, etc.), Azerbaijan, Pakistan, the Turkish states of Central Asia and the Muslim countries of Southeast Asia (Bekdil, 2020).

Qatar is Turkey's most important partner in the Gulf region. Joint production agreements have been signed between the two countries in the field of arms production. Political and military cooperation is shown by the deployment of Turkish soldiers in Ankara by Qatar and the establishment of a military base (Vagneur-Jones and Kasapoglu, 2017). The North African region can be considered a traditional zone of influence in Turkey. Since the Justice and Development Party (AKP) came to power in 2003, North Africa has returned to the focus of Turkish geopolitics, with Ankara aiming to increase its influence in Morocco, Algeria, Tunisia and Libya as well. In the Libyan civil war, Turkish drones gained a tactical advantage over the Government of National Accord (GNA) on several occasions. The main purpose of Ankara's direct military intervention was, according to experts, to control access to the country's important raw materials and to control the sea borders of the eastern Mediterranean basin (Málnásky, 2020). It is also important for Turkey to limit and reduce the influence of Egypt and the United Arab Emirates in North Africa (Saddiki, 2020).

Turkey considers the countries of the African continent, including sub-Saharan Africa, a priority in the field of military industrial cooperation (Besenyő and Oláh, 2012). The most important markets are South Africa, Tunisia, Ghana, Nigeria, Chad, Libya, Egypt, Burkina Faso, Kenya, the Democratic Republic of Congo, Cameroon and Senegal (Besenyő, 2021). Azerbaijan is an important ally of Turkey in the Caucasus region. The two countries signed a Strategic Partnership Agreement and Mutual Assistance in 2010. In September 2020, an old historical, ethnic, ideological conflict dating back many decades has once again escalated into a direct armed conflict between the Azerbaijani and Armenian parties (Al-Youssef and Escher, 2021). Turkey rejoined the conflict on the Azerbaijani side, this time directly by selling military equipment to Azerbaijan. Kazakhstan is one of the most important partners in Turkey in Central Asia. The two countries are involved in joint production of both optical and radio electronic products in the field of military products (Kussainova, 2021).

6. Breakthrough Opportunities for the Turkish Military Industry - Development of Drone Capabilities (UAVs)

Anka-S and Bayraktar TB-2 are currently the best known drones in the Turkish military industry. Medium-altitude, long-flight (MALE) drones can stay in the air for up to 24 hours. Of the two constructions, the Anka is larger and heavier, but the smaller Bayraktar also has a wingspan of 12 meters, a length of 6.5 meters and a maximum take-off weight of 650 kilograms and 5-8 thousand meters, respectively. Both types completed their first mission in southeastern Turkey in 2016 against targets of the Kurdistan Workers' Party (PKK). Unmanned aerial vehicles were initially used primarily as part of Turkey's "fight against terrorism," along with southeastern Turkey in northern Iraq and Syria. However, Turkish drones soon appeared on the international market as well: in

2018, Qatar and then Ukraine signed an agreement to procure Turkish drones. With this, Turkey has caught up with the United States, Israel, China and Iran as an exporter of combat drones (Tapia, 2021).

During the year 2020, Turkish drones appeared in more and more battlefields. This effect brought some analysts to conceive the expression “Bayraktar diplomacy” (Borsari, 2021). In the Turkish *Spring Shield* operation in Idlib, Syria, in early March 2020, the drones played a key role and caused significant casualties in the ranks of the Assad regime (Hoenig, 2014). Regarding Libya, Turkish Bayraktars sent in support of the GNA made headlines by destroying a Russian-made Pancir-Sz1 air defense system in May (Delalande, 2019). In the Eastern Mediterranean and the Aegean, some of the patrols and reconnaissance tasks were taken over by Turkish drones, further bolstering the maritime border dispute off the coasts of Greece, Cyprus and Turkey. Finally, a significant number of Turkish combat drones also arrived in Azerbaijan, which contributed greatly to Baku’s military success in Karabakh (Kasapoglu, 2021).

The development of the Turkish military industry has gained momentum during the rule of AKP, which has been in power since 2002. While according to Turkish official data, 20% of the military equipment used by Turkey in the early 2000s came from domestic production by 2018. As the declared Turkish goal of creating a fully self-sufficient military industry for the domestic production of drones is also part of this trend. In the case of Bayraktar drones, for example, only 7% of the parts come from imports, the rest from domestic production. However, recent events have once again showed to the Turks that even this relatively small percentage can be a serious threat. During the Karabakh war, it became more widely known that Canada was supplying parts to Bayraktar (Daily Sabah, 2022).

In the past, Turkey has faced a Western arms embargo in a number of occasions. Most of the time, U.S. law has suspended certain agreements. The decision reassures the Turks that they must strive for the fullest possible independence if they want to advance their interests. According to Turkish official data, since 2014 the Turkish Armed Forces (TSK) had 86 Bayraktar TB-2s (Shay, 2019). There are several benefits to using drones in the battlefield. Perhaps the most important of these is cost-effectiveness, and here we need to think about both the market price of drones and the political costs. Although the Anka and Bayraktar drones are far from cheap constructions (the price of a Bayraktar TB-2 is estimated at around USD 5 million), they are still much cheaper than fighter jets; especially if the cost of training the fighter pilot is added. Thanks to the use of unmanned aerial vehicles, there is no need to risk the lives of soldiers in the battlefield, so decision-makers do not have to account for the casualties in front of their constituents (Tapia, 2021).

The use of drones also provides a kind of perceived or real denial. For example, it is not always possible to clearly identify the nationality of the operator (in this case, Turkish, Azerbaijani or Libyan) who controls the drones, thus making it easier to avoid possible prosecution, either domestically or internationally. The use of drones is considered by some to be an effective means of avoiding escalation, as shooting a drone, for example, is likely to elicit a milder response from the attacked party than if it had lost a fighter and the lives of its people. However, the the United Nations Institute for Disarmament Research (UNIDIR) warns that increased use of drones will increase the chances of accidental and unintended escalation (Woodhams and Borrie, 2018).

The Turkish drones were indeed remarkably effective, destroying many targets in the battlefields mentioned above. However, several other aspects are worth considering. First, the aircrafts are not valuable in themselves; in many cases, they are more of an executive role in an integrated system. Effective reconnaissance, a communication system, and electronic jamming (here we can highlight the Turkish Coral System) are all essential elements of a successful drone operation, as are well-trained personnel. However, drones are far from invulnerable. Turkey, for example, lost at least 20 drones in Syria (DefenseWorld, 2020) and more than 40 drones in Libya (Avia, 2020) in 2020. Neither the Bayraktar TB-2 nor the Anka-S has any active or passive defense against attack from either the ground or the air. In addition, the enemy’s effective electronic warfare can force

them to the ground. Experience to date has shown that Turkish combat drones were highly effective and wreaked havoc against opponents who were surprised by the large-scale use of drones and did not have effective air defense and strong electronic interference. It is therefore advisable for the forces of the 21st century to prepare for war against the drones (Woodhams, 2018).

Although most of the Anka-S and Bayraktar TB-2 drones have been heard in various studies, they are no longer the top products of the Turkish drone industry. In the next period, Bayraktar Akıncı and Anka-Aksungur, which are larger in size than their predecessors and can carry a greater payload, can be learned more and more widely. However, the Turkish military industry is also made with smaller assets. The Kargu-2 small, rotary-wing “kamikaze drone” is planned to be used in swarms, and the Alpague construction, which can be used by individual fighters, may soon be in operation (Crino and Dreby, 2020).

7. Strengthening Hungarian-Turkish defense relations and future opportunities

With regard to Hungary, three directions of military industrial development can be distinguished, which are defined by the *Zrínyi 2026 Defense and Armed Forces Development Program* aimed at the development of the Hungarian military industry. One is when, building on the knowledge of the Hungarian industrial and service base, it strives to develop significant components, subsystems and software used in the military industry, which are at the forefront of the world and thus have a good chance of becoming the focus of global military companies and system integrators. In this case, although they are not end products, this is the easiest way to put a country on the world map of the military industry. The more successful companies that supply important system components to large players, the better the country's bargaining position when purchasing a platform or weapon system. In addition, the contribution to the development of the national economy is high, as the valuable research and development activity at the beginning of the supply chain takes place among domestic economic actors (Balogh, 2019).

Another possibility for the Hungarian national economy is to initiate military activities that offer a real opportunity to expand the domestic section of the supply chain as significantly as possible. In such cases, if the given activity was not previously found in the domestic economy, the solution may be to start the low value-added assembly process in Hungary. By reversing the resulting profit, knowledge accumulation and economic efficiency development can be achieved with a constantly evolving and expanding supplier network, a labor market background, and educational and research institutional cooperation (triple helix). This will allow a shift in the supply chain towards the production of key components, then towards innovation and development, and the gradual expansion of the range of related services.

The third opportunity for the development of the Hungarian military industry is knowledge transfer. In this case, we attract civilian or military knowledge and technology by attracting foreign direct investment to Hungary (which can be the foreign acquisition of a domestic company, a greenfield investment or the establishment of a joint venture) or the foreign acquisition of domestic economic operators (acquisition of a foreign company or establishment of a joint venture abroad) in the domestic economy, which enables the competitive production of some modern military product or component.

The last example is that the Hungarian Armed Forces also concluded a contract for the supply of two products of the Turkish company Nurol Makina within the framework of the Defense and Armed Forces Development Program. Ejder Yalçın - capable of transporting a maximum of 11 people - is standardized in Hungary under the name Gidrán - for the purchase of a total of 250 armored infantry vehicles and smaller NMS vehicles for up to 7 people - and for the assembly and further development of part of the ordered quantity in Kaposvár, Hungary - a decision has been made. The acquisition of the vehicles will be used in part to fulfill NATO's commitment to equip a sniper brigade after the regularization. In addition to the Turkish manufacturer, the German company

Rheinmetall will be involved in further development (VPK News, 2020). Hungary has also shown interest in purchasing the Bayraktar TB-2s (Brownsword, 2021).

For all three military industry development opportunities, successful cooperation between the defense sector and the civilian economy is of a great importance. To this end, it is essential that the defense sector understands the thinking of economic actors, the logic of the operation of the business sector. If this is not done, the cooperation of civil society actors may become uncertain, or if they do work together, the cooperation will have very limited results. It is no coincidence that in 2015 the U.S. announced its third 'offset' strategy to turn existing knowledge in the civilian sector (such as Silicon Valley startups) that was previously invisible or untapped into defense capabilities, increasing its declining technological advantage against its rivals. The Institute of Modernization of the Hungarian Armed Forces was established in Hungary for a similar purpose (Balogh, 2019).

Conclusions

Turkey has set itself the strategic goal of becoming fully self-sufficient in the military industry in just a few years. This is also the goal of the country not to be exposed to external assistance in an armed conflict in the field of military equipment. While Turkey clearly had to rely on foreign suppliers to meet its military needs in the first years of the 2000s and had significant imports from the military industry, Turkey is now moving closer to establishing a self-sufficient national military industry. Furthermore, Turkey can increasingly be described as a major military producer and exporter. Turkish-made military vehicles, drones, various devices, and weapons are already being used in many parts of the world, which also supports the country's geopolitical interests. And Turkish munitions and machines have been involved in several armed conflicts and have been successfully tested in several cases.

References

- Al-Youssef, M. and Escher, M. 2021. Kampfdrohnen: der Wettflug der Rüstungsindustrie zur Todesmaschine. *DerStandard* <https://www.derstandard.de/story/2000124570606/kampfdrohnen-der-wettflug-der-ruestungsindustrie-zurtodesmaschine>
- Andryeyeva, N., Nikishyna, O., Burkynskyi, B., Khumarova, N., Laiko, O. and Tiutiunyyk, H. 2021. Methodology of analysis of the influence of the economic policy of the state on the environment. *Insights into Regional Development*, 3(2), 198-212. [https://doi.org/10.9770/IRD.2021.3.2\(3\)](https://doi.org/10.9770/IRD.2021.3.2(3))
- Avia. 2020. Russian Pantsir-S air defense systems destroyed 25% of all Bayraktar TB-2 drones built by Turkey. https://avia.pro/news/rossiyskie-zrpk-pancir-s-sbili-v-livii-47-tureckih-dronov-bayraktar-tb2?utm_referrer=https%3A%2F%2Fzen.vandex.com
- Bağcı, H. and Kurç, C. 2017. Turkey's strategic choice: buy or make weapons? *Defence Studies*. 17(1), 38-62. <http://doi.org/10.1080/14702436.2016.1262742>
- Bakir, A. 2020. Turkey's Defense Industry in the Covid Age. *Newlines Institute for Strategy and Policy*. Terrain Analysis. <https://newlinesinstitute.org/turkey/turkeys-defense-industry-in-the-covid-age/>
- Bakir, A. 2021. Mapping The Rise of Turkey's Hard Power, Part 2: Domestic Industry. *Newlines Institute for Strategy and Policy*. Terrain Analysis. <https://newlinesinstitute.org/uncategorized/mapping-the-rise-of-turkeys-hard-power-part-2-domestic-industry/>
- Balogh, O. 2019. The Importance of the Zrínyi 2026 Defence and Military Development Program. *Vojenské rozhledy*, 28(3), 55-70. ISSN 1210-3292. www.vojenskerohledy.cz
- Barrinha, A. 2014. The Ambitious Insulator: Revisiting Turkey's Position in Regional Security Complex Theory. *Mediterranean Politics*, 19(2), 165-182.

- Bekdil, B. E. 2020. Turkish industry prospers, but foreign relations are limiting its potential. *DefenseNews*. <https://www.defensenews.com/top-100/2020/08/17/turkish-industry-prospers-but-foreign-relations-are-limiting-its-potential/>
- Besenyő, J. and Oláh, P. 2012. One of the new competitors in Africa: Turkey. *AARMS*, 11(1), 135–148. http://real.mtak.hu/83768/1/real_OneofthenewcompetitorsinAfricaTurkey_2012_u.pdf
- Besenyő, J. 2019. Barry Buzan's Securitization Theory and the Case of Iraqi Kurdish Military Action against ISIS in 2014. *Journal of Security and Sustainability Issues*, 8(3), 285-306. [http://doi.org/10.9770/jssi.2019.8.3\(1\)](http://doi.org/10.9770/jssi.2019.8.3(1))
- Besenyő, J. 2021. Turkey's growing interest in the African continent. *JCEEAS – Journal of Central and Eastern European African Studies*, 1(1-2). <https://jceas.bdi.uni-obuda.hu/index.php/jceas/article/view/4/4>
- Borsari, F. 2021. Rabat's Secret Drones: Assessing Morocco's Quest for Advanced UAV Capabilities. *Italian Institute for International Political Studies (ISPI)*, <https://www.ispionline.it/en/publicazione/rabats-secret-drones-assessing-moroccos-quest-advanced-uav-capabilities-31207>.
- Brownsword, S. 2021. Turkey Driving Drone Proliferation in Its Quest for Market Supremacy. *Drone Wars*. <https://dronewars.net/2021/07/05/turkey-driving-drone-proliferation-in-its-quest-for-market-supremacy/>.
- Buzan, B., Waever, O. and De Wilde, J. 1998. *Security: A New Framework for Analysis*. Boulder, CO: Lynne Rienner.
- Buzan, B. 1991. *People, States and Fears*. Harvester Wheatsheaf, Hertfordshire.
- Buzan, B. and Hansen, L. 2009. *The Evolution of International Security Studies*. Cambridge University Press.
- Cannon, B. J. 2021. Turkey's defense industry and military sales in Sub-Saharan Africa: Trends, rationale, and results. *International Security and Terrorism*. <https://trendsresearch.org/insight/turkeys-defense-industry-and-military-sales-in-sub-saharan-africa-trends-rationale-and-results/>
- Chehabeddine, M. and Tvaronavičienė, M. 2020. Securing regional development. *Insights into Regional Development*, 2(1), 430-442. [https://doi.org/10.9770/IRD.2020.2.1\(3\)](https://doi.org/10.9770/IRD.2020.2.1(3))
- Corte Réal-Pinto, A. G. 2017. Une exception néolibérale? Le projet de turquification de l'armement. *Revue internationale de politique de développement*, 8. <https://doi.org/10.4000/poldev.2456>
- Crino, S. and Dreby, A. 2020. Turkey's Drone War in Syria – A Red Team View. *Small Wars Journal*. <https://smallwarsjournal.com/jrnl/art/turkeys-drone-war-syria-red-team-view>
- Daily Sabah. 2022. Turkish army receives new Bayraktar TB2s with local electro-optical system. <https://www.dailysabah.com/business/defense/turkish-army-receives-new-bayraktar-tb2s-with-local-electro-optical-system>
- Defence and Security Policy of the Turkish Republic 2011. in: CIDOB International Yearbook 2011, Barcelona. https://www.cidob.org/en/publications/publication_series/cidob_international_yearbook/cidob_international_yearbook_2011_country_profile_turkey
- DefenseWorld. 2020. Libyan War Claimed 25 Large military Drones in 2020. https://www.defenseworld.net/news/27332/Libyan_War_Claimed_25_Large_military_Drones_in_2020#.YiX8-WjMIuV
- Delalande, A. 2019. How Libya's skies became battleground for UAE-Turkey proxy war, *Middleeasteye*. <https://www.middleeasteye.net/news/how-libyas-skies-became-battleground-uae-turkey-proxy-war>
- Demir, I. 2020. Transformation of the Turkish Defense Industry: The Story and Rationale of the Great Rise. *Insight Turkey* 2020. 22(3), 17-40. <https://www.insightturkey.com/file/1273/transformation-of-the-turkish-defense-industry-the-story-and-rationale-of-the-great-rise>
- Dunne, J. P., Nikolaidou, E. and Smith, R. P. 2005. Is there an Arms Race between Greece and Turkey? *Peace Economics, Peace Science and Public Policy*, 11(2). <https://doi.org/0.2202/1554-8597.1086>
- Fysh, M. C. and Bindemann, M. 2018. Person Identification from Drones by Humans: Insights from Cognitive Psychology. *Drones*, 2(4), 32. <https://doi.org/10.3390/drones2040032>

- Gurini, F. 2020. Turkey's unpromising defense industry. *Carnegie Endowment for International Peace*, <https://carnegieendowment.org/sada/82936>
- Ilchenko, O., Brusakova, O., Burchenko, Y., Yaroshenko, A. and Bagan, Y. 2021. The role of a defence industry in the system of national security: a case study. *Entrepreneurship and Sustainability Issues*, 8(3), 438-454. [https://doi.org/10.9770/jesi.2021.8.3\(28\)](https://doi.org/10.9770/jesi.2021.8.3(28))
- Hoenig, M. 2014. Hezbollah and the Use of Drones as a Weapon of Terrorism, *Public Interest Report*, 67(2). <https://uploads.fas.org/2014/06/Hezbollah-Drones-Spring-2014.pdf>
- Karaosmanoglu, A. L. and Kibaroglu, M. 2003. *Defense Reform in Turkey*, in: *Post-Cold War Defense Reform: Lessons Learned in Europe and the United States*, New York. 1-30.
- Kasapoglu, C. 2022. Techno-Geopolitics and the Turkish Way of Drone Warfare. *Issue Brief*. Atlantic Council. https://www.atlanticcouncil.org/wp-content/uploads/2022/03/Techno-Geopolitics_and_the_Turkish_Way_of_Drone_Warfare.pdf
- Kasapoglu, C. 2021. Hard Fighting in the Caucasus: The Azerbaijani Armed Forces' Combat Performance and Military Strategy in -the 2020 Nagorno-Karabakh War. *SAM Papers*. 18. <http://sam.gov.tr/pdf/sam-papers/SAM-Papers-No.-18.pdf>
- Kazan, I. 2003. *Regionalisation of Security and Securitisation of a Region*. Copenhagen: University of Copenhagen Press.
- Kussainova, M. 2021. Turkey, Kazakhstan to boost defense industry cooperation. *Anadolu Agency*. <https://www.aa.com.tr/en/turkey/turkey-kazakhstan-to-boost-defense-industry-cooperation/2134550>
- Limba, T., Agafonov, K., Paukštē, L., Damkus, M. and Plēta, T., 2017. Peculiarities of cyber security management in the process of internet voting implementation. *Entrepreneurship and Sustainability Issues*, 5(2), 368-402. [http://doi.org/10.9770/jesi.2017.5.2\(15\)](http://doi.org/10.9770/jesi.2017.5.2(15))
- Lisin, E., Kurdiukova, G., Ketoeva, N. and Katina, J. 2018. Sustainability issues of territorial power systems in market conditions. *Entrepreneurship and Sustainability Issues*, 6(2), 1041-1052. [http://doi.org/10.9770/jesi.2018.6.2\(38\)](http://doi.org/10.9770/jesi.2018.6.2(38))
- Málnásky, A. 2020. Change of Direction in Turkey's Africa Policy. What is Behind the Turkish Intervention in Libya? *Strategic Impact*, 74, 74-84. <https://www.cceol.com/search/article-detail?id=884889>
- Mikhaylov, A. S., Mikhaylova, A. A. and Savchina, O. V. 2018. Innovation security of cross-border innovative milieus. *Entrepreneurship and Sustainability Issues*, 6(2), 754-766. [http://doi.org/10.9770/jesi.2018.6.2\(19\)](http://doi.org/10.9770/jesi.2018.6.2(19))
- Morgan, F. E. et al. 2008. Dangerous Thresholds: Managing Escalation in the 21st Century, *RAND Corporation*, 20-28, <https://www.rand.org/pubs/monographs/MG614.html>.
- Nordic Monitor. 2020. Turkey records significant drop in defense industry exports in January-August 2020. <https://nordicmonitor.com/2020/09/turkey-records-significant-drop-in-defence-industry-exports-in-january-august-2020/>
- Saddiki, S. 2020. The New Turkish Presence in North Africa: Ambitions and Challenges. *Konrad Adenauer Stiftung, Med Dialogie Series*, 33. <https://www.kas.de/documents/282499/282548/The+New+Turkish+Pres%20ence+in+North+Africa.pdf/1ef5bc1d-f900-a9b5-6fb0-619c94ec37b1?ver%20sion=1.0&t=1607419637085>
- Shay, S. 2019. The Important Role of Turkish Drones in the Libyan War. *Israel Defense*. <https://www.israeldefense.co.il/en/node/39539>
- Tapia, F. S. 2021. The Turkish defence industry. First-class strategic asset. Analysis Paper. *Instituto Espanol de Estudios Estrategicos*. https://www.ieee.es/Galerias/fichero/docs_analisis/2021/DIEEEA06_2021_FELSAN_IndustriaTurca_ENG.pdf
- The Military Balance 2021. Routledge, Taylor & Francis, 11-304. ISBN: 9781032012278
- TRT World. 2018. Turkey tops the international weapon export rating. <https://www.trtworld.com/turkey/turkey-tops-the-international-weapon-export-rating-24880>
- TRT World. 2019. Turkey among top 100 in global arms industry. <https://www.trtworld.com/turkey/turkey-among-top-100-in-global-arms-industry-22395>
- Turkey's Strategic Vision 2023 Project. TASAM, 2012. <http://www.tsv2023.org/index.php/en/>

Turkish Defence & Aerospace. 2020. How Turkey became one of the world's leading manufacturers of weapons systems. *Defense News*. <https://www.defensenews.com/native/turkish-defence-aerospace/2020/07/21/how-turkey-became-one-of-the-worlds-leading-manufacturers-of-weapons-systems/>

Tvaronavičienė, M. 2018. Towards internationally tuned approach towards critical infrastructure protection. *Journal of Security and Sustainability Issues*, 8(2), 143-150. [https://doi.org/10.9770/jssi.2018.8.2\(2\)](https://doi.org/10.9770/jssi.2018.8.2(2))

Vagneur-Jones, A. and Kasapoglu, C. 2017. Bridging the Gulf: Turkey's forward base in Qatar. *Foundation for Strategic Research*, 16. <https://www.frstrategie.org/en/publications/notes/bridging-gulf-turkeys-forward-base-qatar-2017>

VPK News. 2020. Hungary buys Turkish armored vehicles Ejder Yalçın. https://vpk.name/en/474002_hungary-buys-turkish-armored-vehicles-ejder-yaln.html

Wiśniewski, R. 2015. Military-Industrial aspects of Turkish defence policy. *Rocznik Integracji Europejskiej*, 9, 215-228. <https://doi.org/10.14746/rie.2015.9.14>

Woodhams, G. and Borrie, J. 2018. Armed UAVs in conflict escalation and inter-State crisis. *UNIDIR Resources*. <https://www.unidir.org/files/publications/pdfs/armed-uav-in-conflict-escalation-and-inter-state-crisis-en-747.pdf>

Woodhams, G. 2018. Weapons of Choice: The Expanding Development, Transfer and Use of Armed UAVs, *UNIDIR*, pp 14-15. <http://unidir.ch/files/publications/pdfs/weapons-of-choice-the-expanding-development-transfer-and-useof-armed-uavs-en-723.pdf>

Zegart, A. 2018. Cheap Fights, Credible Threats: The Future of Armed Drones and Coercion. *The Journal of Strategic Studies*, 6-46. <https://doi.org/10.1080/01402390.2018.1439747>

Funding: The research was partly financed by, Óbuda University (Hungary), and University of Pécs (Hungary)

János BESENYŐ is an associate professor in the Doctoral School for Safety and Security Sciences at Óbuda University (Hungary) and head of the Africa Research Center. Between 1987 and 2018, he served as a professional soldier and served in several peace operations in Africa and Afghanistan. He received a PhD in military science from Miklós Zrínyi National Defense University (Hungary) and he received a habilitated doctorate at Eötvös Loránt University (Hungary). In 2014, he established the Scientific Research Center of the Hungarian Defence Forces General Staff, and was its first leader from 2014 to 2018. His most recent publication is Darfur Peacekeepers: The African Union Peacekeeping Mission in Darfur (AMIS) from the Perspective of a Hungarian Military Advisor

ORCID ID: orcid.org/0000-0001-7198-9328

András MÁLNÁSSY is a PhD student at the Doctoral School of Earth Sciences, University of Pécs, Hungary. He works as a security and defense policy expert. Research interests: Turkey and its defense industry; security and defense policy; geopolitics.

ORCID ID: orcid.org/0000-0002-3196-4967

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:
@IntoInsights

Copyright © 2022 by author(s) and VSI Entrepreneurship and Sustainability Center
This work is licensed under the Creative Commons Attribution International License (CC BY).
<http://creativecommons.org/licenses/by/4.0/>





Publisher

<http://jssidoi.org/esc/home>



BUILDING A MODEL FOR SECURING REGIONAL DEVELOPMENT FROM ECOLOGICAL THREATS

Mohammed R. Chehabeddine^{1*}, Sabina Grabowska², Abel Femi Adekola³

¹ Department of Business Technologies and Entrepreneurship, Vilnius Gediminas Technical University (VILNIUS TECH),
Saulėtekio al. 11, LT-10223 Vilnius, Lithuania

² University of Rzeszow, al. mjr W. Kopisto 2A, bud. A2 pok. 33, 35-959 Rzeszow, Poland

³ Jay S. Sidhu School of Business & Leadership, Wilkes University, USA

E-mails: ¹ mohamad.chehab-eddine@vilniustech.lt (Corresponding author); ² sgrabowska@ur.edu.pl;
³ abel.adekola@wilkes.edu

Received 25 March 2022; accepted 21 May 2022; published 30 June 2022

Abstract. This paper aims to build a Sustainable Development (SD) model that considers ecological threats. We need to identify and measure those threats to prevent them from hindering sustainable regional development. The authors mine the ecological threats' indicators related to the 17 UN Sustainable Development Goals (SDGs) from the World Bank database. They found that the ecological threats affect eight SDGs out of the seventeen SDGs, as well as 43 security indicators that measure ecological threats. The obtained results are used to build a Sustainable Development Ecological Security Model made out of selected ecological indicators. The model is instrumental for further constructing an index, which allowed for estimating a level of security of sustainable development from ecological hazards. The study's novelty lies in considering ecological security issues while measuring SD. The obtained results may be instrumental for measuring countries' secure sustainable development and managing the processes through relevant economic policies.

Keywords: Sustainable Development (SD); Sustainable Development Goals (SDGs); Ecological threats; Regional Development Model; Organization for Security and Co-operation in Europe (OSCE); World Bank

Reference to this paper should be made as follows: Chehabeddine, M.R., Grabowska, S., Adekola, A.F. 2022. Building a model for securing regional development from ecological threats. *Insights into Regional Development*, 4(2), 22-40.
[http://doi.org/10.9770/IRD.2022.4.2\(2\)](http://doi.org/10.9770/IRD.2022.4.2(2))

JEL Classification: Q2, Q51

1. Introduction

1.1 Principles of Sustainable Development

The conservation of the ecosystem is a crucial principle of Sustainable Development (SD) which means development activities must be carried out according to the earth's capacity (Mensah, 2019). SD's overarching summative principle is the systematic incorporation of environmental, social, and economic concerns into all aspects of decision-making across generations. According to Guillén-Royo (2018), sustainable development necessitates action in three areas, including development strategies that encourage economic growth, social equality, and the reduction of adverse environmental impacts (Guillén-Royo, 2018). In general, sustainable development synchronizes economic, environmental, and social growth to increase overall intergenerational welfare while balancing intergenerational interest (Jin, Qian, Chin, & Zhang, 2020; Sun, Jin, Tsai, & Jakovljevic, 2022).

1. Economic sustainability involves a production system that meets current consumption levels without jeopardizing future needs (Lobo, Pietriga, & Appert, 2015).
2. Social sustainability entails equity, empowerment, accessibility, participation, cultural identity, and institutional stability (Goodland & Daly, 1996).
3. Environmental sustainability is a concern for natural environment and how it can continue to be productive and resilient to support human life. It relates to ecosystem integrity and the carrying capacity of the natural environment (Disano, 2006).

1.2 The Interpretation of Regional Development in Sustainable Development

The development of regions is commonly understood as the holistic growth of a community (social, economic, environmental, healthcare, technological, cultural, and recreational) on a particular territory (Jovovic et al., 2017) which we might add inclusivity; as a result, the development of a region must be based on the optimal expansion of constituents of sustainable development pillars (social, environmental, and economic development), and aimed at specific life-level maintenance and quality improvement (Jovovic et al., 2017).

1.3 The Sustainable Development Goals (SDGs)

Sustainable development means a harmonious balance of environmental health, ecological vitality, and social order with inclusivity (Faisal, Tunaboyle, & Koyuncu, 2020); this approach is valid for all countries irrespective of their development level.

The SDGs represent a well-balanced set of economic, social, and environmental goals and targets. To achieve the SDGs, countries must recognize and appreciate the existence of potential trade-offs and devise strategies to deal with them (Mensah, 2019). The SDGs' successful implementation will rely on piercing through the complex interactions between the goals and their targets for a better understanding of the intricacies. An integrated approach to sustainability would necessitate realizing the potential of its vital dimensional pillars while also managing the tensions, trade-offs, and synergies among these dimensions. The SDGs are an essential tool for promoting the long-term achievement of the three pillars of sustainable development (economics, environment, and social) (Griggs et al., 2013).

In 2015 the United Nations (UN) proposed 17 new Sustainable Development Goals (SDGs), with targets for sustainability accompanying each pillar. It contained 17 global goals, 169 targets, and 230 indicators that all countries must meet by 2030 (United Nations <https://sdgs.un.org/goals>; Faisal et al., 2020); these 17 SDGs are depicted in Figure 1.



Figure 1. The 17 UN Sustainable Development Goals (SDGs)

Source: United Nations <https://sdgs.un.org/goals> ("THE 17 GOALS | Sustainable Development," n.d.)

These 17 SDGs can be categorized into the three sustainable pillars; Table 1 depicts all 17 goals arranged into three pillars: social, environmental, and economic) (Kostoska & Kocarev, 2019).

Table 1. The 17 sustainable development goals are clustered into economic, environmental, and social pillars

Sustainable Pillars	Associated Goals					
Economic	1 NO POVERTY	2 ZERO HUNGER	3 GOOD HEALTH AND WELL-BEING	8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	
Environmental	6 CLEAN WATER AND SANITATION	7 AFFORDABLE AND CLEAN ENERGY	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION	14 LIFE BELOW WATER	15 LIFE ON LAND
Social	4 QUALITY EDUCATION	5 GENDER EQUALITY	10 REDUCED INEQUALITIES	11 SUSTAINABLE CITIES AND COMMUNITIES	16 PEACE, JUSTICE AND STRONG INSTITUTIONS	17 PARTNERSHIPS FOR THE GOALS

Source: Created by the authors based on (Kostoska & Kocarev, 2019)

Environmental sustainability is vital for two convincing reasons. First, it reduces the possible adverse environmental externalities associated with climate change, such as heatwaves, rising sea levels, flooding, droughts, food insecurity, wildfires, and displacement of people. Second, it is a precondition for sustainable development (Opoku, Dogah, & Aluko, 2022).

2. Literature Review

2.1 The Debate about the SDGs

The SDGs are integrated (and indivisible) and create a balance between the three facets of sustainable development (economic, social, and environmental) for the whole world (developed and developing countries alike) to make them perform their best in reducing inequalities considerably (Kostoska & Kocarev, 2019). According to the SDGs, sustainable development aspires to achieve social progress, environmental balance, and economic growth. However, policymakers face the issue of implementing the SDGs concurrently due to multiple interlinkages within and between these goals, including synergy and potential trade-offs (Pradhan, et al., 2017) as well as doing it equitably. However, these interconnections currently have a weak conceptual and scientific foundation to emphasize the urgent need for holistic and comprehensive techniques and tools to assess the nature and strengths of these interactions as well as how they affect policy and execution (Pradhan et al., 2017).

The SDGs' development objectives and targets are interdependent but interrelated, a crucial characteristic (Tosun et al., 2017). For instance, addressing climate change issues (SDG 13) could benefit energy security (SDG 7), biodiversity (SDG 14), and oceans (Le Blanc, 2015). Climate change (related to SDG 13 and SDG 6) leads to water-related disasters, because the imbalance between evaporation and precipitation creates either shortage or excess of water in the ecosystem accordingly (Yadav & Zeeshan Ibrar, 2022).

The actions for achieving sustainability have positive links with the SDGs related to environmental dimensions (Goals 6, 7, 12, 13, 14, and 15) as they mutually reinforce each other. However, these efforts may directly contradict the SDGs regarding social and economic factors (Goals 1, 2, 3, and 8). The SDGs incorporate the 5Ps spanning the 17 SDGs: people, planet, prosperity, peace, and partnership, emphasizing the interdependence of the targets and the need for integrated and coordinated goal execution, as shown in Table 2 (Zhai & Chang, 2018; Ho & Goethals, 2019).

Table 2. The 5Ps concept in the 2030 Agenda for Sustainable Development

P's (Themes)	People					Prosperity					Planet					Peace	Partnership
SDG's	1	2	3	4	5	7	8	9	10	11	6	12	13	14	15	16	17
Interrelation between P's	Interacted with each other															People & Prosperity	People & Planet

Source: Created by the authors based on Zhai & Chang (2018); Ho & Goethals (2019); Kostoska & Kocarev (2019)

2.2 Ecological Security

Sustainable development changes its context in the conditions of accelerating global warming. If a decade ago economic growth was emphasized, now is the time to focus on the survival of the planet as a priority. Therefore ecological security, in rather broad sense (Ciszek, 2012; Wysokinska-Senkus et al., 2021) has to be analyzed, measured and managed.

Ecological security means that hazards related to air contamination, soil, and water have to be identified, grouped, and the level of their importance identified.

Biological invasions, land-use intensification, and water scarcity jeopardize sustainability (Ho & Goethals, 2019). Furthermore, the environmental degradation mainly reflected in increasing levels of carbon dioxide (CO₂). Emissions dominates the global discourse on climate change and its consequential global warming (Opoku et al., 2022).

It is important to understand how to avoid these ecological threats that affects our regional development. Measuring their harm is the essential for devising policies for protecting our ecosystem of these ecological hazards. Previous research used traditional indicators to measure sustainability without considering the impact of ecological threats on our regional development. For example, the Ecological Footprint model measures sustainability based on converting human resource consumption and bio-productivity in a country and compares the consumption footprint to the regional bio-capacity (Liao, Li, Yan, & Hu, 2004) which these days, is found to be insufficient to determine the sustainable development of the country.

3. Methodology

For the mining of security SDGs indicators for G20 Countries related to the mitigation of ecological threats, international databases are used (e.g., the World Bank database is used since it has an SDGs database, and filtering these SD goals into the required eight security goals allows to get the related indicators). G20 countries were chosen because they are the leading countries that have reached a high green development level, whereas the medium ones move fast toward a green economy, and some laggards get worst (Shao, Jin, Tsai, & Jakovljevic, 2022).

3.1 Ecological Threats' Categorizations

The new security vision identified challenging traditional security concepts intersecting with each other, as well as, introducing non-traditional threats such as cyber threats, Geo-engineering, STEM, etc. Hence, the new security vision expands these threats categorized into 5 Types, 3 States and 5 Premises (Nardin, 2017).

Providing the summary below, Table 3 categorizes the regional threats in terms of types and premises to analyze and conclude the highest harmful regional threats that impacts regions and sustainable development goals which in turn, impacted regional development.

Table 3 also lists the concentration of ecological threats in terms of type and premise highlighted in dark blue, while their related SDGs are mentioned inside the environmental and ecological threat type cells.

The full version of categorizing the regional threats that include their states by the link located in the Data Availability Statement in the Table named "Regional Threats Analysis".

Table 3. The summary expanded the vision of regional threats

N	Regional Threats	Threat types					Threats Premises					Authors
		A	B	C	D	E	I	II	III	IV	V	
		State Centere d	Huma n	Hybrid	Environ -mental	Ecological	Tradi tional	Old & New Threats combined and Interact e d	New develo pments of unconv entional threat	Upgra ded Old Threat s	Old Threats affected by external Factors (Globali zation, pollutio n)	
1	Massive Migration			✓			✓					(Campbell, 2019)
	Gender-Based Violence		✓				✓					(Gerring, 2019)
	Water Availability				✓ SDG6						✓	(Zawahri & Weinthal, 2019)
	Food Insecurity		✓	✓							✓	(Resende, & Abdenur, 2019)
2	Populist Security		✓				✓					(Garrett, 2019)
	Extremist & Terrorism			✓			✓					(Joshi, 2019)
	Corruption			✓			✓					Euromonitor International
3	Critical Infrastructure					✓ SDG9			✓			(Addington, 2019)
4	Climate Change				✓ SDG13					✓		(Below, 2019)
	Geoengineeri ng					✓ SDG11			✓			(Beevers, 2019)
5	Cyber Security Threats			✓					✓			(Lifländer, 2019)
	STEM			✓					✓			(Sebastiani, Sanchez & Manrod, 2019)
	Energy Insecurity				✓ SDG7						✓	(Davis, & Drake, 2019)
	Supply Chain Risks & Uncertainty			✓					✓			(Bachkar, K., & Hebron, L., 2019)
	Oil Price Shock	✓						✓				Euromonitor International (Formentos, & Gokcek, 2019)
	Global Trade War	✓		✓				✓				
	Invisible Foes, Micro-enemies, Pathogens and Global Health Insecurity					✓SDG13 ✓SDG14 ✓SDG15				✓		

Source: Categorization created by the authors

3.2 Reasons for choosing Ecological threats among other Regional Threats

Table 3 provides an overview of regional threats. The hazards related to the environment of our living planet are for instance, climate change, water security, and energy security, while the ecological threats are related to ecosystems and other forms of life, such as geoengineering, micro-enemies, pathogens, and pollution. Both types of threats are interlinked.

These ecological threats reflect the SDG insecurities such as water, energy, infrastructure, footprint, biodiversity, and terrestrial ecosystem. The aforementioned are trans-state and non-human. These ecological threats are mainly old threats affected by new external factors or old upgraded threats that have less focus, which now requires more attention to predict further threats. So, the scope of this research is ecological threats.

This research focuses on the planet security theme due to its endangered ecological threats. However, other threatening SDGs, such as SDG 11, belong to the prosperity theme and the social pillar. According to Moyer and Bohl (2019), several SDGs are closely related to human development, indicating a tendency to develop programs to consider human development and environmental elements together.

Therefore, it is necessary to include SDG 9 & SDG 11 along with the environmental SDGs (6, 7, 12, 13, 14, 15) to have eight SDGs (6, 7, 9, 11, 12, 13, 14 & 15) that are related mainly to mitigating ecological threats. These eight goals are described in detail in Table 3, which is also provided by the link located in the Data Availability Statement.

3.3 The World Bank Group

The World Bank Group is a significant source of funding and information for developing countries worldwide, providing a wide range of financial items and technical assistance and helping countries share and apply cutting-edge information and solutions to their problems (<https://www.worldbank.org/en/who-we-are>). They partner with governments, International Bank for Reconstruction and Development (IBRD) and International Development Association (IDA), which provides developing-country governments with finance, policy advice, and technical aid. IDA concentrates on the world's poorest countries, whereas IBRD aids middle-income and creditworthy poorer countries. Furthermore, The International Finance Corporation (IFC), The Multilateral Investment Guarantee Agency (MIGA), and The International Centre for Settlement of Investment Disputes (ICSID) are all focused on supporting the private sector in developing nations.

The World Bank Group supports private enterprises, including financial institutions, with finance, technical assistance, political risk insurance, and dispute resolution through these entities. World Bank database is the official organization of providing United Nations Sustainable Development (UNSD) indicators; accessing the database is through logging into the databank – World Bank website <https://databank.worldbank.org/home.aspx>.

The sequence of actions is as follows:

- 1 - Selecting the Sustainable Development Goals database from the available 84 databases is our concern for securing SDGs.
 - 2 - Selecting the targeted G20 group countries that control two-thirds of world economies and select the targeted period afterward.
 - 3 - Then selecting the targeted goals, the eight security SDGs (6, 7, 9, 11, 12, 13, 14, 15)
- SD Goal #6 - Ensure universal access to and sustainable management of water and sanitation,
SD Goal #7 - Ensure access to affordable, reliable, sustainable, and modern energy for all,
SD Goal #11 - Make cities and human settlements more inclusive, safe, resilient, and sustainable,
SD Goal #12 - Ensure sustainable consumption and production patterns,
SD Goal #13 - Take immediate action to combat climate change and its consequences,
SD Goal #14 - The need to protect the oceans and seas,

SD Goal #15 - The protection of the terrestrial ecosystem, sustainable forest management, and combating desertification.

Applying the filter in the series drop list, as discussed previously, these specific goals are related to Ecological security.

The data is exported as an Excel spreadsheet containing a table of 43 UNSD (United Nations Sustainable Development) indicators encompassing the 8 Goals, associated 20 targets, and the 43 attributed coded indicators related to mitigating the ecological threats.

For the model building, we made two steps; the first step is the conceptualization phase in which the goals are set, and the next step is the operationalization phase in which the indicators are formulated.

Building the flowchart for the model starts from regional sustainable development and goes toward planet security sustainable development indicators as shown below in Figure 2. This model can be used as a tool to measure and rank the sustainability of countries that enable policymakers to take the appropriate decisions and or actions.

4. Results and Discussion

4.1 Ecological Threat Indicators

Analysis of SD goals show that six goals of seventeen are related to environmental issues.

SD Goal #6 focuses on clean water and sanitation.

SD Goal #7 ensures accessible, affordable, reliable, sustainable, and modern energy.

SD Goal #9 focuses on infrastructure security by having efficient and healthy transportation by minimizing their Co2 emissions.

SD Goal #11 focuses on cities' security by having safe and healthy cities by minimizing losses related to cities' disasters and the Environmental Impact of cities, such as Solid Waste and Pollution.

Municipal environmental management is the environmental activities performed by local authorities in the municipalities to enhance city security (Mostovoy et al., 2021).

SD Goal #12 tackles consumption and production.

Consumption patterns have to be changed; stewardship of resources has to become a lifestyle; the circular economy has to become an integral part of daily life; organic farmer as to be a natural choice.

The indicator, i.e., the share of certified organic agricultural area in organic farms in the total agricultural area of agricultural holdings, has improved in the last decade.

SD Goal #13 tackles climate change. Economic growth leads to an increase in energy consumption, which, in its turn, leads to the emission of Co2 into the atmosphere. Switching towards renewable energy sources is an inevitable choice by producers and households.

The priorities are effectively reducing Co2 concentration in the atmosphere and introducing innovative technologies to use available energy sources, including geothermal energy development.

One of the indicators of this priority is the share of energy from renewable sources in gross final energy consumption.

SD Goal #14 is formulated in order for oceans and seas to be preserved. Here, tourism activities have to be rethought for urbanization and deterioration to be prevented (Sun & Ye, 2022).

The priority is also to increase the share of the maritime economy sector in GDP and increase employment in the marine economy.

An indicator describes the percentage of fish stocks within the sustainable levels.

To achieve SD Goal #14, "Biodiversity Protection," critical areas of biological diversity must be identified and protected.

Overusing agrochemicals has led to the destruction of natural resources and reduced production. Such form of agriculture relies heavily on inputs, including seeds, pesticides, fertilizers, and irrigation water, leading to higher production costs and adversely affecting the health of humans and animals (Abdar, Amirtaimoori, Mehrjerdi, &

Boshrabadi, 2022) (Zulfiqar & Thapa, 2017). The indicator is the share of forest land in the land area, about 30%. This Goal's degree of implementation is determined by the indicator of the percentage of devastated and degraded land requiring reclamation in the total area.

Table 4 lists the main ecological threats with descriptions related to eight security SDGs, the security targets, the security code of the Goal and task, and their SD pillar and theme categorization for each ecological threat.

Table 4. The 43 Ecological threats Indicators based on SDGs

No.	Main Ecological Threats	Security Targets	Ecological threats security SD Tasks	Ecological threats Indicators Description	Indicator SDG code (Goal, Task)	Indicator pillar, Theme
1	Water Insecurity	Availability and Accessibility water	Securing drinking water	People using at least basic drinking water services (% of population)	6.1	Environmental, Planet
2				People using safely managed drinking water services (% of population)		
3			Securing sanitation and handwashing	People practicing open defecation (% of population)	6.2	
4				People using at least basic sanitation services (% of population)		
5				People using safely managed sanitation services (% of population)		
6				People with basic handwashing facilities including soap and water (% of population)		
7			Securing freshwater	Annual freshwater withdrawals, total (% of internal resources)	6.4	
8				Level of water stress: freshwater withdrawal as a proportion of available freshwater resources		
9				Renewable internal freshwater resources per capita (cubic meters)		
10				Water productivity, total (constant 2010 US\$ GDP per cubic meter of total freshwater withdrawal)		
11			Securing water related ecosystem	Change in the extent of water-related ecosystems over time	6.6	
12	Energy Insecurity	Stable, Sustainable and Accessible Energy	Electricity accessibility and stability	Access to electricity (% of population)	7.1	Environmental, Prosperity
13				Access to clean fuels and technologies for cooking (% of population)		
14			Renewable energy sustainability	Renewable electricity output (% of total electricity output)	7.2	

INSIGHTS INTO REGIONAL DEVELOPMENT

ISSN 2669-0195 (online) <http://jssidoi.org/jesi/>

2022 Volume 4 Number 2 (June)

[http://doi.org/10.9770/IRD.2022.4.2\(2\)](http://doi.org/10.9770/IRD.2022.4.2(2))

15				Renewable energy consumption (% of total final energy consumption)		
16			Energy intensity	Energy intensity level of primary energy (MJ/\$2011 PPP GDP)	7.3	
17	Infrastructure Insecurity	Efficient, Safe, and Healthy infrastructure	Transportation (Efficient and Safe)	Air transport, passengers carried	9.1	Economic, Prosperity
18				Railways, passengers carried (million passenger-km)		
19			Healthy CO2 emissions reduction	CO2 emissions (kg per PPP \$ of GDP)	9.4	
20	Cities threats	Safe and Healthy cities	Minimize losses related to cities disasters	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	11.5	Social, Prosperity
21				Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters		
22			Minimize environmental impact of cities such as solid waste & pollution	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	11.6	Social, Prosperity
23	Resources Consumption threats	Sustainable Ecosystem	Reduce ecological footprint	Adjusted net savings, excluding particulate emission damage (% of GNI)	12.2	Environmental, Planet
24				Coal rents (% of GDP)		
25				Forest rents (% of GDP)		
26				Mineral rents (% of GDP)		
27				Natural gas rents (% of GDP)		
28				Oil rents (% of GDP)		
29				Total natural resources rents (% of GDP)		
30			Reduce fossil-fuel consumption	Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools	12.8	
31	Climate change threats	Stable and Safe climate	Control Climate impact	Droughts, floods, extreme temperatures (% of population, average 1990-2009)	13.1	Environmental, Planet
32			Augment disaster risk reduction such as GHGs emissions and geoengineering impacts	Disaster risk reduction progress score (1-5 scale; 5=best)	13.2	
33	Aqua Insecurity	Sustainable production and threats prevention on Aqua systems	Coastal ecosystem SD	Proportion of national exclusive economic zones managed using ecosystem-based Approaches	14.2	Environmental, Planet
34			Aqua production	Aquaculture production (metric tons)	14.4	

35				Capture fisheries Production (metric tons)		
36				Total fisheries Production (metric tons)		
37			Marine protection	Marine protected areas (% of territorial waters)	14.5	
38				Forest area (% of land area)		
39			Terrestrial conservation	Terrestrial and marine protected areas (% of total territorial area)	15.1	
40				Terrestrial protected areas (% of total land area)		
41				Fish species, threatened		
42			Biodiversity extinction	Mammal species, threatened	15.5	
43				Plant species (higher), threatened		

Source: Created by the authors, based on World Bank- sustainability database

The legend below is based on the retrieved data from the World databank for G20 countries and shows that five non-available indicators are highlighted in grey color. Also, there are two available indicators with no available data highlighted in green.

The remaining thirty-six indicators are available. Their data are retrieved and attached by the link located in the Data Availability Statement in the tab named "Ecological threats indicators" of the Excel sheet named "Appendix".

Color coding	Indicator data Availability in World bank databases	Quantity
	N/A	5
	Available but not recorded	2
	Available	36

The above two tables are listed by the link located in the Data Availability Statement as a reference.

4.2 Implications of Sustainable Development Goals security Indicators

Many indicators are either grouped in a framework of categories or aggregated into an index to make a problem visible (Pravitasari et al., 2018); however, there are criteria to identify and select the appropriate indicators for aggregation such as credibility, relevance, and legitimacy (Hák, Janoušková, & Moldan, 2016).

The relationship between the indicators and the facts they reflect must be empirically tested using proper methodologies (Hák, Janoušková, & Moldan, 2016), considering the challenges in selecting indicators and determining their weights.

The eight ecological Security SD Goals are related to three SD pillars, and SD indicators are retrieved from these ecological Security SD Goals.

The originality of this SD model is that it lists 43 SD indicators to measure ecological security, which can be used to mitigate ecological threats to enhance regional SD.

Previous studies mainly focused on reviewing and comparing the indicators developed to measure sustainable development. However, it does not measure the harm of ecological threats to our regional development. It does not account for securing SD related to these ecological threats based on securing SD Goals. In contrast, this research considers these security issues that affect our ecosystem security and, ultimately, SD security, which is the concern of the policymakers and stakeholders.

This model can serve as a framework for constructing an index that measures countries' performance, which can be used for countries' ranking based on theoretically grounded sustainable development parameters.

It would allow policymakers to rate policy initiatives aimed at the same policy goals based on their effectiveness at getting the country on a sustainable development path. It will enable ranking policy initiatives and harmonizing policies aimed at diverse sectors and goals (Štreimikienė & Baležentis, 2013).

4.3 Model Construction

Filtering 1443 indicators available in the World Bank into 404 sustainable development indicators, then reviewing the filtered indicators, their categories and themes.

Below, Figure 2 describes the flow chart of the proposed SD Ecological Security Model, whereas the list of indicators along with their implications included in the Sustainable Development Ecological Security Model is provided in Table 5 below. They are listed in the same sequence in Figure 2 from up to downward, starting from environmental indicators till ending with economic indicators. Besides that, the table shows the Targeted Direction of change for these indicators based on their long definitions, Statistical concepts, and methodology listed in the Appendix - Series Metadata that is provided by the link located in the Data Availability Statement.

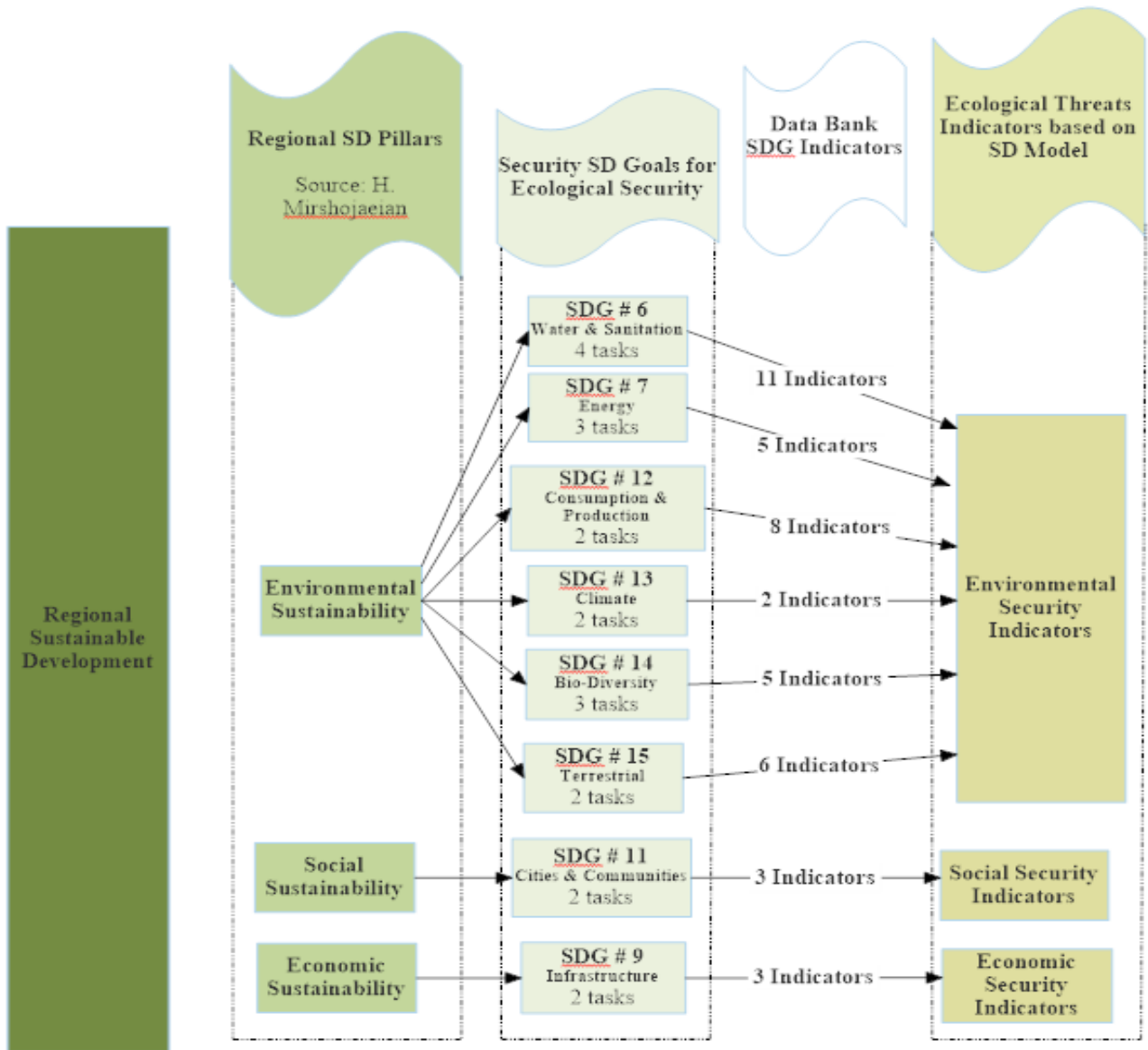


Figure 2. Sustainable Development Ecological Security Model

Source: created by the authors

Table 5. The list of indicators' implications

Indicator number	Indicator Description	Sustainability Pillar	SDGs	Targeted Direction of change	Data Availability
1	People using at least basic drinking water services (% of population)	Environmental	6	↑	Yes
2	People using safely managed drinking water services (% of population)	Environmental	6	↑	Yes
3	People practicing open defecation (% of population)	Environmental	6	↓	Yes
4	People using at least basic sanitation services (% of population)	Environmental	6	↑	Yes
5	People using safely managed sanitation services (% of population)	Environmental	6	↑	Yes
6	People with basic handwashing facilities including soap and water (% of population)	Environmental	6	↑	Yes
7	Annual freshwater withdrawals, total (% of internal resources)	Environmental	6	↑	Yes
8	Level of water stress: freshwater withdrawal as a proportion of available freshwater	Environmental	6	↓	Yes
9	Renewable internal freshwater resources per capita (cubic meters)	Environmental	6	↑	Yes
10	Water productivity, total (constant 2010 US\$ GDP per cubic meter of total freshwater withdrawal)	Environmental	6	↑	Yes
11	Change in the extent of water-related ecosystems over time	Environmental	6	↑	No
12	Access to electricity (% of population)	Environmental	7	↑	Yes
13	Access to clean fuels and technologies for cooking (% of population)	Environmental	7	↑	Yes
14	Renewable electricity output (% of total electricity output)	Environmental	7	↑	Yes
15	Renewable energy consumption (% of total final energy consumption)	Environmental	7	↑	Yes
16	Energy intensity level of primary energy (MJ/\$2011 PPP GDP)	Environmental	7	↓	Yes

17	Air transport, passengers carried	Environmental	12	↑	Yes
18	Railways, passengers carried (million passenger-km)	Environmental	12	↑	Yes
19	CO2 emissions (kg per PPP \$ of GDP)	Environmental	12	↓	Yes
20	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	Environmental	12	↓	No
21	Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters	Environmental	12	↓	No
22	PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	Environmental	12	↓	Yes
23	Adjusted net savings, excluding particulate emission damage (% of GNI)	Environmental	12	↑	Yes
24	Coal rents (% of GDP)	Environmental	12	↓	Yes
25	Forest rents (% of GDP)	Environmental	13	↑	Yes
26	Mineral rents (% of GDP)	Environmental	13	↓	Yes
27	Natural gas rents (% of GDP)	Environmental	14	↓	Yes
28	Oil rents (% of GDP)	Environmental	14	↓	Yes
29	Total natural resources rents (% of GDP)	Environmental	14	↓	Yes
30	Number of sustainable tourism strategies or policies and implemented action plans with agreed monitoring and evaluation tools	Environmental	14	↑	No
31	Droughts, floods, extreme temperatures (% of population, average 1990-2009)	Environmental	14	↓	Yes, but no available records
32	Disaster risk reduction progress score (1-5 scale; 5=best)	Environmental	15	↑	Yes, but no available records
33	Proportion of national exclusive economic zones managed using ecosystem-based approaches	Environmental	15	↑	No
34	Aquaculture production (metric tons)	Environmental	15	↑	Yes
35	Capture fisheries Production (metric tons)	Environmental	15	↓	Yes
36	Total fisheries Production (metric tons)	Environmental	15	↓	Yes
37	Marine protected areas (% of territorial waters)	Environmental	15	↑	Yes
38	Forest area (% of land area)	Social	11	↑	Yes

39	Terrestrial and marine protected areas (% of total territorial area)	Social	11	↑	Yes
40	Terrestrial protected areas (% of total land area)	Social	11	↑	Yes
41	Fish species, threatened	Economic	9	↓	Yes
42	Mammal species, threatened	Economic	9	↓	Yes
43	Plant species (higher), threatened	Economic	9	↓	Yes

Source: Created by the author, based on World Bank - Sustainability database

The list of indicators included in the model with their data from the year 2010 to 2019 is additionally provided by the link located in the Data Availability Statement.

5. Conclusions and Limitations

5.1 Conclusions

The authors came to the following insights:

- in contemporary conditions sustainable development can be secured only if ecological threats are neutralized;
- those threats have to be identified and measured, therefore a set of 43 indicators was suggested;
- Sustainable Development Ecological Security Model was constructed, which clearly showed place of environmental security indicators in sustainable development of regions; data for G20 countries was collected;
- The obtained results may be instrumental for measuring countries' secure sustainable development and managing the processes through relevant economic policies.

5.2 Limitations

The collection of indicators is limited to selecting ecological indicators threatening SD goals, provided in World Banks' Sustainability database. We provided data collected for G20 countries in the Appendix. The data of a few extracted indicators is not available for some tackled countries, therefore, further results are subject to several uncertainties and qualifications where knowledge gaps and measurement issues could cause uncertainty that warrant further consultation by experts.

5.3 Future Improvement

All indicators, particularly for developing nations, are hampered by the poor quality and coverage of available data, inconsistent techniques, weak time series, and major gaps. Governments must ensure and acknowledge that data collecting is primarily their duty. Investing in data collection pays off handsomely in terms of better decision-making. However, using the most recent methodology and data, it is possible to compute an index for earlier years to begin measuring relative performance between nations and how each country's performance changes over time.

References

- Addington, D. &. (2019). Cyber security threats and solutions for the private sector. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp.181-195)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Bachkar, K., & Hebron, L. (2019). Risk and uncertainty in the global container supply chain. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 209-222)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Beevers, M. D. (2019). Geoengineering: A new and emerging security threat? M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 32-43)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Below, A. (2019). The existential threat multiplier. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp.18-31)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Campbell, Joel R. (2019). The international migration issue after the Syrian Civil War, Brexit and Trump. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp.118-129)). New York, USA: Routledge by Taylor & Francis. <https://doi.org/10.4324/9781315102061>
- Ciszek, M. (2012). Bezpieczeństwo ekologiczne i zrównoważony rozwój w aspekcie Strategii Bezpieczeństwa Narodowego Rzeczypospolitej Polskiej. *Studia Ecologiae et Bioethicae*. 10(1), 29-41.
- Davis, M. A., & Drake, J. (2019). Competition and cooperation in energy policies: Dilemmas for national security and influence. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 56-66)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Formentos, A., & Gokcek, G. (2019). Invisible foes and micro-enemies: Pathogens, diseases, and global health security. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 106-117)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Garrett, C. S. (2019). Steeped in insecurity? M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 222-232)). New York: Routledge. <https://doi.org/10.4324/9781315102061>
- Gerring, N. (2019). A threat to human security in the Global North and Global South. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 82-92)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Joshi, S. (2019). Sub-state actors' threats to international security. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp.133-145)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Lifländer, C. M. (2019). Emerging threats in cyberspace: The next domain of warfare. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp.170-180)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Resende, E., & Abdenur, A. E. (2019). governance, Food security. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 93-105)). New York: Routledge. <https://doi.org/10.4324/9781315102061>
- Sebastiani, J., Sanchez, J., & Manrod, M. (2019). Threats from STEM. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 196-208)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Zawahri, N. A., & Weinthal, E. (2019). The intersecting dimensions of water security. M. G. Gueldry, *Understanding New Security Threats* (1st issue., pp. (pp. 44-55)). New York, USA: Routledge. <https://doi.org/10.4324/9781315102061>
- Abdar, Z. K., Amirtaimoori, S., Mehrjerdi, M. R. Z., & Boshrahadi, H. M. (2022). A composite index for assessment of agricultural sustainability: the case of Iran. *Environmental Science and Pollution Research*, 1, 1–13. <https://doi.org/10.1007/S11356-022-19154-6/FIGURES/8>
- Disano, J. A. (2006). Meeting the Johannesburg target. *Natural Resources Forum*, 30(2), 85. <https://doi.org/10.1111/J.1477-8947.2004.00085.X-II>
- Faisal, A., Tunaboylu, B., & Koyuncu, I. (2020). Environmental And Social Sustainability Index (ESSI). *Present Environment and Sustainable Development*, 14(1). <https://doi.org/10.15551/PESD2020141025>
- Goodland, R., & Daly, H. (1996). Environmental Sustainability: Universal and Non-Negotiable. *Ecological Applications*, 6(4), 1002–1017. <https://doi.org/10.2307/2269583>
- Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M. C., Shyamsundar, P., ... Noble, I. (2013). Sustainable development goals for people and planet, 495(7441), 305–307. <https://doi.org/10.1038/495305a>
- Guillén-Royo, M. (2018). Sustainability and Wellbeing: Human Scale Development in Practice. *Sustainability and Wellbeing*. <https://doi.org/10.4324/9781315762135>
- Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable Development Goals: A need for relevant indicators. *Ecological Indicators*, 60, 565–573. <https://doi.org/10.1016/J.ECOLIND.2015.08.003>
- Ho, L. T., & Goethals, P. L. M. (2019). Opportunities and Challenges for the Sustainability of Lakes and Reservoirs in Relation to the Sustainable Development Goals (SDGs). *Water*, 11(7), 1462. <https://doi.org/10.3390/W11071462>
- Jin, H., Qian, X., Chan, T., & Zhang, H. (2020). A Global Assessment of Sustainable Development Based on Modification of the Human Development Index via the Entropy Method. *Sustainability*, 12(8), 3251. <https://doi.org/10.3390/SU12083251>
- Jovovic, R., Draskovic, M., Delibasic, M., & Jovovic, M. (2017). The concept of sustainable regional development-institutional aspects, policies and prospects. *Journal of International Studies*, 10(1), 255–266. <https://doi.org/10.14254/2071-8330.2017/10>
- Kostoska, O., & Kocarev, L. (2019). A Novel ICT Framework for Sustainable Development Goals. *Sustainability*, 11(7), 1961. <https://doi.org/10.3390/SU11071961>
- Le Blanc, D. (2015). Towards Integration at Last? The Sustainable Development Goals as a Network of Targets. *Sustainable Development*,

- 23(3), 176–187. <https://doi.org/10.1002/SD.1582>
- Liao, C., Li, L., Yan, Z., & Hu, B. (2004). Ecological security evaluation of sustainable agricultural development in karst mountainous area. *Chinese Geographical Science*, 14(2), 142–147. <https://doi.org/10.1007/s11769-004-0023-1>
- Lobo, M. J., Pietriga, E., & Appert, C. (2015). An evaluation of interactive map comparison techniques. *Conference on Human Factors in Computing Systems - Proceedings*, 2015-April, 3573–3582. <https://doi.org/10.1145/2702123.2702130>
- Mensah, J. (2019). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. *Cogent Social Sciences*, 5(1). <https://doi.org/10.1080/23311886.2019.1653531>
- Mostovoy, N., Carasso Romano, G. H., Rabinowitz, D., Soroker, S., & Carmi, N. (2021). The municipal council, my neighbors and me: Social environmental influences in the city. *Journal of Environmental Management*, 288, 112393. <https://doi.org/10.1016/J.JENVMAN.2021.112393>
- Moyer, J. D., & Bohl, D. K. (2019). Alternative pathways to human development: Assessing trade-offs and synergies in achieving the Sustainable Development Goals. *Futures*, 105, 199–210. <https://doi.org/10.1016/J.FUTURES.2018.10.007>
- Nardin, T. (2017). The new realism and the old. *Critical Review of International Social and Political Philosophy*, 20(3), 306–319. <https://doi.org/10.1080/13698230.2017.1293348>
- Opoku, E. E. O., Dogah, K. E., & Aluko, O. A. (2022). The contribution of human development towards environmental sustainability. *Energy Economics*, 106, 105782. <https://doi.org/10.1016/J.ENERG.2021.105782>
- Pradhan, P., Costa, L., Rybski, D., Lucht, W., & Kropp, J. P. (2017). A Systematic Study of Sustainable Development Goal (SDG) Interactions. *Earth's Future*, 5(11), 1169–1179. <https://doi.org/10.1002/2017EF000632>
- Pravitasari, A. E., Rustiadi, E., Pratika Mulya, S., & Nursetya Fuadina, L. (2018). Developing Regional Sustainability Index as a New Approach for Evaluating Sustainability Performance in Indonesia Spatial Modelling of Land Use Change in Gunung Halimun Salak National Park and Its Buffer Area View project Developing Regional Development a. *Environment and Ecology Research*, 6(3), 157–168. <https://doi.org/10.13189/eer.2018.060303>
- Shao, M., Jin, H., Tsai, F.-S., & Jakovljevic, M. (2022). How Fast Are the Asian Countries Progressing Toward Green Economy? Implications for Public Health. *Frontiers in Public Health*, 9, 2365. <https://doi.org/10.3389/FPUBH.2021.753338/BIBTEX>
- Štreimikienė, D., & Baležentis, A. (2013). Integrated Sustainability Index: the Case Study of Lithuania. *Intellectual Economics*, 7(3), 289–303. <https://doi.org/10.13165/IE-13-7-3-02>
- Sun, F., & Ye, C. (2022). Modelling of the environmental sustainability assessment index for inhabited islands. *Earth Science Informatics*, 1–10. <https://doi.org/10.1007/S12145-022-00769-9/FIGURES/3>
- Sun, J., Jin, H., Tsai, F.-S., & Jakovljevic, M. (2022). A Global Assessment of Sustainable Development: Integrating Socioeconomic, Resource and Environmental Dimensions. *Frontiers in Energy Research*, 10, 50. <https://doi.org/10.3389/FENRG.2022.816714/BIBTEX>
- THE 17 GOALS | Sustainable Development. (n.d.). Retrieved December 11, 2021, from <https://sdgs.un.org/goals>
- Tosun, J., Leininger Tosun, J. J., & Leininger, J. (2017). Governing the Interlinkages between the Sustainable Development Goals: Approaches to Attain Policy Integration. *Global Challenges*, 1(9), 1700036. <https://doi.org/10.1002/GCH2.201700036>
- Wysokinska-Senkus, A., Hadryjanska, B., & Senkus, P. (2021). The state and prospects for the development of a systemic approach to manage environmental resources in the context of ecological safety. *European Research Studies Journal*, XXIV(Issue 4), 180–198. <https://doi.org/10.35808/ERSJ/2571>
- Yadav, V., & Zeeshan Ibrar. (2022). Relationship of Water Stress and Flood Damage for Sustainable Development. *Water Resources Management*, 36(4), 1323–1338. <https://doi.org/10.1007/S11269-022-03083-7>
- Zhai, T., & Chang, Y. C. (2018). Standing of Environmental Public-Interest Litigants in China: Evolution, Obstacles and Solutions. *Journal of Environmental Law*, 30(3), 369–397. <https://doi.org/10.1093/JEL/EQY011>
- Zulfiqar, F., & Thapa, G. B. (2017). Agricultural sustainability assessment at provincial level in Pakistan. *Land Use Policy*, 68, 492–502. <https://doi.org/10.1016/J.LANDUSEPOL.2017.08.016>

Data Availability Statement: More information and data can be found in the repository on Zenodo:

[BUILDING MODEL FOR SECURING REGIONAL DEVELOPMENT FROM ECOLOGICAL THREATS | Zenodo:](https://zenodo.org/record/6577771/files/BUILDING_MODEL_FOR_SECURING_REGIONAL_DEVELOPMENT_FROM_ECOLOGICAL_THREATS/BUILDING_MODEL_FOR_SECURING_REGIONAL_DEVELOPMENT_FROM_ECOLOGICAL_THREATS.pdf)

md5:737bb33c0e7cef1ede8c0e1b75d70ae9

Mohammed CHEHABEDDINE

ORCID ID: <http://orcid.org/0000-0001-5059-9048>

Prof. Sabina GRABOWSKA

ORCID: <http://orcid.org/0000-0003-0530-708X>

Prof. Abel Femi ADEKOLA

Web of Science records: <https://www.webofscience.com/wos/author/record/3598954>

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:
@IntoInsights

Copyright © 2022 by author(s) and VsI Entrepreneurship and Sustainability Center
This work is licensed under the Creative Commons Attribution International License (CC BY).
<http://creativecommons.org/licenses/by/4.0/>



Open Access



Publisher

<http://jssidoi.org/esc/home>



WORK AFTER RETIREMENT: THE EVIDENCE OF SUSTAINABLE EMPLOYMENT FROM LITHUANIAN ENTERPRISE*

Julija Moskvina

*Lithuanian Social Research Centre, Institute of Sociology, A. Gostauto st. 9, LT-01108
Vilnius, Lithuania*

E-mail: julija.moskvina@dsti.lt

Received 14 April 2022; accepted 25 May 2022; published 30 June 2022

Abstract. While the population is ageing fast in Lithuania the possible ways of adaptation of older people in labour market should be analysed thoroughly. A small private company operating in the sector of electric installation was selected as a case. Analysis was aimed to reveal the main sector-specific enterprise-level factors for participation in labour market after the official retirement age. Paper presents both employee's and employer's perspectives on sustainable employment. The case study presents the experience of the 72 years old electrician and the employer's undertakings to encourage older workers to continue their careers. The data from the micro-level are analysed within the socio-economic context of the country. The case study shows that a long career is probable when both the business and the employees benefit from it, and the employee's health condition is satisfying. From the employer's perspective, the benefits derived from the employment of the high-skilled, experienced, and reliable workers; and from the older employee's perspective, such aspects as self-realisation and favourable conditions at the workplace have a great value.

Keywords: sustainable employment; aging; case study; electric sector; skilled manual work; Lithuania

Reference to this paper should be made as follows: Moskvina, J. 2022. Work after retirement: the evidence of sustainable employment from Lithuanian enterprise. *Insights into Regional Development*, 4(2), 52-62. [http://doi.org/10.9770/IRD.2022.4.2\(4\)](http://doi.org/10.9770/IRD.2022.4.2(4))

JEL Classifications: J14, M54, Z130

1. Introduction

Together with Latvia and Bulgaria, Lithuania is distinct from other European Union (EU) countries by the shortest life expectancy. The average Lithuanian citizen expects to live 5 years less than the average European citizen (76.5 and 81.3 accordingly, Eurostat data 2019). The male life expectancy is much shorter than females during the years: it was 69.2 and 79.7 years accordingly in 2015 and 70.1 and 80 in 2020. The process of Lithuanian population ageing is also one of the fastest in the EU. The common unfavourable demographic situation in the country is caused by the fast population decrease due to high net emigration and negative natural

* Paper was elaborated on the basis of research material collected in 2015 for the project 'Mobilising the Potential of Active Ageing in Europe (MOPACT)'. MOPACT is a project coordinated at the Department of Sociological Studies at the University of Sheffield (UK) and funded by the European Commission under the Seventh Framework Programme. More information at: <http://mopact.group.shef.ac.uk>

growth. The challenges for the economic development appear in this context as the shortage of labour force in specific spheres is experienced already now. Lithuanian scientists (Mikulionienė, 2011; Skučienė et al., 2015), as well as international organisations (European Commission, International Labour Organisation), stress the need for additional measures for labour market integration addressed the older population (Bouman et al., 2015).

The shortage of talents in the construction sector is widely recognised in the context of the ageing workforce (Smallwood, Emuze, 2017). Despite the Pandemic, the Lithuanian construction sector was stable and recently demands a more qualified labour force (Užimtumo tarnyba, 2021a). Lithuanian Methodological Centre for Vocational Education and Training (2008) revealed some negative qualitative aspects of the labour force in the construction sector in Lithuania: the workers often demonstrate a lack of responsibility, dutifulness, situation management skills, inventiveness, and low interest in innovations. Many skilled workers (as well as technicians and specialists) have poor practical skills. The up-to-date news about the new technologies / materials and adequate work skills, together with time management and project management skills are scarce. Within the context of the shortage of high-skilled employees, the value of older workers in the construction sector is increasing. And as studies show a longer stay in the labour market depends on favourable organisational practices, the wish of older employees themselves, and socio-economic conditions.

Sustainable work in old age is closely related to employability issues. As Van der Klink et al (2016) pointed out, employability has interactive nature embracing both the importance of individual efforts and capabilities to participate in employment longer and their balance with the structural factors. Thus the sustainability of work can be developed in an environment that is valuable for the worker and valued by the work context. The interaction of ageing individuals and businesses in the changing social, economic, and technological environment should be thoroughly analysed while searching for the recipes for the sustainability of work in older age. In order to develop employment sustainability in older age, a reconciliation of the worker's and company's targets should be achieved. Schinner et al. (2017) suggest the set of competencies that must be developed both at individual and organisational levels to find the desired equilibrium. The older workers have the professional, methodological, social as well as self-management competencies that can be fully disclosed at the workplace when both organisational and individual competencies are coordinated and synchronised, the technological transformations are accepted, communication processes are smooth, and teamwork is used as a lever for collaboration. However, the described model is not complete without the health dimension.

The recent studies point out the importance of the physical conditions for the longer career. While speaking about construction sector it is stressed that the working conditions are unfavourable, especially for older workers. Due to heavy manual work the risk of injury and ill health are very high. More than one in five (20.9%) fatal accidents at work in the EU28 in 2014 took place within the construction sector (Eurostat quot. from Eurofound, 2018). Ill health or musculoskeletal disorders are the common reasons to leave the work at construction sector. The overall working conditions are often severe (dirty, noisy environments, lack of natural lighting and ventilation). The construction sector workers usually perform repetitive movements, heavy lifting and work in awkward and cramped positions (Arndt, Putz-Anderson, 2005). Eves et al. (2016) found that construction workers of all ages have a high prevalence of musculoskeletal symptoms. Reports of musculoskeletal symptoms were high for electricians in the wrists/hands, lower back, knees, ankles/feet.

While analysing organizational policies towards retaining older workers at work some important factors were revealed by Dutch scholars (Conen et al., 2014). The case study of three enterprises (including construction enterprise) show that business-cycle effects play a role in recruitment behaviour towards older workers: economic downturns decrease the likelihood of recruitment of older workers. The training initiatives, learning-on-the job routines, mentoring concepts and knowledge transfers from older/retiring employees to younger employees (or vice versa) seem to be consistent over time and has positive effect on career prolongation. Health and safety-related policies, including free safety work clothing, extensive physical examination, use of tools and materials to

relieve heavy work, and stricter rules on the maximum weights that can be carried, at least partly were stimulated by institutional forces. However, despite the efforts made by the company, the “choice to extend working lives seems largely to be supply-driven as mainly depends on wants and capabilities of employees” (Conen et al., 2014).

Indeed, the active role of employees is an important factor for successful aging at work (Kooij, 2015, Kooij et al, 2020). Providing more autonomy for the older workers can prolong the career of construction workers. Virtanen et al. (2014) found that good mental health in combination with the opportunity to control work time seem to be key factors in extended employment into older age. In addition, high work time control might promote work life participation irrespective of employees’ somatic disease status. Zaniboni et al. (2016) found that decision authority increases the satisfaction of older construction workers and thus increases their mental health.

Despite the growing demand for labour force, economically active people over 65 years old constitute only a tiny part of the working population, especially in the sectors with prevalent hard manual work. Thus, it is important to investigate what drives old-age manual workers to continue working. The main goal of the paper is to identify the individual- and company-level reasons as well as contextual factors for a long career (after retirement age) performing skilled manual work in an electric sector company. The identified factors of sustainable work in older age at the small size electric company are compared with the findings of the previous studies. The factors that can prevent successful workers-employer collaboration in older age are presented here as well.

2. Methodological approach

Despite shorter life expectancy Lithuanians withdraw from the labour market later than average European citizen - at the age of 61.9 and 61.5 years respectively; the total duration of working life in Lithuania was 37.4 years and 35.7 years in EU-27 in 2020. The rise of the official retirement age (which in 2015 was 61.5 for females and 63.3 for males and in 2020 gradually reached 65 years for both genders) has an impact on the longer stay in the labour market. Growing demand for skilled and high-skilled workers and the low replacement rate of old-age pensions create financial incentives for prolongation of the working life after the official retirement age (Skučienė, Moskvina 2016).

The overall employment situation is positive in Lithuania: the employment rate (age 15-64) during the last decade increased by more than 10 percentage points and in 2020 was 71.6% (higher than in EU, 67.6%). The employment rate of the older population (65+) is traditionally high in Lithuania and was growing. In 2015 it was 6.3% (while in EU 5.4%) and in 2020 went up to 11.2% (in comparison 5.7% in EU-27). While the working-age population is shrinking and the number of employed has limited growth perspectives, the share of older people in employment is growing. According to Eurostat employed people age 65+ constituted 2.5% in 2015 and 4.4% in 2020 (Graph 1) in Lithuania.

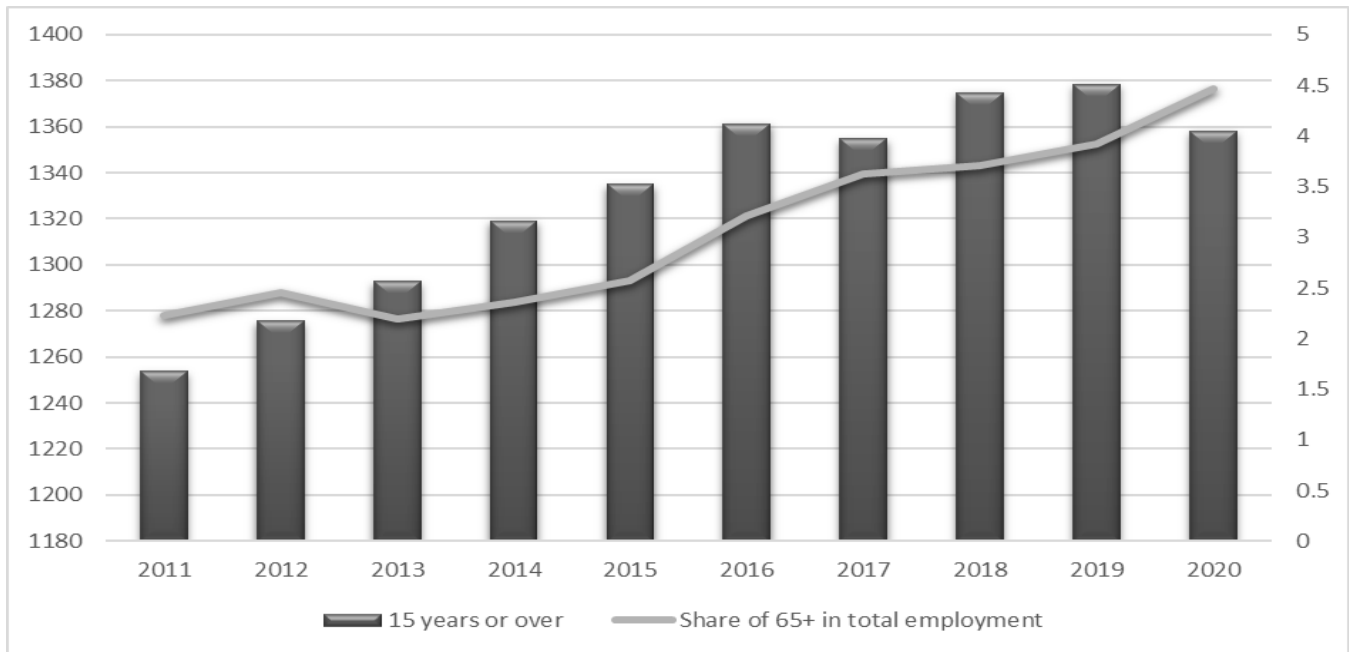


Figure 1. Number of total employed (age 15+, thous.) and share of older population employed (age 65+, %) in Lithuania.

Source: Calculated from Eurostat data

The construction sector in Lithuania together with other economic activities such as retail, manufacturing, and transport experience a shortage of workforce. For 2022 it was predicted demand for more than 7 thous. employees in the construction sector in Lithuania (MOSTA, 2020). Demand for the skilled labour force is growing and is shrinking for low- and un-skilled in the country. Skilled workers constitute the biggest share of all employees in the construction sector. The demand for all employees except unskilled workers is predicted in the construction sector as well (Užimtumo tarnyba, 2021a). Despite the growing demand for skilled workers in the construction sector, both vocational and higher education institutions prepare about 50% of the employees demanded in this sector. The mismatch problem is partly related to the ageing issue as well. As the study of the Methodological Centre for Vocational Education and Training (2008) indicated, in 2007 every 10th employee in the construction sector was 55 years or older. Fast labour force ageing in the construction sector is confirmed by Lithuanian Public Employment Service, for example, nowadays employees aged 50+ constitute almost half of the total staff in one of the larger real estate developers in Lithuania in 2021 (Užimtumo tarnyba, 2021b).

The case study presents the situation in the company, which belongs to the construction sector, specifically the electrical installation sub-sector. In 2015, when the case study was conducted, the total number employed in the construction sector in Lithuania was 105 thousand people, which constituted almost 8% of the total employed. The sector of specialised construction activities (to which the works of electrical installation belong) covers more than 30 thousand employees. Almost 3 thousand enterprises (mostly small, with up to 4 employees) are operating in this sub-sector in Lithuania (Statistics Lithuania). The highest number of construction enterprises operates in Vilnius and Kaunas regions.

The recent decades show the resistance of the construction sector to economic fluctuations. The economic crisis in 2008 had a significant negative impact on the construction service, however together with the growing national economy, this sector was growing too. As the construction service was recovering from the crisis period, the incomes from work in this sector were growing (Lithuanian Bank, 2014). During the recent Global Pandemic construction sector shrunk on a small scale and recovered with the higher demand for labour and increasing

wages. According to Statistics Lithuania a mean gross wage in the construction sector at the beginning of 2015 was 638 Eur. and in 2020 almost doubled to 1106 Eur. However, it was still 11% lower than the average gross wage in the country.

As the macro-level data do not provide sufficient explanation for the existing examples of working in old age, it was decided to analyse the good organisational practice using the case study method. The case study was performed in a small-sized private company that represents the sub-sector of electric installation works within the construction sector. Among a total number of 13 employees, 7 have reached the official retirement age. A director of the analysed company, a head of the unit, a foreman, a technical designer, and 4 operatives were older than the official age of retirement. According to the Resolution No 836 of the Lithuanian Government (2011) in 2015 the official retirement age for men was 63 years and 2 months. The oldest worker in the company (72 years old) was selected as an informant. The company resides in Vilnius - the Lithuanian capital and the biggest city in the country. The services of electric designing and electrical installation are delivered across Lithuania and abroad (Belarus, Ukraine). The company is one of the leading in the market and shows high competitiveness. The analysed company was selected as an example of good practices of successful ageing at work within the research project 'Mobilising the Potential of Active Ageing in Europe (MOPACT)'.

Two semi-structured interviews representing a business' and worker's sides (further in the text informants are called Director and Employee) were conducted in May 2015. Also, the secondary statistical data analysis was performed in order to evaluate the case of sustainable employment in the context of national social policy, labour market, and demographic situation. The SWOT analysis of the organisational practices was performed on the basis of collected information in order to evaluate the transferability of such experience.

3. Conducting research and results

3.1. Main findings from the interview: employer's perspective

Historical context. The transition period of 1990 – 1998 was characterised by significant changes in the appearing national labour market: bankruptcies and mass redundancies, rapidly increasing unemployment, a mismatch of labour supply and demand, and a growing number of private-sector employees (Gruževskis, 2011). The social-economic context of the transitional period of the Lithuanian economy had a crucial role in the development of the current business model that allows utilising the potential of older employees. Together with many other enterprises, the last job place of the Director of the analysed company - the heating plant – in the mid-1990th experienced technical restructuring as well as economic constraints. According to Director, the heating plant was interested to rid of the workers that reached the official retirement age. The main reason to fire them was economic (cutting the costs) as the employees with the longer work experience were entitled to bigger salaries.

Till 1995, 25 of February Lithuanian legal regulations allowed early retirement for the people that worked under precarious conditions. Thus, people that were retired according to the mentioned regulation usually were rather young - 55-57 years old. The Director of the analysed company was one of the early retirees as he worked under precarious conditions in the hot workshop (OG (1994) Nr. 59-1153). After becoming a non-volunteer pensioner, the decision of independent business development was taken. The Director established his own private electric company hiring his former colleagues and other workers at the age of retirement. Initially created age structure of the company where half of the workers are the compeers of the Director is actual till now.

Reasons for employing older workers. Besides the above-mentioned contextual driver for the employment of older employees, Director indicated specific work-related factors for such a business model. As it was mentioned

during the interview, the older workers are more experienced, they are more responsible in the sphere of accident prevention, and they keep a more serious approach towards the work tasks. All these qualities are proved during the long period of their work. As well older workers already have all or most of the required qualification proof documents (certificates, references) so there is little need to invest in their training.

Though the psychological aspect is also important when hiring older employees (excerption from the interview “It’s more comfortable to work with the group of people of the same age”), pragmatism is the underlying concept of the selected business model. First, the older workers are more experienced. In the case of a new project, they start to work without additional training. The older workers are capable to teach young colleagues. Employer wouldn’t entrust expensive equipment to the less experienced workers. High-skilled experienced employees allow the company’s competitiveness. Workers with different experiences can help develop broader spheres of the company’s activity, to compete for more profitable projects.

Hiring older workers is a safer choice for the employer – usually, they bring good recommendations or are chosen due to personal professional familiarity. It should be mentioned that the recruitment process of the older employees in the Company is rather informal. In case of a vacant job place, the existing network of former colleagues is used first. Hereby the efforts related to recruiting process are minimised.

Undertakings to retain older workers. As older workers are seen as an advantage to the company, the employer is interested to prolong their working life. Employment opportunities provided by Company are enabling them to fully use their professional potential and, at the same time, reconcile their family and work obligations. Employees are also able to perform the work tasks that meet their health conditions. For example, experienced older electricians are offered to perform only a part of the task that requires high-level qualification, preciseness, and proficiency, whereas tasks related to heavy physical loads, endurance, or climbing (e.g., lifting heavy loads, working at height, etc.) are delegated to younger workers who are less experienced but physically stronger. The retired ex-employees, at their request, are invited to do one-off jobs requiring specific skills under fixed-term employment contracts. The workers of the company are provided with vocational training and safety at work training if needed.

To be more precise, the set of the following measures is applied by the employer to make the company more attractive to older workers:

a) *Flexible adjustment of employment contracts.* As work in the construction sector is seasonal (mostly from April to October), the different forms of employment contracts are used in the company. Three options are available for the workers of retirement age with regard to the seasonal character of employment: annual leave without pay, dismissal during the winter period, and part-time contracts.

b) *Transfer of work experience.* To introduce the practice of work experience transfer such an example was presented during the interview: “Older and younger (vocational school graduate) workers were changing sockets, cables, etc. in “X” store. During the one-week work project, the older worker was teaching a younger colleague by showing practical work examples. After a younger worker was able to perform the same tasks, the older colleague was performing only more complicated and dangerous operations (under the voltage)”.

c) *Tasks sharing.* “Performing the task of automation of valves at thermoelectric power station both older and younger workers were involved. The young workers were asked to do such physically demanding tasks as stretching/installing the cables in the long narrow tunnel, assembling heavy electrical boxes, etc. The older workers were responsible for the tapping/connection. It is worth mentioning that only certified workers are allowed to do this type of job. The appropriate certificate costs about 1000 Euros”. The following example also illustrates the value that older skilled workers bring to the company.

d) *Training.* Some of the electric installation sector’s peculiarities determine the high involvement of the employee in the skill upgrading process. The obligatory re-certification for every skilled electric worker must be performed once in two years. In addition, certain certificates are valid only for certain construction/finishing

objects. Thus, the capability of the company is directly related to the number of certificates workers possess. The company pays full price for required certificates and other skill-upgrading courses/exams. In the case of older employees, the process of gaining certificates is easier and faster due to rich knowledge and professional experience as well as the ability to pass exams externally.

e) *Financial incentives.* The maximum financial incentive for good work seeks up to the amount of one monthly salary. This is a substantial sum taking into account that the average gross wage in 2015 in the private sector was about 690 EUR.

f) *Social activities.* Once per year the corporate party is organised for the staff. The company covers the expenses.

SWOT analysis. The main strengths, weaknesses, opportunities, and threats for the sustainable work at the older age were identified at organisational level during the interview.

Strengths:

- High qualification of the staff.
- No need to invest much into qualification of older workers.
- Stable and predictable salary.
- Easy recruitment.
- Job meets the need of employees.
- Smooth communication between employer and employees. Common values.

Weaknesses:

- The age (death probability).
- Shrinking pool of potential older employees.
- Health (employees often decide to stop career after seasonal/winter work break).

Opportunities:

- Transfer of experience to the young generation of workers.
- Easy to grow or reduce capabilities of the company depending on the needs and economic context.

Threats:

- As the old-age employees are the peers and constitute more than half of the staff, there is a possibility that most of them will decide to stop working at the same time (collapse of the activities).
- Changes in social policy regulations. The example from the recent economic crisis shows that cutting off the pensions for working pensioners reduces the motivation to stay in labour market after the age of retirement. In 2009, in the midst of the global economic crisis, it was decided to reduce social insurance pensions in Lithuania in order to balance the budget of the Social security insurance fund. The reduction was entrenched in the Provisional Law on Recalculation and Payment of Social Benefits (No XI-537, 2009) effective in 2010-2011. The pensions of the working old-age pensioners have been temporarily reduced almost by 25% (Social Report, 2011).

Thus, the idea to employ workers that are reached the age of retirement could be transferred to other private companies interested in high-skilled, experienced, and reliable workers. However specific conditions must be created at the company in order to attract old-age workers: task sharing, the possibility to combine work and leisure time, and competitive and paid on time salary. Interpersonal relations between employer and employee must be taken into account as well.

3.2. Main findings from the interview: employee's perspective

Work and retirement experience. The Employee has a long work experience as an electro-locksmith. He is a high-skilled worker of the 6th category (the highest level of qualification). In the last years before the official retirement age (since 1991) he worked in an automation workshop at the local thermoelectric power plant. In 2004 the Employee reached the official age of retirement. However, he continued to work for two more years till he was dismissed. After a certain period of being a non-working pensioner, he got a work proposal from his former colleague Director of the analysed Company. The work proposal was accepted by Employee with pleasure. The work experience of the Employee at the Company at the moment of the interview was 7 years.

Reasons for and benefits of a long career. The reasons to continue working are listed below. The sequence of the reasons that were presented during the interview is preserved:

1. Habit to follow daily working regime (excerption: "I like to wake up early")
2. Time structuring (excerption: "There is nothing to do at home")
3. Preferred job; willingness to do this specific work (excerption: "I wished to do this kind of work since I was doing military service (i.e. was young)")
4. Benefit for the health (excerption: "When men move not much it is not good for the health")
5. Financial reasons (excerptions: "Money is never too much", "I want to give support to the family", "I got higher pension due to longer working years").

It is worth mentioning that health and a healthy lifestyle are the personal values of the Employee. His hobbies are related to physical activities: gym, diving, etc. This finding confirms conclusions from Van der Klink et al (2016) that values constitute an important aspect of employment and employability.

At the same time, the financial reason was mentioned by the Employee only after the interviewer asked about material aspects of his work.

The interview showed that the reasons for longer working life are also related to the specific conditions at the Company. The benefits of working in the Company according to the Employee are such: possibility to do preferred work; doing usual work in a familiar environment (excerption: "it's easy for me to pass the required exams"); season job as a possibility to take a rest and spend more time for hobbies during winter period; possibility to perform family responsibilities (the Employee is taking care of 92 years old disabled mother and disabled brother); possibility to work together with well-known reliable older colleagues (excerption: "it's easier to communicate with same-age colleagues"); good and paid on time salary.

Barriers. One of the main barriers mentioned during the interviews was the specific work limits. The older workers usually are not able to perform such physically demanding tasks as drugging, digging, etc. Working under unfavorable weather conditions like strong heat or freeze also reduces the motivation of older workers to work. The young workers instead are willing to take hard part of work in order to gain professional experience.

Conclusions

With regard to specific characteristics of the construction sector such as seasonality and growing demand for a high-skilled labour force, the benefit from the chosen organisational policy is obvious for the employer: experienced, high-skilled, reliable, and loyal old-age employees contribute to the competitiveness of the company. The experience from the analysed Company could be transferred into the businesses with the same staff management strategies (small enterprise, the same age of employer and employees, utilisation of the network of former colleagues while recruitment). The aspects of the high autonomy at work and competitive salaries should be also considered as important factors of sustainability of such initiative within other sectors.

At the personal (employee) level maintaining the usual work style, path, and environment, as well as the possibility to combine work and leisure time and/or family responsibilities and avoid part of the physically demanding tasks are the main factors for a sustainable work. The analysed enterprise provides favourable working conditions embracing above mentioned factors.

Concluding it can be stated that existing informal collaboration between employer and employee creates a favourable environment for elongation of working life. Specific characteristics of the sector (seasonal work, growing demand for high-skilled workers, long and costly training of employees needed) give special value to the experienced, highly qualified, and reliable employees of old age. In terms of the future perspectives, the sustainability of the long career practices is limited only by the employable/productive life of the company's employees.

References

- Arndt, R., & Putz-Anderson, V. (Eds.). 2005. *Cumulative Trauma Disorders: A Manual for Musculoskeletal Diseases of the Upper Limbs*. Taylor & Francis.
- Bouman, R., Horne, R., Milasi, S., & Prasad, N. 2015. Ageing and labour market implications for Lithuania. *ILO Research Department Working Paper*, (6).
- Conen, W., Henkens, K., & Schippers, J. 2014. Ageing organisations and the extension of working lives: A case study approach. *Journal of Social Policy*, 43(4), 773-792.
- Eaves, S., Gyi, D. E., & Gibb, A. G. 2016. Building healthy construction workers: Their views on health, wellbeing and better workplace design. *Applied ergonomics*, 54, 10-18.
- Eurofound. 2018. Occupational accidents and diseases. European Observatory of Working Life. 26 April 2018. Retrieved from: <https://www.eurofound.europa.eu/sr/node/52180>
- Eurostat. 2020. *Fatal accidents at work within the construction sector – share from impact with a stationary object (victim in motion)*, 2018. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_-_statistics_on_causes_and_circumstances&oldid=461849
- Gruževskis, B. 2011. Darbo, gyventojų užimtumo bei darbo rinkos politikos tyrimai Lietuvos raidos kontekste. *Aktualūs socialinės politikos klausimai. Socialinė raida ir politika*, 9, 31-91.
- Kooij, D. T. 2015. Clarifying and discussing successful aging at work and the active role of employees. *Work, Aging and Retirement*, 1(4), 334-339.
- Kooij, D.T., Zacher, H., Wang, M. & Heckhausen, J., 2020. Successful aging at work: A process model to guide future research and practice. *Industrial and Organizational Psychology*, 13(3), pp. 345-365.
- Lithuanian Bank. 2014. *Lietuvos ekonomikos apžvalga*, Retrieved from http://lb.lt/lietuvos_ekonomikos_apzvalga_2014_m_geguzes_men.
- LR Government Resolution No 836 (2011).
- LR Law on State Social Insurance Pensions, No 59-1153 (OG, 1994).
- LR Provisional Law on Recalculation and Payment of Social Benefits, No XI-537 (09 12 2009).
- Methodological Centre for Vocational Education and Training (Profesinio mokymo metodikos centras). 2008. *Statybos sektoriaus studija. Darbuotojų ir kvalifikacijos kaitos prognozių tyrimo ataskaita*. Ekspertai: Averjanovienė V., et al. Vilnius.

Mikulionienė, S. 2011. Population ageing in Lithuania: the need for a new attitude towards ageing. In Hoff, Andreas, ed. *Population Ageing in Central and Eastern Europe: Societal and Policy Implications*. Series: New Perspectives on Ageing and Later Life. Surrey. Ashgate Publishing, Ltd., 2011.

MOSTA. 2020. *Žmogiškasis kapitalas Lietuvoje 2019*: Kryptis – ateities darbo rinka. Mokslo ir studijų stebėsenos ir analizės centro (MOSTA) apžvalga. Vilnius.

Public employment service (Lietuvos darbo birža). 2015. *Darbo rinkos tendencijos 2015 m. I pusmetį*, Retrieved from http://www.ldb.lt/Informacija/DarboRinka/Tendencijos_pdf/2015%20m.%20I%20pusme%C4%8Dio%20ap%C5%BEvalga.pdf (accessed 5 September 2018).

Schinner, M., Calero Valdez, A., Noll, E., Schaar, A.K., Letmathe, P. & Ziefle, M., 2017. July. 'Industrie 4.0' and an aging workforce—a discussion from a psychological and a managerial perspective. In *International Conference on Human Aspects of IT for the Aged Population* (pp. 537-556). Springer, Cham.

Skučienė, D., & Moskvina, J. 2016. Policy and Decision to Retire in Central and Eastern European Countries. *European Policy Analysis*, 2(1), 67-97.

Skučienė, D., Bartkus A., Moskvina J., & Uleckienė A. 2015. *Senėjanti visuomenė: kaip mes pasirengę?* Monografija. Vilnius: Lietuvos socialinių tyrimų centras. P. 332.

Smallwood, J., & Emuze, F. 2017. The impact of an ageing workforce on the construction industry in Australia. In *Valuing People in Construction* (pp. 104-123). Routledge.

Social Report 2009-2010, 2011. Lithuanian Ministry of Social Security and Labour.

Statistics Lithuania. 2013. *Lietuvos ekonomikos ketvirtinė apžvalga*, Retrieved from <http://osp.stat.gov.lt/services-portlet/pub-edition-file?id=3708>

Statistics Lithuania. *Official Statistics Portal*, Retrieved from <http://osp.stat.gov.lt/en/>

Užimtumo tarnyba, 2021a. *Darbo rinkos situacija statybos sektoriuje 2021 vasario mėn.* Pranešimas.

Užimtumo tarnyba. 2021b. *Darbuotojų nerandančios įmonės gręžiasi į vyresnius žmones*, Retrieved from <https://uzt.lt/news/darbuotoju-nerandancios-imonės-grežiasi-i-vyresnius-zmones/>

Van der Klink, J.J., Bültmann, U., Burdorf, A., Schaufeli, W.B., Zijlstra, F.R., Abma, F.I., Brouwer, S. & Van der Wilt, G.J. 2016. Sustainable employability—definition, conceptualization, and implications: a perspective based on the capability approach. *Scandinavian journal of work, environment & health*, pp.71-79.

Virtanen, M., Oksanen, T., Batty, G. D., Ala-Mursula, L., Salo, P., Elovainio, M., ... & Kivimäki, M. 2014. Extending employment beyond the pensionable age: a cohort study of the influence of chronic diseases, health risk factors, and working conditions. *PLoS One*, 9(2), e88695.

Zaniboni, S., Truxillo, D. M., Rineer, J. R., Bodner, T. E., Hammer, L. B., & Krainer, M. 2016. Relating age, decision authority, job satisfaction, and mental health: a study of construction workers. *Work, Aging and Retirement*, 2(4), 428-435.

Funding: The research was funded by the European Commission under the Seventh Framework Programme. More information at: <http://mopact.group.shef.ac.uk>

Julija MOSKVINA is Senior Researcher at the Labour Market Research Institute of the Lithuanian Social Research Centre, with experience in analysis of employment policies and unemployment issues. In her research, she particularly focuses on active labour market policies, vulnerable groups at labour market, labour market transitions, as well as an ageing labour force.

ORCID ID: orcid.org/0000-0002-7020-0273

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:
@IntoInsights

Copyright © 2022 by author(s) and VsI Entrepreneurship and Sustainability Center
This work is licensed under the Creative Commons Attribution International License (CC BY).
<http://creativecommons.org/licenses/by/4.0/>



Open Access



Publisher

<http://jssidoi.org/esc/home>



SECURITY OF EUROPEAN CRITICAL INFRASTRUCTURES OUTSIDE THE EUROPEAN UNION: A REVIEW OF THE WESTERN BALKANS NATIONAL LAWS

Milica Sikimić

Obuda University, Bécsi út 96/B, 1034 Budapest, Hungary

E-mail: milica.sikimic@uni-obuda.hu

Received 18 April 2022; accepted 25 May 2022; published 30 June 2022

Abstract: From the very beginning of the 21st century, the European Union took measures to develop a common security framework for critical infrastructure protection and to harmonize measures and standards between states. European critical infrastructures should be determined from the national critical infrastructure, which implies the regulations / rules for critical infrastructure protection are an important factor in European security and national laws. The paper examines the representation and impact of the provisions of DIRECTIVE 2008/114 / EC in the specific laws for security and protection of European critical infrastructures outside the European Union. In the Western Balkans, four specific laws were adopted setting out national frameworks for the establishment of critical infrastructure protection frameworks. The results of the analysis are based on the incorporation and implementation of the suggested common European Union approach for critical infrastructure protection in the national legislations of Western Balkan countries.

Keywords: European critical infrastructures, security, national laws, Western Balkans.

Reference to this paper should be made as follows: Sikimić, M. 2022. Security of European critical infrastructures outside the European Union: A review of the Western Balkans national laws. *Insights into Regional Development*, 4(2), 63-72. [http://doi.org/10.9770/IRD.2022.4.2\(5\)](http://doi.org/10.9770/IRD.2022.4.2(5))

JEL Classifications: N40

1. Introduction

The connection and interdependence of different infrastructure elements among each other highlights the common goals of national and European community security in terms of critical infrastructure protection (Rehak et al, 2016; Stergiopoulou et al, 2016; Besenyo, Feher, 2020). Legal norms of national legislation must not conflict with European treaties, laws adopted by European institutions, agreements concluded by the EU with third countries and international organizations, and the case law of the European Court of Justice (Borzel, 2016; Shumilo et al. 2021; Poustourli, 2016; Skara, Hajdini, 2021). Regarding the harmonization of regulations of member states and states striving to become members, i.e., meeting the conditions for membership arising from documents such as directives - as is the case with the critical infrastructure protection - it is necessary to incorporate their content into domestic law (Noutcheva, 2009; Mišević, Dark, 2017; Andryeyeva et al. 2021). Directives can be of varying degrees of generality, and states decide independently how and in what form they will apply the guidelines from the directives.

Specific measures in the development of the European Program for the Protection of European Critical Infrastructure were launched in 2004 (European Commission, 2004; European Commission, 2005). Central to the development of the security framework is "Council Directive 2008/114 / EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection" (hereinafter DIRECTIVE 2008/114 / EC), which contains guidelines for defining European Critical Infrastructures (hereinafter ECIs) and operationalizing the strategic European framework (European Commission 2008). DIRECTIVE 2008/114 / EC represents an organizational approach to the protection of ECIs, and the same approach was proposed for the protection of national critical infrastructure, while the organization of protection consists of several important components. First of them is the definition and sectoral approach, and then the organization of protection through the Operator security plans - OSPs, risk assessment, Security Liaison officer / Contact person - SLO, National contact point, and identification and designation of ECIs (European Commission, 2008).

The primary and ultimate responsibility for infrastructure protection is allocated in the individual Member States, their national legislation, and the owners/operators of critical infrastructure (Petrakos, Kotzanikolaou, 2019). Furthermore, ECIs are determined from the national critical infrastructure, thus the importance of national security measures and standards for the security of the region is not under the question (Chehabeddine, Tvaronavičienė, 2020).

Since countries have different geographical, spatial, political, socio-economic, and other factors, it is clear that critical infrastructure facilities, systems, and networks cannot be identical in all countries and regions. Vital infrastructure facilities are primarily identified at the national level, and ECIs are then designated from the ranks of national critical infrastructure (Lazari, Simoncini, 2016; Poustourli, 2016; Poustourli et al. 2015; Rehak et al. 2019). In 2018, the implementation of the guidelines of DIRECTIVE 2008/114 / EC was evaluated, which led to the conclusion that 18 European Union member states adopted proposals and requirements by amending the existing or adopting new national legislation. In agreement with neighboring countries, 11 Member States have designated at least one ECIs. At the European Union level, 93 ECIs were identified, of which 88 are in the energy sector and 5 in the transport sector (European Commission, 2019; Lazari, Simoncini, 2016).

The directives do not prescribe mandatory instruments for achieving results, but they do prescribe the results that candidate countries must achieve. Thus, Sweden and the United Kingdom are known as countries that have a developed framework for the protection of critical infrastructure, but do not have special national laws governing this area. On the other hand, countries such as Croatia (Law on critical infrastructures 2013), Bulgaria, Greece (Keković, Ninković, 2020), Hungary, Romania (Alexandru, Vevera, Ciupercă, 2019; Trbojević, 2018) have special national laws used to regulate the area of critical infrastructure protection.

In terms of establishing a framework of critical infrastructure protection, countries face significant differences between the financial and institutional capacities of the European Union member states and non-member states of the European Union (Petrakos, Kotzanikolaou, 2019). The geopolitical space of the Western Balkans consists of the Republic of Serbia, Kosovo, Bosnia and Herzegovina, the Republic of Northern Macedonia, Montenegro, and Albania. These countries are not member states of the European Union, but they are trying to reach and meet the standards of European integration. Most of the countries analyzed in this paper have opted for the adoption of specific national critical infrastructure protection laws, which contain the definition of critical infrastructure from DIRECTIVE 2008/114 / EC (with reasonable language/translation differences) and the basic sectoral distribution of vital infrastructures. To harmonize national legislation with the European Union regulations, and from the aspect of critical infrastructure protection, it is necessary to adjust the regulatory framework that includes the definition of critical infrastructure and ECIs, sectoral approach, operator security plans, liaison officers, contact point for coordination at the national level. The goal of this paper is to analyze the national laws for the protection of critical infrastructures in the Western Balkans, with an emphasis on the incorporation of provisions and

operationalization of approaches for the critical infrastructure protection under DIRECTIVE 2008/114 / EC. In addition, we analyzed the provisions of national laws regulating the attitude of these countries towards ECIs, each of which, except Kosovo, directly borders one of the European Union member states.

The research in the article is based on the legal dogmatic method, comparative method, and content analysis. The paper identifies the key critical infrastructure protection components presented in DIRECTIVE 2008/114 / EC. This is followed by a comparative analysis that examines the impact and representation of the provisions of DIRECTIVE 2008/114 / EC in the specific laws (*lex specialis*) of the Western Balkans. In addition to official European and national regulations, there were also several other sources such as website articles, journals, and books.

In the Western Balkans countries, four specific laws were adopted setting out national frameworks for establishing critical infrastructure systems and incorporating (partly) the provisions of Directive 2008/114 / EC, and implementing critical infrastructure protection approaches in each country. The laws were adopted by Serbia, Kosovo, Montenegro, and Republika Srpska (an entity in Bosnia and Herzegovina with legislative powers in its territory). The Republic of Northern Macedonia and Albania have not yet adopted special legislation, nor has Bosnia and Herzegovina at the state level (only one entity). The laws of Serbia and Montenegro stipulate that the provisions on the protection of ESIs will be applied on the day of the country's accession to the European Union, the law of Kosovo does not specifically define the time frame for the application of ECIs, while the law of Republika Srpska does not define ECIs but International Critical Infrastructure (Sikimić, Gnjatović, 2021). In the final remarks, the authors try to determine the degree of application of the analyzed provisions in each of the analyzed countries, as well as causes and dilemmas in the process of operationalization of adopted laws, and they try to make recommendations for future actions regarding the protection of ECIs outside the European Union.

The limitations of the research are that the analysis does not cover several national laws from each country that regulate certain aspects of security and protection, such as regulations for dealing with emergencies caused by natural disasters or cyber security. The research is focused only on the national *lex specialis* that define national critical infrastructure and ECIs. In addition, laws in Albania and Northern Macedonia were not analyzed, as such specific laws have not yet been adopted.

Through this paper, the authors want to contribute to the development of research regarding critical infrastructure in the scientific and academic community of the Western Balkans, where this subject, despite its relevance, seems underestimated. The practical significance is visible in a kind of cross-section of the situation in the field of critical infrastructure protection from the aspect of the process of integration (of analyzed countries) into the European community and protection of ECIs outside the European Union territorial borders (see more in: Petrović, 2022; Fejzullahu, Beleg, 2022).

2. National legal frameworks for critical infrastructure protection in the Western Balkan countries

Although the DIRECTIVE 2008/114/EC provides guidance on the protection of ECIs, the primary and ultimate responsibility for infrastructure safety is addressed to the Member States individually, their national legislation and critical infrastructure owners/operators. It emphasizes that it is necessary for the states to respect a common minimum when they evaluate responses to security requirements. The DIRECTIVE 2008/114 / EC also emphasizes an approach that takes into consideration all sources of threats and dangers, and it recommends involvement of the private sector in order to establish an integrated system for protection. Firstly, it is necessary to identify, determine and name national critical infrastructures within the sector, and subsequently to apply the criteria of interdependence, connectivity and cross-border element in order to designate.

Below, in the paper we analyzed national legislations in Western Balkans countries that adopted special laws for the critical infrastructure protection, according to the key components of the mentioned approach for the protection of ECIs:

- Sectoral approach,
- Operator security plans – OSPs,
- Security Liaison officer / Contact person – SLO,
- Identification / designation and protection of ECIs, and
- National contact point.

The interconnectedness and interdependence of various infrastructural elements places the interest of critical infrastructure protection at the centre interlace between foreign policy and national security. It is also important to mention the policy of the European Union regarding the harmonization of regulations of the member states and the states that aspire to become member states. Thus, it is necessary to incorporate directive's guidance into domestic laws.

In 2018, the Republic of Serbia adopted the "Law on Critical Infrastructure" (Law on Critical Infrastructure, Official Gazette of the Republic of Serbia No. 87/2018). In order to make a review of this law, we analyzed several its articles.

- In the article 6 we see a sectoral approach where it is defined that the identification and determination of critical infrastructure are carried out in eight sectors of critical infrastructure: energy, transport, water, and food supply, health, finance, telecommunications and information technology, environmental protection, functioning of state bodies. For each of the above sectors of critical infrastructure one of the ministries that submit to the Ministry of Interior a proposal for critical infrastructure in its sector is responsible for, and critical infrastructure, at the proposal of the Ministry of Interior, is determined by the Government of Republic of Serbia
- The article 8 refers that measures to reduce risks, responsibilities, and duties, and a framework for action to eliminate or reduce the consequences of security threats to critical infrastructure, are set out in the Security Plan of the Risk Management Operator.
- Critical infrastructure operators are required by the legislator to appoint a Liaison Officer. This person is in charge of ensuring constant control of risks and threats, informs the Ministry of the Interior on the evaluation of risks, threats, and vulnerabilities, coordinates the Security Plan of the operator for risk management, and performs all other tasks related to critical infrastructure. The designated person must be licensed as a Liaison Officer, according to the article 9.
- According to the articles 12 and 13, ECIs is a critical infrastructure of interest to at least two Member States of the European Union and may be determined in sectors defined by the European Commission. ECIs are protected on the territory of the Republic of Serbia in the same way as national critical infrastructure unless European Union regulations require otherwise. It is important to emphasize that Article 24 defines that the provisions relating to ECIs will start to apply on the day of the accession of the Republic of Serbia to the European Union.
- The contact point for exchanging information with the Member States and bodies of the European Union, and coordination of activities related to ECIs is the Ministry of Internal Affairs of the Republic of Serbia. The mentioned Ministry is also in charge of supervising the implementation of the Law on Critical Infrastructure and by-laws adopted based on this Law, and it performs inspection supervision (Law on Critical Infrastructure, Official Gazette of the Republic of Serbia No. 87/2018, Articles 16-18).

The Assembly of the Republic of Kosovo adopted Law No. 06 / L - 014 on Critical Infrastructure, which was promulgated by Decree No. DL-016-2018 and published in the Official Gazette of the Republic of Kosovo in April 2018. The article 23 stipulates that the Law will take effect “one (1) year after its publication in the Official Journal of the Republic of Kosovo” (Official Journal of the Republic of Kosovo, No. 5/2018).

- According to the article 5 “The National Critical Infrastructure of the Republic of Kosovo shall be divided into sectors based on common areas of interest, to facilitate cooperation between partners and actors of the sector.” Critical infrastructure sectors include premises of the Government, health care and public health, information and communication technology, transport, water, and wastewater services. ”Identification and determination of critical infrastructure will be carried out by the Ministry of Interior, in cooperation with reference bodies and international partners.
- The article 9 refers: Owners/operators of national critical infrastructure and ECIs must develop an Operator Security Plan or equivalent plan that should contain the prescribed minimum of measures. "An operator security plan or equivalent plan includes the identification, selection, and identification of all necessary measures to reduce vulnerabilities and ensure the operation of all identified critical areas or facilities or network systems."
- The article 10 stipulates that each critical infrastructure sector should have a Security Coordinator, with a representative of the Ministry of Interior acting as Deputy Security Coordinator. In addition, owners/operators of national critical infrastructure should designate a Liaison Security Officer to act as a contact point for security issues of the national critical infrastructure facility, as well as connections between owners/operators of national and European critical infrastructures.
- The article 11: "ECI is a classification of critical infrastructure located in a European country whose disruption or destruction will have a significant impact on at least two other European countries." The Government of the Republic of Kosovo, at the proposal of the Ministry of Interior, determines possible ECIs in the energy and transport sectors and their subsectors. Concerning the Security Plans of the Operators and the Liaison Officer in charge of the security of ECIs, the same provisions which regulate the duties of these persons in the protection of national critical infrastructure are applied.
- The Ministry of Interior of the Republic of Kosovo has been designated as the contact point for the protection of ECIs. This Ministry also supervises the implementation of the Law on Critical Infrastructure of the Republic of Kosovo, written in the articles 17 and 19.

Bosnia and Herzegovina consist of two entities and one district, with an extremely complex security system in which overlapping competencies between state and entity bodies often come to focus. No special law on critical infrastructure was adopted at the state level, nor in the entity of the Federation of Bosnia and Herzegovina or the Brcko District of BIH. In the entity of Republika Srpska, in July 2019, the "Law on Critical Infrastructure Security in the Republika Srpska" was adopted (Official Gazette of Republika Srpska, No 58/19).

- The article 3 lists the sectors from which critical infrastructure is determined, namely: industry, energy, and mining; information and communication infrastructure; traffic; healthcare; utility services; water management; food and drinks; finance; production, storage, and transport of hazardous materials; public services; upbringing and education; cultural and natural assets. According to the articles 5 and 8, the competent republican administrative bodies propose critical infrastructure from their sectors, and the Minister of the Interior confirms the identified critical infrastructure by a decision. The methodology for determining critical infrastructure is also adopted by the Minister of the Interior.
- The article 12: Responsible entities of critical infrastructure prepare a Security Plan, which includes measures to protect and ensure the continuation of critical infrastructure.
- For each sector of critical infrastructure, the Security Coordinator for Critical Infrastructure and

his deputy are appointed, as well as the person responsible for the management and protection of critical infrastructure facilities. The Security Coordinator and the person responsible for the management and protection of critical infrastructure are in charge of implementing the Security Plan for Critical Infrastructure Protection, for communication and coordination of protection with other sectors and the Ministry of Interior.

- In the article 4, paragraph 8 we seen that this law does not recognize ECIs but defines the International Critical Infrastructure as an infrastructure "which is defined as critical between two neighboring countries."
- The Ministry of the Interior cooperates (in the context of this paper it is the contact point) with the critical infrastructure bodies of other countries and is in charge of supervising the implementation of the Law on Critical Infrastructure Security of the Republika Srpska, regulation of the articles 15- 18.

In December 2019, Montenegro adopted the "Law on Determination and Protection of Critical Infrastructure", which was published in the Official Journal of Montenegro, no. 72/2019 of 26. 12. 2019, effective on 3. 1. 2020.

- According to the articles 9-11, identification and determination of critical infrastructure is performed in the sectors of energy, transport, water supply, health, finance, electronic communications, information and communication technologies, environmental protection, functioning of state bodies, and other areas of public interest. Ministries in charge of certain sectors submit proposals for critical infrastructures to the Ministry of the Interior. At the motion of this Ministry, the Government of Montenegro determines the critical infrastructure.
- The article 14 and 15 prescribe the obligation of critical infrastructure operators to develop a Security Plan for the protection of critical infrastructure and to obtain the consent of the Ministry of Interior for the developed plan. Exceptionally, if a critical infrastrucutre operator already has a protection plan that qualifies for critical infrastructure protection, that plan will be considered a Critical Infrastructure Protection Security Plan.
- The articles 18-20 prescribes the obligation for critical infrastructure operators to appoint a person for critical infrastructure protection (Coordinator) chosen among the employees. The coordinator must be qualified for the protection of critical infrastructure, and evidence for that qualification is passing the professional exam for the critical infrastructure protection.
- The legal provisions on ECIs will be applied from the day of Montenegro's accession to the European Union, and ECIs may be determined in the sectors set by the European Commission body responsible for the critical infrastructure protection. ECIs are protected the same as national critical infrastructure in Montenegro unless otherwise defined by European Union regulations – the articles 24-25.
- The Ministry of the Interior is the contact point for the exchange of information and coordination of activities related to ECIs with other Member States and European Union bodies. The mentioned Ministry is also in charge of supervising the implementation of the Law on Determining and Protecting Critical Infrastructure – the articles 27 and 33.

Table 1: Components of the ECIs protection included into the Western Balkans national laws

Directive 2008/114/EC	Republic of Serbia	Kosovo	Bosnia and Herzegovina		Montenegro	North Macedonia	Albania
			Republika Srpska	Federation of Bosnia and Herzegovina			
Sectoral approach	√	√	√	-	√	-	-
Operator security plans - OSPs.	√	√	√	-	√	-	-
Security Liaison Officers - SLO.	√	√	√	-	√	-	-
European critical infrastructure protection contact points - ECIP contact points'	√	√	√	-	√	-	-
European Critical Infrastructures	√	√	-	-	√	-	-

Source: author's creation

North Macedonia and Albania did not adopt national laws on critical infrastructure (Mitrevska, Mileski, 2019: 141-157). The situation is similar in the neighbouring Albania, which also lacks in a special law on critical infrastructure.

3. Final remarks

The full operationalization of critical infrastructure protection in the Western Balkans still seems a long shot, but real steps were taken to draft and adopt normative solutions, following the guidelines of the European Union. The Republic of Serbia, Kosovo, Montenegro, and Republika Srpska adopted special laws according to which the protection of critical infrastructure and ECIs should be implemented. In addition to legislation, working groups were set up to draft bylaws or general rules to assess risk in all sectors and identify critical infrastructure. The Ministries of the Interior are in charge of implementing and supervising the implementation of the adopted laws, and it is prescribed that these ministries perform the tasks of the national contact point for the exchange of information on critical infrastructure. Judging by the number of adopted laws, formed working groups for drafting bylaws, and methodologies developed for determining critical infrastructure, we can conclude that in the Western Balkans there is a political and professional aspiration to establish a stable and efficient system for critical infrastructure protection. The main goal in the management of critical infrastructure in the Western Balkans is the institutionalization of the adopted regulations.

However, according to available data, there are still no formally designated national critical infrastructure nor ECIs in the Western Balkans, no security coordinators/liaison officers appointed, and no verified security plans (Mitrevska, and Mileski 2019). The causes of the current situation in this area are in the institutional, administrative, financial, and personnel capacities of the analyzed countries, i.e. their national security systems. Although these factors are not identical in all analyzed countries, the sluggishness of the administrative system in the implementation of prescribed solutions is singled out as a common feature of these countries. One of the dilemmas is cooperation with the private sector, which owns a significant number of critical infrastructure

facilities. In this regard, it is necessary to revise or amend the legislation in several areas, primarily in the field of information security. On the other hand, more flexible legal solutions compared to the European union countries are one of the leading factors that attract larger companies to operate in one of the Western Balkan countries.

The political and security challenge for the entire region is the issue of Bosnia and Herzegovina, i.e. the current problem of division of competencies between the state and the entities, which is reflected in the critical infrastructure protection framework, which is not legally regulated at the state level in this country. In addition to coordinated critical infrastructure management at the international level, harmonization is also needed at the bilateral level (DCAF 2021; Charokopos 2021). The recommendation from the article is improvement of cooperation between the countries of the Western Balkans, regarding harmonizing methodologies, and close cooperation of national contact points for critical infrastructure - ministries responsible for interior affairs.

References

- Alexandru, A., Vevera, V., Ciuperca, E.M. (2019). National security and critical infrastructure protection. International Conference KNOWLEDGE-BASED ORGANIZATION 25(1), 8-13. <http://doi.org/10.2478/kbo-2019-0001>
- Andryeyeva, N., Nikishyna, O., Burkinskyi, B., Khumarova, N., Laiko, O., Tiutiunyk, H. (2021). Methodology of analysis of the influence of the economic policy of the state on the environment. *Insights into Regional Development*, 3(2), 198-212. [http://doi.org/10.9770/IRD.2021.3.2\(3\)](http://doi.org/10.9770/IRD.2021.3.2(3))
- Besenyó, Janos. Feher, Andras. 2020. Critical infrastructure protection (CIP) as new soft targets: Private security vs common security. *Journal of Security and Sustainability Issues*, 3(1), 5-18. [https://doi.org/10.9770/jssi.2020.10.1\(1\)](https://doi.org/10.9770/jssi.2020.10.1(1))
- Borzell, T. A. (2016). Building Member States: how the EU promotes political change in its new members, accession candidates, and eastern neighbors. *Geopolitics, History, and International Relations*, (8), 76-112. <http://doi.org/10.22381/GHIR8120164>
- Charokopos, M. (2021). Policy Analysis - Building Networks of Change in the Western Balkans: Looking Back, Moving Forward. EUI School of Transnational Governance. URL: https://cadmus.eui.eu/bitstream/handle/1814/71876/PA_2021_14_STG.pdf?sequence=1&isAllowed=y
- Chehabeddine, M., Tvaronavičienė, M. (2020). Securing regional development. *Insights into Regional Development*, 2(1), 430-442. [http://doi.org/10.9770/IRD.2020.2.1\(3\)](http://doi.org/10.9770/IRD.2020.2.1(3))
- European Commission. (2004). Critical Infrastructure Protection in the fight against terrorism. Brussels.
- European Commission. (2005). Green Paper on a European Programme for Critical Infrastructure Protection. Brussels.
- European Commission. (2008). COUNCIL DIRECTIVE 2008/114/EC on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. Brussels.
- European Commission. (2019). Evaluation of Council Directive 2008/114 of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. Brussels.
- Fejzullahu, A., Belegu, B. (2022). The challenges of public administration reforms in Kosovo in the context of Eurointegration process. *Journal of Liberty and International Affairs*, 8(1), 292-307. <https://doi.org/10.47305/JLIA2281292f>
- Geneva Centre for Security Sector Governance – DCAF. (2021). Western Balkan CERT Cooperation. Editors: Klaus-Peter Kossakowski, Mirosław Maj, and Don Stikvoort. URL: https://www.dcaf.ch/sites/default/files/imce/Events/CybersecurityConference_BackgroundPaper_WesternBalkanCERT.pdf
- Keković, Z., Ninković, V. (2020). Zaštita kritične infrastrukture – sistemski pristup. Centar za analizu rizika i upravljanje krizama, Beograd.

Lazari, A., Simoncini, M. (2016). Critical Infrastructure Protection beyond Compliance. An Analysis of National Variations in the Implementation of Directive 114/08/EC. *Global Jurist*, 3(16), 267-289. <https://doi.org/10.1515/gj-2015-0014>

Miščević, T., Mrak, M. (2017). The EU Accession Process: Western Balkans vs EU-10. *Politička misao: časopis za politologiju*, 54(4), 185-204. URI: <https://hrcak.srce.hr/190343>

Mitrevska, M., Mileski, T. (2019). Republic of North Macedonia and Critical Infrastructure Protection. In *Critical infrastructure: concept and security challenges*, edited by Marina Mitrevska, Toni Mileski, and Robert Mikac, 141-157. Skopje: Friedrich Ebert Stiftung. URL: https://skopje.fes.de/fileadmin/user_upload/images/critical/Critical_Infrastructure_EN_-_web.pdf

Noutcheva, G. (2009). Fake, partial and imposed compliance: the limits of the EU's normative power in the Western Balkans. *Journal of European Public Policy*, 16, 1065-2084. <https://doi.org/10.1080/13501760903226872>

Official Gazette of Republic of Kosovo. (2018). Law on critical infrastructure. Priština.

Official Gazette of Republic of Serbia. (2018). Law on critical infrastructure. Beograd.

Official Gazette of Republika Srpska. (2019). Law on Critical Infrastructure Security in the Republika Srpska. Banjaluka.

Official Gazette of the Republic of Croatia. (2013). Law on critical infrastructures. Zagreb.

Official Gazzete of Montenegro. (2019). Law on Designation and Protection of Critical Infrastructure. Podgorica.

Petrakos, N., Kotzanikolaou, P. (2019). Methodologies and Strategies for Critical Infrastructure Protection. In *Critical Infrastructure Security and Resilience* edited by Dimitris Gritzalis, Marianthi Theocharidou, and George Stergiopoulos:17-35. Springer.

Petrovic, M. (2022). Towards gradual integration of the Western Balkans into the European Union: the case of Serbia. *Journal of Liberty and International Affairs*, 8(1), 308-321. <https://doi.org/10.47305/JLIA2281308p>

Poustorli, A., Ward, D., Zachariadis, A., Schimmer, M. (2015). An Overview of European Union and United States Critical Infrastructure Protection Policies. Paper presented at conference organized by Kocaeli University İzmit, October. Kocaeli, Turkey.

Poustourli, A. (2016). A Concise Survey of Security Standards and Certification Services. 13th INTERNATIONAL CONFERENCE "STANDARDIZATION, PROTOTYPES AND QUALITY: A MEANS OF BALKAN COUNTRIES' COLLABORATION, Brasov, Romania, November 3 - 4, 2016.

Rehak, D., Markuci, J., Hromada, M., Barcova, K. (2016). Quantitative evaluation of the synergistic effects. *International Journal for Critical Infrastructure Protection*, 14, 3-17. <https://doi.org/10.1016/j.ijcip.2016.06.002>

Rehak, D., Senovsky, P., Hromada, M., Lovecek, T. (2019). Complex approach to assessing resilience of critical infrastructure elements. *International Journal of Critical Infrastructure Protection*, 25, 125-138. <https://doi.org/10.1016/j.ijcip.2019.03.003>

Shumilo, O., Lytvyn, I., Shablysty, V., Kornyakova, T., Popovich, I. (2021). Legal mechanism to ensure national security in the field of use of natural resources. *Entrepreneurship and Sustainability Issues*, 8(3), 455-470. [http://doi.org/10.9770/jesi.2021.8.3\(29\)](http://doi.org/10.9770/jesi.2021.8.3(29))

Sikimić, M., Gnjatović, D. (2021). European security framework and critical infrastructure protection in the Republic of Srpska. *Security, Police, Citizens, 16 (1-2): 95-112*. URL: https://www.researchgate.net/publication/351660452_EUROPEAN_SECURITY_FRAMEWORK_AND_CRITICAL_INFRASTRUCTURE_PROTECTION_IN_THE_REPUBLIC_OF_SRPSKA

Skara, G., Hajdini, B. (2021). Enforcement of the European Union law before the Albanian Constitutional Court and the High Court. *Journal of Liberty and International Affairs*, 7(3), 229-249. <https://doi.org/10.47305/JLIA2137229s>

Stergiopoulou, G., Kotzanikolaou, P., Theocharidou, M., Lykou, G., Gritzalis, D. (2016). Time-based critical infrastructure dependency analysis for large-scale and cross-sectoral failures. *International Journal for Critical Infrastructure Protection*, 12, 46-60. <https://doi.org/10.1016/j.ijcip.2015.12.002>

Trbojević, M. (2018). Zaštita kritičnih infrastrukture - iskustva tranzicionih zemalja. *Politička revija*, 2, 99-118. <https://doi.org/10.22182/pr.5622018.5>

Milica SIKIMIĆ is a PhD candidate at the Doctoral School on Safety and Security Sciences, and member of Africa Research Institute at Obuda University, Budapest, Hungary. Also, she is a senior teaching assistant at the Faculty of Security Science, University of Banja Luka, Bosnia and Herzegovina. Her research interests embrace a wide range of topics in the area of national security, security policy and critical infrastructures.

ORCID iD: <https://orcid.org/0000-0002-5957-7280>

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:
@IntoInsights

Copyright © 2022 by author(s) and VsI Entrepreneurship and Sustainability Center
This work is licensed under the Creative Commons Attribution International License (CC BY).
<http://creativecommons.org/licenses/by/4.0/>



Open Access

**Publisher**<http://jssidoi.org/esc/home>

POOR GOVERNANCE AND MASSIVE UNEMPLOYMENT IN NIGERIA: AS CAUSES OF BRAIN DRAIN IN THE BUHARI ADMINISTRATION (2015-2020)

Benedict Ogheneakpoje Ighoshemu ¹, Ufuoma Benson Ogidiagba ²

¹Department of Political Science, Delta State University, Abraka, Delta State, Nigeria

²Department of Political Science, College of Education, Warri, Delta State, Nigeria

E-mails: ¹ ominiapere@gmail.com; ² bengidinige11@gmail.com

Received 15 March 2022; accepted 30 May 2022; published 30 June 2022

Abstract. Like other African countries of the developing world, Nigeria underperforms due to a lack of state capacity to deal with the present-day complexities of governance, thereby leading to poor governance, massive unemployment, and brain drain in the Buhari administration. Poor governance is the absence of good governance. Close observation of governance in Nigeria indicates a poor attempt at democratic consideration and unstable politics thereby leading to a battered economy, impoverishment of citizens, corruption, mismanagement of public funds, infrastructure decay leading to massive unemployment which results in human capital flight, a barrier to Nigeria's quest for consolidating democracy. As a result of visionless leaders, selfish, nepotism, mediocrates, tribalistic and opportunist in the political space of the country. This paper examines the electionary campaign promises of the Buhari administration on security for all citizens, bumper economy, and anti-corruption, with the analysis of secondary data, it examines the relationship between poor governance, massive unemployment, and brain drain in Nigeria from 2015 to 2020, adopting the relative deprivation of frustration-aggression theory to x-ray the concepts of poor governance and massive unemployment, resulting to human capital flight. This study has identified poor governance and massive unemployment leading to brain drain in this administration and made valuable recommendations.

Keywords: poor governance; massive unemployment; brain drain; administrations

Reference to this paper should be made as follows: Ogheneakpoje Ighoshemu, B., Ogidiagba, U.B. 2022. Poor governance and massive unemployment in Nigeria: as causes of brain drain in the Buhari administration (2015-2020). *Insights into Regional Development*, 4(2), 73-84. [http://doi.org/10.9770/IRD.2022.4.2\(6\)](http://doi.org/10.9770/IRD.2022.4.2(6))

JEL Classifications: J11, J88

1. Introduction

One of the striking features of contemporary society in most African countries is the deterioration in the living standards of the citizens, where the horrors of mass starvation have haunted the senses of the people (Nkwachukwu 2004), especially in Nigeria where poor governance, insecurity, corruption, greed, poverty, inequality, unemployment, banditry, kidnapping, tribalism, nepotism, and various agitation have threatened the unity, peace, development, and progress of the country in the face of the Buhari civilian administration, causing Nigerians leaving the shores of the country for greener pastures.

It is an axiom that Nigeria is richly endowed by providence with human and material resources critical for national advancement and development. However, since gaining political independence, Nigeria has continued to go the path befitting failed, weak, and “juvenile” states. A state that had very great prospects at independence and was touted to lead Africa out of the backwoods of underdevelopment and economic dependency, Nigeria is still stuck in the league of very poor, corrupt, underdeveloped, infrastructural decaying, crisis-riven, morally bankrupt and leadership deficient country. Rather than become an exemplar of transformational leadership, modern bureaucracy, national development, national integration, and innovation. Nigeria seems to be infamous for whatever is mediocre, corrupt, insanely violent, and morally backward (Imhonop and Urim, 2012).

Nigeria's leadership suffers from extreme moral depravity and attitudinal debauchery (Agbor, 2012), Agbor argues that the success or failure of any society depends largely on the mannerism of its leadership. He added that the result of poor leadership in Nigeria is embodied as poor governance and manifested inconsistent political crisis and insecurity, poverty of the citizens, a debilitating miasma of corruption and rising unemployment, and the continual flight of the citizens' skilled professionals. Over the decades, there has been a recurrent and sustained argument that the Nigerian state like African countries and other developing nations of the world, underperforms due to a lack of state capacity to deal with the contemporary complexities of governance. The ability to continue to control state power enables them to allocate national resources and positions of office as they wish. This promotes wanton, suboptimal allocation of national resources and positions and the ensuring macro-economic mismanagement which results in persistent economic cataclysm.

Poor leadership resulting in poor governance starts from the pronouncement “money is not our problem, but how to spend it” (Gen. Yakubu Gowon 1973). This statement made civil servants (permanent secretaries) inflate contract sums leading to massive corruption that today, is inimical to Nigerians. The Buhari administration with all the negative attributes of good governance and democracy brought Nigeria to where we are today, a state of hopelessness, impunity, lawlessness, academic/industrious brain drain, and living in fear.

This paper seeks to examine the inglorious role of the leaders resulting in poor governance, and massive unemployment leading to brain drain in Nigeria in the Buhari administration, using the frustration-aggression theory to analyze poor governance and massive unemployment resulting in the brain drain syndrome in the administration. The paper also examines existing literature on the triple problems of poor governance, massive unemployment, and brain drain, identifies the causes, and suggests ways to tame this ugly monster.

The objective of the Study:

The main objective of the study is to critically examine the leadership style or the character of Buhari leadership from 2015 to 2020 resulting in poor governance and massive unemployment as the main cause of brain drain in Nigeria, while the specific objectives are to:

- (a) Examine the leadership style of the Buhari civilian administration and brain drain, (b) examine the causes of poor governance in the administration, and (c) examine the rise of unemployment in Nigeria today.

Research Questions:

The Impact of the leadership style of Buhari administration on Nigeria's democracy, and its citizens?

Why are there Mass unemployment and brain drain in the Buhari administration?

Significance of the Study:

The literature reveals that in some developed countries of the world, the unemployment rate has witnessed an upsurge above 50%. Specifically, a report has shown that in developing countries, the primary employment difficulty faced is underemployment in the informal sector. Accordingly, the international labour organization (ILO), estimates a minimum of 600 million jobs would need to be generated over the next ten years to absorb the

current number of unemployment and provide job opportunities for the projected 40 million new applicants yearly (UN, 2016).

The problem caused by unemployment and poor governance in this administration has led to the brain drain syndrome and a downturn in the economic fortunes of the country. Today, many graduates are unemployed and unable to achieve their dreams with their academic qualifications. Added to this, are millions of unemployed persons who now venture into all sorts of criminalities to survive. This study is aimed at highlighting the causes of poor governance, its effect on unemployment, brain drain, and its consequences on the development of Nigeria. It also seeks to proffer solutions to the growing wave of massive unemployment and brain drain in the country.

2. Literature Review

Concept of Governance

This study requires the clarification of some concepts considered fundamental to the variables to be studied and based on the opinions of notable authorities. This will help readers familiarize themselves with the subject matter of the study.

Governance like the government can be good, poor, or bad, poor governance and bad government have similar characteristics: corruption, impunity of leaders, whimsical, nepotism, expedient decision-making short-sightedness, and the total opposite of good governance. In the same way, good governance criteria are accountability, ethics in decision-making and implementation, action responsiveness and rule-bound decision making (Rule of law), transparency and predictability, long term view of public interest, right to expect laws, a fair judicial system, politically accountable law-making, and an effective and reform-minded bureaucracy.

According to UNDP (1997:19), “a system of governance is good when it satisfies these conditions. It is participatory, meaning it allows both men and women a voice in decision-making, either directly or indirectly. It is legitimate and acceptable to the people transparent and accountable, promotes equity and equality, and operates by the rule of law which means legal frameworks are fairly and impartially enforced, responsive to the needs of the people, and efficient and effective in the use of resources.” In the view of Oluwa, 2012 cited in Nwanegbo, Umara and Ikyase (2017:24), good governance is “a function of effective, visionary, transparent, trustworthy and credible political leadership whose driving force is an improvement in the collective well-being of the citizens through well-conceived, effectively implemented economic policies and human development programmes.” According to Kaufman Karcy and Mastruzzi 2006 cited in Woleola (2017:156) is “the degree of involvement of the citizens of the state in the election of their political leaders and ultimately their representatives in government”. Thus, participation in the mainstream of good governance needs to be informed and organized, which requires freedom of association and Expression and organized civic groups in the society.

Poor governance is the direct opposite of good governance where all the enumerated characteristics are not visible in the administration of President Buhari civilian rule since 2015 till date. His administration lacked focus, accountability, transparency, rule of law, lack ethical decision-making and implementation, no interest for the common citizen (vulnerable and minorities) no respect for human life and dignity (Umara and Ikyase 2017:160) Poor governance has been responsible for the persistent rise in the activities of herders, Bandits, kidnappers, serial killing for money rituals, yahoo boys and yahoo plus, people committed to the propagation of religious and tribal differences, and the Boko haram insurgency in Nigeria

Poor governance has brought a vicious cycle of corruption, poverty, social class struggle, and massive unemployment leading to violent militant groups. One of the vexing issues bedeviling Nigeria in this administration is the coercive nature of their democratic rule opened channels for abuse and kit clove treatment on Insurgency and Insecurity, violation of human rights, and gross disregard for the rule of law, resulting in the

emergence of deadly Islamic jihadist groups, religious extremist, secessionist, separatist movement from all regions of the country. However, insecurity, corruption, massive unemployment and object poverty of citizens has taken on a full-blown since the emergence of the Buhari administration in 2015, resulting in the capital flight of skilled and professionals to developed countries of the world.

Massive Unemployment

Unemployment has assumed an epidemic dimension and is ravaging both the rural and urban communities in Nigeria. The upsurge of unemployment in this administration of Buhari is unspeakable, the majority of the unemployed, particularly youths can be seen vending in the informal sector. It is an open secret to see graduates and postgraduates in the streets of Nigeria hawking, riding keke or Okada (motorbike) to earn a living of a meal a day. This disguised unemployment and underemployment is not healthy for the economy, Chiazor, Zoya and Udume (2017) opine that “in the short term, they seem to be employed but the resources used in training these unemployed Nigerians in the various tertiary instructions would have gone to waste if they cannot find employment in the medium and long terms. There are graduates from the various institutions of higher learning in the country that have been searching for employment in the last seven years. Added to this class is an army of secondary and primary school leavers and countless millions of uneducated youths who daily roam the streets for none existent jobs.

The unemployed have become ready tools in the hands of all types of insurgent groups in Nigeria. They form a pool from where new recruits are sourced daily by these evil groups' commissions (NPC, 2013). The Nigerian population Commission in its report stated that half of the population of Nigeria is made up of youths who are between 15-34 years of age. The unemployed and frustrated youth population is a reservoir for instability and the spread of social vices (Daily Trust 14th May 2015). Unemployment has become one of the fundamental developmental challenges facing Nigeria at the moment. With a very high population and numerous universities in Nigeria turning out graduates in their thousands every year, with no ready market for employment, the wave of unemployment has assumed a crisis dimension.

The scourge of unemployment ravaging the country currently is so horrendous that it has become a time bomb waiting to explode. It should not be allowed to detonate the time to solve the problem of unemployment now. In this paper, we shall look at the causes and consequences of unemployment and make a suggestion on how to tame the monster.

Causes of Unemployment:

(i) Poor governance: Poor governance is one of the major causes of unemployment. When the government in power does not have the capacity and the intellectual capacity to govern, the economy of the country will shrink, there will be no law and order, citizens will be left to their faith, no infrastructural development, and no industries for citizens to work and earn a living and the existing ones sack their workers due to the poor economy.

(ii) Neglect of the Agricultural sector: The agricultural sector has been the leading provider of employment in Nigeria, especially in the sixties when the sector provided employment for more than 90 percent of the Nigerian population.

However, with the discovery of oil, attention was anchored on or where employment capacity is very low. The resulting effect is that a large number of job seekers have no place in the oil industry. Even with the expansion of the industry, unemployment has continued to grow at an alarming rate. Until the early 1970s, agriculture remains the mainstay of Nigeria's economy. It constituted the major income earner for the country and the largest employer of labour as over 90 percent of the population worked, and earn their daily income from the sector. (Chiazor, Ozoya and Udume, 2017).

(iii) Lack of Enabling Environment: The poor economy and the lack of enabling environment that has characterized the economy over the years have continued to pose a serious challenge to employment generation in Nigeria. This, coupled with insecurity has hampered investors coming to invest in the country, especially in this Buhari regime where kidnapping, banditry, and insurgency enjoy the patronage of the administration with kid-glove treatment on them. The factors are further exacerbated and as a result, millions of people move to the urban cities with the hope of securing lucrative jobs in the industries and also being able to enjoy the social amenities that abound in the urban cities/centres. The Implication of this has been that most rural areas have remained neglected in the allocation of social and economic resources.

(iv). Systemic Problems in Education: The falling standard of education had been blamed on the high rate of unemployment in the country. It has been argued that many universities and other tertiary institutions turn out half-baked products in their thousands yearly that are hardly suitable for the labour market. This assertion was however refuted by Ndefon (2009) that the problem is systemic, where the curriculum has not been designed to meet with the present-day realities and in most cases, there are poor facilities and sometimes non which are available to train the students. In the same vein Samuel (2011) laid much emphasis on certificate acquisition while neglecting the application of the knowledge and skills acquired to meet the challenges of contemporary Nigeria. However, Ogunlade (2007) blamed the systemic problem in Nigeria's educational system on the colonial legacy which continues to rub shoulders and even persist as the order of the day in contemporary Nigeria. The negative public attitude or prejudice against agriculture persists.

(v) Gradual collapse of the manufacturing sector: The absence of a vibrant manufacturing sector which can absorb the massive unemployed people in Nigeria is a cause of unemployment. The First, Second, and Third Republics and the military regimes were able to build some industries, and factories that absorbed some good numbers of Nigerians in work thereby unemployment was insignificant. According to Chiazor, Ozoya, and Udume (2017), “over 800 industries collapsed in Nigeria today and over 37 factories closed shop since 2009. Half of the remaining operating firms have been classified as “ailing” a situation that poses a great threat to the survival of the manufacturing sector in the country in the years ahead

Consequences of massive unemployment:

The increasing level of unemployment in Nigeria is one issue that has been responsible for the resurgence of militia groups in the country. Unemployment has been identified as one of the major causes of social vices in the country which includes armed robbery, political thuggery, kidnapping, Fulani herdsman, banditry, and hostage-taking (Adegoke, 2015). Indeed, massive unemployment in Nigeria is responsible for the spate of Boko Haram, banditry, herder clashes with farmers, kidnapping, militancy, armed robberies, and insurrection in the country. Unemployment has also encouraged the increasing feminization of poverty among young females, which has encouraged prostitution as a means of survival and led to the trafficking of young ladies across international borders, pushing hard drugs with transnational security implications (Akwara et al., 2013). Furthermore, the negative consequences of massive unemployment include poverty, psychological problems, political Instability, breakdown of law and order, unproductive labour force contributing to drug abuse, crime, violence, low GDP, and all manners of social delinquent behaviours.

Massive unemployment in Nigeria today contributed to the high rate of brain drain, poverty, and insecurity of lives and property. With the growing rate of unemployment and underemployment, Nigeria has suffered an enormous loss in terms of growth and development opportunities which have engaged their wasteful human capital resources (Nwagwu 2014).

Brain Drain

Brain drain is the number of highly trained individuals who are professionals in their various endeavours entering a country to live and work where greater opportunities are offered. Alem (2016) sees brain drain as it was created by the British Royal Society to refer to the exodus of professionals, engineers, scientists, and physicians via emigration from the United Kingdom to the United States of America. According to Eise and Foster (2018) brain

drain is the movement of highly skilled individuals or most educated people to advanced countries from the developing nations where their services are appreciated. Brain drain in Nigeria is seen by the researcher as the movement of middle-class and highly skilled people from Nigeria to developed countries in search of a better standard of living quality life, good salaries, access to advanced technology, stable political condition, and security.

Causes of Brain Drain in Nigeria

Besides poor governance and massive unemployment as the causes of Brain drain, there are other factors leading to human capital flight from Nigeria to developed nations, such as corruption, a crippled economy, insecurity, human right violation, failed infrastructure, low standard of Education, poor health facilities and high rate of poverty.

Corruption

In Nigeria the level of corruption is getting worst by the day, to get anything done you need to know someone in high places, thereby unqualified people occupied great positions, a bribe is the order of the day.

Crippled Economy

Brain drain is a loss in terms of money used to employ skilled manpower from developed societies to replace migrated manpower from Nigeria, the petroleum industry hired skilled expatriates to drill and exploit oil at a staggeringly high price of over 40% of its profits to foreign companies Emeagwali (2009). Taxes of migrated human capital go to their resident countries, thereby leaving their own country's economy crippled.

Insecurity

Since the emergence of the Buhari administration in 2015, the security situation in the country is getting worst by the day ranging from Boko Haram insurgency in the North East, Fulani herdsmen attack on farmers and innocent citizens in all parts of the country, Bandits, kidnapping, worst still is the Tuesday 24th August 2021 attack on the Nigeria Defense Academy where military personnel's are trained. Due to the insecurity in the country professionals, skilled, and highly educated citizens are leaving the country to the developed countries for safety and a good environment for better-paid jobs (Saudi Arabia recruiting Nigeria Medical Doctors in thousands). In an unsecured environment, no investor will come to risk his/her life and capital.

Low Standard of Education

In the Buhari administration standard of education is on the decline, with constant strikes by university lecturers, poor working conditions of service, poor curriculum development of an educational system and relevant education compared to their counterpart, and with constant kidnapping of school children. United Nations Education funds (UNICEF) said in the vanguard of Saturday 28th August 2021 that at least 1000 students have been abducted by bandits in Nigeria since 2020. With this, students and teachers are afraid of their lives and cannot learn nor teach adequately in such an environment for a good standard of education.

High Rate of Poverty

In the Buhari administration, the poverty rate is astronomical, parents cannot afford two meals for their family in a day, and over 75% of Nigerians live below a dollar per day. Those who can afford to travel for a better life outside the shores of the country are all leaving. These few factors enumerated show the rate at which Nigerians are leaving the country for better working conditions and payment, better lives, and safety of their lives and properties. No investor will come to invest in such a Nation, thereby impoverishing the citizens the more.

Consequences of Brain Drain:

In Nigeria, brain drain is identified as one of the factors hampering the growth and development of the Nation and the cause of the high blow on the economy. Human capital flight in Nigeria lead to:

Reduction of quality services. One of the major effects of Brain drain is the reduction in quality of service due to the absence of qualified personnel or skilled persons in the health sector, tertiary institutions, and research centers as a result leading to a fall in educational standards, health sectors are in the verge of collapse.

Retardation of economic growth. Human capital resources and the flight of skilled labourers result in the decline of the economic growth of a nation. Poor economic growth in Nigeria is a result of several factors such as lack of investment due to poor governance, insecurity and poor enabling working environment, institutional failure, and inadequate infrastructures in the health sector, education, roads, energy, and other facilities that make life worth living. Boyo (2013) observed that with the growing aging population, those developed nations (Canada, United States, and United Kingdom) enjoy the gains of filling labour shortage without paying the cost of educating them. Adepoju (2008) noted that the absence of competent individuals have a direct and negative effect on the quality of services delivery to the public in the home countries. In the health sector, brain drain has led to inadequate health care delivery, making most Nigerians leave to abroad for medical treatment.

Reduction of technological development. A country whose skilled and highly innovative personnel find their way to other developed countries will be reduced in the level of technological development. Nigerians are the best in most America and European countries in their various human endeavours technologically, medically, just name it leaving their country at a loss.

3. Theoretical Framework

This paper intends to analyze poor governance, and mass unemployment leading to brain drain using frustration–aggression theory by John Dollard (1939) modified by Leonard Berkowitz (1969) and Breuer, Scharkow and Quandt (2015). Which might prove appropriate for a discourse of this nature? The frustration-aggression theory presents us with a heuristic tool for interrogating the central issues of this study.

Frustration–Aggression Theory

In our quest to place this study in its proper perspective, the theoretical framework adopted in explaining massive unemployment is the frustration-aggression theory. Frustration-aggression hypothesis was formulated by Dollard Miller, Mover and Sears (1939) has the central premise that the occurrence of aggressive behaviors' always presupposes the existence of frustration. Frustration-aggression theory from its beginnings in the late 1930s until today, it has been applied and studied in a variety of areas, including clinical and social physiology, ethology, sociology, criminology, and medical research. It has also been used to explain the behavior of animals (Scott, 1948; Berkowitz, 1983).

This paper is applying the theory exclusively to the study of human behavior. Within the discipline of psychology, frustration-aggression theory has been used in a variety of domains, ranging from self-regulation (Harrison, Davies, Treasure and Tchanturia, 2011) and imitation learning (Hanratty, O'Neal and Sulzer, 1972) to developmental (Jegard and Walters, 1960); Nelson, Gelfand, and Hartmann, 1969) organization (Fox and Spector, 1999; 1978) and media psychology (Breuer, Scharkow and Quandt, 2015; Wingrove and Bond, 1998).

From the above theory of frustration-aggression, the absence of good governance principles in governing a state has resulted in the outflow of Nigeria doctors, professionals, scientists, and other experts as a result of poor governance, resulting in lack of a congenial environment for learning and inadequate facilities for professionals to practice, the absence of a quality standard of living, prospect for career advancement, better salaries and insecurity of lives and properties, resulting to frustration and aggressive approach to happenings. Nigeria's leaders need to address fundamental problems of poor governance in the country with the international political order of

accountability, nation-building, and rule of law which will eventually improve the citizens' wellbeing. However, the inability of leaders to make a distinction between governance and self-service by manipulating power to their advantage and those who served their nations without reservation is a major problem against the paradigm of democratic good governance. In a country where poor leadership reigns supreme, Nigerian leaders should emulate other developing nations whose leaders serve to the best of their abilities. Leaders like Dr. Nelson Mandela of the Republic of South Africa, Julius Nyerere of Tanzania, and Nigerian leaders should use their positions to satisfy the interest of Nigerians.

4. Research Method

The researcher adopted the historical method and relied on secondary sources of data that engages archival review of the poor governance of the Buhari administration 2015-2020 and the witnesses of massive unemployment leading to human capital flight in Nigeria. The data were drawn from published and unpublished sources such as periodicals, official, organized documents, newspapers, textbooks, journals, and internet materials. These data were analysed and carefully interpreted in the area of study which led to significant findings that contribute to the stock of knowledge.

5. Data Presentation, Analysis, and Discussion of Findings

Impact of the Leadership Style of the Buhari Administration on Nigeria Democracy and its Citizens?

The leadership style of Buhari has been a laggard one from his military days to his democratic civilian administration, his regime in Nigeria has experienced poor economic growth, hardship on citizens, and a high inflation rate of goods and services. His most likely undoing could be a lack of ability and capacity to manage such a large country with diverse ethnic groups, religious believers, and intellectuals. Leadership is important to demonstrate a better quality of governance which enhances societal development because it is a process of influencing the action of a structured group towards setting and attainment of goals.

The Buhari civilian administration had no impact on governance and Nigerian citizens. He brought untold hardship, poverty, insecurity, and massive unemployment resulting in citizens leaving the country with his laggard style of leadership of anocracy.

Why are there Massive Unemployment and brain drain in the Buhari Administration?

The unemployment rate in this administration in Nigeria rose from 21.5% to 33.7% from December 2020 to March 2021 according to the National Bureau of Statistics (NBS). The NBS explained that the number of unemployed Nigerians rose to 35.20 million in the fourth quarter (Q4) of 2020 on the back of jobless occasioned by the outbreak of COVID-19 pandemic and its stifling impact on business during the period.

Due to the absence of engineering infrastructure, the economy is unable to sustain itself internally, thus exporting jobs through pervasive import dependence Nigeria is an agrarian economy, but the recent breakdown of the rural economy due to, widespread insecurity, herders/farmers crisis has worsened the unemployment rate. The three challenges of the rising unemployment rate in Nigeria, the first two are age-long while the third assumed an unprecedented dimension since the Buhari administration in 2015. The first two challenges are inimical to full employment of labour and capital, the third factor of formulated to address the inherent weakness in the socio-economy fueling unemployment.

The government should start to implement policies on birth and immigration controls to lay the foundation for labour optimization. They must start bridging the infrastructure deficits. This will mechanize the economy and enable it to become internally self-sustaining with a high multiplier effect.

There should be no room for rural insecurity if agriculture which forms the natural base of employment is to be revived. The government of Buhari has not been serious in these areas rather laughable policies of traders' money, meager cash transfer, and temporary employment (n-Power) across the 774 local government areas of the country are mere waste of resources. They cannot form the kind of capital that can generate massive productive employment on a sustainable basis. The high unemployment rate and insecurity are mutually reinforcing evils, one can lead to the other but insecurity is the most terrible. The Gross Domestic Production GDP growth rate since the Buhari administration has been weak and below the population growth rate. According to Uwaleka (2021) "sustainable economic growth, measured by GDP growth rate, is a necessary condition for economic development and by extension low employment rates". We must note that the quality of economic growth is critical to job creation. Unemployment and poverty rates were high due to the GDP growth rate witnessed during those periods was non-inclusive in the oil sector than in the employment elastic sector. The oil sector employs an insignificant proportion of the labour force. Poor infrastructure, especially power, insecurity and general hostile business environment have not encouraged entrepreneurship and micro-business, the educational system is also to be blamed. These are some of the factors responsible for a high rate of unemployment leading to human capital flight in the Buhari administration.

4. Summary, Conclusion, and Recommendations

Summary

Having analyzed the important indices and critical factors for good governance, the position of Nigeria in terms of good or poor governance can be better understood. Good governance is about performance and conformance. Good governance and development performance are indivisible. Without the care fundamental of good governance- without transparency and accountability, the rule of law, electoral legitimacy, efficient and effective services delivery, predictable administration, civil liberties, and participation and consensus orientation. Good governance, in its political and economic, and social dimensions, underpins sustainable human employment, mass participation, economic empowerment, and poverty reduction, no amount of funding and charity will set a country on the path to prosperity. In Nigeria, the deteriorating quality of government, epitomized by a bureaucratic obstruction, pervasive, rent-seeking, weak judicial systems, failure of public institutions, and arbitrary decision making have hampered socio-economic and political development. Poor governance can be observed within the Nigerian contest as the prevalence of poor service delivery, ineffective anti-corruption mechanism, lack of effective popular participation, misuse of executive powers, massive corruption, and absence of openness in policy formulation. To progress from poor governance to good governance and from weak to strong development performance, Nigerian leaders, and political elites must adhere to the care fundamental of good governance without which socio-economic and political development will continue to be an illusion. Worst is the increasing rate of unemployment which causes brain drain is the state of insecurity in the Buhari administration, payment of ransom to kidnappers is one of the worst initiatives and pervasiveness of the government in the last six years, today school pupils are being kidnapped for ransom. The Depchi College girls, the Kankara schoolboys to mention a few. Negotiating with terrorists cannot guarantee a lasting solution but embolden them to keep making endless demands. The governor of Katsina Aminu Masari went into negotiation with bandits and today over twenty local councils out of thirty-four in the state are under siege. Poor governance resulting in massive unemployment has given rise to human capital flight (brain drain), thereby helping to deflate the economy, promoting service delivery in the health and educational sectors, most high and middle manpower, skilled and professionals are leaving the country for better living, security of lives and properties in developed countries.

Conclusion

The paper analysed and assessed governance in the Buhari administration based on time-tested principles and international indices of good governance. Therefore, based on these principles and indices clearly enunciated the assessment shows evidence of poor governance in the administration of Buhari government since 2015 till date. To have good governance practice in Nigeria, governance must reflect on all the principles of good governance theory to embrace it in all ramifications, ranging from justice, transparency, accountability, responsible leadership, public participation in government, effectiveness, and efficiency, freedom, and civil liberties, zero corruption tolerance to free, fair and credible elections among others. Unemployment has become one of the most crucial problems facing this administration. It is, therefore, necessary to create jobs and generate employment for the unemployed Nigerians, to give them a sense of belonging and discourage them from engaging in the sundry acts of threat to security in the country. In Nigeria today, massive unemployment has led to a brain drain and led to incessant ethnoreligious crises, Fulani herders/farmers wahala, electoral and communal violence among others. Nigeria which ought to be the giant of Africa, has become the sleeping giant, whose economic and human resources have been emasculated by unscrupulous politicians? This explains why armed robbery, Kidnapping, terrorism, thuggery, and all sorts of social vices persist in Nigeria today.

Recommendations

The researchers recommended good governance theory principle and practices in Nigeria's democracy; the leadership at all levels of government (federal, state, and local governments), as well as policymakers, must think outside the box and throw up great innovations and new ideas that will help to reduce the rate of unemployment and underemployment to stop citizens leaving the country. Nigeria needs to adopt a skill-oriented educational curriculum that will train the required skilled technical manpower that will help build and maintain its crucial infrastructures that are badly needed to drive the nation's economy and also to create employment, attractive condition of service, security, rule of law and enabling environment. Nigeria's reserve army of the unemployed as it is today is a time bomb. It should not be allowed to explode, all institutions of governance should be properly monitored, all allegations of corrupt practices of the past should be duly investigated, and airing public officers should face the worth of the law and any government in power should bring to the barest minimum the perceptions of domination, marginalization, alienation of one ethnic/religious group against the others and political order of accountability, nation-building and rule of law must be advocated for better and conducive Nigeria.

References

- Adegoke, N. (2015). Youth unemployment and security challenges in Nigeria. *Asian Journal of Humanities and Social Studies*, 3(1), 13-22. <https://www.ajouronline.com/index.php/AJHSS/article/download/2245/1187>
- Agbor, U. I. (2012). Leadership behavior and the crisis of state failure in Nigeria: Towards a transformational leadership attitude for addressing Nigeria's failing state. *International Journal of Public Policy and Administration Research*, 2(4). <https://www.iiste.org/Journals/index.php/PPAR/article/view/2612>
- Akwara, A. F., Akwara, N. F., Enwuchola, J., Adekunle, M. & Udaw, J. E. (2013). Unemployment and poverty: Implications for National security and good government in Nigeria. *International Journal of Public Administration and Management Research*, 2(1),
- Arora, N. D. (2012). Political Science. Tata Mc-Graw Hill Education Private Limited, 7 West Patel Nagar, New Delhi 110008
- Berkowitz, L. (1983). Aversively stimulated aggression: Some parallels and differences in research with animals and humans. *American Psychology*, 38, 1135-144. <https://doi.org/10.1037/0003-066X.38.11.1135>

- Breuer, J., Scharkow, M. & Quandt, T. (2015). Sore losers? A reexamination of the frustration-aggression hypothesis for collocated video game play. *Psychology of Popular Media Culture*, 4 (20), 126-137. <https://doi.org/10.1037/ppm0000020>
- Chiazor, I. A. Zoya, M. I., & Udume. (2017). Unemployment in Nigeria: A time bomb waiting to explode: Issues, Diagnoses and the way forward. *Advances in Social Science Research Journal*, 4(2) 183-194. <https://doi.org/10.14738/assrj.17.2555>
- Daily trust newspaper (2015) newspaper <https://dailytrust.com>
- General Gowon, Y (1973) Speech on oil boom in Nigeria.
- Hanratty, M. A., O. Neal E. & Sulzer, J. I. (1972). Effect of frustration upon imitation of aggression. *Journal of Personality and Social Psychology*, 21(1), 30-34. <https://doi.org/10.1037/h0031903>
- Harrison, A., Genders, R., Davies, H., Treasure, J., & Tchanuria, K. (2011) Experimental measurement of the regulation of anger and aggression in woman with anorexia nervosa. *Clinical Psychology*, 18(6), 445-452. <https://doi.org/10.1002/cpp.726>
- Imhonop, D. G. Urim, U. M. (2012). Nigeria's Expensive democratic federation: A confederal option for development. A paper presented at the learned conference and summit of the society for peace studies and practice on "Nationalities, Identities and Terrorism. The Nigeria Experience" held at the institute of African studies, university of Ibadan, November 5 - 6 2012.
- Scott, J. P. (1948). Dominance and the frustration aggression hypothesis. *Physiological and Biochemical Zoology*, 21(1) 31-39. <https://doi.org/10.1086/physzool.21.1.30151978>
- Jegard, S & Walters, R. H. (1960). A study of some determinants of aggression in young children. *Child Development*, 31(1), 739-747. <https://doi.org/10.1111/j.1467-8624.1960.tb04988.x>
- Nelson, J. D, belfand, D. M.& Hartmann, D. P. (1969) Children's aggression following competition and exposure to an aggression model. *Child Development*, 40(4), 1085-1097. <https://doi.org/10.2307/1127014>
- Nkwachukwu, O. (2004). Civil society and poverty reduction in Africa. *African Journal of Political and Administration studies*, 1(1) <https://www.ajpasebsu.org.ng/civil-society-and-poverty-reduction-in-africa/>
- Nwagwu, E. J. (2014) Unemployment and poverty in Nigeria: A link to national insecurity. *Global Journal of Politics and Law Research*, 2(1), 19-35. <https://www.eajournals.org/wp-content/uploads/Unemployment-and-Poverty-in-Nigeria-A-Link-to-National-Insecurity.pdf>
- Nwanegbo, C. J Umera, I. & Ikyase, J. T (2017). Security and the challenges of Security Nigerian State: Appraising the activities of Fulani herdsmen in north - central Nigeria. *Studies in Politics and Society*, 5(1), 203-217.
- Ogundiya, I. S. (2010). Democracy and good governance. Nigeria's dilemma. *African Journal of Political Science and International Relations*, 4(6), 201- 208
- Oluwa, K. (2012) Fixing Nigeria: Good governance as missing link. Retrieved from [http://news.breakingNigeria.com/fixing + Nigeria - good governance](http://news.breakingNigeria.com/fixing+Nigeria+good+governance)
- Samuel, A. (2011). The Democratic Challenges in Nigeria and the step toward achieving the vision 20:20:20. *Journal of Arts and Social Sciences*, 1(1), 14-22.
- Spector, P. E. (1978) Organizational frustration: A model and review of the literature. *Personal Psychology*, 31(4), 815-829. <https://doi.org/10.1111/j.1744-6570.1978.tb02125.x>
- United Nations (2016) United Nation World Youth Report. <https://www.un.org/development/desa/youth/world-youth-report.html>
- UNDP. (1997). Human development to eradicate poverty. Oxford: Oxford University Press
- Vanguard Newspaper (2020), Vanguard Newspaper October 20, 2020. <https://www.vanguardngr.com/>
- Uwaleka, U. (2021). Why jobs are disappearing in Nigeria. Vanguard Newspaper April 4, 2021 <https://www.vanguardngr.com/>
- Wingrove, J. & Bond, A. J. (1998). Angry reactions to failure on a cooperative computer game: The effect of trait hostility, behavior inhibition and behavioral activities. *Aggression Behavior*, 24(1), 27-36.

[https://doi.org/10.1002/\(SICI\)1098-2337\(1998\)24:1<27::AID-AB3>3.0.CO;2-P](https://doi.org/10.1002/(SICI)1098-2337(1998)24:1<27::AID-AB3>3.0.CO;2-P)

Woleola, J. E. (2017). Good governance Theory and the quest for good governance in Nigeria. *International Journal of Humanities and Social Science*, 7(5), 154-161.

World Bank, World Governance Indicators (2016). <http://info.worldbank.org/governance/wgi/>

Author Contributions: Conceptualization: *B.O.I., U.B.O.*; methodology: *B.O.I., U.B.O.*; writing—original draft preparation: *B.O.I., U.B.O.*, writing; review and editing: *B.O.I., U.B.O.* The authors have read and agreed to the published version of the manuscript.

Benedict OGHENEAKPOJE IGHOSHEMU

ORCID ID: <https://orcid.org/0000-0001-8819-5778>

Ufuoma Benson OGIDIAGBA

ORCID ID: <https://orcid.org/0000-0002-4127-4951>

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:
@IntoInsights

Copyright © 2022 by author(s) and VsI Entrepreneurship and Sustainability Center

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>



**Publisher**<http://jssidoi.org/esc/home>

THE ROLE OF ENTREPRENEURSHIP AND INNOVATION IN THE ENVIRONMENTAL AND ECONOMIC DIMENSIONS OF GROWTH*

Ali Maâlej*National School of Engineers of Sfax, University of Sfax, Tunisia**E-mail: ali.maalej@enis.tn**Received 16 April 2022; accepted 16 May 2022; published 30 June 2022*

Abstract. This study is mainly performed to examine the effects of renewable energy, entrepreneurial activity, and innovation on GDP and CO₂ emissions in 13 European countries from 2002 to 2017. The estimation of the feasible generalized least square (FGLS) method shows that the share of renewable energy consumption in accordance with the total energy consumption, entrepreneurial activity, and innovation, defined by the number of patents, increases the economic growth but inversely decreases CO₂ emission. The share of research & development expenditure to GDP lowers the CO₂ emission without having any impact on the economy. With reference to these results, a set of implications are deduced, specifically for policymakers. The substitution of renewable energy and the encouragement of innovative entrepreneurs to undertake green businesses are essential to attain the objectives of sustainable development.

Keywords: entrepreneurship; innovation; economic growth; environment; European countries

Reference to this paper should be made as follows: Maalej, A. 2022. The role of entrepreneurship and innovation in the environmental and economic dimensions of growth. *Insights into Regional Development*, 4(2), 85-95, [http://doi.org/10.9770/IRD.2022.4.2\(7\)](http://doi.org/10.9770/IRD.2022.4.2(7))

JEL Classifications: L26, Q51, C01, O44

1. Introduction

Dynamic cultural entrepreneurship and a well-studied national innovative ecosystem are indicatives of the socio-economic well-being of the countries throughout the world. In this vein, Barba-Sanchez et al. (2022, p. 1) ascertain that entrepreneurial activity is basically crucial for its contribution to an area's economic and social development. It increases employment creation as a vehicle for reaching competitiveness as well as innovation in the market. Almodóvar-González et al. (2020, p. 9) suggest that entrepreneurial activity plays a different role depending on the economic stage of the country. Pradhan et al. (2020, p. 1114) demonstrate that higher innovation

* The dissemination of the research supported by European Union's Horizon 2020 project H2020-MSCA-RISE-2014 CLUSDEV MED, Grant Agreement Number 645730730

and entrepreneurship promote long-run economic Growth in Eurozone countries. Facchini (2009, p. 8) confirms that an entrepreneur's role is significant in the development process by improving the production techniques with product innovation propositions, which may interrupt the market consumption routines. The final objective of the business undertaking is mainly to replace the traditional competitive means with more revolutionary ones. Schumpeter (1934, p. 66) shows that entrepreneurs are innovators, who open up new markets, modern ways of firm organization, and trendy inputs, making their projects more appealing. Colino et al. (2013, p. 2) consider entrepreneurship as distinctive individuals, describing human capital in the neoclassical production function. Accordingly, entrepreneurship contributes to the productive system by a combination of productive factors, notably capital and labor. In this respect, more entrepreneurial resource allocation implies higher levels of production and well-being. Facchini (2009, p. 4) corroborates that the entrepreneur theory introduced by Kirzner (1973, 2005) is designed to explain how to improve the economic well-being of the population of the rich countries rather than to elaborate on the variable Y through the production function. More precisely, it is a theory about searching for the creation of new goods and services, added to their variety augmentation and possible cheapness. The concept of the green market is motivated by the growth in environmental awareness. According to Gupta and Dharwad (2021, p. 3603), increasing demand for environmentally friendly products induces today's consumers to be more and more concerned with the environment by being inclined to green markets. Even the entrepreneurs are more cautious today by being much closer to socially responsible citizens. They know their roles in a sustainable business environment, looking for a better future. Shepherd and Patzel (2011, p. 144) argue that entrepreneurial act results in new products and services which are compatible with people's health. It is actually well-documented by a set of researches in biotechnology and pharmaceutical industries. Kirzner (1973, p. 30) thinks that alertness is the quality that practically allows entrepreneurs to identify opportunities for profits. Shepherd and Patzel (2011, p. 144) mark out that entrepreneurs are essentially motivated by profit-making and, notably, the actions making the market more and more efficient. Dean and McMullen (2007, p. 69) argue that the entrepreneurial acts are likely to lead to overcoming the market efficient functioning barriers, contributing to more reasonable use of environmental and natural resources, and to a more ecologically sustainable economy. In this context, entrepreneurship is considered a solution to many environmental issues. It results in sustainable economic growth (Shepherd and Patzel, 2011; Omri, 2018, Jinjiang et al., 2020). Shepherd and Patzel (2011, p. 137) believe that the entrepreneurial acts can keep the ecosystem intact, react to climate change, lessen the environmental degradation and deforestation, diversify the agricultural activities with the flow of freshwater supply, and finally maintain biodiversity. Omri (2018, p. 9) studies the impact of entrepreneurial activity on CO₂ emission. He shows that the contribution of entrepreneurship to environmental degradation is lower for high-income countries compared to the upper-middle-income, lower-middle-income, and low-income countries. Ben Youssef et al. (2020, p. 232) confirm that the combination of entrepreneurship and sustainable development seems to be useful when it is accompanied by innovative tendencies and societal quality. Indeed, the main objective of this study is to deeply expand the investigation of the roles played by innovation and entrepreneurship in relation to sustainable development and the maintenance of a dynamic economy in euro countries. A test of the contribution of entrepreneurial activity, innovative economic growth, and environmental protection in European countries will be conducted.

2. Literature Review

2.1. Entrepreneurship, innovation, and growth

Joseph Schumpeter (1883-1950) affirms that a market-oriented economy is continuously adapting a dynamic system, which creates new opportunities through a steady constructive change. The essence of capitalism, associated with entrepreneurs, implies a constant search for novelty and innovation. The entrepreneurs seek a turn through their research and development (Schumpeter 1934). They rule out old competitive sources by replacing them with new ones, following production technique improvements. They break the existing consumers' routines, which predominate the market. The goal of the business undertakers is simply to seek new competitive means. Conversely, the market process can also be a creative and non-destructive construction (Audretsch et al., 2006). In

fact, it is an accumulated knowledge that no longer reflects a rift. It reveals a sense of continuity since the entrepreneurs respond to the incomplete commercialization of the new knowledge produced by the large groups (Audretsch et al., 2006; Facchini, 2009). Firms' knowledge contribution brought into the market is a favor for business-undertaking as well as new firms' entrance. Added to this business environment is the entrepreneurs' knowledge emanating from their different individual experiences. Shane (2000, p. 449) corroborates that their knowledge allows them to identify opportunities for profit-making. With respect to the Solow Model, Facchini (2009, P. 9) argues that economic growth is measured by the production function. More importantly, the endogenous growth theory elaborates the scene furtherly by adding the traditional factors of production, known as labor, capital, and knowledge. Unlike these factors, knowledge is characterized by spillover effects. In line with the politicians, economic experts confirm that to reach an expected level of growth, an investment in research and human capital is inevitable. Nevertheless, Audretsch et al. (2006) argue that knowledge production is inadequate if it does not emanate from the entrepreneurs themselves. They think that the entrepreneurs are the missing link in the theory of endogenous growth. In the endogenous growth model, the firm produces knowledge (A) in the initial stage, which turns into the input in the consecutive one. Galindo and Méndez (2014) examine the relationships between entrepreneurship, innovation, and growth in 13 developed countries from 2002 to 2007. They find out that the more entrepreneurial activity and the more innovative sources are, the more economic enhancement looks like. In addition, their examination implies that a positive but tighter money supply is likely to intensify innovation and entrepreneurial activities. Pradhan et al. (2020) scrutinize the effects of entrepreneurial acts, innovative applications, and economic growth on the Eurozone countries between 2001 and 2016 by carrying out the Granger causal relations. By using the vector error-correction model, their study shows that entrepreneurship along with innovation stimulates a noticeable economic growth in the long run. However, in the short run, the case is different in terms of causal relations, which shows inconsistency. Their findings indicate that the Eurozone countries are required to base their developmental strategies on policies promoting regular innovations and creating entrepreneurial incentives.

2.2. Entrepreneurship, innovation, and environmental sustainability

Several studies confirm that entrepreneurship plays an important role in environmental sustainability. Jinjiang et al. (2020) conducted research examining the contribution of opportunity-based entrepreneurship to the environmental quality of 67 countries from 2015 to 2017. Their findings intensify that entrepreneurship is positively related to environmental quality and that institutional context has a positive moderating effect on opportunity-based entrepreneurship in addition to the environmental quality of sustainable development. Omri (2018) investigates the relationship between entrepreneurship and CO₂ emission from 2001 to 2011 in 69 countries subsumed under four cognate income-based panels: 22 high-income developed countries, 14 upper-middle-income countries, 23 lower-middle-income countries, and 10 low-income countries. The findings accentuate that entrepreneurial activity, particularly in high-income countries, affects the environment negatively at first. However, later, the environmental scene gets better. It shows an inverted U-shaped connection between entrepreneurial activity and environmental contamination. Evidently, the entrepreneurial acts are a remarkable factor in getting fewer environmental problems, solely in the high-income developed countries. Hanohov and Baldacchino (2017) point out that entrepreneurial knowledge accelerates the process of opportunity seizing. Accordingly, it is recommended that entrepreneurial knowledge and skills are efficient in leading to sustainable development. Nakamura and Managi (2020) emphasize the U-shape relation between entrepreneurship and the marginal cost of CO₂ emissions in economic development. Japan, as a developed country, has a median level of CO₂ marginal cost, and China, for instance, which has a low level of CO₂ abatement, witnesses higher rates of entrepreneurial activities. For countries positioned close to the turning point, further promotion of environmental and social entrepreneurship through technological innovation will help achieve greater sustainable progress; this fact seems vital for future sustainable development. Ben Youssef et al. (2018) analyze the effect of entrepreneurial activity on environmental degradation from 2001 to 2014. Their analysis shows that entrepreneurship activity in Africa leads to environmental degradation. With reference to innovation and institutional variables in the analysis, the impact of both forms of entrepreneurship on sustainability seems positive, indicating that a higher level of

innovation and better quality of institutional variables constitute a motivating force to reach a higher level of entrepreneurship and sustainability. Mongo et al. (2021) use an autoregressive distributed lag (ARDL) model from the pooled mean group (PMG) estimator to examine the impact of environmental innovations on CO₂ emissions of 15 European countries from 1991 to 20014. Their findings show that in the long-term, the environmental innovations lower the CO₂ emissions. However, in the short term, the effects are rebound. Their study is a recommendation of introducing new policies combining the environmentally economic tools with the ecological economy. This economic integration is an incentive for regulatory changes, encouraging individuals to consume in a different way. It makes them favor products and services with less undesirable effects on the environment. Du et al. (2019) investigate the impact of green technology innovations on CO₂ emissions based on a data panel covering 71 economies from 1996 to 2012. They show that the effect of green technology innovations on the reduction of CO₂ is intertwined with the level of income. Green technology innovations are not essentially very effective in reducing CO₂ emissions for the economies whose income levels are below the threshold. The mitigating effect of green technology is clearly noticeable for high levels economies overcoming the threshold. However, the transition of regime occurs at an extremely high-income level.

3. Methods

This study explores the effect of entrepreneurial activity and innovation on GDP and CO₂ emissions in 13 European countries[†] from 2002 to 2017. Following Maalej and Cabagnols (2020), the Cobb–Douglas production functions are adopted. Four-way linkages are investigated by making use of the following system of equations:

Alternative specifications of the growth function:

$$\text{Eq1: } Y_{it} = A_1 GFCF_{it}^{\alpha_{1i}} RE_{it}^{\alpha_{2i}} TEA_{it}^{\alpha_{3i}} RD_{it}^{\alpha_{4i}} e^{\pi_{it}}$$

$$\text{Eq2: } Y_{it} = A_2 GFCF_{it}^{\varphi_{1i}} RE_{it}^{\varphi_{2i}} TEAEu_{it}^{\varphi_{3i}} PAT_{it}^{\varphi_{4i}} e^{\delta_{it}}$$

Alternative specifications of the environmental function:

$$\text{Eq3: } CO_{it} = A_3 Y_{it}^{\theta_{1i}} RE_{it}^{\theta_{2i}} TEA_{it}^{\theta_{3i}} RD_{it}^{\theta_{4i}} e^{\varepsilon_{it}}$$

$$\text{Eq4: } CO_{it} = A_4 Y_{it}^{\beta_{1i}} RE_{it}^{\beta_{2i}} TEA_{it}^{\beta_{3i}} PAT_{it}^{\beta_{4i}} e^{\mu_{it}}$$

The logarithmic transformation of the four equations is given by:

$$\ln(Y_{it}) = \ln(A_1) + \alpha_{1i} \ln(GFCF_{it}) + \alpha_{2i} \ln(RE_{it}) + \alpha_{3i} \ln(TEA_{it}) + \alpha_{4i} \ln(RD_{it}) + \pi_{it}$$

$$\ln(Y_{it}) = \ln(A_2) + \varphi_{1i} \ln(GFCF_{it}) + \varphi_{2i} \ln(RE_{it}) + \varphi_{3i} \ln(TEA_{it}) + \varphi_{4i} \ln(PAT_{it}) + \delta_{it}$$

$$\ln(CO_{it}) = \ln(A_3) + \theta_{1i} \ln(Y_{it}) + \theta_{2i} \ln(RE_{it}) + \theta_{3i} \ln(TEA_{it}) + \theta_{4i} \ln(RD_{it}) + \varepsilon_{it}$$

$$\ln(CO_{it}) = \ln(A_4) + \beta_{1i} \ln(Y_{it}) + \beta_{2i} \ln(RE_{it}) + \beta_{3i} \ln(TEA_{it}) + \beta_{4i} \ln(PAT_{it}) + \mu_{it}$$

The subscript $i=1, \dots, N$ denotes the country while $t=1, \dots, T$ signifies the time period. “ π, δ, ε and μ ” are the residual term assumed to be identically, independently, and normally distributed. The parameters, $\alpha_j, \varphi_j, \theta_j$ and $\beta_j / j=1, \dots, 4$, are the returns to scale associated with the explanatory variables $\ln(A_j / j = 1, \dots, 4)$ is a global constant. Variable “Y” is the gross domestic product per capita (constant 2010 US\$); “CO” is the CO₂ emissions (metric tons per capita); GFCF is the gross fixed capital formation per capita (constant 2015 US\$); “RE” is the renewable energy consumption (% of total final energy consumption); “TEA” is the Total Early-Stage Entrepreneurial Activity rate ; innovation variables: “RD” is the research and development (R&D) expenditure (% of GDP) and “PAT” is the number of patents per thousand of population (residents and non-residents). The

[†] Sweden, Finland, Norway, United Kingdom, Germany, Belgium, Netherlands, Croatia, France, Greece, Spain, Switzerland, and Hungary

entrepreneurial activity variable is collected from the Global Entrepreneurship Monitor (GEM) data and the rest are collected from the World Bank Indicators.

Equations 1 and 2 are used to explore the marginal effects of gross fixed capital formation, the share of renewable energy to total energy consumption, R&D expenditure, the number of patents per thousand of population, and entrepreneurship activity on economic growth. Several works maintain that the driving forces of economic growth are: GFCF (Maalej and Cabagnols, 2020; Saidi and Omri, 2020), RE (Maalej and Cabagnols, 2022), TEA (Pradhan et al. 2020; Dhahri et al., 2021), innovation: RD and PAT (Pradhan et al. 2020; Maradana et al., 2019).

Equations 3-4 are used to examine the marginal effects of economic growth, renewable energy, R&D expenditure, and entrepreneurship activity on CO₂ emission. Several research corroborate that the CO₂ emissions is maintained by: Y (Rahman and Vu, 2020; Maalej and Cabagnols, 2020, 2022), RE (Maalej and Cabagnols, 2022), TEA (Jinjiang et al., 2020; Nakamura and Managi, 2020), innovation: RD and PAT (Dauda et al. 2019; Maalej and Cabagnols, 2022).

Following the approach of Maalej and Cabagnols (2020), a set of specifications tests will be performed to determine the appropriate estimation model for four-panel data. The data will be analyzed with STATA 13

Table 1. Correlation matrix between study variables

	lnCO	lnY	lnGFCF	lnRE	lnRD	lnPAT	lnTEA
lnCO	1.0000						
lnY	0.3421	1.0000					
lnGFCF	0.2832	0.9720	1.0000				
lnRE	-0.4079	0.1331	0.1895	1.0000			
lnRD	0.1767	0.6528	0.6604	0.1966	1.0000		
lnPAT	0.2334	0.5859	0.5647	0.2012	0.5803	1.0000	
lnTEA	-0.2141	0.0125	-0.0101	0.2064	-0.2154	-0.0992	1.0000

The table 1 above indicates that there is a very important correlation between lnY and lnGFCF (COR(lnY, lnGFCF)=.972). It reveals a very close relationship between the two variables. For the innovation variables, the table displays the existence of a positive association between lnRD and, respectively, lnY and lnGFCF (COR(lnRD, lnY)=.652 and COR(lnRD, lnGFCF)=.660). Similarly, the positive association between lnPAT and, respectively, lnY, lnGFCF and lnRD is also significant, exceeding 50%. This result clearly shows the importance of innovation in capital and economic growth. The close links between these variables are likely to lead to problems of collinearity and ultimately disturb the estimates of the model parameters.

4. The Estimated Method and Results

The set of tests, notably Likelihood Ratio, the Breusch-Pagan LM and the Hausman are used to identify the individual-specific effects (the fixed and random ones). It is deduced that the regression model is supposed to be an individual FE model for Eq1 and Eq2 and an individual RE for Eq2 and Eq4.

The Breusch-Bagan and modified Wald tests are conducted, respectively in order to detect the existence of intra and inter individual heteroscedasticity in the residuals of the individual FE and RE model. It is noticed that the phenomenon of heteroscedasticity is present in four equations.

A Pesaran's (2004) CD test is used to identify possible cross-sectional dependence in the error term between the entities (De Hoyos and Sarafidis, 2006). The errors exhibit cross-sectional correlation in four equations.

Finally, a serial correlation is responsible for several optimistic standard errors (Torres, 2007). To check this complication, a Wald test is performed, which validates the presence of the first-order autocorrelation in the four equations.

The AR1 process may differ across countries. It gives rise to panel specific AR1 (PSAR1) (Beck and Katz, 1995). The restriction of a common autocorrelation parameter is reasonable when the individual correlations are nearly equal, and the time series are short (StataCorp, 2019). Conversely, in the current study, the time span is long (16 years), and the individual correlations are different according to each equation. In conclusion, the panel specific AR1 is chosen, and at the same time the error structure is determined by the panel heteroscedasticity, autocorrelation, and contemporaneous correlation (HPAC) in four equations.

Estimations are performed with the feasible generalized least square (FGLS) method (Blackwell, 2005). FGLS have the same optimal properties as GLS for panel data. It avoids the GLS assumption that specifies the covariance matrix Ω , which is known (Podestà, 2002). Reed et al. (2009) find that FGLS is the overall best performer on efficiency ground, but it does not concern the confidence intervals. The estimations are performed independently on each of the four equations. They are represented in the following table 2.

Table 2. Estimation results

Explanatory variables	Growth function		Environmental function	
	Eq 1: lnY	Eq2: LnY	Eq 3: lnCO	Eq4: LnCO
lnY			.304***	.338***
lnGFDF	.713***	.739***		
lnRE	.014***	.005**	-.191***	-.191***
lnTEA	.016***	.013***	-.030***	-.030***
lnRD	.0007		-.022***	
lnPAT		.016***		-.024***
Cons	4.073***	3.912***	-.507***	-.892***
Wald chi2(4)	7032.03***	9091.83***	1077.54***	1218.97***

Note: ***denotes significance at the 1% level

**denotes significance at the 5% level

4.1. Results of growth function: Eq1 and Eq2

The results show that the effect of the variable lnGFDF is positively remarkable on lnY in European countries (lnGFDF->lnY~ 0.7). These studies' findings confirm that the gross fixed capital formation is the engine of economic Growth (Maalej and Cabagnols, 2020; Saidi and Omri, 2020).

Principally, they indicate that the renewable energy consumption share with regard to the overall amount of energy consumption increases the economic growth. It reveals the increase in renewable energy consumption, being replaced by non-renewable energies, which improves growth in the European countries. The results collaborate with the results of Maalej and Cabagnols (2022, p. 17), which support that the renewable energy consumption share in accordance with the overall amount of the energy consumption raises the economic growth in the Northern European countries. In contrast, Dogan et al. (2020, p. 4) argue that the effect of renewable energy consumption on economic growth depends on the income level of the OECD country. When renewable energy consumption is peroxided by total consumption or absolute value, the effect is positive for lower and low-middle income. However, the effect of renewable energy on growth becomes negative for middle, high-middle, and higher income. In low-income (like Estonia, Iceland, Slovak, Slovenia, and Luxembourg), renewable energy has a positive impact on GDP, while in high-income countries (like considering 2010 data, United States, United Kingdom, Japan, Italy, Germany, and France) renewable energy exerts a negative influence over GDP. But when the renewable energy is peroxided by the renewable energy consumption share in relation to the overall amount of

the energy consumption, the result implies a negative impact on growth. Furthermore, the present results shed more light on the influence of innovation on the impact of renewable energy on growth. The current study's findings show that the contribution of renewable energy to economic growth is different between Eq1 ($\ln RE \rightarrow \ln Y = 0.14$) and Eq2 ($\ln RE \rightarrow \ln Y = 0.05$). This is probably explained by the effect of renewable energy on economic growth, which could be influenced by innovation per se.

Again, the present results indicate that entrepreneurial activity improves economic growth in general. The results practically go with those of Almodóvar-González et al. (2020, p.14), which indicate the existence of a positive relationship between entrepreneurship and economic growth in the advanced countries' environments. However, in the context of the poorest countries, entrepreneurial activity slows down economic growth. Comparing the different developmental levels of countries, Linán and Fernández-Serrano (2014, p. 693) affirm the presence of a negative global relationship between entrepreneurial activity and economic growth.

For the variables of innovation, only the number of patents has a positive and significant effect on growth. The effect of R&D expenditure is very weak. It is without significance, which may be explained by the R&D expenditure indirect improvement of the economic growth through the increase of the number of patents (Galindo-Martín et al. 2021). Audretsch et al. (2006) demonstrate that the biggest countries of the European Union witness a low growth but a highly noticeable level of investment in human capital, research, and development. Generally, they view that there is no necessary relationship between growth and investment in R&D. They argue that entrepreneurs are the vehicle for converting knowledge into growth. These entrepreneurs are likely to perceive the opportunities for profits as they are capable of exploring an amount of knowledge that has not been exploited by existing firms yet. They predict that a country will have a level of growth much more significant than that of the entrepreneurs' activities while the investment in R&D is high. Furthermore, they think that a country can have a little investment in R&D but equally compensate for it by an excess of entrepreneurial activities. On the contrary, a country may have a high level of R&D with no noticeable growth.

4.2. Results of environmental function: Eq3 and Eq4

The results show that the effect of GDP on CO₂ emission is positively significant. 1% increase in $\ln Y$ makes a 30% reduction in $\ln CO_2$, which indicates that the production in the European countries causes considerable pollution. Generally, in the developed countries, Muhammad (2019, p. 16) states that CO₂ emission is increased due to the positive effect of economic growth, using the generalized method of moments (GMM) and the Seemingly unrelated regressions model. However, the effects of the Sys GMM model are indicative of the economic growth, which shows a negative and non-significant effect on the CO₂ emissions. Maalej and Cabagnols (2020, p. 141) demonstrate that the effect of GDP on CO₂ emission is positive and significant in the oil-rich Middle East/North Africa (MENA) countries, while it is negative and non-significant in oil poor countries. Omri (2018, p. 9) show that the CO₂ emissions, due to the output growth, are larger for high-income countries, generally relying on the service and industry sectors for growth and development enhancement. These sectors, practically, require extensive use of energy, resulting in a huge amount of CO₂ emission.

The overall amount of the energy consumption considered with regard to the renewable energy consumption share has a negatively significant effect on the CO₂ emission. 1% increase in $\ln RE$ makes a 19% reduction in $\ln CO_2$, which gives evidence that renewable energy use contributes to environmental improvements. With respect to the state-of-the-art, renewable energy is a vehicle for reducing the levels of carbon emissions. It proves the case that the higher use of renewable energy, the lower CO₂ emission (Dogan and Seker, 2016; Maalej and Cabagnols, 2022).

The entrepreneurial activity has a significantly negative effect on the CO₂ emission. 1% increase in $\ln TEA$ causes a 3% reduction in $\ln CO_2$. It clearly indicates that the entrepreneurial activity in Europe is essentially based on an environmentally friendly principle. Jinjiang et al. (2020, p. 6) show that entrepreneurship has a negative impact on

CO₂ emission per capita. It means a positive impact on the environmental quality. Omri (2018, p. 9) affirms that entrepreneurial activity contributes to the environmental improvement of the high-income developed countries, compared to the sample showing other types of countries. Gu and Zheng (2021, p. 623) support that entrepreneurship is proportionally reversible: on the one hand, it promotes the technological progress of enterprises; on the other hand, it exacerbates the environment through the mediating effect of the technological progress. Environmental regulation negatively moderates the impact of the technical effects on pollution. Entrepreneurship does not only promote the productive scale of enterprises but also increases corporate pollution emissions through the scaling mediation effect. Moreover, the environmental regulations negatively moderate the impact of the scaling scale effect on pollution.

The obtained results reveal that the innovation variables lower the CO₂ emission. A 1% increase in lnRD gives a 22% reduction of lnCO₂ in Eq1, while a 1% increase in lnPAT provides a 24% reduction of lnCO in Eq2. In this sense, Apergis et al. (2013, p. 57) show that after the adoption of the International Financial Reporting Standards, R&D expenditures lower the CO₂ emission in European manufacturing firms in the UK, France, and Germany. Maalej and Cabagnols (2022, p. 19) clearly indicate that the number of patents per thousand of population causes a reduction in CO₂ emissions in the Northern European countries. Dauda et al. (2019, p. 15033) prove that innovation reduces CO₂ emissions in G6 countries (Canada, France, Germany, Italy, Japan, United Kingdom) while it increases emissions in MENA (Bahrain, Egypt, Morocco, Tunisia, Algeria, Israel, United Arab Emirates) and BRICS countries (Brazil, Russia, India, China, and South Africa).

Conclusion

This study analyzes the effect of renewable energy, entrepreneurial activity, and innovation on GDP and CO₂ emissions in 13 European countries from 2002 to 2017. In the same vein, the estimation of the FGLS method is indicative of the renewable energy consumption with respect to the overall amount of energy consumption as well as the entrepreneurial activity and innovation, defined by the number of patents that increase the economic growth and inversely decrease the CO₂ emission. Similarly, the share of R&D expenditure to GDP lowers the CO₂ emission without having an influence on the economy. Generally, the study's findings give rise to political implications, which are helpful for improving the environmental qualities in the developed countries, being essentially liable to pollution throughout the world with regard to their pursuit of prosperity and global economic importance.

- These countries are required to reduce the extensive use of non-renewable energies, causing serious pollution to the environment. They are recommended to use hydroelectricity, solar energy, and geothermal and wind sources of energy. In addition, they are in an urgent need to show a strong willingness to utilize technological progress to keep an equal balance between their economic growth and environmental friendliness. Their efforts are supposed to control and reduce environmental pollution without doing harm to their economic growth and development. Sarkodie and Adams (2018, p. 1598) maintain that substituting the finite and scarce fossil fuel energy sources with renewable energy ones will not only ensure environmental quality but also lead to escape from an economic dependency on traditional sources of energy. In fact, renewable energy sources are not internationally traded, as is the case with fossil fuels. The high rate of renewable sources accessibility reduces the extensive dependency on fossil fuel importation, which guarantees both secure energy and economic productivity.

- These countries are recommended to encourage innovation and entrepreneurial activities in order to conform to the principles of sustainable development. Pukka (2021 p. 448) emphasizes that technological development is the key to reducing greenhouse-gas emissions. More importantly, technology-specific strategies are needed to meet climate friendliness. Accordingly, supporting innovative entrepreneurs within the framework of sustainable entrepreneurship is suitable for the sustainable development challenge. Gu and Zheng (2021, 623) deduce that measuring the effect of innovative entrepreneurship on the environment is strenuous. Innovative entrepreneurship may be considered a double-edged arm on the environment: on the one hand, innovation may cause

environmental pollution; on the other hand, it is likely to improve the environmental quality with reasonable prudence. Gupta and Dharwad (2021, p. 3606) maintain that the dynamic chain of green products, designs, and supply courses in a system of a green manufacturing process gives rise to a green environment. In this context, green-tending enterprises enable their owners to practice sustainable businesses, which enlighten three elementary pillars of sustainability, notably equitable economic growth, environmental friendliness, and abidance to human rights.

Despite the implications discussed above, we infer that our study suffers from various limitations. Firstly, it measures environmental degradation only by CO₂ emissions while other indicators could have been studied (total Green House Gas emissions: CO₂, CH₄, N₂O, F-gases, etc.). Secondly, it lacks explicit measurements of sustainable entrepreneurship and sustainable innovation. Finally, it studies the effect of entrepreneurial activity and innovation on GDP and CO₂ emissions only in the case of developed countries. Future studies could be triggered by studying this effect for both developed and developing countries and demonstrating how this effect depends not only on the behaviors and motivations of entrepreneurs but also on stages of economic development.

References

- Almodóvar-González, M., Fernández-Portillo, A. & Díaz-Casero, J.C. (2020). Entrepreneurial activity and economic growth. A multi-country analysis. *European Research on Management and Business Economics*, 26, 9-17. <https://doi.org/10.1016/j.iedeen.2019.12.004>
- Apergis, N., Eleftheriou, S. & Payne, J.E. (2013). The relationship between international financial reporting standards, carbon emissions, and R&D expenditures: evidence from European manufacturing firms. *Ecological Economics*, 88, 57-66. <https://doi.org/10.1016/j.ecolecon.2012.12.024>
- Audretsch, D.B., Keilbach, M.C. & Lehmann, E.E. (2006). *Entrepreneurship and Economic Growth*, Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780195183511.001.0001>
- Beck, N. & Katz, J.N. (1995). What to do (and not to do) with Time-Series Cross-Section Data. *American Political Science Review*, 89(3), 634-64. <https://doi.org/10.2139/ssrn.1658640>
- Ben Youssef, A., Boubaker, S. & Omri, A. (2018). Entrepreneurship and sustainability: the need for innovative and institutional solutions. *Technological Forecasting & Social Change*, 232e241 <https://doi.org/10.1016/j.techfore.2017.11.003>
- Blackwell, J.L. III. (2005). estimation and testing of fixed-effect panel-data systems. *The Stata Journal*, 5(2), 202-207. <https://doi.org/10.1177/1536867X0500500205>
- Colino, A., Benito-Orsio, D. & Rueda-Armengot, C. (2013). Entrepreneurship culture, total factor productivity growth and technical progress: Patterns of convergence towards the technological frontier. *Technological Forecasting & Social Change*, TFS-17869; No of Pages 11, <http://dx.doi.org/10.1016/j.techfore.2013.10.007>
- Dauda, L., Long, X., Mensah, C.N. & Salman M. (2019), The effects of economic growth and innovation on CO₂ emissions in different regions. *Environmental Science and Pollution Research* <https://doi.org/10.1007/s11356-019-04891-y>
- De Hoyos, R.E. & Sarafidis, V. (2006). Testing for cross-sectional dependence in panel-data models. *The Stata Journal*, 6(4), 482-496. <https://doi.org/10.1177/1536867X0600600403>
- Dhahri, S., Slimani, S. & Omri, A. (2021). Behavioral entrepreneurship for achieving the sustainable development goals. *Technological Forecasting & Social Change*, 165, 120561. <https://doi.org/10.1016/j.techfore.2020.120561>
- Dean, T.J. & McMullen, J.S. (2007). Toward a theory of sustainable entrepreneurship: reducing environmental degradation through entrepreneurial action. *Journal of Business Venturing*, 22(1), 50-76. <https://doi.org/10.1016/j.jbusvent.2005.09.003>
- Dogan, E., Altinoz, B., Madaleno, M. & Taskin, D. (2020). The impact of renewable energy consumption to economic Growth: A replication and extension of Inglesi-Lotz (2016), *Energy Economics* <https://doi.org/10.1016/j.eneco.2020.104866>

- Dogan, E. & Seker, F. (2016). Determinants of CO2 emissions in the European Union: The role of renewable and non-renewable energy. *Renewable Energy*, 94, 429-439. <http://dx.doi.org/10.1016/j.renene.2016.03.078>
- Du, K., Li, P. & Yan, Z. (2019), Do green technology innovations contribute to carbon dioxide emission reduction? Empirical evidence from patent data. *Technological Forecasting & Social Change*, 146, 297-303. <https://doi.org/10.1016/j.techfore.2019.06.010>
- Facchini, F. (2007). Entrepreneur et croissance économique: développements récents. *Revue D'économie Industrielle*, 55-84. <https://doi.org/10.4000/rei.2033>
- Galindo-Martin, M-Á., Castano-Martinez, M-S. & Mendez-Picazo, M-T. (2021). The role of entrepreneurship in different economic phases. *Journal of Business Research*, 122, 171-179. <https://doi.org/10.1016/j.jbusres.2020.08.050>
- Gu, W. & Zheng, X. (2021). An empirical study on the impact of sustainable entrepreneurship: Based on the environmental Kuznets model. *Journal of Business Research*, 123, 613-624. <https://doi.org/10.1016/j.jbusres.2020.10.011>
- Gupta, M. & Dharwal, M. (2022). Green entrepreneurship and sustainable development: A conceptual framework, *Materials Today: Proceedings*, 49(8), 3603-3606. <https://doi.org/10.1016/j.matpr.2021.08.148>
- Hanohov, R. & Baldacchino, L. (2017), Opportunity recognition in sustainable entrepreneurship: an exploratory study. *International Journal of Entrepreneurial Behavior & Research*. <https://doi.org/10.1108/IJEBR-12-2015-0275>
- Jinjiang, H., Nazari, M., Yingqian, Z. & Ning, C. (2020). Opportunity-based entrepreneurship and environmental quality of sustainable development: a resource and institutional perspective. *Journal of Cleaner Production*, 256(20), 120390 <https://doi.org/10.1016/j.jclepro.2020.120390>
- Kirzner, I. (1973). *Competition and Entrepreneurship*, The University of Chicago Press, Chicago and London, traduction française en 2005, Concurrence et esprit d'entreprise, Paris, Economica
- Linán, F. & Fernández-Serrano, J. (2014). National culture, entrepreneurship and economic development: Different patterns across the European Union. *Small Business Economics*, 42, 685-702. <https://doi.org/10.1007/s11187-013-9520-x>
- Maalej, A. & Cabagnols, A. (2020). Energy consumption, CO² emissions and economic Growth in MENA countries. *Environmental Economics*, 11(1), 133-150. [https://doi.org/10.21511/ee.11\(1\).2020.12](https://doi.org/10.21511/ee.11(1).2020.12)
- Maalej, A. & Cabagnols, A. (2022). CO2 emissions and growth: exploring the nexus between renewable energies, economic activity and technology. *Journal of Energy and Development*, 46(1-2).
- Maradana, R.P., Pradhan, R.P., Dash, S., Zaki, D.P., Gaurav, K., Jayakumar, M. & Sarangi, A.K. (2019). Innovation and economic Growth in European Economic Area countries: The Granger causality Approach. *IIMB Management Review*, 31, 268-282, <https://doi.org/10.1016/j.iimb.2019.03.002>
- Mongo, M., Fateh Belaïd, F. & Ramdani, B. (2021). The effects of environmental innovations on CO2 emissions: Empirical evidence from Europe. *Environmental Science and Policy*, 118, 1-9, <https://doi.org/10.1016/j.envsci.2020.12.004>
- Muhammad, B. (2019), Energy consumption, CO² emissions and economic growth in developed, emerging and Middle East and North Africa countries. *Energy*, <https://doi.org/10.1016/j.energy.2019.03.126>
- Nakamura, H. & Managi, S. (2020), Entrepreneurship and marginal cost of CO2 emissions in economic development. *Economic Analysis and Policy*, 67, 1–14. <https://doi.org/10.1016/j.eap.2020.05.004>
- Omri, A. (2018), Entrepreneurship, sectoral outputs and environmental improvement: International evidence. *Technological Forecasting & Social Change*, 128, 46-55. <https://doi.org/10.1016/j.techfore.2017.10.016>
- Pauku, E. (2021), How could Finland promote renewable-energy technology innovation and implementation? *Clean Energy*, 447–463, <https://doi.org/10.1093/ce/zkab024>
- Pesaran, M.H. (2004). General diagnostic tests for cross-section dependence in panels, University of Cambridge, Faculty of Economics, Cambridge Working Papers in Economics No. 0435 <https://doi.org/10.2139/ssrn.572504>

Podestà, F. (2002). Recent Developments in Quantitative Comparative Methodology: The Case of Pooled Time-Series Cross-Section Analysis. *Dss Papers Soc*, 3(2).

Pradhan, R.P., Arvin, M. B., Nair, M. & Bennett, S.E. (2020). The Dynamics Among Entrepreneurship, Innovation, and Economic Growth in the Eurozone Countries. *Journal of Policy Modeling*. <https://doi.org/10.1016/j.jpolmod.2020.01.004>

Reed, W.R. & Ye, H. (2009). Which panel data estimator should I use? *Applied Economics*, 43(8), 985-1000. <https://doi.org/10.1080/00036840802600087>

Saidi, K. & Omri, A. (2020). The impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. *Environmental Research*, 186, 10956. <https://doi.org/10.1016/j.envres.2020.109567>

Shane, S. (2000). Prior Knowledge and the Discovery of Entrepreneurial Opportunities. *Organization Science*, 11(4), 448-469. <https://doi.org/10.1287/orsc.11.4.448.14602>

Sarkodie, S.A. & Adams, S. (2018), Renewable energy, nuclear energy, and environmental pollution: Accounting for political institutional quality in South Africa. *Science of the Total Environment*, 643, 1590–1601, <https://doi.org/10.1016/j.scitotenv.2018.06.320>

Shepherd, D.A. & Patzelt, H. (2011). The New Field of Sustainable Entrepreneurship: Studying Entrepreneurial Action Linking "What Is to Be Sustained" With "What Is to Be Developed". *Entrepreneurship Theory and Practice*, 1042-2587. <https://doi.org/10.1111/j.1540-6520.2010.00426.x>

Schumpeter, J. (1934), *The Theory of Economic Development*, Cambridge, Mass: Harvard University Press.

StataCorp (2019). *Stata: Longitudinal Data/Panel Data Reference Manual*, Release 16, Statistical Software. College Station, TX: StataCorp LLC.

Torres-Reyna, O. (2007). *Panel Data Analysis Fixed and Random Effects Using Stata (v. 4.2)*, Data & Statistical Services, Princeton University.

Funding: *The dissemination of the research supported by European Union's Horizon 2020 project H2020-MSCA-RISE-2014 CLUSDEVME, Grant Agreement Number 645730730*

Ali MAÂLEJ, PhD in economics, University of Sfax, Tunisia,
ORCID ID: <https://orcid.org/0000-0003-1011-7512>

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:
@IntoInsights

Copyright © 2022 by author(s) and VsI Entrepreneurship and Sustainability Center
This work is licensed under the Creative Commons Attribution International License (CC BY).
<http://creativecommons.org/licenses/by/4.0/>



**Publisher**<http://jssidoi.org/esc/home>

RANSOMWARE: A COMPREHENSIVE STUDY OF THE EXPONENTIALLY INCREASING CYBERSECURITY THREAT

Attila Máté Kovács*Doctoral School on Safety and Security Sciences, Óbuda University, Baranyai utca 31c, 1117 Budapest, Hungary**E-mail: kovacs.attilamate@uni-obuda.hu**Received 10 April 2022; accepted 27 May 2022; published 30 June 2022*

Abstract: Ransomware threats and incidents have exponentially increased causing both financial and reputational losses to organizations of all sizes and sectors. Ransomware attacks became the talk of the news when the world was hit by COVID 19 pandemic and people shifted to remote work in large numbers (Brynjolfsson et al., 2020, p. 13-14). Cybercriminals and threat groups are using various types of social engineering techniques such as email phishing, smishing, spear phishing attacks to spread ransomware infections in systems and networks. To protect organizations, users, and IT infrastructures it is important to understand how ransomware works, and how various threat actors use it to exfiltrate confidential data and information. Hence a critical approach toward ransomware infection and its mitigation by using different techniques is discussed and analyzed in this research paper concerning other scholarly articles and papers.

Keywords: ransomware; cybersecurity threat

Reference to this paper should be made as follows: Kovács, A. M. 2022. Ransomware: a comprehensive study of the exponentially increasing cybersecurity threat. *Insights into Regional Development*, 4(2), 96-104. [http://doi.org/10.9770/IRD.2022.4.2\(8\)](http://doi.org/10.9770/IRD.2022.4.2(8))

JEL Classification: 033

Additional disciplines: safety and security

1. Introduction

Ransomware is a malicious malware that restricts a user's access to his system by encrypting files and folders that resides on it and demands a payment normally in the form of bitcoin to regain access to the encrypted files and to restore normal functionality. Various social engineering techniques commonly email phishing, spear phishing, smishing, and BEC attacks are used by threat actors to deliver ransomware into users' systems and demand extortion money.

Cyber extortion dates to the 1980s. The PC Cyborg Trojan (Tailor and Patel, 2017), the first ransomware that came into existence in 1989, restarted the target system approximately 90 times. During the process, the Cyborg Trojan encrypted all files and folders in the C drive and rendered the system unusable. Ransomware attacks carried out in the 1990s and early 2000s were conducted by hackers whose main aim was to gain fame through cyber pranks and vandalism (Srinivasan, 2017). More sophisticated and modern ransomware appeared around 2005 and quickly became a new strategy for cybercriminals to infect organizations (Chesti et al., 2020). Various families of ransomware were identified by researchers that inflicted different scales of damage to various industries (Lorenzo, 2018). Of these areas, the attacks on health care institutions and hospitals are the best known.

These are carried out primarily by criminals, but in many cases even by members of terrorist organizations (Besenyő et al., 2021).

Ransomware in its different variants is usually aimed at encrypting user data. After data has been encrypted, a ransom is extorted. The data is only released after payment of the mostly digital ransom. With ransomware, a wide variety of organizations have already fallen victim to an extortion attempt: large corporations, medium-sized companies, and even hospitals (see Figure 1).

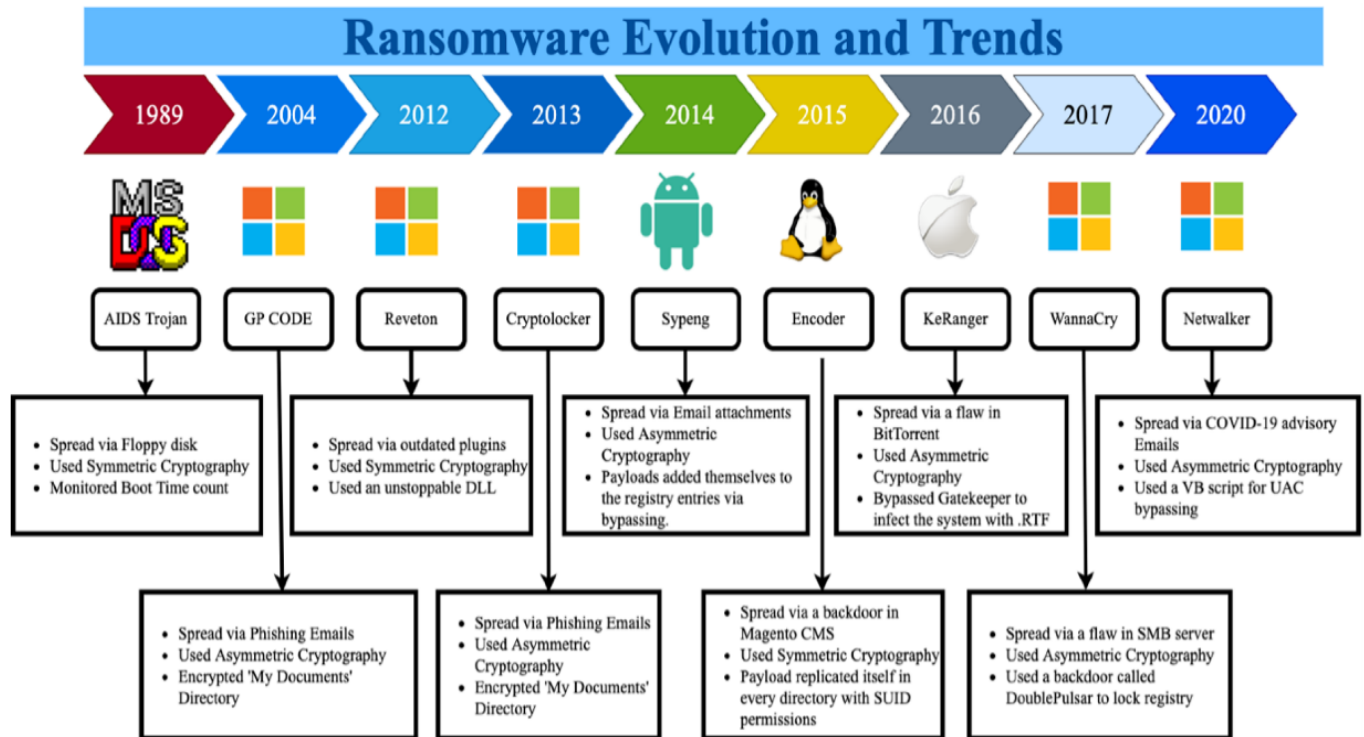


Figure 1. Evolution of Ransomware

A survey was conducted by Sophos (Sophos, 2021) led by Vanson Bourne across 5400 IT decision-makers in 30 countries. According to the researcher's key findings, it was estimated that 54% of the organizations were hit by ransomware and cybercriminals were able to successfully encrypt their important data. The average ransom paid by mid-sized organizations was US\$170,404. The retail and education sector has been severely hit by ransomware attacks. Data is money and adversaries have found ransomware to be very useful in gaining their vendetta to be successful (see Figure 2).

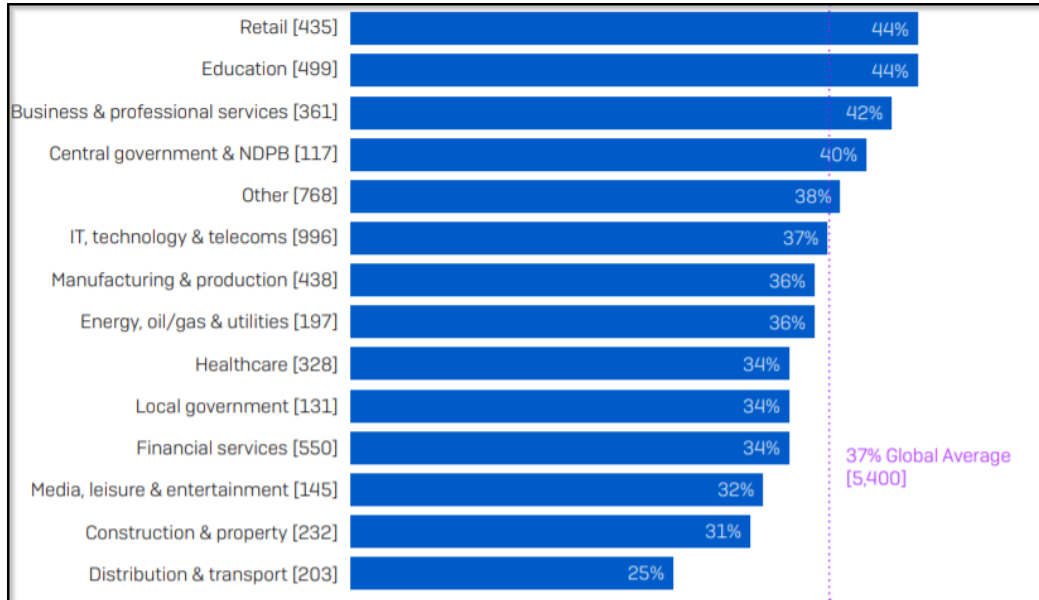


Figure 2. Among various business sectors retail & education sector has been severely hit by Ransomware

Ransomware is a typical attack vector utilized by cybercriminals to carry out nefarious operations such as preventing access to personal data until a ransom is paid. Adversaries demand the ransom in form of cryptocurrency such as bitcoin. The use of cryptocurrencies makes it difficult for law enforcement to track down recipient transactions (Alshaikh et al., 2020). The surge in Ransomware attacks was seen during the Covid 19 pandemic when an Android app called CovidLock was developed to study and analyze heat patterns on Covid-19 (Hama Saeed, 2020). As soon as users installed this application their contacts, gallery, and access to social media accounts were locked and a ransom was asked to be paid, in case of failure to pay the ransom adversaries threatened to make their data public.

In general, ransomware is breakdown into three categories – scareware, locker, and crypto (Atapour-Abarghouei et al., 2019) as shown in Figure 2. Scareware tricks a user into installing software or an executable by using pop-up ads, hence downloading the malware. Adversaries exploit human emotion of fear using scareware rather than encrypting files or locking the system until the ransom amount is paid (Andronio et al., 2015). The locker ransomware aims to disable primary functions of the target system by encrypting files that normally lock the system keyboard or screen. To overcome this malware the system can be rebooted into safe mode or using the on-demand virus scanner which eradicates the infection (Adamu & Awan, 2019). Crypto ransomware encrypts users' sensitive and important files instead of locking the basic functionality of the system. This type of ransomware is relatively hard to decrypt and uses strong encryption techniques which are nearly impossible to crack (see Figure 3).

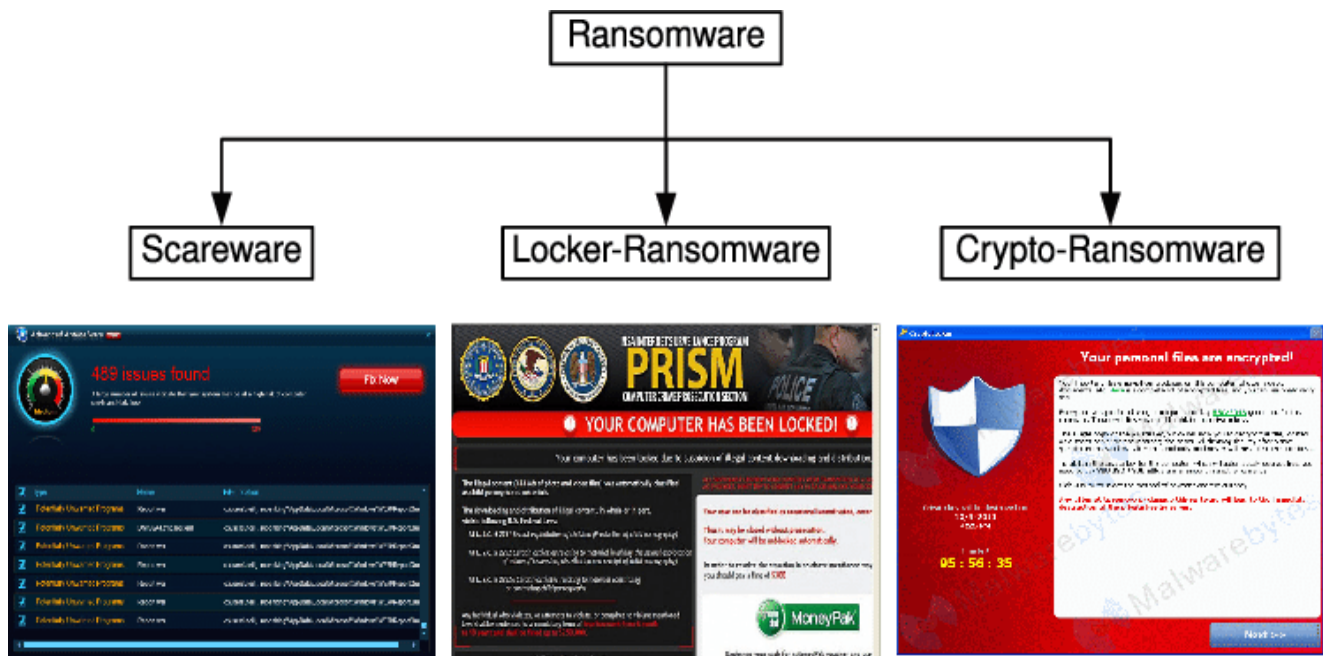


Figure 3. Categories of Ransomware

2. Literature review

A relatively higher number of scholarly research has been conducted on Ransomware, its propagation, and mitigation. Attacks using ransomware have become increasingly complex and have been adopting enhanced encryption techniques, which make it nearly impossible to retrieve data unless the ransom is paid.

Researchers created awareness among unskilled users of the organization regarding the dangers of ransomware (Gupta & Tripathi, 2017). The researchers listed down the threats due to ransomware such as system shutdown, loss of sensitive information, and financial loss. The study proposed mitigation techniques such as email security, intrusion detection, security policies, and the adoption of best practices.

Different types of ransomware have also been analyzed based on their ransom value (Hernandez-Castro et al., 2017a). The analysis was done on Cryptolocker, CryptoWall, and TeslaCrypt based on the price of ransom and the data available to the hackers. This encourages adversaries to adopt strategies that enable them to gain more financial value by targeting organizations.

The most popular and common environment targeted by cybercriminals is android due to its popularity among users of all kinds (Mercaldo et al., 2016). The research proposed the analysis of ransomware attacks on android mobile environments by taking malware samples and then analyzing them based on their behavior by applying a set of logical rules. The analysis aided in the identification of different types of ransomware. Mobile environments are more prone to ransomware attacks and its detection can be achieved by using approaches such as static, dynamic, and hybrid approaches (Manish, 2020). The static approach used techniques such as Linear regression, SVM, Code analysis, etc. At the same time, the dynamic and hybrid approaches used taint analysis, encryption, foreground, obfuscation, text, and image classification respectively. The research pointed out the accuracy of the proposed methodologies to be in the range of 95% - 98% which is quite a good score in the detection of ransomware in the android environment.

Various types of approaches have been used to detect ransomware. The most effective and common ones include the signature-based approach and the behavior-based approach. The signature-based approach detects unique patterns in ransomware source code and analyzes function calling sequences in ransomware code. The patterns are saved into a database that is used by an anti-malware solution for malware detection in executables. Signature-based approaches are effective and convenient as they have fewer false positives. According to research this approach is ineffective against obfuscated code in ransomware and is unable to detect new patterns unless manual hunting is used (Goyal et al., 2019).

In a behavior-based approach, researchers created an artificial virtualized environment to see the behavior of ransomware when it interacts with the system (Grant & Parkinson, 2018). The researchers analyzed the behavior of ransomware when it interacts with the file system of the operating system. The analysis was conducted through a file monitoring system that helped in monitoring the interaction of the malware with files. The research concluded that every ransomware has a unique ability to interact with file systems and files and can be distinguished by an individual or shared patterns.

Another approach was employed to study ransomware behavior on networks using reverse engineering (Zimba et al., 2018). The research focused on uncovering the interaction of the famous WannaCry ransomware interactions with the network. Dynamic analysis was used to detect the interaction of the malware with the network. The code analysis fetched the adapter properties of the infected network to extract information about the malware whether it resides on the private or public subnet to assess the propagation level and damage inflicted.

Similar research was conducted on the WannaCry ransomware based on an analysis of two components (Akbanov et al., 2019). The first component extracts a list of IP addresses based on local and public subnet and scans the internal and external network for MS17-010 vulnerability. The second component was based on the ransomware encryption process as it uses RSA keys for encrypting the files.

Prevention techniques for ransomware included categorizing ransomware characteristics of different variants (Singh, 2017). The research focused on analyzing different families of ransomware and its characteristics. The research concluded that many families of ransomware exhibited similar characteristics which made the detection and prevention relatively easier for known patterns of malware infection.

A new technique to recover from ransomware was introduced which assumed that the ransomware that targeted the windows system used the CNG cryptographic library to encrypt user files and folders (Lee et al., 2017). As per the research, the ransomware uses the same keys that are on the host so the retrieval can be achieved by using the same keys to decrypt the files.

The use of machine learning has aided in the detection of ransomware by using reverse engineering, static analysis, and machine learning techniques (Poudyal et al., 2018). The framework proposed in the research used analysis techniques that analyzed raw binaries, libraries, function calls, and assembly code.

3. Methodologies and Techniques

The research community has put earnest efforts into analyzing ransomware of different variants and has presented different methods of preventing ransomware. The main objective of doing this research is to present ransomware prevention techniques for organizations that can be easily adopted and implemented by organizations including common users.

4. User Training

The major cause of ransomware infecting organizations is the lack of user awareness of such cybersecurity threats. An organization can adopt state-of-the-art frameworks and security controls but still fail to protect its confidential data if its users are not aware. Adversaries always go for low-hanging fruits and use social engineering techniques (Hinson, 2008) such as email phishing, BEC attacks, smishing, etc. that entice the users into clicking malicious links and installing malware that results in a ransomware infection. Another way that the network or system may get infected is by using cracked or unpatched software (Kumar et al., 2016) downloaded from unverified sources.

To make the user aware of all the threats associated with ransomware a user awareness session should be conducted by organizations twice or thrice a month. Cyber drills should be conducted in which internal phishing campaigns should be launched to test the user's knowledge related to ransomware.

5. High damages caused by Emote and Wannacry

The Emotet malware program represents a possible attack vector. It is able to read contact relationships from mailboxes and subsequently send very authentic spam mail automatically. As a result, it has a high level of distribution and, at the same time, a comparatively high success rate in infecting corporate networks. Emotet and reloaded malware have thus already caused high damage to those affected in business and administration - and regularly reappear with new functions to cause damage supplemented by further techniques and malware.

Advanced attacks are characterized by the fact that they use malicious functions that used to be deployed manually in selected attacks, but are now deployed semi-automatically over a wide area. A variety of malicious functions means that advanced variants pose a significantly greater threat. In addition to the widespread use of increasingly sophisticated spam by malware such as Emotet, in many cases, the perpetrators are now taking a phased approach.

Whereas some time ago individual computers were encrypted and a ransom was demanded per encrypted PC, today affected corporate networks are first spied on in a targeted manner. In the process, data is often extracted and an assessment of the respective victim is made. The perpetrators then tailor their ransom demands to the affected organization. Encryption is often targeted and may include existing backups. Corporate networks are often completely compromised. The previously leaked data is often used to increase pressure on victims to act by threatening to publish or resell the data if the ransom for the encrypted data is not paid. The cleanup of affected networks can take months depending on the size of the affected network. Most recently, in several cases non-payment was threatened with the publication of previously stolen data, and in some cases, this was carried out. Against this background, consistent preventive action is becoming increasingly important.

Two other relevant examples connected to mass effects and psychology can be WannaCry and Jigsaw.

On Friday, May 11, 2017, the world was shaken by a series of huge cyber attacks that brought several hospital systems in the UK to a standstill and led to the suspension of emergency care. These attacks occurred on the same day. It was identified as a ransomware virus and named WannaCry being followed by further variations (WanaCrypt0r 2.0, WCry), which locked down infected PCs and issued a screen message telling the users that the only way to bring the system back online was to pay \$300 in cryptocurrency. According to cybersecurity companies, the vulnerability that was exploited in the attack was leaked shortly before WannaCry went viral by a team of hackers who used the name Shadow Brokers. The Shadow Brokers claimed to have obtained valuable data from the United States National Security Agency (NSA) in the time leading up to the attack. In just a single day, the number of infected computers surpassed the 100,000 mark.

The Jigsaw ransomware virus, if not the biggest attack, is probably the scariest, and the best example of psychological warfare; the malware, like the character in the horror film Saw, does not kill instantly, but "plays" with the victims, who are given 24 hours to pay the equivalent of one hundred and fifty dollars in bitcoins and get the unlock key. If they do not pay within the first hour, the ransomware deletes a file. After the second hour, one more, and so on for 72 hours. Because that's when everything is destroyed. Jigsaw even warns users not to try to restart the computer, or they can kiss the files goodbye immediately. And at the end of the message, a countdown timer starts, adding to the fear.

6. Understanding Shadow IT

Shadow IT as a phenomenon and term is defined as any hardware, software, or solution that is being utilized by users without the formal knowledge of the IT department (Silic & Back, 2014). Since the software or application being used by users is unknown to the IT department, this software can be a major cause of ransomware infection. Non-IT users may download software from unverified sites that could lead to malicious backdoor installation and may infect the system with ransomware.

To overcome the problem of users installing unverified software, all the users should be connected to the company domain and should not be allowed to install any type of software without the approval of the IT department. This can be reached via clearly defining the access control rules and authorization rules on the authentication mechanisms such as RADIUS or Domain.

7. Keeping Operating systems, applications & Services updated

Cybercriminals exploit older versions of operating systems, applications, and services. The security loopholes in unpatched or older versions of OS or applications running on the system are exploited by cybercriminals. They utilize various techniques such as remote code execution (Sharma & Singh Tomar, 2015) which allows initial access to the system. The adversary can then install the malware that will encrypt all files and folders of the target user.

It is strongly recommended to the organization keep their systems, applications, and services updated to the latest version. The latest software and applications have built-in auto-update options that automatically update themselves. This is true for both mobile devices and PCs.

8. Implementing Endpoint Detection Response Solution

Endpoint Detection Response (EDR) is an integrated solution that can continuously monitor real-time data of endpoints with rule-based automated detection and response. The whole point of implementing an EDR solution is to monitor each activity on the endpoint so that the risk of being infected by ransomware is minimized. EDR solution helps to analyze data patterns collected from various endpoints and automatically respond to threats to mitigate, contain, and notify the users.

9. Segmentation and Zero Trust Network

It is very important to segment your network based on trust boundaries, the type of data that is shared both internally and over the internet. Each network segment should be properly divided, and a clear information flow should be established with the right access control techniques. By setting up clear boundaries, in case of a ransomware infection, the malware will be restricted to that target system rather than propagating in the entire network.

The Zero Trust network is based on the principle that trust is nothing and validates everything (Sheikh et al., 2021). By validating traffic at every level of the IT infrastructure there will be a less likely chance that a system or host would be compromised by a ransomware attack.

10. Conclusion

Ransomware attacks will continue to rise and will become more complex and sophisticated with each passing day. It is very important to employ appropriate security controls that leverage ransomware attacks. Pattern Detection, behavior analysis, and code analysis are some of the most common ways that can detect, analyze and prevent ransomware attacks. These techniques can be embedded into enterprise tools that will help organizations protect their sensitive and critical data. By following a systematic plan that not only emphasizes using state-of-the-art tools but also basic security controls that may get missed by IT and security departments. Organizations and individuals should follow the discussed approach in the previous section to minimize the rate at which ransomware infections occur and to protect their organization's critical assets and data from adversaries.

References

- Besenyő, J., Márton, K., & Shaffer, R. (2021): Hospital Attacks Since 9/11: An Analysis of Terrorism Targeting Healthcare Facilities and Workers, *Studies in Conflict & Terrorism*, <https://doi.org/10.1080/1057610X.2021.1937821>
- Brynjolfsson, E., Horton, J., Ozimek, A., Rock, D., Sharma, G., & TuYe, H.-Y. (2020). *COVID-19 and Remote Work: An Early Look at US Data*. National Bureau of Economic Research. <https://doi.org/10.3386/w27344>
- Sophos. (2021). The State of Ransomware 2021. <https://secure2.sophos.com/en-us/medialibrary/pdfs/whitepaper/sophos-state-of-ransomware-2021-wp.pdf>
- Tailor, J. & Patel, A. (2017). A Comprehensive Survey: Ransomware Attacks Prevention, Monitoring and Damage Control. *International Journal of Scientific Research*, 4.
- Srinivasan, C. (2017). Hobby hackers to billion-dollar industry: the evolution of ransomware. *Computer Fraud & Security*, (11), 7-9. [https://doi.org/10.1016/s1361-3723\(17\)30081-7](https://doi.org/10.1016/s1361-3723(17)30081-7)
- Fernández Maimó, L., Huertas Celdrán, A., Perales Gómez, Á.L., García Clemente, F.J., Weimer, J., & Lee, I. 2019. Intelligent and Dynamic Ransomware Spread Detection and Mitigation in Integrated Clinical Environments. *Sensors*. 19(5):1114. <https://doi.org/10.3390/s19051114>
- Chesti, I. A., Humayun, M., Sama, N. U., & Jhanjhi, N. (2020a). Evolution, Mitigation, and Prevention of Ransomware. In *2020 2nd International Conference on Computer and Information Sciences (ICCIS)*. IEEE. <https://doi.org/10.1109/iccis49240.2020.9257708>
- Alshaikh, H., Ramadan, N., & Ahmed, H. (2020). Ransomware Prevention and Mitigation Techniques. *International Journal of Computer Applications*, 177(40), 31–39. <https://doi.org/10.5120/ijca2020919899>
- Hama Saeed, M. A. (2020). Malware in Computer Systems: Problems and Solutions. *IJID (International Journal on Informatics for Development)*, 9(1), 1 <https://doi.org/10.14421/ijid.2020.09101>
- Adamu, U., & Awan, I. (2019). Ransomware Prediction Using Supervised Learning Algorithms. In *2019 7th International Conference on Future Internet of Things and Cloud (FiCloud)*. IEEE. <https://doi.org/10.1109/ficloud.2019.00016>
- Gupta, G., & Tripathi, D. K. (2017). Study on ransomware attack and its prevention. *Computer Science*, 3(5).
- Mercaldo, F., Nardone, V., & Santone, A. (2016). Ransomware Inside Out. In *2016 11th International Conference on Availability, Reliability and Security (ARES)*. IEEE. <https://doi.org/10.1109/ares.2016.35>
- Android Ransomware and Its Detection Methods. (2020). *International Journal of Innovative Technology and Exploring Engineering*, 9(4), 1252–1255. <https://doi.org/10.35940/ijitee.d1632.029420>

- Goyal, P. S., Kakkar, A., Vinod, G., & Joseph, G. (2019). Crypto-Ransomware Detection Using Behavioural Analysis. In *Reliability, Safety and Hazard Assessment for Risk-Based Technologies* (pp. 239–251). Springer Singapore. https://doi.org/10.1007/978-981-13-9008-1_20
- Grant, L., & Parkinson, S. (2018). Identifying File Interaction Patterns in Ransomware Behaviour. In *Computer Communications and Networks* (pp. 317–335). Springer International Publishing. https://doi.org/10.1007/978-3-319-92624-7_14
- Zimba, A., Wang, Z., & Chen, H. (2018). Multi-stage crypto ransomware attacks: A new emerging cyber threat to critical infrastructure and industrial control systems. *ICT Express*, 4(1), 14–18. <https://doi.org/10.1016/j.ict.2017.12.007>
- Akbanov, M., Vassilakis, V. G., & Logothetis, M. D. (2019). WannaCry Ransomware: Analysis of Infection, Persistence, Recovery Prevention and Propagation Mechanisms. *Journal of Telecommunications and Information Technology*, 1, 113-124. <https://doi.org/10.26636/jtit.2019.130218>
- Singh, T. (2017). Evolving Threat Agents: Ransomware and their Variants. *International Journal of Computer Applications*, 164(7), 28–34. <https://doi.org/10.5120/ijca2017913666>
- Poudyal, S., Subedi, K. P., & Dasgupta, D. (2018). A Framework for Analyzing Ransomware using Machine Learning. In *2018 IEEE Symposium Series on Computational Intelligence (SSCI)*. IEEE. <https://doi.org/10.1109/ssci.2018.8628743>
- Hinson, G. (2008). Social Engineering Techniques, Risks, and Controls. *EDPACS*, 37(4-5), 32–46. <https://doi.org/10.1080/07366980801907540>
- Kumar, S., Madhavan, L., Nagappan, M., & Sikdar, B. (2016). Malware in Pirated Software: Case Study of Malware Encounters in Personal Computers. In *2016 11th International Conference on Availability, Reliability and Security (ARES)*. IEEE. <https://doi.org/10.1109/ares.2016.101>
- Silic, M., & Back, A. (2014). Shadow IT – A view from behind the curtain. *Computers & Security*, 45, 274–283. <https://doi.org/10.1016/j.cose.2014.06.007>
- Sheikh, N., Pawar, M., & Lawrence, V. (2021). Zero trust using Network Micro Segmentation. In *IEEE INFOCOM 2021 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)*. IEEE. <https://doi.org/10.1109/infocomwkshps51825.2021.9484645>

Attila Máté KOVÁCS works at Óbuda University Doctoral School on Safety and Security Sciences; Cognizant [CEHv11 Certified Ethical Hacker; Certified Chief Information Security Officer and ISO27000 auditor]. After earning a post-graduate degree in Energy Economics from the Regional Centre for Energy Policy Research, Budapest Corvinus University, for a thesis on Electricity Capacity Mechanisms, he also deepened his knowledge in two proficiency fields of his interests, Artificial Intelligence and Machine Learning, at Kürt Academy and Stanford. At the start of his career, he worked as a strategy consultant at Roland Berger Strategy Consultants and Accenture and later at Cyber Services Plc in international information security Research & Development projects. Before joining Cognizant in 2021 in an Information Security Management position, he worked at the air navigation service provider Hungarocontrol, personally contributing to the remote tower and remotely controlled aerial vehicle development and regulatory initiatives.

ORCID ID: 0000-0001-5088-5749

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

Copyright © 2022 by author(s) and Vsl Entrepreneurship and Sustainability Center

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>

