

FOURTH INTERNATIONAL SCIENTIFIC CONFERENCE  
ITEMA 2020

Recent Advances in Information Technology, Tourism,  
Economics, Management and Agriculture

## **CONFERENCE PROCEEDINGS**

October 8, 2020  
ONLINE-Virtual



# Contents

<b>EVALUATING GREEN IT IN LOCAL ADMINISTRATION</b> .....	<b>1</b>
Manuel Landum M. M. M. Moura Leonilde Reis	
<b>A NEW APPROACH IN QUANTIFYING USER EXPERIENCE IN WEB-ORIENTED APPLICATIONS</b> .....	<b>9</b>
Vasilije Vasiljević Nenad Kojić Natalija Vugdelija	
<b>COMPARATIVE ANALYSIS OF WEB APPLICATION PERFORMANCE IN CASE OF USING REST VERSUS GRAPHQL</b> .....	<b>17</b>
Milena Vesić Nenad Kojić	
<b>USE OF “OWASP TOP 10” IN WEB APPLICATION SECURITY</b> .....	<b>25</b>
Nikola Nedeljković Natalija Vugdelija Nenad Kojić	
<b>A FRAME OF REFERENCE FOR RESEARCH OF A BLOCKCHAIN- BASED SOLUTION TO CORPORATE GRC-MANAGEMENT</b> .....	<b>31</b>
Le Chen	
<b>GRAPH DATABASE MANAGEMENT SYSTEMS AND GRAPH THEORY</b> .....	<b>39</b>
Kornelije Rabuzin Sonja Ristić Robert Kudelić	
<b>SMALL AND MEDIUM-SIZED ENTERPRISES IN TOURISM AND THEIR IMPACT ON REGIONAL DEVELOPMENT</b> .....	<b>47</b>
Katarína Kráľová Jana Sochuláková Dagmar Petrušová	
<b>THE MARKETING MIX - A BASIC TOOL IN THE MANAGEMENT OF THE TOURIST DESTINATION</b> .....	<b>55</b>
Delia Fratu	
<b>THE IMPORTANCE OF ACQUIRING INTERCULTURAL COMMUNICATIVE COMPETENCE FOR PRESENT AND FUTURE TOURIST PROFESSIONALS IN MONTENEGRO</b> .....	<b>69</b>
Gordana Mušura	
<b>ECONOMIC BENEFITS OF ŠUMAVA NATIONAL PARK</b> .....	<b>73</b>
Josef Stemberk	
<b>THE ROLE OF INTERNATIONAL AND PROFESSIONAL ORGANISATIONS’ IN DEFINING STATE-OWNED ENTERPRISES</b> .....	<b>83</b>
Ioana Andreea Ciolomic Ioana Natalia Beleiu	
<b>TESTING THE EMPIRICS OF WEAK FORM OF EFFICIENT MARKET HYPOTHESIS: EVIDENCE FROM LAC REGION MARKETS</b> .....	<b>91</b>
Hortense Santos Rui Dias	

Paula Heliodoro Paulo Alexandre <b>THE IMPACT OF THE COVID-19 ON THE FINANCIAL MARKETS: EVIDENCE FROM G7.....</b>	<b>103</b>
Paula Heliodoro Rui Dias Paulo Alexandre Maria Jesus Mizeley <b>THE DOW JONES INDUSTRIAL AVERAGE (DJIA) STOCK MARKET INDEX AND THE CHAOTIC GROWTH MODEL .....</b>	<b>113</b>
Vesna Jablanovic <b>RANDOM STRATEGY VERSUS TECHNICAL ANALYSIS STRATEGY IN THE US MARKET .....</b>	<b>121</b>
Miroslav Svoboda Martina Sponerová <b>CASH FLOW FORECASTING FOR INTERNATIONAL PROJECTS IN THE PROCESS OF CAPITAL BUDGETING DURING THE COVID-19 PANDEMIC .....</b>	<b>129</b>
Biljana Pejović Dragana Trifunović Aleksandra Živaljević <b>ANALYSIS OF RESEARCH AND DEVELOPMENT EXPENDITURE IN EUROPEAN UNION COUNTRIES .....</b>	<b>137</b>
Lubica Hurbánková <b>EUROPEAN UNION, ROMANIA AND RAILWAY TRANSPORT.....</b>	<b>143</b>
Clara Elena Muț Ciprian Benjamin Benea Adrian Negrea Secara-Onita Adina Catarig Andra <b>BASIC ELEMENTS OF THE FINANCIAL FUNCTION IN BUSINESS ENTITIES .....</b>	<b>151</b>
Slobodan Bracanović <b>HUNGARIAN IFRS IMPLEMENTATION FROM TAX PERSPECTIVE .....</b>	<b>159</b>
Gábor Fehér Éva Karai <b>CLASSIFICATION OF FINANCIAL MECHANISMS OF HEALTHCARE SYSTEMS IN THE COUNTRIES OF EUROPEAN UNION .....</b>	<b>169</b>
Nadiya Dubrovina Stanislav Filip Vira Dubrovina <b>PREPARING SCHOOL GRADUATES FOR THE LABOUR MARKET .....</b>	<b>177</b>
Mária Nováková Silvia Capíková <b>THE INFLUENCE OF KNOWLEDGE MANAGEMENT ON THE DEVELOPMENT OF INNOVATION IN THE ENTERPRISES IN THE REPUBLIC OF NORTH MACEDONIA-SELECTED RESULTS.....</b>	<b>185</b>
Marija Pendevska	

<b>OPERATION MANAGEMENT USING ITIL AND COBIT FRAMEWORK.....</b>	<b>201</b>
Joaquina Marchão Paula Ventura	
<b>HOW DATA ANALYTICS HELPS MANAGEMENT IN GLOBAL PANDEMIC SITUATION .....</b>	<b>209</b>
Dimitar Dimitrov Radko Radev	
<b>PURCHASING BUSINESS IN THE CONDITIONS OF THE PANDEMIC CRISIS .....</b>	<b>219</b>
Sandra Mrvica Mađarac Zvonimir Filipović Marko Eljuga	
<b>THE NECESSITY OF PSYCHOHYGIENE IN THE WORK OF TRADERS.....</b>	<b>225</b>
Zuzana Birknerová Dagmara Ratnayake Kaščáková	
<b>SOCIAL NETWORKS, COGNITIVE BIASES AND FAKE NEWS: CAN A SIMPLE COMPUTER MODEL EXPLAIN A COMPLEX PHENOMENON? .....</b>	<b>231</b>
Blaž Rodič	
<b>CHALLENGES IN MANAGING INTELLECTUAL PROPERTY RIGHTS DURING CORONAVIRUS PANDEMIC .....</b>	<b>239</b>
Mario Lukinović Larisa Jovanović Vladimir Šašo	
<b>KEYWORD ANALYSIS WITH USING STATISTICAL METHODS .....</b>	<b>251</b>
Dominika Krasňanská Mária Vojtková	
<b>GREENHOUSE GAS EMISSIONS PRODUCED IN AGRICULTURE SECTOR IN EU .....</b>	<b>257</b>
Mariana Dubravská Elena Širá	
<b>HOUSEHOLD/INDIVIDUALS IN THE PROCESS OF PRODUCTION AND DELIVERY OF ELECTRICITY FROM RENEWABLE ENERGY SOURCES – PHOTOVOLTAIC SYSTEMS.....</b>	<b>267</b>
Serjoza Markov	
<b>LEVELS OF SOME PRIORITY SUBSTANCES ON ADRIATIC SEA, ALBANIA .....</b>	<b>277</b>
Aurel Nuro Bledar Murtaj	
<b>HEAVY METAL ACCUMULATION AND CHEMICAL COMPOSITION OF ESSENTIAL OILS OF LEMON BALM (<i>MELISSA OFFICINALIS L.</i>) CULTIVATED ON HEAVY METAL CONTAMINATED SOILS .....</b>	<b>287</b>
Violina Angelova	



# EVALUATING GREEN IT IN LOCAL ADMINISTRATION

Manuel Landum<sup>1</sup>   
M. M. M. Moura<sup>2</sup>   
Leonilde Reis<sup>3</sup> 

DOI:

---

**Abstract:** *This work is prompted by the massive use of Information and Communication Technologies, the need for alignment with the business, the concern for integrated management and the need to protect natural resources and the environment. This article aims to present a framework, multidimensional and multidisciplinary, from the perspective of sustainability, in the treatment of Green IT, involving environmental issues and social responsibility, Governance of Information Technologies and Financial Management, in the context of Public Administration, more specifically in local administration. The methodology used is based on the literature review, in the field of thematic, and on a case study in development in local government, in order to analyze the feasibility and suitability with the validation of the framework. The main results obtained in the case study focus on the use of technology allied to Green IT, with theoretical reflexes for environmental quality and with possible cost reduction.*

**Keywords:** *Green IT, Information and Communication Technologies, Sustainability.*

---

## INTRODUCTION

Public administration, and particularly local administration (LA), is encumbered with a set of rules that make it particularly difficult to implement changes. On the other hand, the use of information and communication technologies (ICT) to support current activities is provoking a high rate of change in the business processes of an organization. Aligned with this, one should note that ecological considerations are a matter of social responsibility that has been gaining visibility in recent years. Green information technology (Green IT) is naturally associated with these themes (Chugh, Wibowo, & Grandhi, 2016), and can be the vehicle for achieving environmental sustainability.

Our concern is the governance of ICT in a local public administration scenario. In fact, there is a social responsibility that cannot be forsaken in the decisions and actions taken by enterprises and it is more so when local public administration is concerned. Having drawn a proposal of good practices that assure the governance of ICT while maintaining the alignment with green IT (Landum, Moura, & Reis, 2020), we then sought to reconcile the green information technology and green information systems perspectives. Having reviewed the state of the art of management practices (Landum, Reis, & Moura, 2020) in what concerns the optimization the governance of ICT a need was felt for a general model to evaluate alternative measures and quantify their suitability.

---

<sup>1</sup> Universidade do Algarve, Portugal, DEEI/FCT, Campus de Gambelas, Faro, 8005-139 Faro, Portugal

<sup>2</sup> Universidade do Algarve, Portugal, DEEI/FCT, Campus de Gambelas, Faro, 8005-139 Faro, Portugal

<sup>3</sup> Polytechnic Institute of Setúbal, Portugal, Campus do IPS, Estefanilha, Setúbal, Portugal

In the perspective of the author (Landum, 2018), the implementation and optimization of ICT management practices, in Local Administration (LA), should consider the reduction/optimization of costs, ubiquity, in the search for greater productivity, guaranteeing safety standards.

Considering a change, or a new process to be implemented, one can separately evaluate how that change will impact an ecological dimension. The literature is mostly unanimous considering that the ecological impact can be equated in terms of carbon footprint, reduction of the number of products for recycling and sustainable use of resources including energy. The evaluation on a social dimension translates to how a service is perceived by its end users. In our present case, one must consider the employees of the ICT department but also the citizens of the municipality. In what concerns the financial impact of a measure again it is twofold as one can distinguish direct and indirect costs and how they translate to the global welfare of the community. A preliminary model for a quantitative evaluation of the alignment with Green IT of a process or operating change is presented. Following this introduction, in the second section the impact of Green IT on LA is described, and in the third section, some final remarks and perspectives of future work are presented.

## **IMPACT OF GREEN IT ON LOCAL GOVERNMENT**

The section presents the theme of Green IT, and the way it has gained status taking into account the global movement that has developed, emerging with its environmental concerns, the problem of climate change, sustainability and the promotion of social and environmental responsibility, linked to technology. Currently the “Green technology plays a fundamental role in achieving the global sustainable development goals. However, the lack of a widely accepted classification system for green technology often hinders the development and adoption of green technology” (Guo, et al., 2020). The European Union (EU), in December 2019, launched the European Ecological Agreement, which states that “Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, Europe needs a new growth strategy that transforms the Union into a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases by 2050; economic growth is decoupled from resource use and no person and no place are left behind. The European Green Deal is our roadmap for making the EU's economy sustainable. This will happen by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all” (Commission, 2019).

The EU has defined as a strategy the launch of the green agreement and the aim is that by 2050 there will be no greenhouse gas emissions, currently “it is by no means certain our society has the capacity to endure – at least in such a way that the nine billion people expected on Earth by 2050 will all be able to achieve a basic quality of life. The planet’s ecosystems are deteriorating, and the climate is changing. We are consuming so much, and so quickly, that we are already living far beyond the earth’s capacity to support us” (ERM Group Company, 2020). The author (Sulaiman, Naqshbandi, & Dezdard, 2015) mentions that “This is a big challenge, and not just for business and economics. It is a call for massive social, political, technological, cultural and behavioral transition. We will need governments to set incentives, targets and rules for a level playing field, civil society actors to hold us to account and to experiment with new ways of delivering social impact”.

In the face of this challenge, it is necessary and evident that (Cai, Chen, & Bose, 2013) the adoption of practices and tools that allow the general management, being an increasing



occurrence in local public organizations. These organizations are shifting the paradigm from management to sustainability, and LA is developing its projects faster than other levels of the public sector, notably PA, regarding integrating environmental and sustainability aspects into operations and strategies. One of the ways to promote the implementation of such practices is "aware-ness of sustainable ICT practices can help organizations to adopt various strategies in developing effective sustainability work practices and educating their employees" (Chugh, Wibowo, & Grandhi, 2016). Aware of the situation, the municipality understudy, strategically embarked on the renovation of its aged computer park, adopting disruptive technologies, environmentally friendly and simultaneously self-sustaining. It should be highlighted that one of the objectives of environmental sustainability is to solve the current needs, without compromising the needs of future generations and this will only be possible if existing natural resources are not currently exhausted.

For the authors (Chugh, Wibowo, & Grandhi, 2016) environmental sustainability can be achieved through the adoption of correct practices in the design, manufacture, use and disposal of ICT. Green ICT, influenced by user practices or the use of appropriate technology to make the environment sustainable, should help reduce the environmental footprint of agencies, so (Moreno & Reis, 2012) they consider that the use of Information Systems (IS) as a means of supporting and improving the organization's activities is indisputable. IS are a key contribution to efficient resource management to achieve an organization's objectives. It should be highlighted that the future of ICT will increasingly be based on the vector of sustainability, therefore (Meneses, 2019) the numerous emerging technologies that characterize industry 4.0, namely artificial intelligence, internet of things (IoT), nano-technology, quantum computing, drones, 3D printing, blockchain, among others, will have uses increasingly focused on sustainability (i.e. on people, the environment and governance processes).

The Green IT approach is often combined with sustainability, knowing that the "Sustainable development is a widely debated issue around the world and there has been increasing pressure on firms to adopt practices that are more environmentally friendly. Among the most crucial practices are Green Information Technology (IT) practices, as most firms use some form of IT to perform their daily transactions" (Sulaiman, Naqshbandi, & Dezdar, 2015), i.e. supports your systems in IT solutions. The concept of Green IT is not equal to IT for Green, but it complements the two definitions "Green IT is the practice of designing, manufacturing, using and disposing of computer, servers and associated subsystems efficiently and effectively with minimal or no impact on the environment, with a strong focus on improving energy efficiency and equipment utilization through steps such as designing energy efficient chips, virtualization, reducing data center energy consumption, using renewable energy to power data centers, and reducing electronic waste" (Cai, Chen, & Bose, 2013), in the perspective of its authors. The concept of IT for Green is based on the "use of information systems to enhance sustainability across the economy, with a focus on IT as a solution" (Cai, Chen, & Bose, 2013).

In short, "local governments are faced with the need to be part of the change from the perspective of sustainability and integrate good practices to improve their own performance" (Cai, Chen, & Bose, 2013).

## **EVALUATING GREEN IT**

Organizations, more specifically LA, feel the need to find models of good ICT practices, which can simultaneously be sustainable, contribution to environmental improvement and align with Green IT, so a schematic plan of a developed Framework is presented, where in this article

only a few vectors will be addressed. We consider that evaluating the alignment with Green IT should include business objectives as well as productivity, reliability, service availability, optimization of management times, information security, cost reduction, environmental impact, and customer satisfaction.

Thus, we equate the alignment with Green IT (1)

$$\text{GreenIT Alignment} = 0.3 \text{ IT} + 0.2 \text{ Fin} + 0.3 \text{ Env} + 0.2 \text{ Soc} \quad (1)$$

considering the contribution of four dimensions, namely IT, financial (Fin), environmental (Env) and social (Soc).

It is thus necessary to distribute the contributing valences by the corresponding dimensions and to translate each of the valences to indicators. In each dimension, the relevant indicators are evaluated. The positive (+) or negative (-) value of the indicator will convey if it furthers or hinders the green alignment, respectively, and is presented in the direction column. The relative relevance of an indicator is conveyed by a weight (in %).

**IT valences:** Hardware, software, information systems, security, governance.

**Financial valences:** Direct and/or indirect costs of IT.

**Environmental valences:** Environmental impact including CO<sub>2</sub> emissions, use of natural resources, contribution to global warming, recycling.

**Social valences:** satisfaction of the citizen, speed of response, number of trips, time on the move, image of the municipality.

The IT dimension (IT) aggregates the indicators that convey the operational goals, namely, to optimize reliability, service availability, optimization of management times, information security and productivity (**Table 1**). The financial dimension (Fin) aggregates the indicators that relate to cost, either capital expenditure (CapEx) or operating expenditure (OPEX) (**Table 2**). The indicators included in the environmental dimension are presented in **Table 3**. The indicators considered in the social dimension convey social satisfaction with the services provided and the perceived image of the municipality (**Table 4**).

**Table 1.** IT indicators

Indicators	Direction	Weight factor
reliability	+	10%
management times	-	5%
service availability	+	10%
productivity	+	15%
quality management	+	5%
number of malfunctions	-	10%
information security	+	20%
ubiquity of access	+	10%
reduction of file space on digital support	+	5%
number of printing equipment's	-	5%
stock of consumables	-	5%

**Table 2.** Financial indicators

Indicators	Direction	Weight factor
cost of infrastructure	-	25%
equipment lifetime	+	20%
training	+	10%
energy costs	-	20%
number of printing equipment's	-	15%
consumable costs	-	10%

**Table 3.** Environmental indicators

Indicators	Direction	Weight factor
energy consumption	-	20%
CO <sub>2</sub> emissions	-	20%
preservation of natural resources	+	10%
suitability for recycling	+	5%
global warming	-	5%
paper file space	-	10%
paper use	-	5%
deforestation	-	15%
number of printing equipment	-	5%
stock of consumables	-	5%

**Table 4.** Social indicators

Indicators	Direction	Weight factor
satisfaction of the citizen	+	10%
image of the municipality	+	10%
well-being of employees	-	10%
time in the circulation of information	-	15%
speed in the response to the citizen	+	10%
number of trips to the service	-	10%
loss of time on travel	-	10%
travel costs to citizens	-	15%
service times	-	10%

Finally, the evaluation of a new process or the global activity will be qualitatively resumed as presented in

**Table 5.****Table 5.** Green IT Alignment

Nominal score	Qualitative score
$\leq 20\%$	Very little aligned
$>20\% \wedge \leq 45\%$	Little lined up
$>45\% \wedge \leq 75\%$	Aligned
$>75\% \wedge \leq 90\%$	Very aligned
$>90\% \wedge 100\%$	Strongly aligned

This model can be used to support strategic decisions and informed choice on changes such as substituting CRT monitors with LCDs, substituting desktop computers by thin clients or making services available online can be facilitated.

## CONCLUSION

The main conclusions focus on the presentation of indicators underlying the various dimensions towards the optimization of ICT management practices in LA to contribute to Green IT. The multidimensional and multidisciplinary Framework has implicitly the possibility of assigning weights allowing for the specificity of each LA thus contributing, in a sense of flexibility and suitability, to promote sustainability and contribute to Green IT.

About the impact of Green IT on LA, the paper presents several contributes in this area, particularly with regard to the quantification of the measures adopted, considering that the approximations to Green IT can be evaluated by the dimensions IT, Financial, Environmental and Social. It is also considered that it is added value that the dimensions under study are comprehensive to include several valences.

As perspectives of future work, it is intended to reflect on the scope of the dimensions under study as well as to analyze the indicators and relative relevance thus contributing to the creation of a quantitative model, applicable by PA and LA, to support the decision-making process while aligning with Green IT.

## REFERENCES

- Cai, S., Chen, X., & Bose, I. (2013). *Exploring the role of IT for environmental sustainability in China: An empirical analysis*. Retrieved: 28th September 2020, <https://www.sciencedirect.com/science/article/pii/S0925527313000480?via%3Dihub>
- Chugh, R., Wibowo, S., & Grandhi, S. (2016). *Environmentally sustainable Information and Communication Technology usage: awareness and practices of Indian Information and Communication Technology professionals*. Retrieved: 29th September 2020, <https://www.sciencedirect.com/science/article/pii/S0959652616304590>
- Commission, E. (2019). *A European Green Deal - Striving to be the first climate-neutral continent*. Retrieved: 15th September 2020, [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en)
- ERM Group Company. (2020). *Sustainability: Can our society endure?* Retrieved: 26th September 2020, <https://sustainability.com/sustainability/>
- Guo, R., Lv, S., Liao, T., Xi, F., Zhang, J., Zuo, X., Zhang, Y. (2020). *Classifying green technologies for sustainable innovation and investment*. Retrieved: 17th September 2020, <https://www.sciencedirect.com/science/article/pii/S0921344919304860>
- Landum, M. (2018). *Conceção de abordagem para otimização das práticas de gestão das TIC*. Retrieved: 17th September 2020, [https://repositorio.ipsantarem.pt/bitstream/10400.15/2634/1/eBook\\_CAPSI%202018\\_RicardoSaoJoao.pdf](https://repositorio.ipsantarem.pt/bitstream/10400.15/2634/1/eBook_CAPSI%202018_RicardoSaoJoao.pdf)
- Landum, M., Moura, M. M., & Reis, L. (2020). *Boas Práticas de TIC em alinhamento com o Green IT*. Retrieved: 22nd September 2020, CISTI'2020 - 15th Iberian Conference on Information Systems and Technologies: [http://www.aistic.org/cisti2020/oc20/modules/request.php?module=oc\\_program&action=summary.php&id=154](http://www.aistic.org/cisti2020/oc20/modules/request.php?module=oc_program&action=summary.php&id=154)

- Landum, M., Reis, L., & Moura, M. M. (2020). Concept of approach to optimize ICT management practices: State of the art. Em L. C. Carvalho, L. Reis, A. Prata, & R. Pereira, *Handbook of Research on Multidisciplinary Approach to Entrepreneurship, Innovation, and ICTs* (pp. pp. 174-199). IGI Global. doi:10.4018/978-1-7998-4099-2.ch009
- Meneses, J. W. (2019). *A sustentabilidade em 2019*. Retrieved: 26th September 2020, <https://www.bcsdportugal.org/noticias/a-sustentabilidade-em-2019>
- Moreno, J., & Reis, L. (2012). *Proposta de implementação de um portal corporativo - Caso Ana Aeroportos de Portugal, S.A.* Retrieved: 25th September 2020, [https://comum.rcaap.pt/bitstream/10400.26/30018/1/Proposta\\_Implementa%c3%a7%c3%a3o\\_Portal\\_Corporativo\\_Ana\\_Aeroportos\\_XXII\\_Jornadas\\_Luso\\_Espanholas.pdf](https://comum.rcaap.pt/bitstream/10400.26/30018/1/Proposta_Implementa%c3%a7%c3%a3o_Portal_Corporativo_Ana_Aeroportos_XXII_Jornadas_Luso_Espanholas.pdf)
- Sulaiman, A., Naqshbandi, M. M., & Dezdar, S. (2015). *Impact of adoption of Green IT practices on organizational performance*. Retrieved: 26th September 2020, [https://www.researchgate.net/publication/280949290\\_Impact\\_of\\_adoption\\_of\\_Green\\_I  
T\\_practices\\_on\\_organizational\\_performance](https://www.researchgate.net/publication/280949290_Impact_of_adoption_of_Green_IT_practices_on_organizational_performance)



# A NEW APPROACH IN QUANTIFYING USER EXPERIENCE IN WEB-ORIENTED APPLICATIONS

Vasilije Vasilijević<sup>4</sup> 

Nenad Kojić<sup>5</sup> 

Natalija Vugdelija<sup>6</sup> 

DOI:

---

**Abstract:** *The primary goal of every developer is to develop the highest quality web application. The quality of the application is not only a subjective assessment of the developer, but objective and representative criteria for measuring performance must be defined. Google provides a model called Web Vitals with a subset of core Web Vitals that are important for quantifying user experience on the web. Some of the metrics are LCP (Largest Contentful Paint, refers to loading), FID (First Input Delay, refers to interactivity) and CLS (Cumulative Layout Shift, refers to visual stability). This paper will present modern technologies and tools for measuring the performance of websites and analyze them on a real example of a web application. The analysis will include the use and measurement of the most important parameters: Lighthouse, PageSpeed Insights, Chrome DevTools, Search Console, web.dev's measure tool, the Web Vitals Chrome extension and Chrome UX Report API.*

**Keywords:** *Web sites, Measuring, Performance, Web Vitals*

---

## INTRODUCTION

Intensive development of the IT industry is a consequence of a large number of consumers of IT services. Such a drastic growth of IT services is primarily based on the improvement of network infrastructure, lower prices of hardware and Internet services. The large number of users who use an increasing number of services has led to the need to improve the entire network infrastructure and enable quality and fast transmission of signals and services (Velinov, 2020). This infrastructure is changing the way the Internet is used and now companies are primarily using websites as a way to present their services and products, and users to find them. A new concept of digital marketing is being created (Star, 2019) that suits new consumers and new ways of doing business. A large number of websites leads to the need for users to opt for some of the offered ones. The user's decision is based on their user experience and the experience that the site leaves them.

The information found on websites should be easily searchable, clear and accessible on different types of devices (Rosenfeld, 2015). Thus, the quality of content search has become extremely important (Drutsa, 2019) because it finds the user what he wants to get in return. The quality of the search is affected by the quality of the website and a large number of

---

<sup>4</sup> Academy of Technical and Art Applied Studies Belgrade - Department School of Applied Studies for Information and Communication Technologies, Zdravka Celara 16, Serbia

<sup>5</sup> Academy of Technical and Art Applied Studies Belgrade - Department School of Applied Studies for Information and Communication Technologies, Zdravka Celara 16, Serbia

<sup>6</sup> Academy of Technical and Art Applied Studies Belgrade - Department School of Applied Studies for Information and Communication Technologies, Zdravka Celara 16, Serbia

techniques and activities are needed for the website to be SEO optimized, and thus have a better position in web search engines (Patil, 2020). In addition to the technical parameters that indicate the quality of the website, one of the key roles is the impression of the user after his arrival on the site. The quality of the user experience is key to the long-term success of any website. The quality of the user experience is based on performance that can be classified and analyzed in a number of ways. A large number of authors have contributed to the development of various tools and techniques for measuring user experience (Castaneda, 2007) and this process is constantly evolving.

For this reason, Google has created a model for providing development guidelines to developers in the process of designing and building web applications, which are extremely important for providing an adequate user experience on the web. This model is called Web Vitals ([www.web.dev/vitals](http://www.web.dev/vitals)). The indicators defined in this way are an empirical measure of the actual user experience that Google analyzes and which are based on the key needs of users: page loading speed, application interactivity, stability, content experience, etc.

In this paper, a set of specific factors called Core Web Vitals will be presented, which represent a general picture of the experience of web pages from the user's perspective, as well as techniques and tools for measuring them. The selected factors will be explained and implemented in a real web application in order to indicate the way in which it is possible to achieve optimal performance of a website.

The work is organized through four chapters: After the Introduction, a selected set of Core Web Vitals factors will be presented. The chapter results will show the quality of their implementation on a real website and at the end will give a conclusion and further guidelines in the work.

## CORE WEB VITALS

As already mentioned, Core Web Vitals are a subset of Web Vitals that are used to measure specific aspects of the user experience when visiting a website. These parameters can be measured and displayed in a large number of Google tools. In this paper, some of them that the authors consider the most important and which in their practice give the most important results of the user experience will be performed.

**LCP (Largest Contentful Paint)** is the largest content color related to reading (loading) and measurement time when the most effective content of the page is probably displayed. The satisfaction of the range in which the largest page contents should be displayed is from 0 to 2.5 seconds from the first start of loading the pages.

**FID (First Input Delay)** represents time needed for web page to respond to user action. It means, when page is loading, and user tries to communicate with page through some action (e.g. button click), browser starts to count time needed to handle user request, and that time is called FID. If possible, that time should be less than 100 milliseconds.

**CLS (Cumulative Layout Shift)** is a cumulative layout shift that represents quantity of shift related to elements in a viewport of a web page. If we want, the user not to experience a bad experience in terms of content stability, the CLS should be less than 0.1.



**L (Lighthouse)** is a tool built in Chrome DevTools that serves for detection of problems that web developers are facing when it's about Core Web Vitals, Progressive Web Apps, Best Practices, Accessibility and Search Engine Optimization in development environment. It provides possibility to generate report based on these categories to get a deeper explanation of every problem, with tips on how to improve every metric. Report can be generated for both mobile and desktop results. In order for the measurements to be credible, it is necessary to open the Lighthouse in Incognito mode.

**LCI (Lighthouse CI)** allows measurements on pull requests before merge and deployment are done.

**SC (Search Console)** is a platform that provides traffic data from Google and helps developers to detect pages on their website that needs to be improved, based on that data. When SC generates report for every page, then PSI (Page Speed Insights) can be used to show opportunities to improve poor performance pages.

**PSI (PageSpeed Insights)** tool allows developers to enter page URL in order to get results of Core Web Vitals metrics. It is based on real traffic data and perspective of users that are visiting page, and also on lab data because Lighthouse is incorporated in generating report, so report looks similarly, with opportunities for optimization and steps that were passed through generating report. Performance result is expressed in percentiles. Best performance result is between 90-100 percentiles. PSI is good when there is a need to share results of metrics with someone, and also when only performance results are needed.

**CUXR (Chrome UX report)** uses Core Web Vitals data of real users on your or competitors' website. So, main purpose is to help developers to realize how users are experiencing pages by tracking metrics of loading, interactivity and stability. That tracking is called RUM (Real User Monitoring). Developers enter URL and get raw API results from previous 28 days. If they have a pretty basic knowledge of SQL, they can query that results based on different parameters on Google BigQuery database. Difference between CUXR and PSI and Lighthouse is that CUXR does not provide list of issues that you can fix. With CUXR, if there is a need for data visualization, using CUXR Dashboard it's very easy to represent results visually with charts. Dashboard is provided by Data Studio and it connects result data on BigQuery, eliminating needs to create charts manually.

**CDT (Chrome DevTools)** are tools that mostly every developer uses in development process. In Performance panel, now layout shift can be identified in an Experience section. By selecting Layout Shift there are further information about shifts detected, and if there is a need to see which element caused shift, get mouse over "Moved from" and "Moved to" fields. Also, on the bottom of the Performance panel, there is an information about TBT (Total Blocking Time) which is related to FID.

**WDMT (web.dev Measure Tool)** is also a tool that uses Lighthouse to generate report about Core Web Vitals. The procedure is the same, provide URL of your page, and get metrics and tips that tell you about fixing issues.

**WVCE (Web Vitals Chrome Extension)** is available in Chrome Web store. It can be added to Chrome and used for measuring vitals on website including LCP, FID and CLS. When it's installed, user need to navigate to URL that wants to measure, and after that, badge icon

provided by extension will update to red or green, depending on metric result. Clicking the icon, user can see further details about every metric.

**WVJSL (Web Vitals JavaScript Library)** is a way of measuring Web Vitals using JavaScript API. Library is imported into project with three functions for getting LCP, FID and CLS. To that functions, developer can pass custom function to send results to database or to do whatever he wants. This way of measuring matches with all above mentioned tools.

**I0 (Image Optimization)** The main problem with poor performance is always related to the images that are used and which are the most difficult type of resource. Image optimization started by reducing the weight of the images. JPEG 2000 progressive and WebP format are used for that. With them, incredible savings in image weight is achieved. You should be careful with the WebP format because it is not supported in all browsers, so use the JPEG format just in case. Images that are important for uploading are uploaded to the CDN. It is recommended that all images be on the CDN as well but in this example the other images are hosted locally. Depending on the device, media queries for images of different sizes are used. Lazy loading images technique is used to defer images outside the viewport. Using lazy sizes, the off-screen image storage is accomplished. It is also possible to defer images loaded via CSS using lazy sizes bgset.

**FM (File minification)** CSS and JS were minified. Gulp is used to minify these files. It is also possible to do this via online tools or WebPack using e.g. css-mini-extract-plugin for css minification. Unused CSS is removed using the purgecss tool. It is necessary to give the path to the desired CSS file as a parameter, and the output is cleared CSS from parts that are not used. The important thing is if you use Bootstrap to clean the file from classes that you do not use. Unused JS and CSS can be found in Google Chrome DevTools, the Sources tab in the Coverage tab. You can start recording and interact with the whole page, and finally see which parts of the code are not used, and delete those parts.

**GC (Gzip compression)** Compression was performed on the server. In addition to gzip, you can also use Brotli.

**TPR (Third-party resources)** For the resources, attributes `rel = "preconnect"`, `rel = "preload"` or `rel = "dns-prefetch"` are added.

**RBR (Resources that block rendering)** CSS resources that block rendering are removed.

**CRP (Critical render path)** A critical render path needs to be done. Critical CSS is detected using a tool called PentHouse. It is best to put critical CSS in the style tag in the head section, to get improved FCP improved.

**C (Caching)** Asset caching has been done, which does not change often on the server.

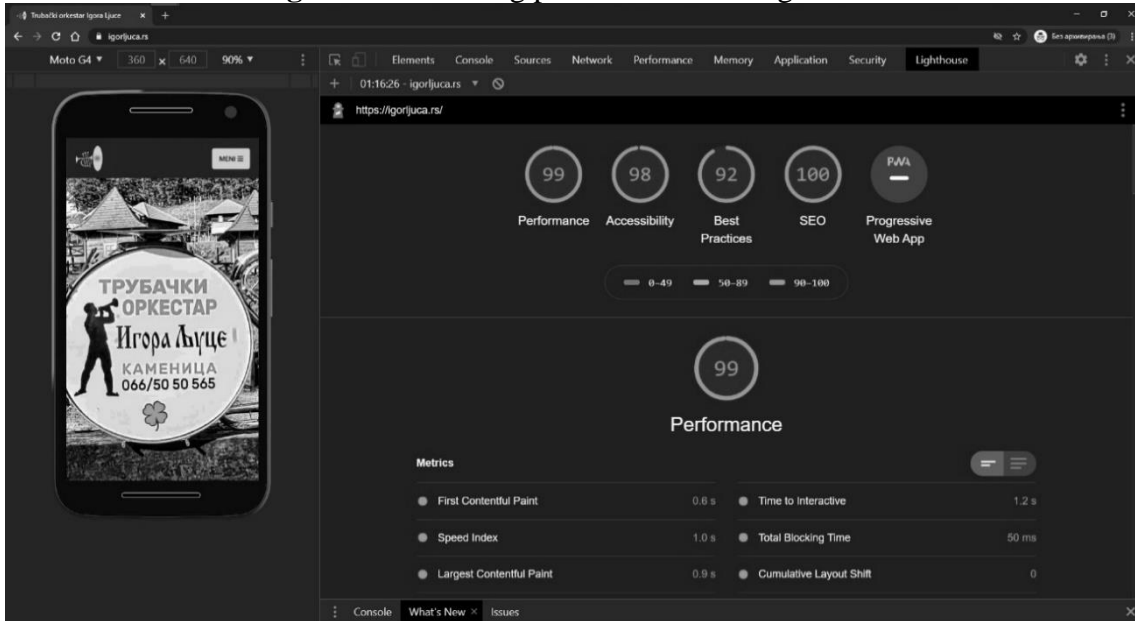
**DSBR (Delay scripts that block rendering)**

Resources that block rendering can be deferred as needed to avoid blocking the main thread. It is also necessary to add `async` if we want the script to be downloaded asynchronously.

## RESULTS`

**Use case 1** - Example of measuring performances in Lighthouse. When we want to use Lighthouse, we should go to webpage that we want to test, in Incognito mode, and with Right Click go to Inspect Elements. Now, we should navigate to the Lighthouse Tab in DevTools menu on the top.

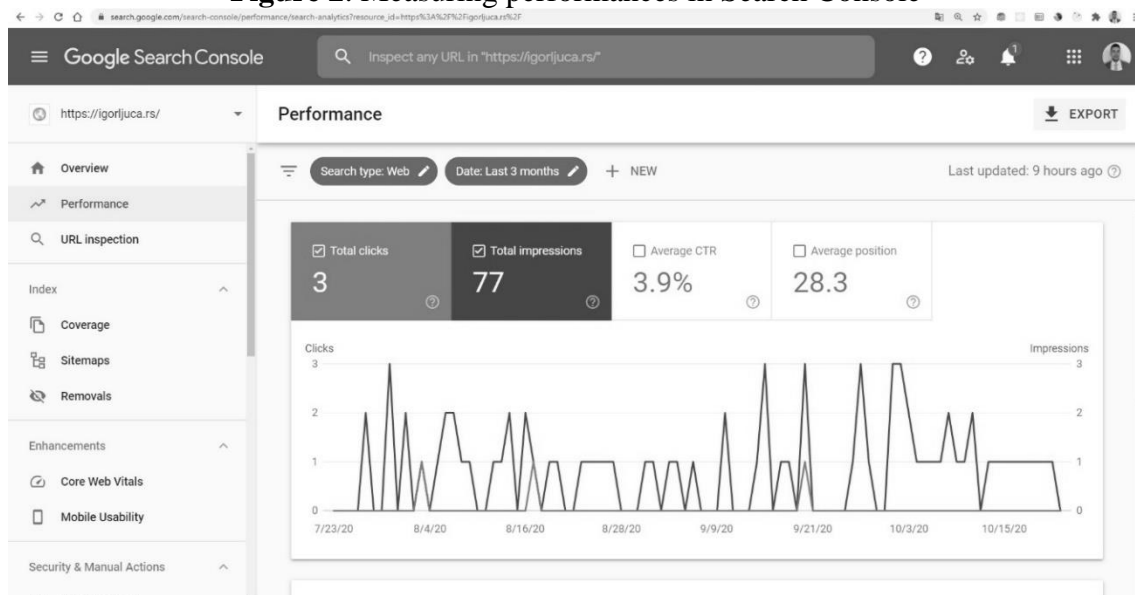
**Figure 1.** Measuring performances in Lighthouse



When we got to the Lighthouse, we can choose categories that we want to measure. For our case, we will select Performance category, then click to Generate Report. After that, we are getting results of measuring as it is displayed on the Figure 1.

**Use case 2** - Search Console is used to identify pages that need to be more optimized for users. Also, we can see much more information about our website, e.g. performance, mobile usability, sitemaps, coverage, removals... This is shown on Figure 2.

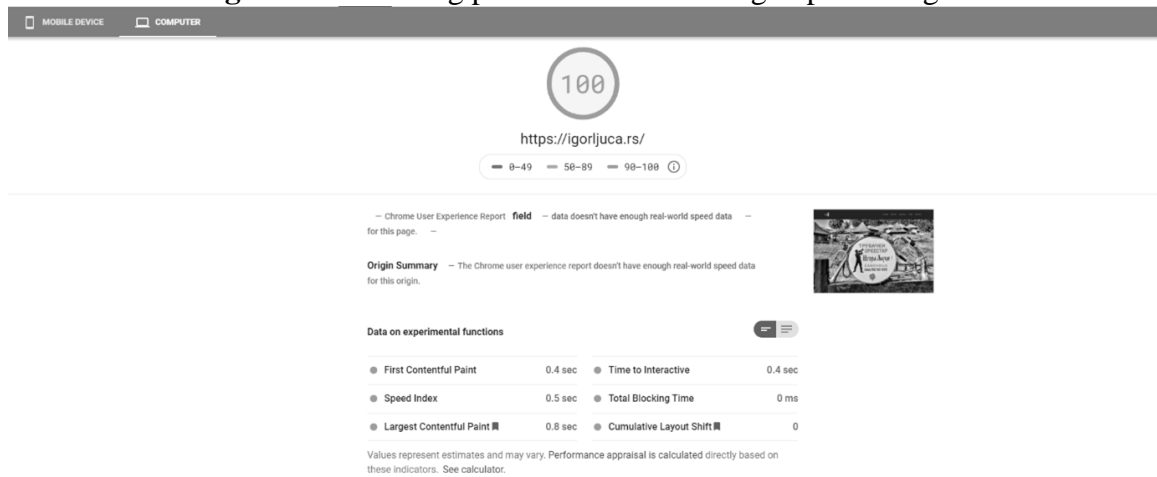
**Figure 2.** Measuring performances in Search Console



Search Console Core Web Vitals section use CUXR to get data about user experience on our page.

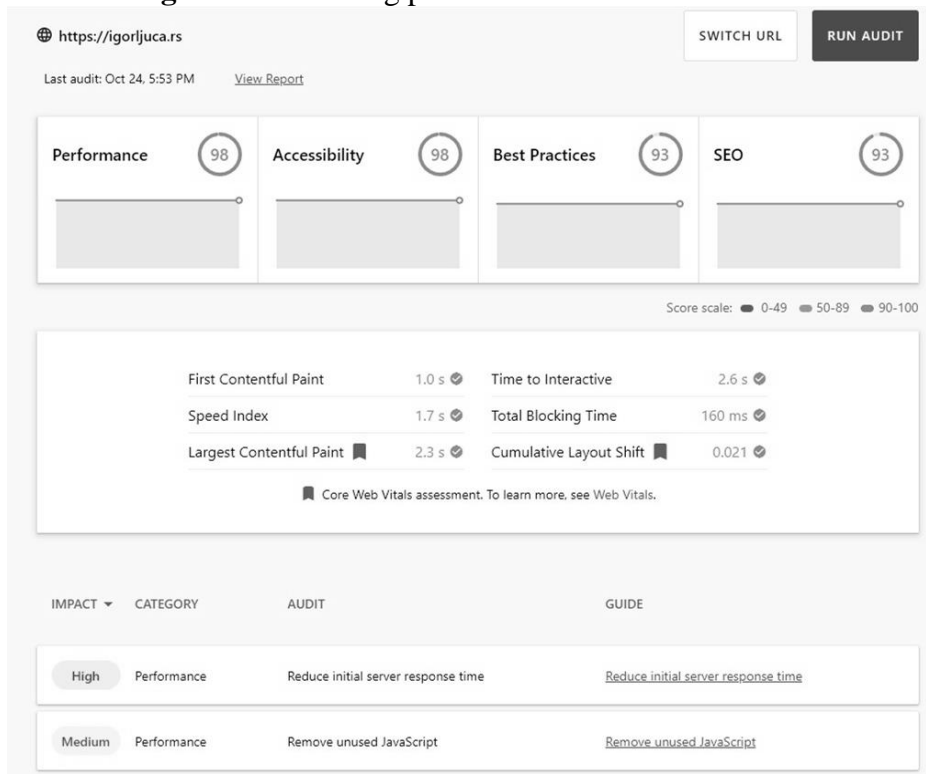
**Use case 3** – Another example of performance measuring is with PageSpeed Insights. Unlike Lighthouse, here we have real data based on our user experiences. Only thing that we have to do is to provide URL of your webpage and to type it in input field. Then click Analyze and see metrics that Google collects from our users, with opportunities how to more optimize our performance and information about passed audits as shown in Figure 3.

**Figure 3.** Measuring performances with Page Speed Insights



**Use case 4** – If we want to measure Web Vitals on Google web.dev site we can simply go to their website [web.dev/measure](https://web.dev/measure) and type URL that we want to inspect. Displayed result on Figure 4 are similar to Lighthouse and PageSpeed Insights.

**Figure 4.** Measuring performances with web.dev site



**Use case 5** – This is example of Chrome DevTools Performance Panel where we can detect Layout Shift and Total Blocking Time on our page, Figure 5.

**Figure 5.** Measuring performances od Layout Shift and Total blocking Time



If we go to DevTools, then go to Performance Tab we should click Record. After that, refresh our page and stop recording. We will see Layout Shift if exist and in Summary tab we can get more information about shift Location. Total Blocking Time is displayed in footer of Performance Tab.

All these examples show a part of the possibility of advanced application of measuring the user experience of web applications, and in addition to the above, many others can improve the quality of the final evaluation of the website.

## CONCLUSION

This paper presents a set of factors that are an integral part of Core Web Vitals. These factors represent an empirical indicator of user experience when evaluating websites and are available in a number of Google tools. As there are a large number of factors that affect the overall user experience, this paper singles out only some that the authors considered to be the most important and given explanations, methods of use and results of their application in a test example of the website.

In general, the results that can be measured are primarily the quality of work of web developers who participated in the creation of the website. These indicators are highly correlated with the attention that developers analyze in the user experience. A large number of applications do not have enviable results and these tools can contribute a lot to paying more attention to these parameters when they can be easily measured and analyzed.

Further work will be focused on the implementation of additional factors and improving the user experience of web applications.

## REFERENCES

- Castaneda J. A. & Muñoz-Leiva F.& Luque T. (2007). Web Acceptance Model (WAM): Moderating effects of user experience, *Journal of Information & Management* Vol. 44, Is. 4, (pp. 384-396), Elsevier.
- Drutsa, A., Gusev, G., Kharitonov, E., Kulemyakin, D., Serdyukov, P., & Yashkov, I. (2019, July). Effective Online Evaluation for Web Search. In *Proceedings of the 42nd International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 1399-1400).
- Karthikeyan, R., Michael, G., & Kumaravel, A. (2017). A HOUSING SELECTION METHOD FOR DESIGN, IMPLEMENTATION & EVALUATION FOR WEB BASED RECOMMENDED SYSTEMS. *International Journal of Pure and Applied Mathematics*, 116(8), 23-28.
- Patil, S. A. (2020). Comparative SEO Techniques Analysis on core WebPages and its Effectiveness in Context of Google Search Engine, *International Journal of Scientific Development and Research*, Vol 5, Is.3 (pp. 420-428)
- Rosenfeld, L. & Morville, P. & Arango, J. (2015). *Information Architecture: For the Web and Beyond*, O'Reilly Media.
- Star, D. (2019). *Digital Marketing 2020: Grow Your Business with Digital Marketing*, Kindle Edition
- Velinov, V. (2020). *MODERN NETWORK ARCHITECTURES NETWORK AND SYSTEM PROTECTION*, Kindle Edition
- [www.web.dev](http://www.web.dev)

# COMPARATIVE ANALYSIS OF WEB APPLICATION PERFORMANCE IN CASE OF USING REST VERSUS GRAPHQL

Milena Vesić<sup>7</sup>   
Nenad Kojić<sup>8</sup> 

DOI:

---

**Abstract:** *Web applications are the most common type of application in modern society since they can be accessed by a large number of users at any time from any device. The only condition for their use is an Internet connection. Most applications run using the HTTP protocol and client-server architecture. This architecture is based on the use of API (Application programming interface), most often REST architecture (Representational State Transfer). If there are several different functionalities on the website that fill their content with data from the web server, for most of them a special HTTP request must be generated with one of the existing methods (GET, POST, PUT, DELETE). This way of communication can be a big problem if the connection to the Internet is weak, there are a lot of HTTP requests because you have to wait for each request to be executed and for the web server to return the data. In this paper, one implementation of GraphQL is presented. GraphQL is an open-source data query and manipulation language for APIs. GraphQL enables faster application development and has less server code. The key advantage is the number of HTTP requests because all the desired data of the page is obtained with one request. This paper will show a comparative analysis on the example of a real website in the case of using the REST architecture and GraphQL in the case of different qualities of Internet connections, code complexity and the number of required requests.*

**Keywords:** *Web page, GraphQL, REST, Performance.*

---

## INTRODUCTION

Web applications are popular solutions today, because they can be accessed at any time, from anywhere, from computers or mobile devices, and they can be accessed as well as Internet pages using a Web browser (Kalmanek, 2010.). Web applications work on the principle of client-server communication. The client communicates with the server using the HTTP protocol (Fielding, 1998.), and in most cases using REST (Neumann, 2018.) for Uniform Resource Identifier (URI). The evolution of Web applications and programming languages has led to the evolution of communication between client and server (Kalmanek, 2010.). Certainly, the API enables this communication, but not necessarily using the REST architectural style (Neumann, 2018.). The paper will describe GraphQL (Freeman, 2019.) as a query language for APIs that allows clients to request what they need and nothing more than that data. GraphQL is not tied to a specific database or storage mechanism, but supports existing code and data.

---

<sup>7</sup> Academy of Technical and Art Applied Studies Belgrade (ATUSS) - Department School of Applied Studies for Information and Communication Technologies Belgrade, Zdravka Celara 16, Serbia

<sup>8</sup> Academy of Technical and Art Applied Studies Belgrade (ATUSS) - Department School of Applied Studies for Information and Communication Technologies Belgrade, Zdravka Celara 16, Serbia

Web applications can be implemented in one of two basic ways: server-side rendering and client server architecture. This is independent of which programming language is used, which technology or code writing architecture. Recently, the client-server architecture is becoming increasingly popular, which is further supported by the great popularity of front-end frameworks for programming client-side programming languages.

HTTP request/response (Fielding, 1998.) plays a key role in such communication. The user experience is based on the design of the application, the content and the speed of the application. The speed of the application is mostly based on the number of HTTP requests and the amount of content that is exchanged through them. For this reason, from the point of view of the speed of application and user experience (Neumann, 2018.), the number of HTTP requests needs to be minimized as much as possible. On the other hand, SEO techniques and web application quality assessment by the web search engine also expect a reduced number of HTTP requests.

The required reduction leads to the need to either change the way the code is written and the individual HTTP requests to the group. This is possible to some extent because the logic by which the related data is conditionally retrieved requires sequentiality in the work.

Therefore, reducing the number of HTTP requests is only possible (Neumann, 2018.). The possible solution is therefore not sought in technologies for reducing requests, but in changing the way of organization and data structure that is returned from the server side to the client part of the web application. GraphQL is therefore one of the candidates that can change this (Freeman, 2019.).

The possibilities of GraphQL will be analyzed in this paper using comparative analysis in relation to the classic REST way of communication of the client part of the web application with the server (Brito, 2020.). This will be observed in relation to different Internet speeds, the volume of data in the database in terms of the number of records in the tables and the number of generated HTTP requests and the time required to implement these requests on the client part of the application.

This paper is organized through four chapters: After the Introduction where the basic ideas and goals are given, the second chapter gives the key features of GraphQL that are basic for its implementation and represent some of the key features that provide developers the ability to implement them better than classical REST form of communication. The third chapter describes the methodology of the observed empirical results, which compares the use of GraphQL and the classical REST form of communication with the server in different operating conditions. Finally, a conclusion and further guidance in the investigation.

## **GRAPHQL**

GraphQL is a query language for APIs (Application programming interfaces) and "server runtime" for executing these queries with existing data (Freeman, 2019.).

The way applications are created has been evaluated in the last twenty years, the biggest change being perhaps the "single page" applications running in the Browser, unlike the earlier multi-page applications running on the server. And for client-server communication, the REST (REpresentational State Transfer) architectural style is still mostly used. REST uses the HTTP (HyperText Transfer Protocol) transmission protocol and the Uniform Resource Locator



(URL) addressing mechanism. It communicates with resources using HTTP methods (GET, POST, PUT, DELETE) to send, retrieve, delete and update.

Using the REST architectural style to display data in different blocks of a single page application, it would be necessary to send multiple HTTP requests (Brito, 2020.). The following image shows an example of how many requests would be forwarded to the server to display all the data on the Gmail homepage. Each block (marked in green) would be populated with data that would be obtained as a single response for each HTTP request.

This way of communication can be a problem if the connection to the Internet is bad, because you have to wait for each request to be executed and for the server to return the data. The difference between REST architectural style and GraphQL is precisely in the number of requests (Brito, 2020.), GraphQL would get all this data by sending one request.

Another advantage is that GraphQL only retrieves the required data. It enables faster application development, has less server code because GraphQL is a layer between the client and the server that does not allow "bad" requests to reach the server side.

GraphQL is not tied to any specific database (Brito, 2019.), it doesn't even have to work with a database.

The GraphQL service is created by defining the types and fields of those types, as well as creating functions for each field and each type (<https://graphql.org/learn/>). When the GraphQL service starts, it can receive queries that it validates and executes. The received query is first checked to ensure that it refers only to defined types and fields, and then a function is run to get the result.

In addition to these feature keys, GraphQL has several very important features that give it a very significant competitive advantage, some of which are (Freeman, 2019.):

- GraphQL addresses the server looking for the values of the explicitly specified object fields. Unlike SQL where asterisk (\*) can be used to select all columns of a table, GraphQL does not have this option, but only those fields whose values are needed are listed.
- The way they communicate (client-server) is not explicitly specified. The SSH, FTP, Web Socket, or HTTP method can be used as the most common mode for the transport mechanism.
- Each query can have an operation type (query or mutation) and an operation name. If they are not specified, then the type of operation will be query, which means that data is required from the server. Operation names are optional, but make the code more readable and easier to debug.
- The server response always corresponds to the request format which is a characteristic of GraphQL. The values required do not have to be simple data types (scalar data types - String, Integer, Float, Boolean or ID), but the value can be an object or a string (complex data types).
- When sending a query, arguments can also be passed. For example, if there is a need to display data for a specific person, then the ID of that person by whom his record is unique can also be forwarded by query.
- GraphQL allows you to send a set of arguments when sending a query, that is, each field nested inside the object can have its own arguments.

- In a system such as REST, only one set of arguments can be passed - query parameters and the URL segment in the request. In GraphQL, each field and nested object can get its own set of arguments, making GraphQL a complete replacement for creating multiple data retrieval APIs. Arguments can even be passed to scalar fields to implement data transformations once on the server, instead of on each client separately.
- Because the result fields match the field name in the query, but do not include arguments, the same field with different arguments cannot be requested directly. That's why aliases are needed - they allow you to rename a field result to anything.
- Fragments are reusable units, that is, a list of fields of a certain type. When there is a need to search for the same group of data in a query, then fragments are created. If fragments were not used in the query, there would be code repetitions. The snippet concept is often used to break complex application data requirements into smaller parts, especially when many UI components have to be combined with different fragments into one initial data set.
- Union is a complex data type. It is used in situations where the server is expected to return results of different types for the search term. It can be compared to if else flow control. It is most often used in searches.
- Working with arguments and their values in most web applications means that these values are dynamic, not "hardcoded".
- It would not be good to pass dynamic arguments directly to a query array, because then the client-side code would have to dynamically manipulate the query array during execution and serialize it into a GraphQL-specific format. Instead, GraphQL has a first-class way to factory-process dynamic values and pass them as a separate dictionary to variables.

**Directives:** Directives allow us to dynamically change the structure and form of queries using variables. The directive can be added to a field or fragment and can affect the execution of the query in any way the server wants. The core GraphQL specification includes exactly two directives that must be supported by any GraphQL server implementation that complies with the specifications:

- @include (if: Boolean) The field is included in the result only if the argument is true.
- @skip (if: Boolean) The field is skipped if the argument is true.

Directives can be useful for getting out of situations where otherwise string manipulation would have to be done to add and remove fields in the query. Server implementations can also add experimental features by defining completely new directives.

**Mutations:** One important thing is addressed to mutations. Mutations are a type of operation that is used when it is necessary to change the data on the server, or when writing, modifying or deleting data.

The difference between queries and mutations is that the functions called by the query are executed in parallel, while the fields called in the mutation are called one after the other. Although changes to the server can be made by sending a query, it is better to use mutations because it is by convention.

**Errors:** Using REST architectural style the result of the request is either 100% success or 100% failure. In GraphQL, queries are executed partially, that is, part of the queries will be executed successfully regardless of the need for a field that cannot receive a response from the server. In the answer, in addition to the requested data, the property of errors for the requested field

whose data cannot be returned is also obtained. The reason for this is that REST uses multiple requests, while GraphQL uses one.

Checking whether the request was successfully executed using the REST architectural style was done by checking the status code, and if the code would start with the number 2, then the request was successfully implemented. Using GraphQL the status code will start with the number 2, but it may happen that part of the query is not successfully implemented. Errors are processed by checking to see if there is an error property in the response.

This type of error occurs when the search box server is disabled. If the field name is changed to start with a capital letter P, the answer will be different because something that does not exist is required.

**Scheme:** GraphQL services can be written in any language. Because it cannot rely on a specific programming language syntax, such as JavaScript, GraphQL uses a schema language. The language of the GraphQL schema is similar to the query language. If the types that will be used in the application are not known, by setting a query for the `__schema` field, which is always available in the basic query type, a list of defined types is obtained.

Some of important things are also addressed to the queries. We can view each field in the GraphQL query as a function or method of the previous type that returns the next type. In fact, GraphQL does just that. Each field on each type has a function called a resolver provided by the GraphQL server programmer. When the field is executed, the corresponding resolver is called to produce the next value. At the top level of each GraphQL server is a type that represents all possible entry points in the GraphQL API, often called the Root or Query type. As each field is resolved, the resulting value is placed in the key / value folder with the field name (or alias) as the key, and the resolved value as the value. This continues from the bottom query field all the way to the original query root type field.

**Resolve:** "Resolve" functions are like small routers. They determine how the types and fields in the schema are connected on the server side. GraphQL "resolve" functions can contain arbitrary code, which means that the GraphQL server can communicate with any type of server code, even with another GraphQL server. For example, the Person type can be stored in an SQL database, while the City type can be stored in MongoDB, or it can even be serviced by a micro service.

Perhaps the biggest feature of GraphQL is that it hides all server complexity from the client. No matter how many server pages the application uses, all the client will see is one GraphQL endpoint with a simple self-documenting API for the application.

## RESULTS

An example of two web-oriented applications is shown to show the difference when using REST architectural style and GraphQL.

Both data storage applications use the PostgreSQL version 11.4 database. The graphical interface pgAdmin version 4.24 was used for data manipulation.

A web application that uses GraphQL as a query language, i.e. a way of communicating between the client and server side, uses the Node.js version 10.15.3 executable as support for

the server part of the code, while GraphiQL, the reference implementation of GraphQL IDE, is used to test servers and queries.

REST architectural style is applied in a web application that uses AJAX requests for client-server communication, i.e. requests are created in the client part of the application in JavaScript programming language, while PHP is used as the server programming language.

Both applications should display all the data from the database on the application's home page, with different client-server communication technologies having a different number of requests to the server.

Using GraphQL, no matter how many records there are in the database, the number of requests will always be one, while using the REST architectural style, the number of requests differs depending on how many records there are within the tables. This happens because one collection of data, which was received in response to an HTTP request, i.e. its element has its own data collection for which it is necessary to send a new HTTP request to the server.

Results of comparison of REST and GraphQL in the execution speed of requests at different flow rates in examples with 10 and 100 records per table in the database. In the example with 10 records per table, using REST architectural style the number of requests is 12, while in the example with 100 records, the number of requests is 102. Using GraphQL in both examples the number of requests is 1.

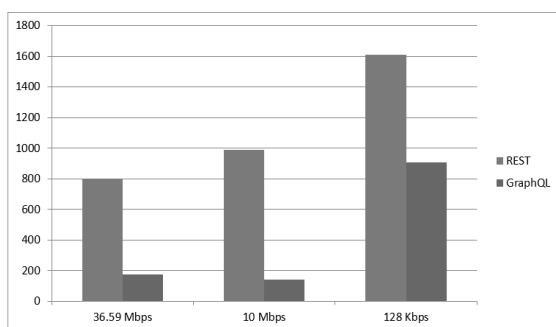
**Table 1.** Execution time of requests for different flow rates with 10 records per table

Flow rate	REST	GraphQL
36.59 Mbps	802ms	174ms
10 Mbps	988ms	139ms
128 Kbps	1.61s	907ms

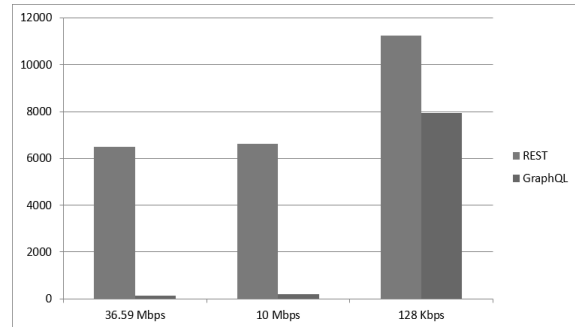
**Table 2.** Execution time of requests for different flow rates with 100 records per table

Flow rate	REST	GraphQL
36.59 Mbps	6.48s	122ms
10 Mbps	6.63s	210ms
128 Kbps	11.25s	7.93s

**Figure 1.** Execution speed of requests at different flow rates with 10 records per table in the database



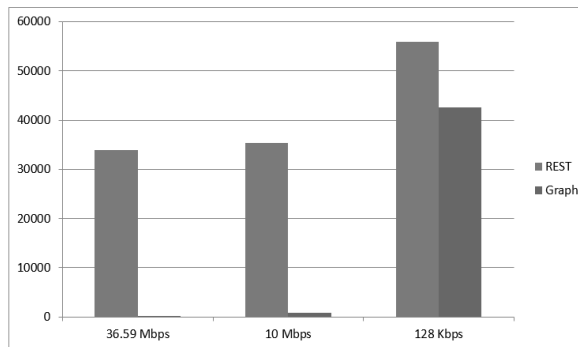
**Figure 2.** Execution speed of requests at different flow rates with 100 records per table in the database



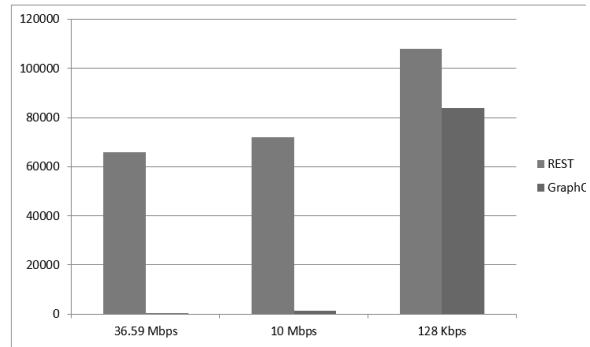
Results of comparison of REST and GraphQL in the execution speed of requests at different flow rates in examples with 500 and 1000 records per table in the database. In the example with 500 records per table, using REST architectural style the number of requests is 502, while

in the example with 1000 records, the number of requests is 1002. Using GraphQL in both examples the number of requests is 1.

**Figure 3.** Execution speed of requests at different flow rates with 500 records per table in the database



**Figure 4.** Execution speed of requests at different flow rates with 1000 records per table in the database



**Table 3.** Execution time of requests for different flow rates with 500 records per table

Flow rate	REST	GraphQL
36.59 Mbps	33.98s	211ms
10 Mbps	35.32s	777ms
128 Kbps	55.96s	42.66s

**Table 4.** Execution time of requests for different flow rates with 1000 records per table

Flow rate	REST	GraphQL
36.59 Mbps	1.1min	352ms
10 Mbps	1.2min	1.37s
128 Kbps	1.8min	1.4min

## CONCLUSION




This paper presents the possibilities of GraphQL and the possibilities of reducing the number of HTTP requests if it is used and compared with REST technology. The real conditions of different faster Internet connections, different number of records in the database and all this from the angle of the total time required to show the user the desired content in the website are analyzed. It has been shown that the use of GraphQL achieves a large reduction in the total time and number of HTTP requests, which is very important for the user experience and the quality of the web application. Further work will focus on analysis with a larger number of tables and records in the database and implementation with different front-end frameworks.

## REFERENCES

- Brito, G., & Valente, M. T. (2020, March). REST vs GraphQL: A Controlled Experiment. In 2020 IEEE International Conference on Software Architecture (ICSA) (pp. 81-91). IEEE.
- Brito, G., Mombach, T., & Valente, M. T. (2019, February). Migrating to GraphQL: A practical assessment. In 2019 IEEE 26th International Conference on Software Analysis, Evolution and Reengineering (SANER) (pp. 140-150). IEEE.
- Fielding, R., & Gettys, J. (1998). Hypertext Transfer Protocol-HTTP/1.1.
- Freeman, A. (2019). Understanding GraphQL. In Pro React 16 (pp. 679-705). Apress, Berkeley, CA.
- Introduction to GraphQL, <https://graphql.org/learn/>

- Kalmanek, C. R., Misra, S., & Yang, Y. R. (Eds.). (2010). *Guide to reliable Internet services and applications*. Springer Science & Business Media.
- Porcello, E., & Banks, A. (2018). *Learning GraphQL: declarative data fetching for modern web apps*. " O'Reilly Media, Inc."
- Neumann, A., Laranjeiro, N., & Bernardino, J. (2018). An analysis of public REST web service APIs. *IEEE Transactions on Services Computing*.
- Sud, K. (2020). Understanding REST APIs. In *Practical hapi* (pp. 1-11). Apress, Berkeley, CA.

# USE OF “OWASP TOP 10” IN WEB APPLICATION SECURITY

Nikola Nedeljković<sup>9</sup>   
Natalija Vugdelija<sup>10</sup>   
Nenad Kojić<sup>11</sup> 

DOI:

---

**Abstract:** *Web application security vulnerabilities can lead to various attacks on users, some of which can have major consequences. It is important to point out the weaknesses that allow abuse, because often increased risk awareness is the first step in protecting web applications. Some of the most critical security risks that organizations face today have been analyzed and uncovered using OWASP Top 10. This paper presents concrete examples of attacks and abuse of web applications. Through the implementation and analysis of attacks on web applications, weaknesses that need to be eliminated in order to protect against potential new attacks are identified. Especially, suggestions to help protect web applications from each type of attack listed and described are provided.*

**Keywords:** *Web Security, Web Attack, Weaknesses Of The Web Application.*

---

## INTRODUCTION

Nowadays, with many jobs being done online to prevent the spread of Covid-19 virus infection, the importance of web application security has increased even further. Normally, a successful business requires some kind of interaction – with other users or with back-end databases, which could be susceptible to attacks. As stated by Alzahrani, Alqazzaz, Zhu, Fu and Almashfi (2017) “threats may compromise web applications’ security by breaching an enormous amount of information, which could lead to severe economic losses or cause damages” (p. 237). In addition to reliable transmission systems and secure communication, another matter of great importance is application-level web security, which, according to Scott, Sharp (2002) “refers to vulnerabilities inherent in the code of a web-application itself (irrespective of the technologies in which it is implemented or the security of the web-server / back-end database on which it is built)” (p. 396). The communication chain that connects end users is as secure as its weakest link. Therefore, it is important to identify any vulnerabilities that may lead to abuse during a multimedia session and to provide secure and reliable communication with appropriate security services and mechanisms. Connecting to a global, public network requires a global approach to using web applications safely, as is noted by Andrian, Fauzi (2019) “application security must be applied to all infrastructure that supports web applications, including the web application itself.” (p. 68). The greater the number of significant transactions performed over the Internet, the more motivated hackers are to carry out an attack. According to Rafique, Humayun, Gul, Abbas, Javed (2015) “hackers in recent years are increasingly targeting web applications, since most networks are closely

---

<sup>9</sup> Enreach Labs, Omladinskih brigada 90 V, Belgrade, Serbia

<sup>10</sup> Academy of Technical and Art Applied Studies Belgrade (ATUSS) – Department ICT College for vocational studies, Zdravka Čelara 16, Belgrade, Serbia

<sup>11</sup> Academy of Technical and Art Applied Studies Belgrade (ATUSS) – Department ICT College for vocational studies, Zdravka Čelara 16, Belgrade, Serbia

monitored through Intrusion Detection Systems (IDS) and firewalls” (p. 29). Web application developers have a very difficult task to create a quality web application that will be protected from malicious attacks, especially if we keep in mind that an army of hackers is working to detect the weaknesses of web applications and that they are very motivated because it often allows them significant financial gain. This is also indicated by Shahriar (2018) “Despite the awareness of web application developers about safe programming practices, there are still many aspects in web applications that can be exploited by an attacker” (p. 1). Additional problem is that there are many inexperienced developers who are not aware of the potential consequences of security vulnerabilities in a web application.

## USING OWASP TOP 10

The Open Web Application Security Project (OWASP) is a nonprofit community of software developers, engineers, and freelancers that provides resources and tools for web application security. Every few years, OWASP publishes a report of the top 10 security risks to web applications. The top 10 risks were first published in 2003 and since then the report has been constantly updated and published every 3-4 years. Current version is from 2017. and can be seen on the OWASP site. Many standards, books and tools list OWASP Top 10 as one of the best resources in the field of web application security, which also notify Rafique, Humayun, Gul, Abbas, Javed (2015) “OWASP Top 10 is aimed at analyzing the security of a system by identifying the vulnerabilities of web applications.” (p. 37).

Information technologies are evolving very fast and we are all witnessing constant changes. The development of web applications is also very intensive and one might think that the list of the biggest risks is changing in the same way, but that is not the case. Most of the problems in the “OWASP Top Ten 2017” are the same, or very similar, as in the first list. The web has advanced significantly, but the security of web applications has lagged far behind that progress. As security risks recur, in order to better understand the security of web applications, certain attack methods are explained in detail.

### Listed are some of the OWASP Top Ten (2017) web application security risks

1. **A1-Injection:** Most web applications use basic systems or functions such as database or e-mail functionality. An application often uses user input to execute a command. If the application does not calculate the user input correctly, malicious code can be inserted, which would lead to the execution of unauthorized commands.
2. **A2-Broken Authentication:** In many cases, web applications contain functionality for user authentication and session management. These functions could be incorrectly implemented which allows attackers to access confidential information. In web applications, ‘logged in’ users are often identified using a session. The application sees if the user is logged in using that session, but it also sees malicious code.
3. **A3-Sensitive Data Exposure:** Leaks of confidential information can have major consequences. An example when not enough security measures are taken is sending a login form containing the username and password to the server via http. Some of the confidential information, in addition to the codes, are credit card details, email addresses and private data.
4. **A8-Insecure Deserialization:** The vulnerability applies to applications that use user-defined input as a serialized object without input validation. It can lead to remote code execution or to perform attack, including replay attacks, injection attacks, and privilege escalation attacks.



5. **A9-Using Components with Known Vulnerabilities:** Using CMS such as WordPress, Joomla! and Drupal often contain vulnerabilities that are known to the general public. Today, there are automatic scanners that use databases to scan a special platform.
6. **A10-Insufficient Logging & Monitoring:** Detecting an attack on a website is only possible if there is enough logging and monitoring of the system. Recording should be by levels of communication with the network, operating system and application.

## EXAMPLES OF POSSIBLE ATTACKS

According to the law, one cannot attack without the permission of the owner, and certain sanctions follow for such an act. Unfortunately, the legal system and supporting institutions are often unable to monitor the development of cybercrime successfully enough, so the perpetrators in many cases remain undetected or unpunished. This makes space for attacks by people who do not plan to commit a crime for personal gain but for various motives, who sometimes try to find and attack vulnerable systems and applications just for fun and cause great damage. Attackers intensively explore areas of vulnerability and attacks are increasingly targeted at web applications. Ethical hackers use their knowledge and skills to analyze and increase security. In order to better protect the system from future attacks, ethical hackers must think like real attackers and act like malicious users. Although ethical hackers may abuse their knowledge at some point, it is easy to distinguish ethical from malicious hackers; according to Engebretson (2010) „differences can be boiled down to three key points: authorization, motivation, and intent” (p. 3).

The following are examples of possible attacks that could seriously compromise the confidentiality, integrity, and availability of data and devices:

1. Example of an attack using social engineering and Cross-site scripting:
  - Step 1:** The attacker sends a special URL to his victim, the text of the message sent by the attacker can be for example: "Can you tell me exactly what THIS means", where THIS is a link to the attacker's website.
  - Step 2:** The victim clicks to open the given URL.
  - Step 3:** JavaScript sends a cookie to the attacker's web server.
  - Step 4:** The attacker saved the cookie to a text file.
  - Step 5:** The victim returns to the original site unaware that she has just given a session cookie to the attacker.
  - Step 6:** The attacker can log in to the site via a session cookie
2. Example of an attack using SQL injection: An attacker searches an application to find fields for user input. He checks whether this input is used for an SQL query, trying to provoke an error message by, for example, adding single quotes, which corrupts the SQL query. If an error occurs, the attacker knows it is vulnerable to SQL injection. Some of the attempts to obtain useful information are:
  - a. `1' union select user(), database() - a`
  - b. `1' union select table_schema, table_name from information_schema.tables where table_schema = '*****' -- a`
3. Example of an attack bypassing login and security barriers:
  - a. Sometimes it is enough for the attacker to, browsing a web application and navigating through the pages, discover access to one of the pages on which users normally need to be logged in to abuse it.
  - b. Also, if by browsing through the cookies the attacker finds a cookie of type `login = false`, which in many cases is a way for the application to differentiate

between logged in and unregistered users, it is enough for the attacker to change the cookie value to *login = true*, or in some cases *login = (username )* to access the application as a logged in user.

4. Example of an attack using insecurities in a CMS: A large number of CMS-s being used have a similar appearance and are very recognizable. Also, the name of the CMS used is written somewhere in the page. By viewing the application code, it is possible to determine exactly which one it is, if it is not directly indicated. An attacker can use some of the well-known CMS scanners – wpscan (Wordpress) and joomscan (Joomla) to find vulnerabilities in the version used by the user. This vulnerability can later be exploited to attack the system.

## METHODS OF DEFENSE

It is important to point out the weaknesses that allow abuse, because often increased risk awareness is the first step in safeguarding web applications. According to Parimi and Babu (2020) “Companies will be responsible for the personal data in future” (p. 924).

There are published lists of activities, like the one on the OWASP site, that can prevent attacks or at least reduce the possibility of abuse. According to Rafique, Humayun, Gul, Abbas, Javed (2015) “OWASP is major source to construct and validate web security processes and standards” (p. 28). The following section lists some of the ways to defend against malicious attacks that are not too demanding for users and that have proven to be very useful in securing web applications.

1. A1-Injection
  - a. Use verified server validations of user entries.
  - b. Use output characters for all dynamic arrays.
  - c. Use LIMIT and other SQL control commands to reduce the number of results obtained, thus making the outflow of information as small as possible in case of a security breach.
2. A2-Broken Authentication
  - a. Implement multifactor authentication.
  - b. Do not place an application with basic credentials.
  - c. Make sure that weak passwords are not being used.
  - d. Align passwords with standards for creating passwords.
  - e. Use the same error messages for all errors.
  - f. Limit the number of incorrect password attempts.
  - a. Use the server to generate a session ID
3. A3-Sensitive Data Exposure
  - a. Classify data and arrange them by sensitivity, and store and dispose of those with the highest sensitivity carefully.
  - b. Do not store sensitive data locally with the user.
  - c. Encrypt all sensitive data.
  - d. Use the latest strong encryption algorithms.
  - e. Encrypt all data in transit, not only sensitive data.
  - f. Disable caching for response that contain sensitive data.
  - g. Verify independently the effectiveness of the server and system configuration.
4. A8-Insecure Deserialization
  - a. Implement integrity checks such as digital signature.
  - b. Enforcing strict type constraints during deserialization before object creation.

- c. Isolate code that deserializes.
- d. Log deserialization exceptions and failures.
- 5. A9-Using Components with Known Vulnerabilities
  - a. Remove unused library and file.
  - b. Continuously inventory the versions of both client-side and server-side components and their dependencies using tools.
  - c. Only obtain components from official sources over secure links.
  - d. Monitor for libraries and components that are unmaintained or do not create security patches for older versions.
- 6. A10-Insufficient Logging & Monitoring
  - a. Ensure all login, access control failures, and server-side input validation failures can be logged with sufficient user context to identify suspicious or malicious accounts.
  - b. Ensure that logs are generated in a format that can be easily consumed by a centralized log management solution.
  - c. Ensure transactions have an audit trail with integrity controls.
  - d. Establish effective monitoring and alerting such that suspicious activities are detected.
  - e. Establish or adopt an incident response and recovery plan.

## **FUTURE RESEARCH DIRECTIONS**

Web applications are being more and more used, so there is a growing awareness of the importance of their security. More users will begin to see the need for a good security policy. A comprehensive analysis of potential risks is important for a good security mechanism. It would be useful to analyze other different types of attacks, such as brute force attacks or attacks using an insecure file upload. In future research, the impact of attacks on the rest of the risks from the OWASP Top Ten list should be paid attention to, as well as which of them are easier and which are more difficult to abuse.

## **CONCLUSION**

Through carrying out and analyzing attacks on web applications, it can be noticed that some weaknesses are easier to abuse than others, as well as that attacks can be more or less harmful to the application and its users, which is why it is necessary to develop an appropriate security policy. Using Components with Known Vulnerabilities is a flaw that can be exploited relatively easily, and depending on the type of weakness detected, the damage can be either minor or major. Some of the vulnerabilities that an attacker can most easily take advantage of are injection and corrupt authentication. By finding an opening for injection, an attacker can easily add some of the well-known codes, after which he would easily attack the application server itself. In contrast, the most difficult flaw for an attacker to abuse is insecure deserialization. It is often difficult to detect and exploit such a flaw, but it is the most harmful to the application and can have major consequences. Also, injection, corrupt authentication and detection of sensitive data are security vulnerabilities that lead to the greatest damage to a web application. These can lead to system crashes, the attacker getting admin rights, sensitive data, such as credit card data and personal data, being released to the public, and the like. The flaw from the list which causes the least damage per attack is insufficient monitoring, but with this flaw the future defense of the system is much more difficult, as is the elimination of the current attack.

## REFERENCES

- Alzahrani, A., Alqazzaz, A., Zhu, Y., Fu, H. and Almashfi, N. (2017). Web Application Security Tools Analysis, *IEEE 3rd international conference on big data security on cloud (bigdatasecurity)*, *IEEE international conference on high performance and smart computing (hpsc)*, and *IEEE international conference on intelligent data and security (ids)*, Beijing, 2017, (pp. 237-242), doi: 10.1109/BigDataSecurity.2017.47.
- Andrian, R., Fauzi, A. (2019). Security Scanner for Web Applications Case Study: Learning Management System *JOIN (Jurnal Online Informatika)* Volume 4 No. 2 | December 2019., 63-68
- Engelbreton, P. (2010) *The basics of hacking and penetration testing: ethical hacking and penetration testing made easy*, Elsevier, USA:Syngress
- OWASP. (n.d.). Top 10-2017 Top 10. Available at: OWASP: [https://www.owasp.org/index.php/Top\\_10-2017\\_Top\\_10](https://www.owasp.org/index.php/Top_10-2017_Top_10)
- Parimi, M., R., Babu, S. (2020) Critical Analysis of Software Vulnerabilities through Data Analytics, *Proceedings of the International Conference on Industrial Engineering and Operations Management* Dubai, UAE, March 10-12, 2020, (pp. 923-934)
- Rafique, S., Humayun, M., Gul, Z., Abbas, A. and Javed, H. (2015) Systematic Review of Web Application Security Vulnerabilities Detection Methods. *Journal of Computer and Communications*, 3, 28-40. doi: 10.4236/jcc.2015.39004.
- Scott, D., Sharp, R. (2002) Abstracting application-level web security *WWW '02: Proceedings of the 11th international conference on World Wide Web* May 2002 (pp. 396–407) <https://doi.org/10.1145/511446.511498>
- Shahriar, H. (2018) Web Security Vulnerabilities: Challenges and Solutions *A Tutorial Proposal for ACM SAC 2018*,” (pp. 1–5),

# A FRAME OF REFERENCE FOR RESEARCH OF A BLOCKCHAIN-BASED SOLUTION TO CORPORATE GRC-MANAGEMENT

Le Chen<sup>12</sup> 

DOI:

---

**Abstract:** *This society has faced many sorts of global challenges, especially the world of business and technological innovation, there's no greater aroused general argument nowadays than digital transformation (DT). Among production-oriented Corporates which many of them have begun to integrate digital technology into most areas of their business. How to well fulfill Corporate Governance, Risk and Compliance (GRC) while expanding existing businesses in the dramatic growth in DT environment has become a major challenge for all Corporates. Through a review of previous studying works and based on existing gaps the author evaluated whether there could be the feasibility of a blockchain-based technology being integrated as a solution to Corporate GRC-Management together with the theory of entire personnel's GRC responsibility system which would be parts of an agenda for the future research on this field and also contribute to Corporates in an overall strategic height level to embrace the coming of DT.*

**Keywords:** *Digital transformation, Corporate GRC-Management, Software, Blockchain*

---

## INTRODUCTION

Currently, many Corporates desire to fully promote DT from top to bottom to develop a new business model to meet global changing and market requirements, however even now the existence of the assortment of GRC software products, how much actual value do they have for Corporate GRC-Management?

PricewaterhouseCoopers mentioned firstly the term “GRC” in 2004, then its diffusion was confirmed in the report which they stated, “The acronym “GRC” (governance, risk and compliance) has rapidly penetrated the business community over the last years.” (Racz et al., 2010, p. 106). Herein in our paper we referred to the integrated approaches for Corporate GRC-Management and develop our work thanks to the study contributed by Racz and his research team, according to them (2010), “The final definition is as follows: ‘ GRC is an integrated, holistic approach to organization-wide governance, risk and compliance ensuring that an organization acts ethically correct and in accordance with its risk appetite, internal policies and external regulations through the alignment of strategy, processes, technology and people, thereby improving efficiency and effectiveness. ’ ” (p. 112-113). This work was carried out in order to propose an innovative solution that supports Corporates fulfill the GRC-Management so as to maximize the safety of organizational operations with an integrated real-time concept through implement GRC in every process in all the internal organization to ensure all operations be carried out ethically, correctly, efficiently and effectively.

---

<sup>12</sup> University for Foreigners "Dante Alighieri" of Reggio Calabria, Via del Torrione 95, Reggio Calabria, Italy

## 1. Objectives and research questions

Although the studies of Nicolas Racz, Edgar Weippl, Andreas Seufert focused on analyzing “comparison with existing GRC software”, but they still stated that, “The products' technology architectures mainly differ in their degree of integration, which is a key topic in future developments. Due to the lack of congruence, industry perspectives and existing state-of-the-art GRC software should only very cautiously be applied in research.” (Racz, N., Weippl, E., & Seufert, A. (2011, January, pp. 1-10). This also confirmed that there is still no empirical research and hypotheses related to perspectives of application of the blockchain technology into Corporate GRC-Management. To fill this gap, specifically, we should take into account the following questions:

- What is blockchain technology actually good for?
- Why could blockchain technology be a solution for Corporate GRC-Management?
- How could a blockchain-based solution for Corporate GRC-Management well work?

## 2. Methodology

Three steps involved in conducting this study include Literature Review, Evaluation and Construction. The method we use in the study is qualitative, that is “Deductive Argumentation-Negative Requirements”. First of all, let us set up a proposition: If the hypothesis “A is positive” holds, such that it makes the B come into existence. Similarly, if we let the hypothesis “A is negative” holds, hence it does not to make the existence of B. Namely,

$$\text{If } A+, \text{ then } B; \text{ if } A-, \text{ then not } B \quad (1)$$

In detail, the premise assumption is that if the existing GRC software is perfect (if A+), then Corporates will no longer face any GRC-Management problems (then B). Based on this, similarly, we use the substitution method with negative hypothesis what means that we can substitute the negative hypothesis into the question. If no conclusion can be obtained, this negative hypothesis assumed must be necessary; if the conclusion can still be drawn, this negative hypothesis supposed is not necessary. That is to say, if we can prove the existing GRC software used by Corporates is not perfect (that is if A-), then for Corporates there are still GRC-Management problems to face (then not B). Therefore, we need to seek a better solution.

## 3. What is blockchain technology actually good for?

What is blockchain? Primavera De Filippi in his research stated, “A blockchain is a decentralized ledger (or state machine) that relies on cryptographic algorithms and economic incentives in order to ensure the integrity and legitimacy of every transaction (or state change). A copy of the blockchain is shared amongst all nodes connected to the network...” (Primavera De Filippi, 2016, p. 6). Nowadays, blockchain technology application exploration has extended to various fields after the application of pioneer Bitcoin:

- *In the Internet of Things and Logistics field:* This field is considered to be a promising application direction of blockchain (DHL Trend Research and Accenture, 2008).
- *In the financial field:* Such as Visa B2B Connect (Ye Chun Qing, 2016), Citibank's testing cryptocurrency dubbed “CitiCoin” (Biggs, J., 2015) has brought a revolutionary change.

- *In the insurance market:* A typical application case is LenderBot<sup>13</sup>, a registered and customized micro-insurance product launched in 2016 by blockchain technology startup Stratumn, Deloitte and next-generation insurance platform LemonWay.
- *In the Public services field (Akins et al., 2013):* Blockchain is closely related to people's production and life in the fields of public management, energy, transportation, etc.

#### 4. Why could blockchain technology be a solution for Corporate GRC-Management?

If blockchain technology has played an important role in promoting these fields, then we have reason to believe that it would also probably be significantly influential in the existing GRC software. Here we will verify the proposition of A- in the Expression (1) (see Section 2), that is, the imperfection of existing GRC software.

a. First of all, in practice, Corporates usually mix these three terms for using still without clear boundaries. Since there is still no “Authoritative Definition” by a World class Authority as OECD, there still exist different arguments about it among the scientific community on GRC, so, the basis of conceptual theory is inconsistent, brings more difficulty to subsequent development of GRC software. While the first peer-reviewed academic paper on the topic was published in 2007 by OCEG<sup>14</sup> founder Scott L.Mitchell in the International Journal of Disclosure and Governance. This groundbreaking paper influenced an entire industry of software and services. According to Nicolas Racz, Edgar Weippl and Andreas Seufert (2010), “However to this day the concept behind the acronym has neither been adequately researched, nor is there a common understanding among professionals.” (p. 106). And let us see, in the light of the extensive literature and available on the current scenario of GRC studied by Nicolas Racz, Edgar Weippl and Andreas Seufert (2010), “One in three of the analyzed publications offers a GRC definition (21%). Two thirds of these definitions explain what is understood by GRC as an integrated concept (67%). The remaining third disregards that the total might be more than the sum of its parts and confines itself to defining the three terms of governance, risk management and compliance separately. (12%)” (p. 110).

b. Secondly, even under the premise of acknowledging the concept of integrated GRC, there are still problems in terms of development technology perspective. Because no releases of both an official concept and statistics on existing GRC software as indications by authoritative Organization (e.g. OECD). According to our preliminary statistics on the Internet, there exist no less than one hundred kinds various types of GRC software on the market, and each product is also very different, hence this requires a mainstream GRC software product with distinctive features to assist Corporates to fulfill GRC-Management.

c. Finally, GRC software has inherent defects as software that cannot be perfect. They stated, “46% of the organizations in our survey have deployed GRC software that covers multiple governance, risk and compliance aspects. Only 29% state that all GRC activities are consolidated in a single software platform, however.” (Racz, N., Panitz, J., Amberg, M., Weippl, E., & Seufert, A., 2010, p. 4). Even GRC software has been used into many organizations, we also worry about the difference from each other and their defects which are

<sup>13</sup> LenderBot is a proof-of-concept micro-insurance platform that uses the bitcoin blockchain for insuring all sorts of things.

<sup>14</sup> Founded in 2002, OCEG is headquartered in Phoenix, AZ. It's a non-profit think tank that is dedicated to achieving a world where every organization and every person strives to achieve objectives, address uncertainty and act with integrity. This approach to business, and to life, is what they call Principled Performance.

the inherent components of software products. According to Humphrey<sup>15</sup> (1999), “One of the things that really bothers me is the common software practice of referring to software defects by the term “bugs.” In my view, they should be called “defects.” ” (p. 1). Anyhow, according to all the above discussion we have proved that the premise assumption is negative what is that if the existing GRC software is not perfect (that is if A-), consequently Corporates should still take into account the GRC-Management problems (then not B).

## 5. How could a blockchain-based solution for Corporate GRC-Management well work?

a. We precisely based on its characteristics that are Decentralization, Persistency, Anonymity and Auditability to proceed our study (Zheng, Z. et al., 2018, p. 357):

- i. **Decentralization.** In conventional centralized transaction systems, the central trusted agency (e.g., the central bank) validated each transaction which generates the cost and the performance bottlenecks at the central servers (Zheng, Z. et al., 2018, p. 357). This is one of the highlights of our proposing to apply blockchain technology to solve GRC-Management which is particularly important in Corporate GRC-Management. It needs to be deployed and promoted by the highest decision-maker of the Corporate to make it a consensus for the development of the Corporate. Corporate GRC-Management which have been given the crucial functions into processes of every department within an organization is a shared responsibility of the entire Corporate, not simply performed only by the GRC-Management Department itself but all departments of the Corporate (will be elaborated further in following Point b).
- ii. **Persistency.** “Since each of the transactions spreading across the network needs to be confirmed and recorded in blocks distributed in the whole network, it is nearly impossible to tamper. Additionally, each broadcasted block would be validated by other nodes and transactions would be checked. So any falsification could be detected easily.” Stated by them (Zheng, Z. et al., 2018, p. 357). The case of Enron scandal became a typical case of Corporate Governance Failure. In the study of Borgia was stated “It is important because good or bad results are very much dependent on the way governance systems operate. It is topical because recent scandals have proved that today’s ostensibly ‘state-of-the-art ’ mode of governance is indeed inadequate. ” (Borgia, F., 2005, p. 6).
- iii. **Anonymity.** With a generated address each user can interact with the blockchain network. Further, many addresses could be generated by user in order to avoid expose the identity...So a certain amount of privacy on the transactions included in the blockchain is preserved thanks to this mechanism (Zheng, Z. et al., 2018, p. 357). Moreover, according to Racz, N., Panitz, J., Amberg, M., Weippl, E., & Seufert, A. (2010), “Number, complexity and importance of GRC requirements steadily increase, resulting in companies undertaking various efforts to better face risks and to ensure the adherence to laws, regulatory standards and voluntarily imposed obligations (Menzies2006).” (p. 1), wherefore the security technology as digital signatures, identity authentication could be used for department supervision by its personnel (as Orphan blocks) so that the Corporate privacy could be well protected.
- iv. **Auditability.** Since on the blockchain each of the transactions is validated and a timestamp is given. So the previous records through accessing any node in the distributed network can be easily verified and traced by users. The traceability and the transparency of the data stored in the blockchain is highly improved (Zheng, Z. et al., 2018, p. 357). It

---

<sup>15</sup> Watts S. Humphrey (July 4, 1927 – October 28, 2010) was an American pioneer in software engineering, who was called the "father of software quality."

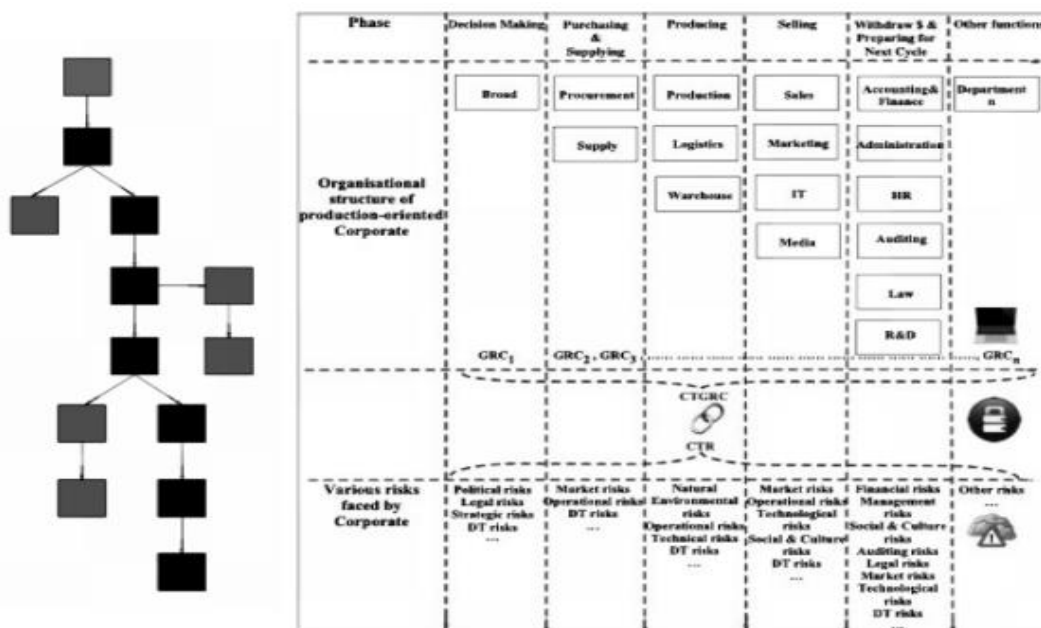


establishes an open and healthy operating environment in which all departments work together in the method of sustainable development and transparency so as to optimize business benefits to the greatest extent.

b. In addition, herein we will elaborate a theory on how to further optimize Corporate GRC-Management. In 2018, a research report released by Accenture showed that despite the industry differences, in the digital transformation, leading companies in each industry stand out. Among them, the production-oriented enterprises in the automotive and parts and consumer electronics industries have the highest proportion of "digital transformation leaders". In the rapidly changing digital market environment, how to improve Corporate GRC-Management for existing businesses has become a great challenge.

i. As one component of GRC, the main risks confronted by Corporates, as we all know, can be divided into two categories: external risks and internal risks. External risks mainly include Political risks, Legal risks, Social and Cultural risks, Technological risks, Natural environmental risks, Market risks, Industrial risks, etc. Internal risks mainly include: Strategic risks, Management risks, Operational risks, technical risk, Financial risks, etc. To facilitate the following elaboration, here we will collectively call the various risks faced by the enterprise the Corporate Total Risk (abbreviated as "CTR"). Concerning production-oriented Corporates, generally, the organisational structure is mainly composed of Decision-making Organisation (Board), Procurement, Supply, Production, Logistics, Warehouse, Sales, Marketing, IT, Media, Accounting&Finance, Administration, HR, Auditing, Law, R & D, GRC and others with different functions. If the risk is distributed to various departments of an organisation, then let us see an example of Corporate's organisational structure shown on the right of Fig.1 below. Since we believe that the consistency of the structure between the blockchain and the Corporates is precisely same, and the comparison is as shown on Fig.1. As blocks are storage units one by one, which records all communication information of each block node within a certain period, just as both the communication and the cooperation between various departments of the Corporate.

**Figure 1.** Blockchain and Risk of organizational structure of production-oriented Corporate



- ii. Furthermore, we consider single department of a Corporate as every single chain. More vividly as shown on the left of above Fig.1 the Genesis block (the topmost one) to the current block is as Board of Corporates, the Main chain (start from 1 block below the topmost block, plus other 6 blocks running through the whole chain) is as the Heads of departments, and Orphan blocks (1 block branched on the left, and two pairs branched from the main chain located on its both outsides of the main chain) are as other Personnel. That is, if the probability of defects in one block or several blocks of Main chain is more higher, the security of the entire blockchain will be greatly reduced; just like a Corporate as shown on the above Fig.1, if the probability of the unfulfilled GRC (which is Corporate Total Risk (abbreviated as “CTR”) in one or more departments is higher, then the higher the probability of unfulfilling Corporate Total GRC (abbreviated as “CTGRC”). Therefore, we believe that the core task for Corporate GRC-Management also the future research direction is to maximize the GRC of each department of the Corporate through blockchain technology. So to discover the form of the relationship between CTGRC and GRC of single department of the Corporate we can write it as:

$$CTGRC = \sum_{i=m}^n GRCi = GRC1 + GRC2 + GRC3 + \dots + GRCn \quad (2)$$

Where  $i$  indicates the number of departments of the Corporate and  $m \geq 1$ , and CTGRC is a constant<sup>16</sup>. Generally, if the relationship between two variables  $x$  and  $y$  can be expressed in the form of  $y = k / x$  ( $k$  is a constant,  $k \neq 0$ ), then  $y$  is called the inverse proportional function of  $x$ . And as there exists the negative correlation between GTGRC and CTR, assume they are two variables and substitute them respectively into  $Y$  and  $X$ , then the relationship of them can be expressed in the form as:

$$CTGRC = k/CTR \quad (3)$$

Where  $k$  is a constant,  $k \neq 0$ , and CTR is a constant<sup>17</sup>. Consequently, we obtain the relationship between CTR and CTGRC which can be written as:

$$\lim_{i \rightarrow \infty} (CTGRC) = \lim_{i \rightarrow \infty} \left( \frac{k}{CTR} \right) = k * \lim_{i \rightarrow \infty} \left( \frac{1}{CTR} \right) = 0 \approx Min[CTR] = Max[CTGRC] \quad (4)$$

Obviously, substitute the Expression (3) into the Expression (4), when  $i$  the number of departments of the Corporate gets closer to infinity, namely, the responsibility of Corporate GRC is distributed into every department till each operation, then CTGRC gets closer to infinity, thus, the limit of the reciprocal of CTGRC converges to zero, then realize the minimization of CTR, namely, the maximization of CTGRC is fulfilled.

## 6. Results

Through a series of arguments above (Sections 3 to 5), we have demonstrated that the existing GRC software is not perfect, so Corporates still need to solve the GRC-Management problems. Therefore, Corporates should also take GRC-Management strategies into account to adapt to the new digital reality with new technologies to optimize Corporate GRC-management. According to the Expressions (2) and (4) we should consider the fact that is only by combining

<sup>16</sup> CTGRC can be quantified by KPI and other performance evaluation indicators, so here we can regard it as a constant in a certain sense.

<sup>17</sup> CTR can be quantified by the Risk Quantification model and other methods to measure risk, so here we can regard it as a constant in a certain sense.

every department's GRC from every dimensions the Corporate should be able to in the true sense realize Corporate GRC-Management through an all-round cooperation. We stated a possible solution for existing GRC-Management based on both blockchain technical characteristics and the theory of entire personnel's GRC responsibility system.

## FUTURE RESEARCH DIRECTIONS

There are still many practical aspects to continue to study:

- *Subject to current laws.* The supporting of laws and regulations, standards, supervision and management system should be strengthened, and especially we need to unify the understanding of integrated Corporate GRC-Management concept.
- *At the technical level.* Although it has the characteristics of greatly improving security, the application of Corporate GRC-Management still has the problem of embedding various processes in the GRC software to be solved, especially we need the prudence in the process of test. We also need to take into account in consideration of Whether these new technologies could own other potential technical advantages.

## CONCLUSION

Overall, we hope that this study work to promote the official release of an integrated GRC definition from the authority level (e.g.OECD) as it has a magnificent meaning on the development of Corporate GRC-Management GRC; and to further elaborate our proposed framework in order to develop a solution based on blockchain technology and the theory of entire personnel's GRC responsibility system, especially when DT has emerged as one of the most important considerations in Corporate's Strategy-Making.

## ACKNOWLEDGEMENT

The author is grateful to Prof. Mavilia Roberto and Prof. Loprevite Salvatore, for their valuable guidance.

## REFERENCES

- Akins, B. W., Chapman, J. L., & Gordon, J. M. (2014). A whole new world: Income tax considerations of the Bitcoin economy. *Pitt. Tax Rev.*, 12, 25. <https://doi.org/10.5195/taxreview.2014.32>
- Biggs, J. (2015). Citibank Is Working On Its Own Digital Currency, Citicoin. *archive (consulté le 20 novembre 2015)*.
- Borgia, F. (2005). Corporate governance & transparency role of disclosure: how prevent new financial scandals and crimes. *American University Transnational Crime and Corruption Center School of International Service*.
- De Filippi, P. (2016). The interplay between decentralization and privacy: the case of blockchain technologies. *Journal of Peer Production, Issue*, (7).
- Humphrey, W. S. (1999). Bugs or Defects?. *CMU SEI*, 1.
- Mitchell, S. L. (2007). GRC360: A framework to help organisations drive principled performance. *International Journal of Disclosure and Governance*, 4(4), 279-296. <https://doi.org/10.1057/palgrave.jdg.2050066>

- Racz, N., Panitz, J., Amberg, M., Weippl, E., & Seufert, A. (2010). Governance, risk & compliance (GRC) status quo and software use: results from a survey among large enterprises.
- Racz, N., Weippl, E., & Seufert, A. (2011). Governance, risk & compliance (GRC) software-an exploratory study of software vendor and market research perspectives. In *2011 44th Hawaii International Conference on System Sciences* (pp. 1-10). IEEE.<https://doi.org/10.1109/HICSS.2011.215>
- Zheng, Z., Xie, S., Dai, H. N., Chen, X., & Wang, H. (2018). Blockchain challenges and opportunities: A survey. *International Journal of Web and Grid Services*, 14(4), 352-375.<https://doi.org/10.1504/IJWGS.2018.095647>

# GRAPH DATABASE MANAGEMENT SYSTEMS AND GRAPH THEORY

Kornelije Rabuzin<sup>18</sup> 

Sonja Ristić<sup>19</sup> 

Robert Kudelić<sup>20</sup> 

DOI:

---

**Abstract:** *In recent years, graph databases have become far more important. They have been proven to be an excellent choice for storing and managing large amounts of interconnected data. Since graph databases (GDB) rely on a graph data model based on graph theory, this study examines whether currently available graph database management systems support the principles of graph theory, and, if so, to what extent. We also show how these systems differ in terms of implementation and languages, and we also discuss which graph database management systems are used today and why.*

**Keywords:** *Neo4j, MS SQL Server, Oracle, Cypher.*

---

## INTRODUCTION

The importance of relational databases has been evident for many years. Transactional systems, CRM systems, ERP systems, and so on rely on relational databases. Last year, we witnessed the 50th year of relational databases. With a solid mathematical foundation and a background in set theory and logic, relational databases are not estimated to vanish, although some authors like to think so. However, in recent years, we have seen large amounts of data arriving from different sources. There are many V's describing the nature of data, and the term "Big Data" has been introduced and used extensively. The first V that one should consider is data volume. Although relational databases can store large amounts of data, PetaBytes (PB) or ExaBytes (EB) can cause problems for relational databases. It takes time to write and read the data from the database. The second V stands for variety since data are heterogeneous in nature. The third V denotes velocity, which means that data are being produced quickly, and they have to be processed rapidly. Sometimes there is not enough time to store the data and then later process the data; the data have to be processed immediately.

In order to deal with Big Data and its challenges, two solutions have been identified: NoSQL databases (including document-oriented, column-oriented, key value and graph databases) or distributed file systems, like the Hadoop framework. Graph databases belong to NoSQL databases, and they rely on a graph data model. In graph databases, data can be stored within the nodes and can have relationships that do connect the nodes. Many examples can be found and modelled using graph databases (computer networks, social network analysis, traffic, etc.). In this study, we present the different types of graphs that are known in graph theory, and we show how these graphs can be implemented in Neo4j. Then we show how MS SQL Server and

---

<sup>18</sup> University of Zagreb, Faculty of organization and informatics, Pavlinska 2, Varaždin, Croatia

<sup>19</sup> University of Novi Sad, Faculty of technical sciences, Trg D. Obradovića 6, Novi Sad, Serbia

<sup>20</sup> University of Zagreb, Faculty of organization and informatics, Pavlinska 2, Varaždin, Croatia

Oracle deal with the graph data model. Furthermore, we also discuss some major trends in GDBMS's global market.

The rest of this study is organized as follows: first we say a few words about graph databases, graph database management systems, and graphs in general. Then we show different types of implementations, including Neo4j, MS SQL Server, and Oracle. Then we discuss some open issues and the potential for future research directions. We also demonstrate a few improvements that we implemented in Neo4j. In the end, the conclusion is presented.

## THE GRAPH DATABASE MANAGEMENT SYSTEMS (GDBMS) PERSPECTIVE

As far as we know in graph databases, we use the terms nodes and relationships (edges or loops in graph theory) that connect the nodes. The number of nodes and relationships can be vast. Since nodes are directly connected through their relationships, graph databases are extremely suitable for problem domains that contain large amounts of interconnected data. In order to create and use graph databases, we have to use a specific graph database management system. There are many purely graph database management systems available, including OrientDB, Neo4j, ArangoDB, etc. In this study, we use Neo4j since it is the most popular, and therefore, has had the widest impact, with support for many functional characteristics. However, the importance of having purely graph database management systems (GDBMS) has decreased over time. If we looked at the page <https://db-engines.com/en/ranking>, a few years ago, Neo4j was on a few occasions placed in the top 10 of systems. However, now it is ranked below that at 22nd place, and other graph database management systems are ranked even lower. Arango and OrientDB are at 59th and 71st place, respectively.

**Table 1.** Top 10 database systems (<https://db-engines.com/en/ranking>)

System	Primarily	Other supported models
Oracle	Relational	Document Store, Graph DBMS, RDF store
MySQL	Relational	Document Store
MS SQL Server	Relational	Document Store, Graph DBMS
PostgreSQL	Relational	Document Store
MongoDB	Document	Search engine
IBM DB2	Relational	Document Store, RDF store
Elasticsearch	Search engine	Document Store
Redis	Key-value	Document Store, Graph DBMS, Search engine, Time series DBMS
SQLite	Relational	
Cassandra	Wide column	

One major change is that all major DBMSs have turned multi-model. In Table 1, we see that many systems support the document model, and that three systems that are in the top 10 support the graph data model: Oracle, MS SQL Server, and Redis. Indeed, the only purely relational database management system in the top 10 is SQLite. It is lightweight and popular due to its size and the possibilities it affords that are extremely useful for smart phones, for example. Some other companies like Mozilla use SQLite for storing cache files, etc.

Since major DB vendors support the graph data model, it is important to keep in mind that in SQL Server, one can use SQL statements and constraints that most users are familiar with, and one can also use the graph database, as we demonstrate later on. Namely, in order to use Neo4j, one needs to learn Cypher or Gremlin, and there are some challenges regarding how to move

data to and from the graph database. So, this could be the reason why GDBMS are not that popular anymore. There were some attempts to build a single language or interface that would make it possible to use graph databases using already known query languages. For more information, look at (He & Singh, 2008) and (Holzschuher & Peinl, 2013). Many studies have been written to show how graph databases outperform relational databases, or to measure which graph database management system is better, such as (Chen et al., 2020) etc. If you are interested in graph databases in general, a good reference is (Robinson et al., 2013). A nice review of relational and graph databases is (Gupta et al., 2020) and (Maleković et al., 2016).

## NEO4J

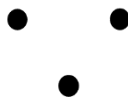
A good book on graphs and graph theory is (Wilson, 1996) And the definitions that are presented in the chapter below come from this book. We have also done some significant work in the field of graph theory, for example (Kudelić, 2016).

Generally speaking, in other studies, people usually talk about nodes and edges. However, there are other concepts presented in graph theory, and in this chapter, we show how they could be implemented in GDBMS Neo4j. “A simple graph  $G$  is a structure that consists of a non-empty finite set  $V(G)$  of elements called vertices, and a finite set  $E(G)$  of distinct unordered pairs of distinct elements of  $V(G)$  called edges” (Wilson, 1996). In this study we assume that simple graphs do not contain loops (i.e., an edge that joins a vertex to itself) and that there is at most one edge that connects a given pair of vertices (Wilson, 1996). If we allowed loops and multiple edges, then we would talk about graphs or multigraphs depending on the situation.

## NULL GRAPH

A null graph’s edge set is an empty set. Because of the fact that edges are not present, we can only see a vertex or more vertices that have no connections between them (Figure 1).

**Figure 1.** Null graph



We could have a graph database that contains nodes that have no relationships, but the importance of graph databases lies in relationships that connect the nodes and that do at the same time contain additional information. The following statement creates three “Person” nodes in an empty database and we check the database content (Figure 2):

```
CREATE (john:Person { firstname: "John", lastname: "Smith" }),
(mary:Person { firstname: "Mary", lastname: "Smith"}),
(jack:Person { firstname: "Jack", lastname: "Smith"})
MATCH (n:Person) RETURN n LIMIT 25
```

**Figure 2.** Creating nodes in Neo4j – null graph

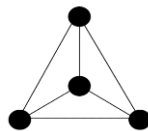


We can see that null graphs can be implemented in Neo4j since we have three nodes that are not connected (Figure 2), but such graphs provide little information. As we said earlier, the connections between the nodes provide valuable information and this is where the strength of graph databases lies.

## COMPLETE GRAPH

In order to explain complete graphs, several definitions are important (Wilson, 1996): “We say that two vertices  $v$  and  $w$  of a graph  $G$  are adjacent if there is an edge  $vw$  joining them, and the vertices  $v$  and  $w$  are then incident with such an edge. Similarly, two distinct edges  $e$  and  $f$  are adjacent if they have a vertex in common... A graph is connected if it cannot be expressed as the union of two graphs, and disconnected otherwise.” In order to see whether complete graphs can be implemented, we should first recall the notion of adjacency. We should also take note that a complete graph has  $n(n-1)/2$  edges. Basically, when an edge connects two vertices, they are adjacent. In a simple complete, graph this has to be true for “each pair of distinct vertices” (Wilson, 1996). Such graphs are denoted by  $K_n$ ;  $K_4$  is presented in Figure 3.

Figure 3.  $K_4$

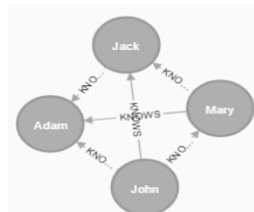


In the next example, we try to implement the complete graph in Neo4j. We would like to add one new person and to make a few relationships between the nodes.

```
MATCH (john:Person {firstname:"John"}), (mary:Person{firstname:"Mary"}),  
(jack:Person {firstname:"Jack"})  
CREATE (adam:Person { firstname: "Adam", lastname: "Smith"}),  
(john)-[:KNOWS {since:2011}]->(mary), (john)-[:KNOWS {since:2012}]->(jack),  
(john)-[:KNOWS {since:2014}]->(adam), (mary)-[:KNOWS {since:2012}]->(jack),  
(mary)-[:KNOWS {since:2013}]->(adam), (jack)-[:KNOWS {since:2011}]->(adam)
```

When we look at the database state, we see that the nodes are connected and the relationships are directed, i.e. they have arrows (Figure 4):

Figure 4. Complete graph



This leads us to the concept of directed graphs. Informally, directed graphs (digraphs) contain vertices and arcs. However, it is not irrelevant which vertex comes first within an arc. In fact, arrows are used to indicate the ordering of vertices in the arc. Therefore, we are dealing with an ordered pair of vertices. This is supported in graph databases since the direction of a relationship can be specified when the relationship is created.

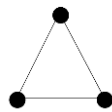


“The degree of a vertex  $v$  of  $G$  is the number of edges incident with  $v$ ... A graph in which each vertex has the same degree is a regular graph” (Wilson, 1996). We can see that “complete graph  $K_n$  is regular of degree  $n-1$ ” (Wilson, 1996). If we neglected the fact that relationships are directed, the graph above would be regular as well.

**CYCLE GRAPHS**

“A connected graph that is regular of degree 2 is a cycle graph. We denote the cycle graph on  $n$  vertices by  $C_n$ ” (Wilson, 1996) (Figure 5).

**Figure 5.** Cycle graph



**Figure 6.** Path graph



If we remove one edge, we get a path graph (Figure 6). Social network analysis shows that if  $a$  and  $b$  are friends and  $b$  and  $c$  are friends, there exists a finite chance that  $a$  and  $c$  will be friends in the future. In social network analysis, some path graphs that include several persons are most likely to turn into connected graphs. Due to space limitations the example is omitted.

**COMPLEMENT OF A SINGLE GRAPH**

“If  $G$  is a simple graph with vertex set  $V(G)$ , its complement  $\bar{G}$  is the simple graph with vertex set  $V(G)$  in which two vertices are adjacent if and only if they are not adjacent in  $G$ ” (Wilson, 1996). What are the implications for graph databases? If we had one instance of a database, it would be interesting to see which nodes are not connected. That way, we would be able to know who does not have friends, we would be able to know who does not ship products to certain countries, etc. The query below would simply find people, in the database created above, that are NOT connected (observe NOT ((a) - [:KNOWS] - (b))):

```
MATCH (a:Person), (b:Person)
WHERE a<>b AND NOT ((a) - [:KNOWS] - (b))
RETURN a, b;
```

**GRAPH DATABASES IN MS SQL SERVER 2019**

In the previous section, we used Neo4j to implement the concepts of graph theory. Here, we use MS SQL Server 2019. In MS SQL Server 2019, users can create one graph per database. A graph consists of an edge and node tables. According to <https://docs.microsoft.com/en-us/sql/relational-databases/graphs/sql-graph-architecture?view=sql-server-ver15>: “A node table is a collection of similar type of nodes. For example, a Person node table holds all the Person nodes belonging to a graph. Similarly, an edge table is a collection of similar type of edges. For example, a Friends edge table holds all the edges that connect a Person to another Person. Since nodes and edges are stored in tables, most of the operations supported on regular tables are supported on node or edge tables.”

Let us look at one example and let us create one small graph using MS SQL Server 2019. We have several employees and we “manage” links that denote which employee is responsible for a certain another employee. First, we create the employee node table using SQL (observe the

“AS NODE” at the end of the CREATE statement) and then we create the “manages” table (observe “AS EDGE” at the end of the statement):

```
CREATE TABLE Employee (ID INTEGER PRIMARY KEY, Name VARCHAR(100), DEPT  
VARCHAR(100)) AS NODE;  
CREATE TABLE manages (SINCE date) AS EDGE;
```

Now, let’s add a few employees:

```
INSERT INTO Employee VALUES (1, 'John', 'IT')  
INSERT INTO Employee VALUES (2, 'Mark', 'IT')  
INSERT INTO Employee VALUES (3, 'Jack', 'Finances')
```

Now let’s specify one row for the “manages” table. Basically, we have to specify three values including \$from\_id, \$to\_id, and SINCE (we use subqueries to return the node id value for \$from\_id and \$to\_id columns):

```
INSERT INTO manages VALUES ((SELECT $node_id FROM Employee WHERE ID = 3),  
 (SELECT $node_id FROM Employee WHERE ID = 1), '2020/01/01')
```

How do we find all of the employees who are managed by Jack?

```
SELECT e2.Name  
FROM Employee e1, manages, Employee e2  
WHERE MATCH (e1-(manages)-> e2) AND e1.name = 'Jack'
```

Here, we see that the SELECT statement is used to retrieve rows from the table. The main difference can be seen in the WHERE clause; the “MATCH (e1-(manages)-> e2)” part looks more like Cypher, than SQL.

## GRAPH DATABASES IN ORACLE

In this section, we give a brief overview of Oracle’s features and graph data model support. According to <https://blogs.oracle.com/oraclespatial/graph-database-and-analytics-for-everyone>, Oracle supports Property Graph database, PGX in-memory graph engine, PGQL graph query language, 50+ Graph algorithms, Support for graph visualization, SPARQL graph query language, Java APIs via open source Apache Jena, W3C standards support for semantic data, ontologies and inferencing, and RDF Graph views of relational tables. Due to space limitations we show one PGQL (property graph query language) example borrowed from <https://pgql-lang.org/>:

```
SELECT owner.name AS account_holder, SUM(t.amount) AS  
total_transacted_with_Nikita  
FROM MATCH (p:Person) -[:ownerOf]-> (account1:Account)  
      , MATCH (account1) -[t:transaction]- (account2)  
      , MATCH (account2:Account) <-[:ownerOf]- (owner:Person|Company)  
WHERE p.name = 'Nikita'  
GROUP BY owner
```

We see that the query looks like an SQL SELECT statement, almost like those found in SQL Server. However, in the FROM clause, we specify the nodes and the edges as well as their “connections.” WHERE and GROUP BY clauses look like traditional SQL clauses.

## DISCUSSION AND FUTURE RESEARCH

As is now obvious based on the discussion above, graph databases are interesting and important, but they do have some issues that are specific and one has to be aware of. In our previous research, we investigated some aspects of graph databases, like integrity constraint implementations (Rabuzin et al., 2016a) and (Rabuzin et al., 2016b). We have also implemented a visual interface (Gremlin By Example) that should make it easier for users to pose queries against the graph database (Rabuzin, Maleković, & Šestak, 2016). This interface is used to enable end users to pose queries against the Neo4j database in a manner similar to the way Query By Example is used to pose queries visually against MS Access. At this time, we are implementing a few other types of constraints given that many things that are supported in relational databases are still not supported for graph databases. One could also extend the research and include other GDBMSs and other query languages as well.

## CONCLUSION

Graph databases are increasingly important. In this study, we had three goals: first we tried to investigate the importance of some of the other concepts that exist in graph theory, beyond those of edges and nodes. We tried to implement the presented concepts in Neo4j. Then we also investigated the graph database management systems that are popular and we used them to implement some examples. Finally, we also demonstrated how query languages look like in three different database systems. For that purpose, we have presented different types of graphs, including null graphs, directed graphs, cycle graphs, complete graphs, etc. We also investigated how these concepts could be implemented in Neo4j and described the repercussions of doing so. Then we showed how the graph data model is implemented in MS SQL Server 2019. The good thing is that one can use existing SQL-like statements to implement the graph database, but we do not have as many advanced features supported as are found in Neo4j. Oracle, on the other hand, supports more features than MS SQL Server and has more algorithms, but uses another query language (PGQL). Regarding the trends, we can see that existing purely graph database management systems have lost their popularity and many relational DBMS systems have turned multi-model. Finally, we can say that it will be interesting to see what the future will bring us.

## REFERENCES

- Chen, J., Song, Q., Zhao, C., & Li, Z. (2020). *Graph database and relational database performance comparison on a transportation network* doi:10.1007/978-981-15-6634-9\_37
- Gupta, S., Pal, S., & Chakraborty, M. (2020). *A study on various database models: Relational, graph, and hybrid databases* doi:10.1007/978-981-15-0361-0\_11
- He, H., & Singh, A. K., (2008). *Graphs-at-a-time: query language and access methods for graph databases*. In Proceedings of the 2008 ACM SIGMOD international conference on Management of data (pp. 405–418).
- Holzschuher, F., & Peinl, R., (2013). *Performance of graph query languages: comparison of cypher, gremlin and native access in Neo4j*. In Proceedings of the Joint EDBT/ICDT 2013 Workshops (pp. 195–204).
- Kudelić, R., (2016). *Monte-Carlo randomized algorithm for minimal feedback arc set problem*. Applied soft computing, 235 - 246. <https://doi.org/10.1016/j.asoc.2015.12.018>

- Maleković, M., Rabuzin, K., & Šestak, M., (2016). *Graph Databases-are they really so new*. International Journal of Advances in Science Engineering and Technology. 4 (2016). Retrieved from <http://bib.irb.hr/prikazi-rad?rad=843723>
- Rabuzin, K., Konecki, M., & Šestak, M., 2016a. Implementing CHECK Integrity Constraint in Graph Databases. *Proceedings of the 82nd IIER International Conference*. Retrieved from <http://bib.irb.hr/prikazi-rad?rad=836861>
- Rabuzin, K., Maleković, M., & Šestak, M. (2016). Gremlin By Example. *International Conference on Advances in Big Data Analytics*, 144–149.
- Rabuzin, K., Šestak, M., & Konecki, M., 2016b. Implementing UNIQUE Integrity Constraint in Graph Databases. *Multi-Conference on Computing in the Global Information Technology*. Retrieved from <http://bib.irb.hr/prikazi-rad?rad=844504>
- Robinson, I., Webber, J., & Eifrem, E., 2013. *Graph Databases*. Information Management. <https://doi.org/http://dx.doi.org/10.1016/B978-0-12-407192-6.00003-0>
- Wilson, J. R., 1996. *Graph Theory*. UK: Addison Wesley.

# SMALL AND MEDIUM-SIZED ENTERPRISES IN TOURISM AND THEIR IMPACT ON REGIONAL DEVELOPMENT

Katarína Kráľová<sup>21</sup> 

Jana Sochuľáková<sup>22</sup> 

Dagmar Petrušová<sup>23</sup> 

DOI:

---

**Abstract:** *A long-term problem of the Slovak economy is significant regional disparities caused by insufficient use of existing local resources. Inefficient and unsystematic use of existing resources at the local level causes a decrease in the competitiveness of these regions, which is also reflected in the overall performance of the economy. In our article, after the initial definition of basic terminology, we will focus on the evaluation of regional disparities and the current development of regional differences in the conditions of the Slovak Republic. We will evaluate the impact of SMEs on regional development in the Slovak Republic. However, we will focus primarily on their positive benefits to reducing regional disparities in the conditions of the Slovak Republic. We will pay particular attention to SMEs operating in the field of tourism in individual regions, how they contribute or in the future can solve the problem of reducing regional disparities.*

**Keywords:** *regional disparities, regional development, small and medium enterprises, tourism.*

---

## INTRODUCTION

Significant differences in the socio-economic level of regions, in their competitiveness, the level of infrastructure is still a current problem in most countries of the European Union, including Slovakia. Differences in the development of individual regions in Slovakia have been evident since 1989. Disparities are generally understood as inequalities, differences, heterogeneities or differences. In the case of regional development, we understand disparity as different levels of social and economic development, which create inequalities between the individual units being compared. Matlovič, R., Klamár, R, Matlovičová, K. (2008, p.5) understand regional disparities as "differences in the degree of socio-economic development of regions which are the result of its unevenness." Gajdoš, P. (2008, p.102) states that "regional disparities are the product of the action of several factors, depending on the quality and development availability of potentials, but also the different positions from which individual regions entered the transformation process." Within the regional economy, there are various institutions and partnerships. Their mission and activities create conditions leading to the development of the region, the formation of its structure and the use of capacities. One of the ways to improve the economic performance of regions is to support the development of business activities and create a unique environment to unite companies of a similar nature.

---

<sup>21</sup> Alexander Dubček University in Trenčín, Faculty of Social and Economic Relations, Študentská 3, 91150 Trenčín, Slovakia

<sup>22</sup> Alexander Dubček University in Trenčín, Faculty of Social and Economic Relations, Študentská 3, 91150 Trenčín, Slovakia

<sup>23</sup> Alexander Dubček University in Trenčín, Faculty of Social and Economic Relations, Študentská 3, 91150 Trenčín, Slovakia

(Habánik et al, 2016, p.146). In the regions, it is important to use mainly local development potential. Small and medium-sized enterprises play an important role in regional development and are an integral part of any advanced market economy, given their contribution to the flexibility of the market mechanism, the potential of the competitive environment and innovative activities. The role of small and medium-sized enterprises in regional development is significantly influenced by the level and stability of the overall business environment. In this paper, we focus on small and medium-sized enterprises operating in the field of tourism in individual regions and their benefit to reducing regional disparities. In the analysis of regional disparities, we had to solve several methodological problems. Firstly, it was the selection of suitable territorial units - regions, secondly it was the selection of suitable indicators and the selection of appropriate statistical tools that allow comparison. In our research, we used the regions of the Slovak Republic (NUTS III level) and the division at the NUTS II level as suitable territorial units. When deciding on the selection of suitable indicators, we were limited by the limitations in the availability of suitable data. Many data are not systematically monitored and therefore a relevant analysis would not be possible. In the analysis of regional disparities, we included the following indicators: registered unemployment rate, regional gross domestic product per capita, motorway network in the regions, at-risk-of-poverty rate in the regions, number of facilities and beds in the regions. We monitored most of the indicators for the period 2010-2019. In some cases, we had to limit ourselves to the period 2010-2018. In the literature we can meet with the application of several statistical tools and indicators to measure disparities. The coefficient of variation is a relative measure of the dispersion derived from the standard deviation (ratio of standard deviation to mean). It is a more suitable tool for comparative analyzes, because it does not depend on the measured values of input indicators. Using the coefficient of variation, we can assess the size of regional differences in terms of selected parameters, but we can also compare these differences.

$$V_k = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}} \cdot \frac{1}{\frac{1}{n} \cdot \sum_{i=1}^n x_i} \quad (1)$$

Where:

$V_k$  is the coefficient of variation

$n$  is the number of observed units,

$x_i$  is the value of the indicator  $x$  for the  $i$ -th region,

$\bar{x}$  is the average rate of the indicator in the whole higher order.

The Gini concentration coefficient was created as a tool for measuring pension inequality. It ranges from 0 (absolute equality) to 1 (absolute inequality). It can be calculated in several ways. This is twice the area between the ideal and real Lorenz curve.

$$GINI = \frac{2}{n-1} \sum_{i=1}^n |F_i - Q_i| \quad (2)$$

Where:

$GINI$  is the Gini concentration coefficient

$n$  is the number of observed units,

$F_i$  is  $F_i = \frac{i}{n}$

## Development of regional disparities in the Slovak Republic based on selected socio-economic indicators

The first of the indicators used in the analysis of regional disparities was the unemployment rate analyzed at the regional NUTS III level. This indicator is a suitable indicator for analyzing socio-economic development in individual regions. It is calculated as the ratio of the available registered number of unemployed to the number of economically active population, where the number of economically active population in the region is mainly affected by the deteriorating demographic situation in some regions of the Slovak Republic (aging of population, migration of the population for work to more developed regions or abroad). Based on the values given in table 1, we can state decreasing differences in the indicator of the registered unemployment rate between the regions of Slovakia in the analyzed period, which can confirm that the development of the economy in the period positively affected the unemployment rate in the regions. The Prešov region has the long-term highest unemployment rate, followed by the Košice region and the Banská Bystrica region.

**Table 1.** Registered unemployment rate in %

Registered unemployment rate (in%)										
region / year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
region of Bratislava	4,63	5,41	5,72	6,17	6,13	5,34	4,51	3,05	2,62	2,83
region of Trnava	8,17	8,88	9,43	9,16	8,03	6,71	4,41	2,6	2,31	2,63
region of Trenčín	9,51	9,95	10,89	10,74	9,56	7,71	5,85	3,53	2,93	3,2
region of Nitra	11,76	13,27	14,08	12,52	11,21	9,71	6,96	4,05	3,12	2,93
region of Žilina	10,86	11,91	12,79	12,51	10,91	8,86	6,92	4,7	4,04	3,96
region of Banská Bystrica	18,86	19,83	20,81	18,26	17,22	14,94	12,8	8,67	7,03	6,69
region of Prešov	17,75	18,95	20,66	19,35	17,45	15,5	13,91	9,68	8,61	8,19
region of Košice	16,78	18,76	19,58	17,23	15,92	14,39	12,76	9,94	8,17	7,57
coefficient of variation	0,3847	0,3732	0,3697	0,3295	0,401	0,3596	0,4363	0,5033	0,5081	0,459
GINI coefficient	0,24732	0,23918	0,23041	0,212034	0,20145	0,2138	0,26994	0,31093	0,312975	0,280676

**Source:** Statistical Office of the Slovak Republic (2020), own calculations and processing

Regional gross domestic product per capita is a basic measure of a region's performance, so it is part of our analysis of regional disparities. From the data given in table 2 it is clear that in the whole monitored period there was an increase in regional gross product per capita in individual regions of the Slovak Republic as well as that the Bratislava Region has long been the most efficient region in Slovakia. The value of the indicator in absolute terms increased by EUR 7,740.22 in the Bratislava region in the observed period. The least efficient region has long been the Prešov region, followed by the Banská Bystrica and Košice regions. Based on the development of the value of the coefficient of variation between all regions of the Slovak Republic at the NUTS III level, we cannot unequivocally state that differences in the amount of gross domestic product per capita between the regions of Slovakia in the analyzed period significantly decreasing. The indicator reached the lowest level in 2018. The development of the value of the GINI coefficient copies the development of the value of the coefficient of variation, so it is balanced in the long run. The indicator of the regional development index calculated by the EU also shows significant differences in the development of individual regions of the Slovak Republic at the NUTS II level, see table no.3.

The Regional Development Index points out that the Bratislava region has long been the most developed region in the Slovak Republic. Other regions of Slovakia achieve a medium level of regional development, but in the long run the lowest level is in the East Slovakia region (NUTS III level: Košice region and Prešov region) and is followed by the Central Slovakia region (NUTS III level: Banská Bystrica region and Žilina region).

**Table 2. Regional gross domestic product per capita in EUR**

Regional gross domestic product per capita in EUR									
	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>Region of Bratislava</b>	31095,78	32793,71	32 862,47	34 543,62	34 460,69	36 157,86	36 657,33	37 514,49	38 836,00
<b>Region of Trnava</b>	13863,69	14940,46	15 187,10	15 073,50	15 777,52	15 667,62	16 191,49	16 702,29	17 917,48
<b>Region of Trenčín</b>	10912,38	11706,48	12 003,48	11 699,84	12 015,03	12 553,47	12 411,41	12 511,77	13 741,78
<b>Region of Nitra</b>	10052,03	11134,63	12 189,44	11 804,78	12 028,61	12 200,01	12 571,72	13 293,20	13 768,71
<b>Region of Žilina</b>	11 095,77	11769,53	11 713,70	11 717,77	12 274,51	12 890,59	12 912,09	13 305,64	14 078,55
<b>Region of Banská Bystrica</b>	9196,38	9 586,50	9 666,44	9 847,08	9 911,78	10 578,30	10 753,07	11 292,08	12 064,18
<b>Region of Prešov</b>	7057,73	7 360,17	8 076,19	8 016,83	8 360,36	8 807,11	9 036,14	9 308,20	10 388,55
<b>Region of Košice</b>	9969,20	10 190,90	10 649,70	10 731,89	11 112,08	11 890,90	11 729,72	12 896,46	13 352,95
<b>coefficient of variation</b>	0,550492	0,547922	0,5249397	0,558649	0,538649	0,541243	0,5430694	0,530826	0,5113511
<b>GINI coefficient</b>	0,270987	0,274163	0,26196	0,270835	0,265569	0,260588	0,260462	0,256005	0,2455731

Source: Statistical Office of the Slovak Republic (2020), own calculations and processing

**Table 3. European Regional competitiveness index**

region/year	2013	2016	2019	Stage of development
<b>Bratislava Region</b>	0,378	0,276	0,43	high
<b>Western Slovakia</b>	-0,562	-0,579	-0,38	medium
<b>Central Slovakia</b>	-0,749	-0,69	-0,53	medium
<b>Eastern Slovakia</b>	-0,871	-0,846	-0,72	medium

Source: [https://ec.europa.eu/regional\\_policy/en/](https://ec.europa.eu/regional_policy/en/)

By analyzing regional disparities, we find that there is a deepening of regional differences in the conditions of the Slovak Republic, which causes the formation of an imaginary dividing line of the southwest and northeast direction. What does it mean? This means the division of the territory of the Slovak Republic into regions with different attractiveness, with differentiated development dynamics, performance and thus also competitiveness. Persistent differences in the dynamics of regional development cause social and economic polarization of regions. They form marginal regions called regions of poverty, which lag significantly behind both socially and economically (table no. 4). The following table shows the percentage of the population at risk of poverty. Based on the development of the value of the coefficients of variation and the GINI coefficient, we can state that it increases the inequality between the regions of East and West Slovakia in terms of at-risk-of-population poverty, which is a consequence of increasing regional differences between these territories. As a result, the number of least developed regions in the Slovak Republic has increased to 20 districts (NUTS IV level region). These districts are concentrated in the Prešov region where there are at most 9 districts, in the Košice region there are 6 districts and in Banská Bystrica there are 5 districts. Up to one fifth of the Slovak population lives in the least developed regions of the Slovak Republic.

**Table 4. At risk of poverty rate by NUTS 2 regions percentage of total population**

At-risk-of-poverty rate by NUTS 2 regions percentage of total population									
region/year	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>Bratislava Region</b>	5,1	7,2	6,3	8	7,8	7,3	5,4	4,6	4,3
<b>Western Slovakia</b>	10,3	11,4	11,9	11,5	10,4	10,1	10,7	10	8,6
<b>Central Slovakia</b>	13,1	13,1	14,1	13,3	15,3	14,9	14,7	14	15,2
<b>Eastern Slovakia</b>	15,8	16,9	16,7	15,8	14,9	14,5	16,3	16,8	17,1
<b>coefficient of variation</b>	0,3576	0,3257	0,3129	0,2338	0,2596	0,2703	0,3574	0,404	0,4537
<b>GINI coefficient</b>	0,2626	0,2112	0,2272	0,1728	0,186	0,1937	0,2597	0,2981	0,3319

Source: <https://ec.europa.eu/eurostat/data/statistics-a-z/abc>, own calculations and processing



The reasons for the emergence of regional disparities in the conditions of the Slovak Republic can be summarized in the following points:

- low competitiveness of material production and services,
- differentiated educational structure,
- spatially differentiated concentration of foreign investments and capital as factors of region development,
- imbalances in regional labor markets,
- Insufficient quality and availability of public infrastructure,
- differentiated intensity of the absorption capacity of the business environment.

Factors of possible development of regions and reduction of regional disparities:

- efficient use of labor,
- better use and development of the region's production potential,
- increasing the innovation capacity of regions,
- increasing support for SMEs in the regions, especially in the field of tourism,
- improving the accessibility of regions by building infrastructure,
- improving the availability of public services.

**Table 5.** Number of SMEs doing business in tourism by size category (as at 30 June 2020)

size category	number of active SMEs	share of active SMEs
micro-enterprises	24 514	96,46 %
small businesses	828	3,26 %
medium-sized enterprises	64	0,25 %
large companies	7	0,03 %
<b>total</b>	<b>25 413</b>	<b>100 ,00%</b>

**Source:** The position of SMEs in tourism with regard to current developments in the industry, SBA, Bratislava, 2020, p. 17

The solution to regional disparities is the effective support and development of business activities in the field of tourism. Tourism activities are linked to the place of its origin, i.e. the region. Therefore, we can consider them as a driving force for the economic development of the region. Tourism is a dynamically developing service sector, which is often considered to be the only tool for the development of lagging regions while preserving the quality of the region's environment and protecting native cultures. Tourism in the Slovak Republic is significantly dominated by small and medium-sized enterprises headed by micro-enterprises (Table 5), because thanks to their flexibility they can flexibly satisfy specific and individual requirements on the demand side. Small and medium-sized enterprises, micro-enterprises create jobs in the regions, contribute to the growth of the region's performance, also have an impact on the growth of revenues to local budgets, etc.

**Table 6.** Headquarters of SMEs doing business in tourism

	Number of active SMEs as of 30.6.2020	Share of active SMEs as of 30.6.2020
<b>Region of Bratislava</b>	5 959	23,5%
<b>Region of Trnava</b>	2 787	11,0%
<b>Region of Trenčín</b>	2 294	9,0%
<b>Region of Nitra</b>	2 932	11,5%
<b>Region of Žilina</b>	2 972	11,7%
<b>Region of Banská Bystrica</b>	2 714	10,7%
<b>Region of Prešov</b>	3 185	12,5%
<b>Region of Košice</b>	2 563	10,1%

**Source:** The position of SMEs in tourism with regard to current developments in the industry, SBA, Bratislava, 2020, p. 19

Regional development in the context of the given facts can therefore be perceived as a "by-product" of tourism and vice versa. The development of tourism in the region brings investors who build or improve the local infrastructure, facilities of the region and provide tourists and locals with more opportunities and a better quality of life. However, it can work the other way around. Because tourism depends on local infrastructure. The quality of infrastructure is an essential determinant of the flow of tourists to the region and thus contributes to the overall development of the region and the reduction of regional disparities. Of course, tourism also brings with its negative effects Table 7.

**Table 7:** The impact of tourism on the development of the region

Positive effects	Negative effects
<ul style="list-style-type: none"> <li>• Stops rural depopulation</li> <li>• Creates jobs</li> <li>• Brings revenue</li> <li>• Finances infrastructure construction</li> <li>• Improves living conditions</li> <li>• Supports agriculture and improves care for the landscape</li> <li>• Strengthens the feeling of belonging to the region</li> </ul>	<ul style="list-style-type: none"> <li>• It leads to a unilaterally oriented and sensitive structure of the economy</li> <li>• If it develops in an uncoordinated manner, it negatively affects its effectiveness</li> <li>• Occupies land by building facilities</li> <li>• It burdens nature and the landscape</li> <li>• Affects the original culture</li> <li>• Brings social tensions and increases inequalities</li> </ul>

**Source:** Gregorová, B. Neradný M, Klaučo M., Masný M., Balková N. 2015. Cestovný ruch a regionálny rozvoj. UMB Banská Bystrica. p. 81

## CONCLUSION

As stated by Grenčíková, A. et al (2019, p. 75): "the area of tourism is influenced by the unpredictability of climatic conditions and customer behavior, and then accommodation and catering services must be provided by support activities, which include e.g. opportunities for sports, hiking, wellness, the possibility of visiting historical monuments and other attractions. Animation services are also used and it is becoming more and more popular, for example. gastronomic tourism, or agrotourism as an escape from the hustle and bustle of the big city, active rest from the stressful factors of today's hectic times." And these facts create a large space for the development of a wide range of business activities of SMEs and the possibility of starting economic activities in lagging regions of the Slovak Republic. So, in conclusion, we can say that the right combination of economic policy instruments and effective regional policy will be able to gradually erase regional disparities in the longer term and contribute to economic growth, job creation and the efficient use of regional resources.

## REFERENCES

- Gajdoš, P. (2008) Current state and development of regional disparities in Slovakia (with emphasis on underdeveloped regions). In: Gajdoš, P., ed., Regional disparities in Central Europe. Sociologický ústav SAV, Bratislava, p. 98-115
- Habánik, J., Kordoš, M., Hošták, P. (2016) Competitiveness of Slovak economy and regional development policies Journal of international studies, vol 9, pp.144-155
- Matlovič, R., Klamár, R., Matlovičová, K. (2008) Vývoj regionálnych disparít začiatkom 21. Storočia na Slovensku vo svelte vybraných indikátorov. Regionální studia / Czech Regional Studies, recenzovaný vedecký časopis, 02/2008, ISSN 1803-1471, p. 2-12
- GÚČIK, M. (2010): Cestovný ruch. 1. vyd. Banská Bystrica: DALI-BB, 2010, 307 p. ISBN 978-80-89090-80-8

- GÚČIK, M. a kol. (2012). Manažment cieľového miesta cestovného ruchu. 1. vyd. Banská Bystrica: Slovak-Swiss Tourism, DALI BB, 2012, 219 p. ISBN 978-80-8141-025-3
- Gregorová, B. Neradný M, Klaučo M., Masný M., Balková N. (2015): *Cestovný ruch a regionálny rozvoj*. UMB Banská Bystrica
- Grenčíkova, A., Petrušová, D., Sokol J.(2019), *The impact of Industry 4.0 on tourism services* online: <https://fsev.tnuni.sk/konferencia2018/Zbornik-industry-4-0.pdf>.  
In: *The impact of Industry 4.0 on job creation Zborník odborných príspevkov z medzinárodnej vedeckej konferencie*. - Trenčín: TnUAD, 2019. - ISBN 978-80-8075-837-0. - p.74-80.  
<https://www.iz.sk/sk/projekty/inkluzivny-rast/najmenej-rozvinute-okresy>
- The position of SMEs in tourism with regard to current developments in the industry*, SBA, Bratislava, 2020, online: [http://monitoringmsp.sk/wp-content/uploads/2020/10/Postavenie-MSP-v-cestovnom-ruchu\\_final.pdf](http://monitoringmsp.sk/wp-content/uploads/2020/10/Postavenie-MSP-v-cestovnom-ruchu_final.pdf)
- <https://ec.europa.eu/eurostat/data/statistics-a-z/abc>,  
Statistical Office of the Slovak Republic, <http://datacube.statistics.sk/#!/lang/sk>
- Statistical Office of the Slovak Republic, [http://statdat.statistics.sk/cognosext/cgi-bin/cognos.cgi?b\\_action=xts.run&m=portal/cc.xts&gohome=](http://statdat.statistics.sk/cognosext/cgi-bin/cognos.cgi?b_action=xts.run&m=portal/cc.xts&gohome=)



# THE MARKETING MIX - A BASIC TOOL IN THE MANAGEMENT OF THE TOURIST DESTINATION

Delia Fratu<sup>24</sup> 

DOI:

---

**Abstract:** *Kotler's 2002 definition of place marketing is as follows: "Place marketing means designing a site to meet the needs of its target markets. The development of places means the development for a place of a systematic long-term marketing strategy, directed towards the identification and development of the natural and potential attributes of an area".*

*The elaboration of a marketing mix for the tourist destination is the main tool for marketing planning and for adopting the most appropriate strategies. Given that each tourist destination has its specificity, the marketing mix must contain its own elements, adapted to the objectives set.*

*In this paper we chose to exemplify a way to apply and combine the components of the following marketing mix: product, price, distribution, promotion, staff, partnerships, packaging, security, process management for the tourist destination Brasov Area.*

**Keywords:** *Place Marketing, Marketing Mix, Tourism, Destination*

---

## 1. BRASOV AREA- A TOURIST DESTINATION

A tourist destination is defined according to the following variables: the attractions and the environment within the destination, the facilities and services available at the destination, the accessibility of the destination, the image and the brand of the destination.

### 1.1. Defining the Tourist Destination Brasov Area

Brasov Area is located in a special natural setting. In the southern part it is delimited by the Făgăraș, Bucegi, Piatra Mare, Piatra Craiului and Postăvaru Mountains, in the Eastern part there is the Brașov depression, and in the Western part it is bordered by the Olt river valley. Due to the geographical potential, mainly mountainous, tourists coming to the area can practice sports and recreational activities in all seasons.

Being located in the center of the country, in the famous Transylvania region, Brasov Area is one of the most visited tourist destinations in Romania. The multitude of ethnic groups (Saxons, Hungarians) that marked the development of this area and their influence on architecture, local culture is an attraction for tourists.

In Brasov Area, tourists can discover one of the most beautiful cities in Romania - the city of Brasov which is a medieval city with a multitude of attractions: cultural tourist attractions (Dramatic Theater Sica Alexandrescu, Brasov Opera, Gheorghe Dima Philharmonic, Reduta Cultural Center, Library County, French Alliance, First Romanian School, etc.), historical and religious tourist attractions (Catherine Gate, Weavers' Bastion, White Tower and Black Tower,

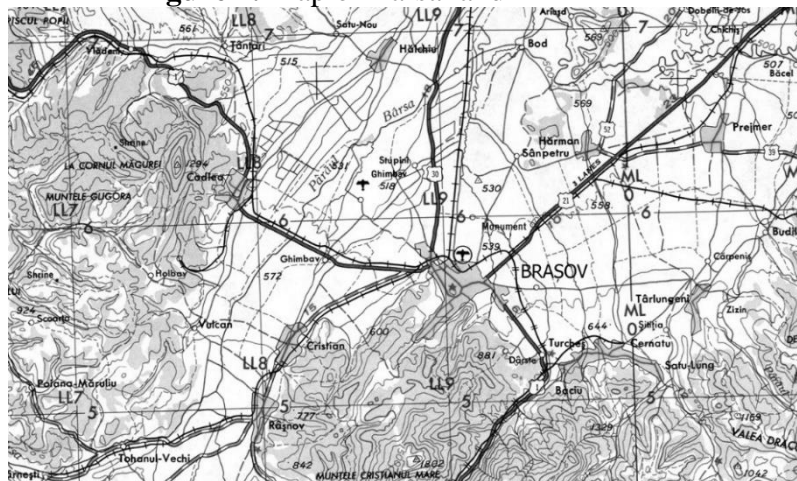
---

<sup>24</sup> Transilvania University Brasov, 32 Avram Iancu street, Brasov, Romania

Graft Bastion, Black Church, St. Bartholomew's Church, St. Nicholas Church, etc.), natural tourist attractions (Tâmpa Nature Reserve), museums (History Museum, Museum of Art and Ethnography, Museum of Urban Civilization, etc.) as well as various events (musical, theatrical, cinematographic, etc.).

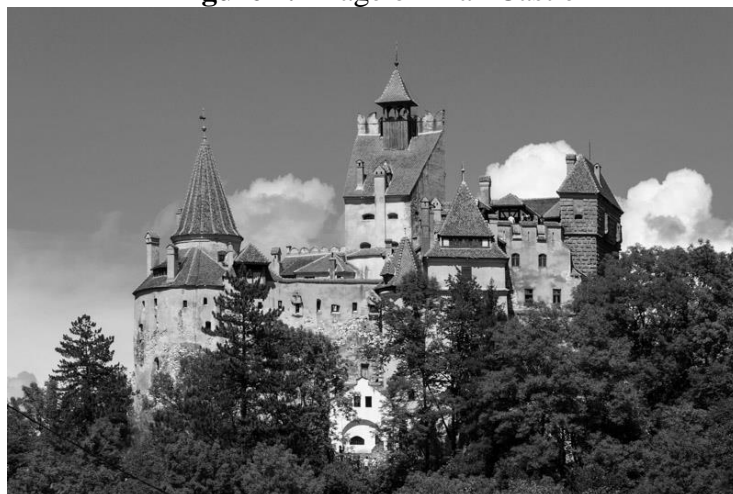
Most of the tourists who come to Brasov Area aim to visit the surroundings of Brasov, very rich in historical, religious, cultural and natural objectives: Poiana Brasov and Predeal resorts are the most famous winter resorts in Romania, during the summer being sought for mountain tourism, cycling, conference tourism; the villages in the Bran-Moeciu area are real Transylvanian mountain villages where tourists can know the local traditions and customs, to mention the presence of the famous Bran castle - Dracula's castle; the town of Râșnov with the peasant fortress; the city of Făgăraș with its fortified fortress; the churches and fortified fortresses in the villages around the city of Brasov; Piatra Craiului National Park Nature Reserve. It should be mentioned that besides the worldwide known Dracula's Castle from Bram Stoker's book which became a brand in itself, we can also say about Bran that it is an important representative of the word "brand" by joining the words Bran-Destination, this as an interpretation modern after its Norwegian origin.

**Figure 1.** Map of Barsa land- Brasov area



Source: [https://upload.wikimedia.org/wikipedia/commons/1/11/Map\\_of\\_Burzenland%2C\\_1959.jpg](https://upload.wikimedia.org/wikipedia/commons/1/11/Map_of_Burzenland%2C_1959.jpg)

**Figure 2.** Image of Bran Castle



Source: <https://www.twoscotsabroad.com/bucharest-to-transylvania-bran-castle/>

**Figure 3.** Image of Rasnov Citadel



**Source:**

[https://en.wikipedia.org/wiki/R%C3%A2%C8%99nov\\_Citadel#/media/File:R%C3%A2%C5%9Fnov\\_Citadel\\_\(Rosenauer\\_Burg\)\\_01.jpg](https://en.wikipedia.org/wiki/R%C3%A2%C8%99nov_Citadel#/media/File:R%C3%A2%C5%9Fnov_Citadel_(Rosenauer_Burg)_01.jpg)

The accommodation possibility is diverse and adapted to all requirements and budgets: from hostels and tourist cabins to hotels and pensions. Tourist services in the Brasov area are developed and diversified as a whole, but there is room for improvement. Meal services are generally diversified and of good quality. There is an untapped opportunity to attract the Western European public interested in organic and home-cooked food with Romanian specifics. This is expected from the accommodation units in the rural area, but most of them opt for the more convenient option, namely the purchase of food from the supermarket.

Even though there is a wide range of local handicrafts, there are not many shops that specialize in selling them. Recently, there have been several shops dealing with the sale and rental of items for outdoor recreation (mountain bikes, tents, etc.).

Travel agencies are an important element for the development of a tourist destination such as Brasov Area. There are about 80 travel agencies in the area but only a few are focused on incoming tourism activity. Along with them, several associations work to promote the area as a tourist destination and to develop a sustainable tourism (Association for the Promotion and Development of Tourism - fulfills the role of destination management organization, County Sustainable Development Agency and Metropolitan Association for Sustainable Development).

Transport services are satisfactory, even good compared to other areas of the country. The railway transport service between Bucharest-Predeal-Brasov is quite good. Lately, most of the roads in the area have been rehabilitated. However, there are still roads that are almost non-functional, mostly in rural areas, they need to be identified and rehabilitated. The inauguration of an airport in the Brasov area would be a future investment that would ensure the development of tourism.

Tourist information services have been improved recently. There is a tourist information network at the level of Brasov Area, comprising 7 centers: Brasov, Predeal, Rasnov, Fagaras, Prejmer, Bran, Zarnesti. The mission of the tourist information offices is to inform the tourists about the attractions in the area and to promote them by offering informative materials.

In Brasov Area, there are several possibilities for schooling in the field of tourism. Transilvania University of Brasov offers those interested the opportunity to study in Economics of Commerce, Tourism and Services. Other schools specializing in tourism are the School of Hotel Management, the Brasov School of Tourism. There are also post-secondary training programs for tourism available in Bran and Brasov.

The access of tourists in the Brasov area is facilitated by the acceptable road and railway infrastructure, compared to other areas of the country, which connects with the country's capital, but also with Western Europe. Transport infrastructure is the biggest problem of Romanian tourism. Investments in a highway that crosses Romania are very necessary and urgent. The construction of an airport would create the possibility of connections between the Braşov Area and the main western cities.

The tourist destination was promoted under the brand "Be.Live It". This brand aims to promote the cultural diversity and dynamics of a modern, new area and was presented at the World's Leading Travel Trade Show in Berlin where it took 2nd place. This brand was designed by the Association for the Promotion and Development of Tourism (APDT) in partnership with the Brasov County Council, the Agency for Sustainable Development of Brasov County (ADDJB) and the advertising agency Firestarter, to represent the tourist destination area. Brasov at the Berlin Tourism Fair and to promote a favorable image of it internationally. The problem was that not enough money was invested to promote it both nationally and internationally. Even if the idea was good, it did not ensure its visibility at all and without promotion it did not have any significant results.

## 1.2. Types of tourism practiced in the Brasov area

The tourist offer of the Braşov area provides conditions for practicing many forms of tourism:

- *Mountain hiking* tourism is favored by the existence of mountain massifs, large areas covered with forests, the existence of marked trails, mountain huts and accommodation bases in neighboring towns.
- *Cultural-historical and religious tourism* is favored by the existence of numerous historical, religious and architectural monuments throughout the area.
- *Sport tourism* such as mountaineering, downhill skiing, cross-country skiing, horseback riding, mountain biking, hang gliding and gliding, hunting and sport fishing in hilly and mountainous areas, "image hunting" safari of some species such as wolf, bear and lynx, in Brasov living 30% of Europe's large carnivorous population.
- *Thematic scientific tourism* by sections of biodiversity, speleology, geology, paleontology. It can be practiced in the nature reserves of the Brasov area.
- *Rural tourism or agrotourism* is practiced especially in the area of Bran villages (Fundata, Moeciu, Bran) and in Poiana Mărului, areas that constitute an area with a special natural, historical and tourist potential, as well as in the Săcele-Tărlungeni area.
- *Ecotourism* is the closest tourism to nature, offered as a tourist product in: Zărneşti area, area in which this type of tourism is developed in the most advanced stage in Romania, favored both by the exceptional natural environment (Piatra Craiului National Park) and by the activity of organizing and promoting this type of tourism by the Administration Piatra Craiului National Park; Vama Buzăului area, gateway to the Ciucaş Massif, where the Ecology and Ecotourism Educational Center currently operates; Buneşti-Viscri area, an incipient area in the practice of ecotourism but with a special potential for a further development in this direction; the Făgăraş area, favored by the natural environment, in



which an incipient ecotourism tourism is practiced, but without a coherent and unitary strategy in this respect.

- *Business and conference tourism*, from the perspective of which the Brasov area enjoys a growing interest.

## 2. THE SYSTEMIC APPROACH OF THE MARKETING MIX OF THE TOURIST DESTINATION BRAȘOV AREA

After having an overview of Brasov area as a tourist destination, let us have a look of the components of the marketing mix from a systemic perspective.

The tourist destination Brasov area is a system because it is a set of elements with certain common features that form an organized whole. The policies and strategies of the marketing mix can be approached from an overall perspective or from that of its component elements.

The tourist destination Brasov area can be divided into component sub-destinations due to the fact that the area is a destination in itself, but also the elements that make it up can be considered independent destinations. In this paper it was considered the division of the area according to the most representative attractions as follows:

- the city of Brasov - is the sub-destination considered the most representative for the area according to the results of quantitative research;
- the fortified churches, the fortresses from Făgăraș, Râșnov, Rupea, Bran castle - were grouped due to the form of tourism they represent, namely the cultural-historical tourism;
- Poiana Brasov and Predeal resorts;
- Piatra Craiului National Park (it is the best known in the category of unique natural attractions).

It is desired to determine the existing connections between the system represented by the Brasov area and its component elements.

**The city of Brasov** - is the sub-destination considered the most representative of the area by both tour operators and tourists. It has been included in various tours of Romania, Transylvania or has been considered an independent destination. As a product policy, it is proposed to design "city-break in Brasov" tourism products, with multiple accommodation possibilities for all budgets, lasting 2 nights / 3 days because it is a sufficient time to discover the city. This product must include the possibility of contracting sports and leisure activities. It is recommended to approach the strategy of stimulating the current market and attracting new tourist markets.

In the case of Brasov, the strategy of low prices should be approached in order to attract as many tourists as possible and to be able to compete with other similar destinations. The city of Brasov is facing the phenomenon of seasonality, so it should be considered the strategy of adjusting tariffs accordingly.

For the distribution and promotion of this type of product, intensive distribution and promotion by all means proposed at the area level is recommended.

We propose a tourist package of the "city-break" type developed over 3 days, the theme "Discover the city of Brasov", with free program and suggested activities: city tour with tourist guide / tourist bus / segway with companion, walk on Tâmpa, circuit of cultural-historical

objectives, various sports activities, entrance to the Aquatic Paradise. As accommodation and dining options, different units will be proposed on classification levels. Tourists will be transported by bus to the destination, only on request.

It is recommended to conclude strategic partnerships between the city of Braşov and cities in other areas of the country (for example Constanţa, Iaşi, Oradea, Arad) and abroad for mutual promotion.

In order to ensure the security of tourists, the strategy of deterring crimes and delinquency can be applied by harshening those who commit crimes against tourists, increasing security (presence of law enforcement in as many locations as possible) and informing about dangerous areas in Brasov Area. It is also recommended to apply the strategy of neutralizing the negative aspects by informing tourists about the security level of the destination Brasov area, by advising tourists to fight against local crime (for example do not leave unsupervised luggage or pay attention to the exchange commission).

### **Churches and fortresses in the Brasov area**

This tourist product is a circuit type and has usually been included in larger circuits (for example, "discovering the areas of Transylvania" or "tour of the fortified cities and churches of Transylvania"). Churches and fortresses in the Brasov area, as well as those in the rest of Transylvania, are attractions of great interest, especially for foreign tourists. These are very well preserved, unique monuments, some of them being in the UNESCO patrimony. It is proposed to keep this tourist product of integrated circuit type but with a clear delimitation of the patrimony of each county because each area included in the circuit is identified with its patrimony. Due to the positioning of these attractions especially in rural areas, this product encompasses two forms of tourism: cultural and rural. As the product will not be changed, it is recommended to adopt the current market stimulus strategy.

Regarding the tariff of this type of tourist product, it must be established in accordance with the other counties that make up the circuit. In this approach, the rates should be the same for both Romanian and foreign tourists. It is proposed to develop an access card to such objectives with a pre-established, preferential, reduced rate for groups. The low price strategy approach is the most appropriate. There are two examples of such churches:

- 1) The **Prejmer fortified church** ( German: *Kirchenburg von Tartlau*) is a Lutheran fortified church in Prejmer (*Tartlau*), Braşov in the Transylvania region of Romania and the ethnographic area of the Burzenland.  
The church was founded by the Germanic Teutonic, and then was eventually taken over by the Transylvanian Saxon community. Initially Roman, it became Lutheran following the Reformation. Together with the surrounding village, the church forms part of the villages with fortified churches in Transylvania UNESCO World Site.
- 2) **Harman Fortified Church is one of the 25 UNESCO WorldHeritage Sites in Romania** Located in the heart of Harman (*Honigburg* in German, meaning *Honey Castle*) village, this fortified church dates back to the 13th century when Saxons built the original structure. Strong walls and bulwarks surrounded the church and on its sides, massive towers were added

**Figure 4.** Map of Prejmer fortified church (UNESCO World Heritage Site)



**Source**

[https://en.wikipedia.org/wiki/Prejmer#/media/File:Prejmer\\_200609.jpg](https://en.wikipedia.org/wiki/Prejmer#/media/File:Prejmer_200609.jpg):

**Figure 5.** Image of Harman Fortified Church (UNESCO World Heritage Site)



**Source:**

[https://en.wikipedia.org/wiki/H%C4%83rman#/media/File:RO\\_BV\\_Harman](https://en.wikipedia.org/wiki/H%C4%83rman#/media/File:RO_BV_Harman)

Even if this type of product could attract a large number of tourists interested in cultural tourism, the discovery of unique monuments, it is not exploited at its real value due to the lack of efficient distribution and promotion. Although this type of product appears in the offer of some Romanian and foreign tour operators, their area should be increased. It is proposed to adopt an intensive distribution strategy, which involves the use of a large number of intermediaries.

The following promotion strategies are recommended for this type of product:

- Documentary information strategy and pedagogical strategy, both meant to provide information that would arouse curiosity;
- Creating events (such as the Medieval Festival Tournament of the Citadels);
- Organizing info-trips for the representatives of the tour operators and travel agencies in order to know directly the tourist product;
- Participation in specialized tourism fairs.

It is proposed to design a tourist package with the theme "Tour of fortified cities and churches in Transylvania" which includes visiting them, visiting Transylvanian villages in their vicinity, providing accommodation and dining in rural areas, entertainment program every evening to discover traditions and local customs. The transport will be done by bus; tourists will be accompanied by specialized guides throughout the tour. The duration will depend on the number of areas included in the circuit.

The design of a tourist package of the type mentioned above involves the consideration of partnerships in the cultural-historical field between the Brasov area and other areas in Transylvania in order to design a unitary product and establish common policies and strategies.

It is recommended that the policies and strategies of security, personnel and process management be the same as those proposed for the city of Brasov.

**Predeal and Poiana Brasov resorts** rank 3rd in the preferences of tourists visiting the Brasov area. These tourist destinations are especially sought after for winter sports (alpine skiing, cross-country skiing, snowboarding, tobogganing, skating, learning sports with the help of specialized instructors). These two tourist resorts are the most famous in Romania and benefit from a highly developed infrastructure, brought to European standards during the organization of the European Youth Olympic Festival in 2013. The tourist product for the winter season should be in the form of "a week in the mountains" which includes, in addition to basic services, a common access card to the ski slopes, daytime entertainment program (e.g. competitions, raffles) and evening (e.g. concerts, traditional evenings). The tourist product Predeal and Poiana Braşov face the phenomenon of seasonality, like any resort dedicated to winter sports. In order to diminish this phenomenon, tourist products destined for the summer season should also be elaborated. The tourist product destined for the summer season should also be in shape for a week in the mountains but with the possibility of practicing summer sports (hiking, cycling, etc.). The strategy that should be considered is to penetrate the internal and external market with the previously proposed products.

A global tariff (all inclusive) should be set for these products. The strategy of low tariffs is recommended for good quality, at least in the short term, in order to face the competition represented by countries such as Austria or Bulgaria. Given that demand is particularly pronounced in winter, the differentiated tariff strategy for the rest of the year should be considered.

It is proposed to adopt the intensive distribution strategy, through a large number of intermediaries: electronic, tour operators and travel agencies, tourist information centers, in tourism fairs, etc.

Regarding the promotion of these products, it is recommended:

- designing a portal intended exclusively for these two resorts, with the possibility of making reservations in real time, with the presentation of all events, possibilities for spending time, etc.;
- production of well-documented, attractive promotional materials to be distributed free of charge to tourists, information centers and travel agencies;
- organizing info-trip excursions for the representatives of the tour operators and travel agencies in order to test these tourist products;
- organizing internationally renowned competitions;
- participation in tourism fairs.

It is proposed to conclude partnerships with other areas of the country (especially the coastal area and Bucharest) as well as abroad in order to promote the offers. Partnerships with major European tour operators are also considered strategic in order to include these products in their offers.

It is proposed to develop a tourist package with the theme "A week in the mountains", lasting 7 days, including accommodation and meals of various categories, access card to the ski slope (winter), rental of sports equipment for winter or for the summer as the case may be, animation program. Tourists will be transported by bus to the destination. Inside the resort, a mini-bus will be made available to tourists who will have regular trips to ensure the transport of tourists from the accommodation to the slopes, during the winter.

For the security of tourists, they will be informed about the security level of certain places in these resorts and by their advice and counseling in order to avoid various frauds (e.g. use of ATMs exclusively in closed spaces, not leaving unattended luggage, use of safes in rooms hotel for storing valuable etc.).

The staff working in tourism in these resorts is helpful and kind, so the quality of the process of providing tourist services is generally considered satisfactory by tourists. Most organizations active in tourism are up to date with technological developments and benefit from state-of-the-art facilities: card readers, online booking systems, etc. Most tourism organizations apply the policy of generating and maintaining customer relations by setting up databases with them and by giving due importance to feedback on the quality of service delivery.

**Piatra Craiului National Park** is unique in the Romanian Carpathians due to the imposing relief of the limestone ridge 25 km long and due to the rare species of flora and fauna. At present there are very few travel agencies or organizations that offer tourist products, stays, or simple trips to protected areas, because they involve a high degree of specialization from the organizers and companions. The tourist offers in the Piatra Craiului National Park area are addressed especially to young people (pupils, students) and include: guided excursions, tourism programs based on cycling and horseback riding, wildlife watching in freedom, climbing. Access to Piatra Craiului National Park offers a unique opportunity to create a combination of themed tourism products (cave exploration, medicinal plants, protection of mountain and ecological areas, observation and study of wildlife, as well as a whole series of recreational excursions, ecotourism or educational excursions), to be sold directly to tour operators and domestic and foreign travel agencies. The most appropriate product strategy is to penetrate the market with such thematic products.

As this nature reserve is a new destination launching on the market, it would be appropriate to adopt the low price strategy primarily because it addresses a category of middle and low income consumers.

The selective distribution strategy is the most appropriate because it involves distributing the product only to tour operators and travel agencies specializing in ecotourism, rural tourism, sports tourism, etc. and in web-sites and tourism fairs with this theme.

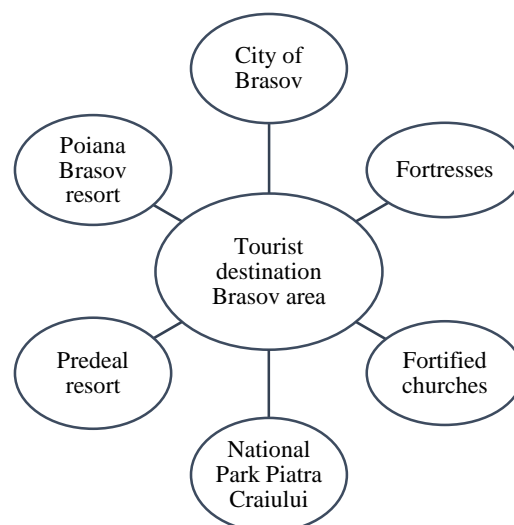
The following promotion strategies are recommended for the types of tourism products listed above:

- Documentary information strategy, meant to inform tourists about this area and to arouse their curiosity;
- Elaboration of promotional materials such as leaflets, tourist guides, CDs, etc. to be distributed to travel agencies, information centers, possibly stores with sports equipment in the country and abroad;
- Distribution of tourist products within web-sites that promote ecotourism, thematic, rural, sports tourism as well as the presentation of products at tourism fairs with the same theme;
- Organizing events for tourists on the occasion of the European Day of National Parks (May 24), within the Piatra Craiului National Park;
- Carrying out exchanges of experience with institutions and organizations from countries with advanced practices in ecotourism, such as Germany and Great Britain, especially because tourists from these areas are interested in Romania in general and Transylvania in particular.

The partnership policy involves concluding them with organizations in the same field at national and European level, on the promotion of tourism products. A series of thematic tourist packages are proposed, targeting market segments such as: cave exploration, wildlife watching in the wild, educational excursions. Such packages require the accompaniment of tourists by specialized guides, depending on the topics considered. Accommodation for tourists will be made at tourist chalets in the Piatra Craiului mountains, a place where meals will be served. The duration of these packages will be 2 days and can be extended upon request. The transport of tourists will be done by bus to the starting point of the mountain route. Regarding the personnel policy, for such tourist products it is necessary the presence of a personnel with a high degree of specialization. That is why it is very important to adopt the right employee recruitment strategy based on experience in the field and a skill test. The staff development strategy must also be adopted in order to be up to date with the requirements of tourists. Regarding the Piatra Craiului National Park, it is recommended to implement the strategy of investments in security equipment and technologies because some activities present a high degree of risk (e.g. exploring caves or observing animals in the wild) and involve the use of special equipment. In terms of process management, as in the case of the other three sub-destinations, it is recommended to conduct market research in order to determine trends in consumer behavior and expectations of tourists.

Area-level policies and strategies as a system are determined by sub-destination policies and strategies as components of the system. Sub-destinations must adopt policies and strategies in line with those at the area level, there must be harmonization between them. For example, in terms of product policy, the products of the components taken in part make up the product offered at the area level. Pricing strategies at the area level as well as at the level of sub-destinations are in line, namely the adoption of low prices. Area-level partnership policies also target component sub-destinations. Sub-destination packages interrelate with the regional package. The distribution and promotion policies and strategies at the destination level in the Brasov area are made up of those proposed within the sub-destinations. So are security, personnel and process management. Considering these aspects, a model of systemic approach of the tourist destination Brasov area is proposed, which consists of sub-destinations. The graphical representation of this model is shown in Fig. nr.6.

**Figure 6.** Relation of policies and strategies at the level of the tourist destination Brasov area and its component elements (sub-destinations)



### 3. The Cluster Strategy Approach

The notion of tourism cluster refers to a geographical concentration of companies and institutions interconnected through tourism activities. It includes providers, services, governments, institutions, universities and competitors. The main objective of a tourism cluster is to bring together companies that usually operate on their own, to build a successful tourism product in a given region.

A cluster structure in tourism should include accommodation, catering services - which is its static element, and transport services, travel agencies and tour operators, car rental services - which are mobile elements.

The tourism cluster includes, in addition to accommodation, meals, entertainment and various attractions, tour operators and travel agencies, guides, car rental and tourist transport services, other services and activities such as organizations and support services, transport infrastructure, education and training, consulting and other business services. It is necessary the participation of all actors active in tourism, not just tourism service providers to design a cluster type structure. The government should encourage and fund programs to attract private investors, invest in infrastructure and promote tourism.

Within tourist destinations these cluster structures appear by themselves but must be supported and developed to reach their maximum potential. Their development should be supported by strategic planning, the support of the authorities, investment in infrastructure and joint marketing efforts. The interdependence that appears at the level of a destination between attractions, services, transport, information, promotion, induces the need for collaboration and it is obvious that if the actors at the destination level work together they have nothing to gain.

The satisfaction of the tourist depends not only on the attractions at the destination but also on the quality and efficiency of the services offered by hotels, restaurants, shops, transport. Therefore, in a global market where competition is very tight between tourist destinations, and in the context where new destinations always appear and the consumer changes his behavior, it is recommended to approach a cluster structure to become and remain competitive in the market. High-level cooperation successfully creates added value for both the tourist destination and the individual entrepreneur.

The first tourism cluster established in Romania "Carpathian Tourism Cluster Romania" is a network of professional and development organizations, with as members decision makers at regional and national level, experts in the tourism industry in Romania and was launched on November 1, 2010. Its mission is to promote sustainable tourism and create added value for the tourism industry in the Carpathian Mountains region. It was established at the initiative of the Association for the Promotion and Development of Tourism in Brasov County together with Monteoru Renaissance - Association for Sustainable Regional Development in Tourism (Buzau County). The marketing action plan for the Carpathian Mountains tourist region will be developed in accordance with the national brand and tourism strategy: "Romania - Explore the Carpathian Garden".

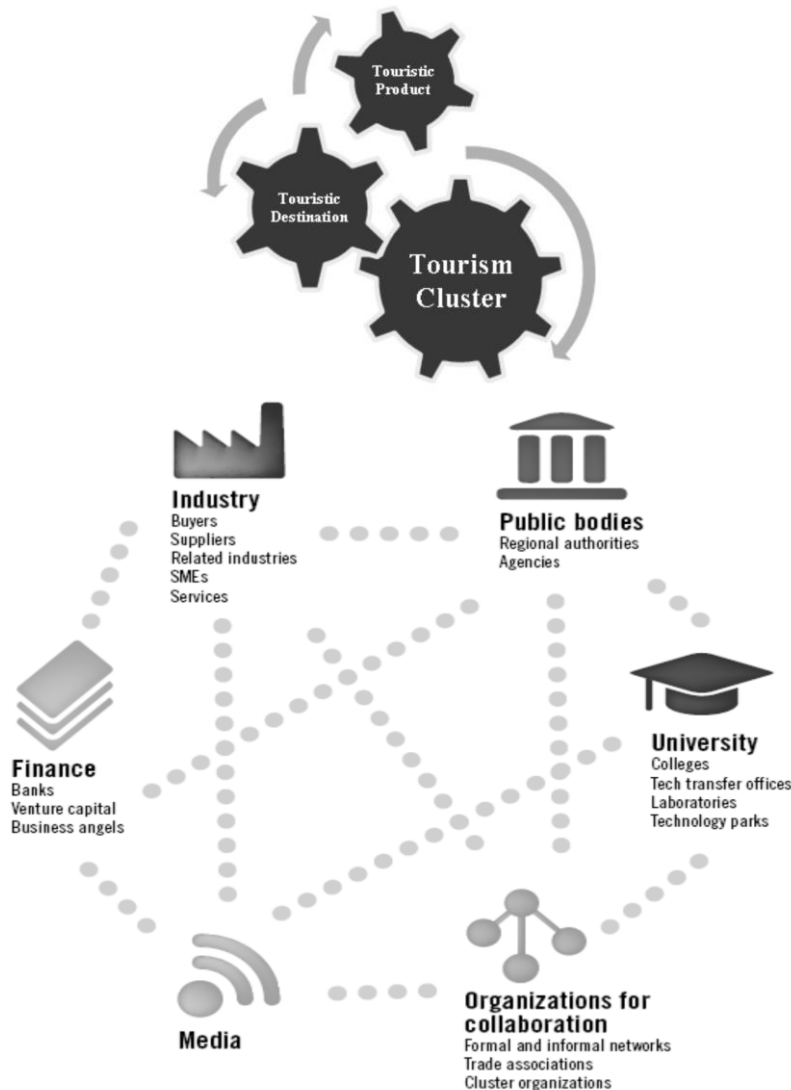
The considered objectives are the innovation and diversification of the tourist products and of the services associated to them, in order to increase the interest of the external and internal markets for the Carpathian Mountains, as a tourist destination. Also, the most important activities are increasing competitiveness by optimizing the value chain in the local tourism

industry and improving the quality of tourism services, in order to reach European standards. The cluster projects have an inter-regional character, focusing for the beginning, on the Carpathian and sub-Carpathian tourist regions in the center of the Carpathian Arc, including the counties of Brasov, Buzau, Sibiu, Covasna, Arges and Prahova. They will contribute to the development of local and regional partnerships, to the development of resources and capabilities of organizations in order to meet the general objectives of the cluster.

However, not all tourist destinations form cluster systems; only when they reach a high level of development can they form such integrated systems. Even if there are many partnerships in the Braşov area, there is no common integrated approach to target all tourism actors and to develop in the sense of harmonizing personal benefits with those in the area and to identify common beneficial development directions.

The following model presented in Figure 7, illustrates a cluster approach at the level of a tourist destination that is proposed for adoption by the Brasov area.

**Figure 7.** The model of a tourism cluster at regional level



**Source:** adapted from Sölvell Ö., Clusters - Balancing Evolutionary and Constructive Forces, 2<sup>nd</sup> ed., DanagardsGrafiska, Ödeshög, January 2009, pp. 16.



The competitiveness of the cluster approach proposed above depends on:

- human resources, natural and anthropic resources, development of tourist infrastructure, accessibility and security;
- current conditions of demand: level of education, preferences and motivations;
- the structure of the private environment and competition.

The competitive strategies that should be adopted inside and outside the cluster are based on the cooperation of all actors at the destination level in the Brasov area in order to innovate and differentiate the tourist experience offered.

Local authorities play a very important role in improving the competitiveness of the cluster by creating and maintaining tourism infrastructure, providing financial support to tourism investment projects, ensuring destination security, preserving the natural, historical and cultural heritage within the cluster.

The role of the University and tourism training schools within the cluster is to encourage the design of innovative and differentiation strategies for the cluster destination and to educate and prepare human resources.

## **FUTURE RESEARCH DIRECTIONS**

The marketing mix proposed as an example for Brasov Area is an aspect that can be discussed for further analysis regarding the variables proposed and also the strategies. The marketing mix specific strategies proposed in this article for Brasov Area, together with the systemic and the cluster approach can be proposed as a good practice example for other similar tourist destinations within a marketing plan. The conclusions resulted can be used in the comparison.

## **CONCLUSION**

Tourism is a dynamic phenomenon, which is constantly changing. The tourist market is constantly changing due to the existing and constantly growing competition. Tourist destinations, the basic pillars of tourism, face many challenges in order to enter and stay in this market. Therefore, the marketing activity within the tourist destinations is of major importance in order for them to be maintained at a competitive level. Marketing approaches in tourist destinations have become indisputable tools for their success.

In recent years, the tourism market has been severely affected by major economic changes which have also led to changes in consumer behavior. In this context, the orientation of tourists towards certain destinations to the detriment of others underlined the need for the current approach of policies and marketing strategies applicable to tourist destinations at a conceptual level.

## **REFERENCES**

- Alhroot, A., Marketing of a destination: Jordan as a case study. PhD thesis, University of Huddersfield. Huddersfield, 2007
- Ashworth, G., Goodall, B., Marketing tourism places, Routledge, New York, 1990
- Avraham, E., et al, Media Strategies for Marketing Places in Crisis, Elsevier, Butterworth-Heinemann, 2008

- Baloglu, S., Kozak, M., *Managing and Marketing Tourist Destinations Strategies to Gain a Competitive Edge*, Routledge, New York, 2011
- Candrea, A., Constantin, C., Ispas, A., *Tourism Heterogeneity in Romanian Urban Destinations, the case of Brasov*, *Tourism and Hospitality Management*, vol.18, no.1. 2012
- Destination Marketing Association, *The Secrets of Packaging Success for Destination Tourism Organizations*, Destination Marketing Association Int Publication, 2007
- Dwyer, L., Kim, K., *Destination Competitiveness: Determinants and Indicators*, *Current Issues in Tourism*, vol.6, m.5, Routledge, 2003
- Fratu Delia: *Factors of influence and changes in the tourism consumer behaviour*. *Buletinul Universității Transilvania Braşov*, Vol. 4 (53) • No. 1 - 2011 • Series V 120, 2011
- Fratu, D., Brychtova, S., *Analysis of the Present Situation in Tourism in two European Regions: Pardubice and Brasov*, *Scientific Papers of the University of Pardubice* 21 (3/2011), p.53-67
- Howie, F., *Managing the tourist destination*, Thomson Learning, Londra, 2003
- Kotler, P., Bowen J., Makens J., *Marketing for Hospitality and Tourism*, fourth edition, Pearson Education International, Upper Saddle River, New Jersey, 2006
- Kotler, P., Asplund, C., Rein, I., Haider, D., *Marketing Places in Europe*, Prentice Hall, 1999
- Malhotra, N., *Marketing research – and applied orientation*, Pearson Education, Prentice Hall, 2006
- Pike, S., *Destination Marketing- an Integrated Marketing Communication Approach*, Butterworth-Heinenmann, Oxford, 2008

# THE IMPORTANCE OF ACQUIRING INTERCULTURAL COMMUNICATIVE COMPETENCE FOR PRESENT AND FUTURE TOURIST PROFESSIONALS IN MONTENEGRO

Gordana Mušura<sup>25</sup> 

DOI:

---

**Abstract:** *The aim of this paper<sup>26</sup> is to discuss and emphasize the importance of acquiring and developing intercultural communicative competence (hereinafter ICC) for tourist professionals in the context of strategic advantages of Montenegro as a tourist destination. Montenegro, as a multicultural, multiethnic and multi-confessional country with a very rich and ancient cultural heritage and preserved natural resources, strives for European integration and achieving international competitiveness in the field of tourism through the development of its strategic advantages. In order to achieve progress in tourism industry, it is necessary to apply an interdisciplinary approach, which includes a symbiosis of elements of culture and tradition with the need and demands of modern tourists who want to communicate with the domicile population, or at least with their hosts, as well as to feel comfortable and welcome at the destination they have chosen for their holiday. Therefore, communicative and affective segments must be added to this interdisciplinary approach which inevitably includes the acquisition of new skills in intercultural communication at the international level. Such communication enables the development of ICC through the inclusion of both linguistic and cultural elements of education in tourism and applying the intercultural approach in foreign language teaching. Furthermore, developing intercultural aspects in tourism should be seen as one of core advantages of smaller and still insufficiently affirmed tourist regions, such as Montenegro, especially in these disruptive circumstances of crisis caused by Covid -19 virus.*

**Keywords:** *Intercultural Communication, Globalization, Intercultural Approach in Foreign Language Teaching, Intercultural Speaker, Intercultural Awareness and Sensitivity, Long-life Learning*

---

## 1. INTRODUCTION

Our contemporary reality is characterized by globalization and interculturality. Migrations of the population and the permeation of their cultures and languages are becoming more and more emphasized, which has imposed the need to focus on the intercultural aspect, both in the school and work environment of people. Tourism, as a branch of economy that includes a large number of people, both tourists and tourist workers and residents of the receptive tourist area, is in direct connection with globalization processes characterized by intercultural contacts and human relations conditioned by their different national, linguistic, cultural, religious and identity differences. Therefore, it is extremely important that all the afore mentioned actors establish appropriate intercultural communication

---

<sup>25</sup> Faculty of Business and Tourism, Akademija znanja, Budva, Montenegro

<sup>26</sup> Some segments of the paper were taken, adapted and translated into English from the doctoral dissertation “Sticanje interkulturene komunikativne kompetencije u nastavi italijanskog jezika kao stranog u osnovnoj školi” (Mušura, 2019). (“Acquiring intercultural communicative competence in teaching and learning Italian as a foreign language at elementary school”)

that will lead to mutual respect and appreciation of cultural differences, tolerance and understanding of "otherness", which are the basic postulates of acquiring intercultural competence. This competence will enable them to overcome stereotypes and prejudices about other nations, especially in the sphere of cultural tourism. In order to achieve this, it is necessary to establish an intercultural approach in teaching in the school system, from the earliest age of children in the lower grades of primary school, through secondary school and higher education at the university, on the one hand, and, on the other hand, to continuously educate tourism workers in the direction of interculturalism, which is in line with the principles of the Council of Europe on long life learning.

## **2. INTERCULTURAL COMMUNICATIVE COMPETENCE**

When communicative competence is combined with intercultural competence, intercultural communicative competence is created (hereinafter ICC), as Byram (1997), the creator of this concept, points out. Acquiring ICC means developing the ability to interact in complex cultural contexts among people who have more than one cultural identity and language. Accordingly, it is necessary to create an intercultural classroom that will be characterized by the transformation of identity, the student as an examiner and the process. When ICC becomes an integral part of the language classroom, students will experience how to use language, build relationships and mutual understanding with members of other cultures, re-examine their own beliefs, viewed through a different perspective, negotiate points of view that are different from theirs and discern into another culture. By incorporating certain activities to promote ICC in the curriculum, students will begin to see how their attitudes, knowledge, and language skills can influence their intercultural experiences (Moeller & Nugent, 2014).

Byram (1997) sees the ICC as a complex system that develops as a result of different non-native speaker experiences, such as formal education, practical work, and independent learning. Byram's model is popular among foreign language teachers and its components are recognized as general competencies that should accompany communicative competence. Corbett (2010, p. 2) notes that the detailed specification of the ICC is still an evolving project, although it was Byram and his colleagues who achieved a great deal by working on this. In the Framework<sup>27</sup>, of which Byram is one of the authors, ICC is understood as a set of knowledge, skills and attitudes. Building on Byram's work, Corbett summarizes five basic aspects of the ICC, namely:

- a) knowledge about oneself and others
- b) to know how to relate to meaning and how to interpret it
- c) developing critical awareness
- d) to know how to reveal cultural information
- e) to know how to relativize oneself and evaluate the attitudes and beliefs of others

## **3. INTERCULTURAL SPEAKER IN INTERCULTURAL COMMUNICATION**

Intercultural learning and teaching have imposed some new challenges on previous models. Corbett (2010, p. 1) points out that they, above all, challenged the conventional goal of language education, which sought to acquire the language skills of the native speaker of the foreign language being taught. For many students, that was an unattainable goal, and as the author notes, many teachers claim that it is now an unnecessary goal, especially if we bear in

---

<sup>27</sup> Common European Framework of Reference for Languages: Learning, Teaching, Assessment. Companion volume new descriptors. (2018). Council of Europe

mind the fact that English is becoming a global and universal language of communication, i.e. a kind of *lingua franca* of the modern age, as it was once the Latin language in the Middle Ages. Therefore, it is more acceptable for most people to establish communication and achieve functional language use than to strive for the perfection of native speakers in the UK, the USA or Australia. Therefore, the intercultural speaker takes precedence in international communication over the native speaker of a language. Intercultural education has certainly contributed to this, when intercultural students, as Corbett further states (*ibid.*), use language to explore different cultures and to mediate in those situations where cultural misunderstandings occur. They do it in a sophisticated way, using their acquired knowledge of culture and developed skills in using the resources of the target language. They are also encouraged to include their personal qualities, such as empathy, openness and respect for others.

The intercultural speaker is the main actor in intercultural communication and therefore it is essential to analyze and observe the development of his intercultural competence, which is very important in modern intercultural and multilingual environments. Byram (1997) defines the term of intercultural speaker as a person who possesses knowledge of one or more cultures and social identities and someone who enjoys discovering and maintaining relationships with people from other cultural backgrounds, even though he is not formally educated for that purpose. It is a person, according to House (2007), who managed to develop his third way, which is among other cultures that are close to him. Such a person should be understood as independent both of his or her original culture and language and of the new culture and language he or she wishes to connect, mediate and harmonize between them. He or she creates something new and autonomous in between, something hybrid, which is the third way. Such a person is an active participant who organizes her or his discourse creatively and independently, offering deeper views and understanding.

The aim of modern foreign language teaching, as an integral part of education for tourism professionals, is no longer for students to master language skills and competencies, but also to acquire plurilingual and intercultural communicative competence that are an integral part of intercultural education. They imply activating all students' potentials related to knowledge of foreign languages, regardless of the level and degree of knowledge, as well as all transversal knowledge from culture, to monitor students' personal development and their needs during language learning, so that progress in development their linguistic and intercultural abilities lead them to become primarily intercultural rather than native speakers of a foreign language.

#### **4. INTERCULTURAL COMMUNICATIVE COMPETENCE IN THE TOURISM IN MONTENEGRO**

This is exactly the profile of an intercultural speaker that all those involved in the tourism sector in Montenegro should strive for. Montenegro has a very diverse population that has lived together for centuries in harmony and mutual tolerance, resisting the dangers that lurked during numerous wars that took place in the long history of this country. In this way, its inhabitants have managed to preserve multicultural, multiethnic and multi-confessional harmony, which can be considered one of the important resources for the development of modern forms of tourism. In addition to this human resource, Montenegro abounds in very numerous and diverse cultural and historical monuments, some of which date back to ancient times. This cultural heritage attracts many tourists from different parts of the world and contributes to the development of cultural tourism. Tourists also like the natural beauties of this country, such as

the beautiful sandy beaches of the Adriatic Sea in the south and the untouched beauty of the mountainous area in the north of the country.

However, this is not enough to meet the needs of the modern tourist who, in addition to an excellent offer of accommodation, gastronomy and entertainment, wants a more complete experience and a more comprehensive approach during his or her stay at a particular destination. Such a tourist wants to feel welcome, to talk to the domicile population, to get to know the peculiarities of the new destination and the way of life of its people. He or she wants to feel the affective side of his or her hosts, i.e. to recognize in their smile and facial expression true hospitality and satisfaction that they welcome him or her as a dear guest. Such a tourist also wants to spend his or her holiday in the belief that he or she will come to the same destination again because it was a nice and pleasant place which he or she will definitely recommend to the family members and friends. Therefore, it is necessary for tourism workers in Montenegro to be sensitized to this aspect of their work, which will include continuous education and training and an interdisciplinary approach. It means that the essential elements of culture and tradition need to be combined with various forms of communication skills and ability to develop cultural sensitivity in contacts with foreign tourists. Apart from being an important component of education for present and future successful tourism professionals, this should be a new form of intercultural dialogue between people in modern globalized world that requires mutual understanding and intercultural awareness and sensitivity. It also requires long life learning and constant training. Furthermore, developing intercultural aspects in tourism should be seen as one of core advantages of smaller and still insufficiently affirmed tourist regions, such as Montenegro, especially in these disruptive circumstances of crisis caused by Covid -19 virus.

## **5. CONCLUSION**

The paper considers the importance of acquiring intercultural communicative competence for present and future tourist professionals in Montenegro. As a small country that strives for European standards and integration and sees its prosperity in the development of tourism as one of the main economic branches, Montenegro has to allow its tourism representatives to improve their intercultural communication. Such communication will enable the development of ICC through the inclusion of both linguistic and cultural elements of education in tourism and applying the intercultural approach in foreign language teaching. Both of these will contribute to a better future in the field of tourism.

## **REFERENCES**

- Byram, M. (1997). *Teaching and assessing intercultural communicative competence*. Clevedon: Multilingual Matters
- Corbett, J. (2010). *Intercultural language activities*. Cambridge: Cambridge University Press.
- Moeller, A. J., Nugent, K. (2014). *Building intercultural competence in the language classroom*. Downloaded from: <http://www.digitalcommons.unl.edu>

# ECONOMIC BENEFITS OF ŠUMAVA NATIONAL PARK

Josef Stemberk<sup>28</sup> 

DOI:

---

**Abstract:** *The main task of nature protection is to preserve or improve the current state of nature. Thus, it might seem that the economic benefits of the national park are not important for the management of the protected area, but calculating the economic benefits of protected areas for the region improves its acceptance among locals and visitors, as well as political and economic actors.*

*From 2017 to 2019, Šumava National Park (Bohemian Forest National Park) in the Czech Republic and Nationalpark Bayerischer Wald (Bavarian Forest National Park) were subjected to extensive socio-economic monitoring, which included, among other things, research focusing on the economic benefits that visitors brought to both national parks. This article presents the results of research of the regional economic benefits that visitors brought to Šumava National Park compared with those in Bavarian Forest National Park, although the methods and findings were not absolutely identical and therefore difficult to compare.*

**Keywords:** *Šumava National Park, Economic Benefits, Acceptance.*

---

## 1. INTRODUCTION

First of all, national parks are a classic tool for large-scale nature protection. After some development, they currently focus on the protection of natural processes. It is a difficult task not only in Central Europe, where it is a particularly challenging task as nature and landscape have been influenced by human use in the long-term. Land use in national parks is limited due to nature conservation, which is often understood as an intervention in spatial planning. Local residents, including political leaders, usually accept national parks with their main functions only reluctantly and see them as a hindrance to regional development. On the other hand, national parks as major natural attractions are among the most sought-after destinations. As a result, their contribution to regional development and its economic benefits is beyond reasonable doubt. This contribution aims to show the economic benefits generated by Šumava National Park, which is the largest national park in the Czech Republic.

### a. Šumava National Park

Šumava National Park was declared in 1991 on an area of 69,000 ha and thus became not only the largest national park in the Czech Republic, but also one of the largest national parks in Central Europe. It stretches in a strip up to 26 km wide along the Czech-German border in the length of 70 km and its southern tip touches the Czech-Austrian border. More than 80% of the territory is covered by forests with numerous fragments of primeval forests. The most valuable are climax mountain spruce forests located in the highest parts of the mountains and in vast Šumava plains at an altitude of about 1,000 m. Numerous peat bogs and wetlands covering about 3,500 ha are protected under the Ramsar Convention on Wetlands. The whole Šumava

---

<sup>28</sup> University Hradec Kralove, Rokitanského 62, 500 03 Hradec Králové III, Czech Republic

National Park area is also protected as a Natura 2000 area. According to the IUCN (International Union for Conservation of Nature) criteria, Šumava National Park is included in Category II (Dudley, 2008). The natural (non-intervention) zone covers 27.7% of the area, i.e., over 15,000 ha. Together with the adjacent Šumava Protected Landscape Area, the area is part of a network of biosphere reserves within the UNESCO Man and the Biosphere Programme. Today, this landscape features both natural values and landscape attractions, in which many traces of the original colonization effort have been preserved. (Těšitel et al, 2005)

The formation of the natural values of the Šumava was significantly influenced by its demographic development. The forested border mountains were inhabited much later than other areas and significantly so only in the 19th century. The displacement of the predominantly German population after World War II and the launch of the Iron Curtain on the Czechoslovak western border after 1948 caused a great discontinuity of socio-economic development in the area. The resulting significant decline in population and the decision to close the area to ordinary people led to the demise of numerous settlements. The only surviving economic activities, i.e., agriculture and forestry, were carried out here in their extensive form. Employment in state-owned enterprises in the primary sector placed low demands on the education of workers, which was reflected in the demographic composition of the population. The educational structure was lower than average. Further economic development of the area was enabled only after the fall of the Iron Curtain and the subsequent establishment of the Šumava National Park when tourism has become the most significant economic sector.

## 2. METHODS

In 2017, a socio-economic monitoring system was introduced in Šumava National Park, which, in addition to quantitative monitoring of the number of visitors, collected qualitative data from questionnaire surveys among the public (Transboundary socio-economic monitoring..., 2020). The surveys focused on both the acceptance of Šumava National Park among the locals and the economic benefits of visitors, which will be discussed in this contribution.

In 2018 and 2019, visitors to Šumava National Park were interviewed in order to find out their expenses in the region. This was done in order to calculate the economic effects of tourism in Šumava National Park based on the number of visitors.

A highly structured questionnaire containing 31 closed as well as open questions, which was available in Czech, German and English, was used. Furthermore, face-to-face interviews were conducted by trained staff from both Šumava National Park and Bavarian Forest National Park. The survey took place at 23 locations in Šumava National Park, for a total of 27 days from June 2018 to May 2019, both on weekdays and on weekends and holidays. The answers of the respondents were recorded in an analogue questionnaire and subsequently converted into the electronic form. The interview took an average of 15 minutes. All visitors over the age of 15 who passed interview points were asked to participate in the survey. A total of 549 complete, error-free questionnaires were obtained and could be evaluated (the rejection quota was around 34.8%).

### a. Visitor counting

The permanent counting of visits using people counting devices took place from 24th November 2017 to 23rd November 2018 at 34 different locations in Šumava National Park. Another standardized counting of people at 66 entrances to Šumava National Park was



conducted by Šumava National Park's collaborators. Data from people counting devices were used to calculate the number of visits in comparison with calculations performed by staff. (More details in: Transboundary socio-economic monitoring..., 2020)

## **b. Regional economic benefits**

In order to ensure comparability with studies in other, especially Central European national parks, including the neighbouring Bavarian Forest National Park, regional economic benefits were determined according to the methodology developed in the study by Job et al. (2008).

## **3. RESULTS**

### **a. Socio-demographic characteristics of the interviewees**

According to the type of visitors, 69.7% of the interviewed were hikers, 14.8% were cyclists or MTB cyclists and 8.5% were cross-country skiers. The remaining 7.0% of respondents were runners, lovers of Nordic Walking or other users (snowshoe hikers, water sportsmen, etc.). 55.6% of respondents were men, 44.4% were women. On average, the respondents were 47 years old. A total of 26.9% of respondents had children with them (0-12 years). 9.7% of respondents were walking one or more dogs. The majority of dogs (89.3%) were on a leash at the time of questioning.

Only 18% of respondents were residents or cottage owners from the Šumava National Park region, i.e., locals. Over 80% of respondents were tourists (with 63% of overnight guests and 19% day-trippers). Of course, a higher proportion of overnight guests have an impact on regional economic calculations, as they spend more money in the region than day-trippers (Arnberger et al., 2015).

More than half of the visitors (54.6%) are employees or office workers, about 20% (21.3%) are retirees, about 14.7% are businesspeople, 4.2% students, 3.8% are on their maternity leave and others make 1.4%. More than 40% (42.2%) of the respondents completed university or higher education and even 44.2% passed the school-leaving examination. About 4.4% completed higher vocational education. Only 9.2% of visitors stated that they had a lower than secondary education (basic, without an apprenticeship certificate, etc.). When compared with the educational structure of the population of the entire Czech Republic, visitors to Šumava National Park boast of a higher level of education than the national average, especially when it comes to the university level (Source: Czech Statistical Office, 2019).

Approximately 80% of respondents answered a voluntary question regarding their gross domestic income, and a total of 45.6% of households had a gross monthly income of CZK 30,000 to 59,999 (Table 1).

**Table 1.** Gross monthly income of households in Šumava National Park.

Šumava NP– gross monthly income of households in CZK	Share in %
<14,999	5,4
15,000-29,999	25,1
30,000-44,999	26,2
45,000-59,999	19,4
60,000-74,999	10,4
75,000-89,999	4,5

90,000-104,999	5,0
105,000-119,999	1,8
120,000-134,999	0,5
135,000-149,999	0,2
>150,000	1,6
Total	100,0

Source: Transboundary socio-economic monitoring, 2020.

### b. Attitude to the 'national park' status

Almost all respondents (98.4%) knew they were in a protected area. The majority of these respondents (90.4%) were able to correctly state the term "national park" when asked about a specific type of protected area. For just over a third of the visitors (35.9%) who stated national park in the previous question, the fact that it is a national park played a very large or large role for their visit on the day of the survey. 3.5% of all respondents stated that they would not come if Šumava National Park did not exist.

In order to ensure comparability with research in other national parks, the concept of affinity with national parks was taken over from Job et al. (2003) in a slightly modified form. The national park visitor in the narrower sense was defined according to three questions:

- (1) Do you know that you are in a protected area? (a closed question)
- (2) If yes, what is its name? (an open question)
- (3) What role did the national park status of this area play for your visit today? (a closed question)

According to the above mentioned view, the national park visitor in the narrower sense knows that he is in a protected area, he can specifically name the national park he or she is visiting and its protection status, and the national park status plays a very large or large role for him or her in deciding to visit this area on the day of questioning. Almost a third of all respondents (31.9%) fell into the category of the national park visitor in the narrower sense.

### c. Number of visitors

In total, about 1,840,000 visitors were counted in Šumava National Park during the monitored period (1 year). The survey participants comprised of 63.4% of overnight guests, 18.9% day-trippers, and 17.7% of local residents.

In order to determine the number of visitors for each type of visitor, the share of the respective types of visitors was divided according to the affinity for the national park (yes / no national park visitor in the narrow sense).

**Table 2.** Distribution and visitor number according to the type of visitors and affinity for the Šumava National Park

Type of visitor according to the affinity to the national park	Respondents		Number of visitors in 017/2018
	Number	Per cent	
Overnight guests: NP visitors in the narrower sense	109	20.2	370 924
Overnight guests: other NP visitors	236	43.7	803 101

Day-trippers: NP visitors in the narrower sense	30	5.6	102 089
Day-trippers: other NP visitors	70	13.0	238 208
Local residents/cottage owners: NP visitors in the narrower sense	33	6.1	112 298
Local residents/cottage owners: other NP visitors	62	11.5	210 984
Total	540	100.0	1 837 605

Source: Transboundary socio-economic monitoring, 2020.

#### d. Economic effects of visitors

For individual types of visitors, net expenses for individual categories of expenses were recalculated according to the current rate of Czech value added tax.

**Table 3.** Day expenditures (mean value, net) of visitors according to categories in the national park region

Day expenditures (net in CZK)	VAT	Overnight guests: NP visitors in the	Overnight guests: other NP visitors	Day-trippers: NP visitors in the narrower	Day-trippers: other NP visitors	Local residents/cottage owners: NP	Local residents/cottage owners: other
Accommodation	15%	353.7	364.1	-	-	-	-
Food / soft drinks in accommodation and catering facilities	15%	152.8	141.6	161.6	138.6	86.0	98.6
Alcoholic beverages in accommodation and catering facilities	21%	27.7	38.3	19.0	15.9	8.7	14.8
Foodstuffs in shops (including own food)	18%#	35.4	34.2	10.9	5.1	17.4	34.1
Books, magazines	10%	1.4	3.8	3.8	-	1.0	0.4
Other purchases: alcoholic products, souvenirs, sports equipment, etc.	21%	23.6	20.4	16.8	18.3	12.9	4.8
Public transport	10%	12.1	5.0	35.0	13.5	9.0	8.4
Parking fees	21%	8.1	7.9	8.0	10.9	12.5	7.3
Refuelling (in the region)	21%	13.7	24.8	29.4	29.1	12.8	36.1
Rental of sports equipment, etc.	21%	9.3	6.9	-	-	-	-
Tickets and admission	15%	17.2	13.3	8.3	1.2	-	-
Municipal taxes / guest card	15%	16.8	16.1	-	-	-	-
Spa treatments / doctor's fee	15%	1.8	2.4	-	-	7.9	1.0

Other expenses	18%*	0.6	-	-	-	-	-
Lump sum	18%^	11.4	80.7	-	6.1	-	-
Total		<b>685.8</b>	<b>759.5</b>	<b>292.8</b>	238.8	<b>168.1</b>	<b>205.5</b>
N		109	236	30	70	33	62

Notices: # Mixed value added tax because food is taxed differently; \* Mixed value added tax for all categories except accommodation; ^ Mixed value added tax for all categories.

Source: Transboundary socio-economic monitoring, 2020.

Table 4 shows a summary of average total expenditure per person according to the type of visitor and affinity for the national park.

**Table 4.** Overview of visitor expenses by type of visitor and affinity for the national park (per person): gross and net, Visitors to the national park in the narrower sense

Type of visitor according to affinity for the national park	Daily expenditures (gross) in CZK	Daily expenditures (net) in CZK
Overnight guests: NP visitors in the narrower sense	794.3	685.8
Overnight guests: other NP visitors	882.3	759.5
Day-trippers: NP visitors in the narrower sense	339.5	292.8
Day-trippers: other NP visitors	278.7	238.8
Local residents/cottage owners: NP visitors in the narrower sense	196.1	168.1
Local residents/cottage owners: other NP visitors	240.7	205.5

Annual turnovers were calculated from daily expenditures according to the types of visitors and affinity for the national park (daily expenditures \* number of visitors – Table 5). The total gross annual turnover was CZK 1,177 million and the net turnover was CZK 1,013 million (Table 5).

**Table 5.** Overview of gross and net annual sales by type of visitor and affinity for the national park: Visitors to the national park in the narrower sense

Type of visitor according to affinity for the national park	Daily expenditures (gross) in CZK	Daily expenditures (net) in CZK
Overnight guests: NP visitors in the narrower sense	294 638 369	254 369 033
Overnight guests: other NP visitors	708 578 908	609 935 368
Day-trippers: NP visitors in the narrower sense	34 658 705	29 891 314
Day-trippers: other NP visitors	66 394 257	56 881 851
Local residents/cottage owners: NP visitors in the narrower sense	22 026 683	18 877 366
Local residents/cottage owners: other NP visitors	50 782 668	43 358 065
Total	1 177 079 590	1 013 312 997

Source: Transboundary socio-economic monitoring, 2020.

The group of overnight guests generated the largest share of economic impacts. Their share in individual economic indicators was more than 80%. The expenditures of this visitor group for

accommodation and meals contributed to the total production (as well as on other monitored economic variables) by more than 50%.

#### e. Calculation of economic benefits

Melichar & Pavelčík (2020) calculated the economic benefits of Šumava National Park using input-output analysis. In 2018, Šumava National Park was visited by 1,837,605 visitors, whose expenditures of CZK 1.18 billion resulted in an increase in regional production (turnover) by a total of CZK 1.4 billion, including multiplier effects. Direct effects on primary providers of tourist products and services (in the sectors of accommodation, catering, transport, retail, refuelling, etc.) amounted to CZK 764 million. Of the total impact on production, CZK 484 million fell on the total increase in gross value added, or gross domestic product of the region's economy (Table 6).

**Table 6.** Total economic impacts of visitors to Šumava National Park: impacts on production, GDP, regional income, wages of employees and employment (in CZK, prices in 2018)

Type of economic effect	Direct impacts	Indirect impacts	Total impacts
Impacts on production	763 666 949	607 301 522	1 370 968 471
Impacts on GDP	290 065 737	193 994 589	484 060 326
Impacts on regional income	204 761 991	135 629 652	340 391 642
Impacts on employees' wages and salaries	120 947 991	54 571 391	175 519 382
Impacts on employment (Number of full-time jobs)	385*	164*	549*

**Source:** Melichar & Pavelčík (2020).

Expenditures of visitors to Šumava National Park also contributed in 2018 to an increase in income in the region of CZK 340 million. Of this amount, CZK 176 million was the wage income of employees of direct providers of tourist products and services and their subcontractors. At the same time, visitors' expenditures contributed to the creation or preservation of 549 jobs in the Šumava National Park region.

## 4. CONCLUSION

Visitors and tourism generate significant regional and economic effects in the peripheral area of the Czech-German border, in Šumava National Park. The annual expenditure (2018) of all visitors (1,837,605) represents CZK 1.18 billion (approximately € 47.1 million). If this data is compared with the neighbouring Bavarian Forest National Park, where the annual gross turnover is € 52.4 million with a calculated annual attendance of 1,361,367 people (Bavarian Forest National Park Administration, 2020), then in both cases tourism creates a significant regional economic effect. (See Table 7, compare with Table 5).

**Table 7.** Overview of gross and net annual sales by type of visitor and affinity for Bavarian Forest National Park.

Type of visitor according to affinity for the national park	Gross turnover in €	Net turnover in €
Overnight guests: NP visitors in the narrower sense	28 976 778	25 831 947
Overnight guests: other NP visitors	13 741 544	12 359 568
Day-trippers: NP visitors in the narrower sense	3 241 801	2 743 845

Day-trippers: other NP visitors	2 756 098	2 339 899
Local residents/cottage owners: NP visitors in the narrower sense	1 933 278	1 647 156
Local residents/cottage owners: other NP visitors	1 751 812	1 492 730
Total	52 401 311	46 415 145

Source: Transboundary socio-economic monitoring, 2020.

In Šumava National Park, a socio-economic monitoring system has been gradually introduced since 2018, but the first research of the economic effects of the national park took place in Bavarian Forest National Park as early as 2007 and is repeated about every five years. (See Table 8). The main reasons for the increase in visitor expenditures (especially those of overnight guests) include the rising standard of accommodation facilities, which can also obtain a "National Park Partner" certificate, whose criteria include environmentally friendly operation as well as the support of the Bavarian Forest National Park approach: 'let nature be nature'.

**Table 8.** Daily expenditures (gross per person), according to the visitor's affinity for the national park.

Type of visitor according to affinity for the national park	Daily expenditures 2007 (gross) in €	Daily expenditures 2013/14 (gross) in €	Daily expenditures 2018/19 (gross) in €
Overnight guests: NP visitors in the narrower sense	49.6	56.2	77.7
Overnight guests: other NP visitors	49.6	56.2	71.9
Day-trippers: NP visitors in the narrower sense	12.3	13.9	18.2
Day-trippers: other NP visitors	12.1	13.7	18.5
Local residents/cottage owners: NP visitors in the narrower sense	9.1	10.4	8.2
Local residents/cottage owners: other NP visitors	6.1	6.9	7.5

Source: Transboundary socio-economic monitoring, 2020.

Overall, the results in both neighbouring and comparable national parks show that soft forms of tourism, where the main reason for the visit is to stay and observe nature, bring significant economic benefits to the region. These results refute the general myth that nature conservation is at odds with socio-economic development (Těšitel et al., 2005) and at the same time support the claim that nature tourism, which combines nature experience with relieving the burden on nature and the environment, and with generating economic benefits, greatly increases the acceptance of protected areas (Job et al, 2005).

## 5. ACKNOWLEDGMENT

I would like to thank all my colleagues working together on the project *“Introduction of a transboundary socio-economic monitoring system in the National Parks of Šumava and Bavarian Forest”* from the Šumava National Park Administration, Bavarian Forest National Park Administration and the methodical and supervisor work of experts from the University of Natural Resources and Life Sciences, Vienna (BOKU). The common Czech-Bavarian project was supported by the European Union.

## 6. REFERENCES

- Dudley, N., (2008). *Guidelines for Applying Protected Area Management Categories*. Gland, Switzerland: IUCN. ISBN 978-2-8317-1086-0
- Těšitel J., Kušová D., Matějka K., Bartoš M. (2005). *Lidé v biosférických rezervacích /People in biosphere reserves*. České Budějovice, Czech Republic: Ústav systémové biologie a ekologie Akademie věd České republiky.
- Arnberger, A., Allex, B., Preisel, H., Eder, R. (2015): *Sozioökonomisches Monitoring Nationalpark Bayerischer Wald: Befragung und Besucherzählung 2013/2014*. Interner Endbericht.
- Job, H., Mayer, M., Woltering, M. (2008). *Die Destination Nationalpark Bayerischer Wald als regionaler Wirtschaftsfaktor*. Germany: Bavarian Forest National Park Administration.
- Job, H., Metzler, D., Vogt, L. (2003). *Inwertsetzung alpiner Nationalparke. Eine regionalwirtschaftliche Analyse des Tourismus im Alpenpark Berchtesgaden*. Münchener Studien zur Sozial- und Wirtschaftsgeographie 43.

## 7. ADDITIONAL READING

- Melichar J. & Pavelčík, P. (2020). *Evaluation of the economic effects of tourism in Šumava National Park*. Charles University/Prague, Czech Republic: Unpublished report.
- Transboundary socio-economic monitoring in Šumava and Bavarian Forest National Parks in the years 2017-2019*. (Final report) (2020), Šumava National Park Administration/Vimperk, Czech Republic: Šumava National Park Administration (published on-line: <https://www.npsumava.cz/sprava-np/seznam-projektu/zavedeni-preshranicniho-socioeconomickeho-monitorovaciho-systemu-v-narodnich-parcich-sumava-a-bavorsky-les-2/>)





# THE ROLE OF INTERNATIONAL AND PROFESSIONAL ORGANISATIONS' IN DEFINING STATE-OWNED ENTERPRISES

Ioana Andreea Ciolomic<sup>29</sup>   
Ioana Natalia Beleiu<sup>30</sup> 

DOI:

---

**Abstract:** *State-owned enterprises (SOEs) have an essential role in national economies worldwide, but regardless of their acknowledged contribution to the global markets, divergent opinions and approaches can be observed when defining and characterizing these entities. On the other hand, international organizations such as OECD, International Monetary Fund, European Commission, United Nations, World Trade Organizations, World Bank, Asian Development Bank, and professional organizations such as IPSASB and Chartered Institute of Management Accountants have an essential role in SOEs' activity. One of the biggest challenges that professional bodies have nowadays is to find a unique definition to match the need of practitioners and capture the complexity of SOEs. Even if there can be identified some common approaches between academicians, international, and professional organizations, there are some delicate areas that require substantial efforts for clarifications. The paper addresses this topic, aiming to clarify the main aspects concerning the definition of SOEs from international and professional organizations' points of view based on qualitative research methods.*

**Keywords:** *State-Owned Enterprises, International and Professional Organisations, Governance.*

---

## INTRODUCTION

Reforms in public management represent a global trend (Ongaro and Valotti, 2008), being frequent when regulations are not correlated with the business world reality or instructions regarding their implementation are missing. Unfortunately, in most countries, the current legislation referring to state-owned enterprises (SOE) is inadequate, adjusting, and restructuring SOEs being a necessity determined by the market and technological changes (Kloviene and Gimzauskiene, 2014).

SOEs' importance strongly increased in the recent period due to a stringent need for effective, efficient, and high-quality public services (Papenfuss and Schmidt, 2015). Recently, both researchers and practitioners focus on aspects regarding good governance to increase organisational efficiency. Christiansen (2011) underlines the importance of SOEs by presenting statistical data that create an overview of the Organisation for Economic Co-Operation and Development (OECD) reporting countries' situation in the year 2008/2009: 2,057 enterprises, employing over 4 million people and with an estimated value exceeding 1.3 trillion US dollars.

---

<sup>29</sup> Babes-Bolyai University, Faculty of Economics and Business Administration, Cluj-Napoca, Romania

<sup>30</sup> Babes-Bolyai University, Faculty of Economics and Business Administration, Cluj-Napoca, Romania

The research presented in this article is mainly qualitative. It aims to clarify the main aspects concerning SOEs' definition from international and professional organizations' point of view. One conclusion of the study is that clearly defined concepts should contribute to a better understanding of the SOEs concept and contribute to good governance by enhancing the quality, consistency, and transparency of government' actions.

The paper's remaining sections are organized as follows: methodological aspects, findings and discussions of SOE definitions used by international and professional organisations, and conclusions of the conducted study.

## METHODOLOGY AND RESEARCH QUESTION

International and professional organisations have divergent opinions and approaches when defining and characterizing state-owned enterprises. One of the biggest challenges that professional bodies have nowadays is to find a unique definition to match the need of practitioners and capture the complexity of SOEs. The purpose of the paper is to create a comprehensive view of the topic of SOEs' definitions used by international and professional organisations related to emerging issues like governance, performance, accounting, and accountability. The study's research question is: *How do international and professional organisations define SOEs?*

The methodology is in line with the interpretative perspective and pays particular attention to the meanings behind SOE. The data collection is based on content analysis of documents issued by worldwide recognised international organisations like OECD, International Monetary Fund (IMF), European Commission (EC), United Nations (UN), World Trade Organisations (WTO), World Bank (WB), Asian Development Bank (ADB) and professional organisations such as IPSASB and Chartered Institute of Management Accountants (CIMA). For each organisation, the table below presents the documents used for content analysis.

**Table 1.** Documents used for content analysis

<b>International organisation</b>	<b>Year</b>	<b>Document</b>
OECD	2005	Corporate governance of state-owned enterprises: A survey of OECD countries
	2014	OECD Guidelines on Corporate Governance of State-Owned Enterprises - Draft for Public Comment
International Monetary Fund	2014	Government Finance Statistics Manual
European Commission	2012	EUROSTAT Foreign Affiliates Statistics Recommendation Material
United Nations	2008	System of National Accounts
	2014	World Investment Report 2014: Investing in the SDGs: An Action Plan
IPSASB	2012	Handbook of International Public Sector Accounting Pronouncements – Vol. I, II
World Trade Organisation	1994	The General Agreement on Tariffs and Trade

**Source:** Author's projection

The selected documents are analysed to identify critical elements used in defining SOEs. The organisations were selected based on their interest regarding the topic of SOEs.

## **FINDINGS AND DISCUSSIONS OF SOE DEFINITIONS USED BY INTERNATIONAL AND PROFESSIONAL ORGANISATIONS**

The concept of SOE is at the top of debates of international and professional organizations such as the OECD, IMF, EC, UN, WTO, WB, ADB, CIMA, and IPSASB. Baring this in mind, to achieve the paper's purpose, we analysed the definitions provided by these institutions. These organisations, except WB, deal with SOEs without considering the level of government (state, regional and local government) while acknowledging the existence of different levels and forms of ownership and control. On the other hand, the World's Bank toolkit focuses on SOEs at the national level. Even though this guideline does not cover municipal and local level SOEs, they admit that many of the concepts and approaches are relevant for them as well. CIMA (professional organisation) and ADB (international organisation) are involved in projects regarding SOEs, but none of their actions aim to define SOEs, the primary constraint of our methodology. Based on this imposed restriction, these organisations could not be included in our analysis.

Readjustment and restructure of state-owned sectors in the context of markets globalization, technological reforms, and deregulation of previously monopolistic markets determined the **OECD** to initiate various projects in this field since 2003. The most relevant projects are "Privatizing State-Owned Enterprise, An Overview of Policies and Practices in OECD Countries" 2003 and "Corporate Governance of State-Owned Enterprises: A Survey of OECD Countries", 2005.

In the OECD Guidelines on Corporate Governance of SOEs, the terms used are "state-owned enterprises", defined as "enterprises where the state has significant control, through full, majority, or significant minority ownership" (OECD 2005, 11). The definition provided by OECD since 2005 is not restrictive, covering two key elements: control and ownership. Although it appears relatively straightforward, several countries had responded in various manners when they applied the OECD definition in their national legislation:

- *Countries that took over the conditions provided by OECD, some even adding other critical elements as legal form or activity (objectives)-* for example, Australia, Austria, Belgium, Czech Republic, Bulgaria, Romania, Italy;
- *Countries that modified the conditions provided by OECD, adding the percentage of ownership/votes –* for example, Estonia, Greece (requires more than 50% of share capital), Hungary (companies in which the state owns at least 10%), Slovenia (the government owns directly or indirectly at least 25% plus one vote of the total capital).

In May 2014, the OECD developed a new draft for public comments on the OECD Guidelines on Corporate Governance of State-Owned Enterprises, with a noticeably different approach related to SOEs' concept from the previous version. According to the new guidelines, the SOE is "any state-owned corporate entity recognised by national law as an enterprise" (OECD 2014). This includes joint-stock companies, limited liability companies, partnerships limited by shares, and statutory corporations with specific legal form and primarily commercial activities. Each government is entitled to choose the recognition or not of other enterprises as SOEs depending on their judgement, regardless of their degree of market/non-market orientation (OECD 2014). OECD's new perspective concerning SOEs consists of both key elements, such as control and ownership and legal form and activity orientation.

While OECD defines SOEs from the governance perspective, **IPSASB** approaches it from the accounting perspective. IPSASB refers to SOEs using the notion "governance business enterprises (GBE)", defined in IPSAS 1 - Presentation of Financial Statements as (IPSASB 2012, 32): "an entity that has all the following characteristics: has the power to contract in its name; has been assigned the financial and operational *authority* to carry on business; *sells goods and services*, in the ordinary course of its business, to other entities *at a profit or full cost recovery*; is not reliant on continuing government funding to be a going concern (other than purchases of outputs at arm's length); is *controlled* by a public sector entity."

Throughout time, IPSASB developed some projects aiming to set the conceptual delimitation of the term. The first Consultation Paper (CP) idea arose in 2008, but IPSASB discussed and approved a brief project on SOEs in March 2012, which started in December 2012. Initially, IPSASB considered four approaches to SOEs (IPSASB 2012): "(a) Do not specifically define SOEs, but provide the high-level characteristics of entities; (b) Clarify the existing definition of SOEs; (c) Narrow the current definition; or (d) Redefine SOEs using a different approach, e.g., based on services provided by entities or the objectives of entities. But, since it received little support, it was decided not to develop a further approach (d)". Further, in 2014, IPSASB suggests two main approaches. The first approach does not define the term. Instead, it produces a list of characteristics for public sector entities, while the second approach is modifying or narrowing the current definition presented in IPSAS 1. Both approaches have two sub-options; the differentiating criteria are the use of statistical terminology (IPSASB 2014).

One can observe that the IPSASB definition concerning SOEs was initially based mainly on control, ownership, and activity criteria. In 2014, the IPSASB decision was to define SOEs using characteristics and acknowledge the role of regulators in determining other specific elements that could help them establish which entities should be recognized as SOEs (the same approach identified in the OECD project).

**European Commission** through EUROSTAT provides a definition based on control and ownership criteria, in accordance with OECD: "there are numerous cases of enterprises controlled by the government directly (through nominating its representatives on the board) or indirectly (through state-owned funds and agencies) that themselves control affiliates in another country" (EC, 2012, p. 32). The novelty of definition consists in introducing the notion of direct or indirect control.

Further, the **International Monetary Fund** (IMF) uses this term in Governance Finance Statistic Manual (GFSM) linking IPSAS and GFSM: "the IPSAS equivalent of a market entity, that is, a GBE" (IMF 2014, 352). The IMF urges international standard-setters to collaborate to align reporting standards for budget, statistics, and accounts.

From the statistical point of view, there are two international frameworks in significant harmony (**European System of Accounts** - ESA and **System National Accounts**- SNA). Although terms as GBE or SOE are not used, they refer to corporations and quasi-corporations similar to SOEs when controlled by public sector units (EC 2010; UNSD 2008, SNA, 2008). The concept of control, from a statistical point of view, is "the ability to determine the general policy or programme of that entity" (EC 2010). Corporations are "created for the purpose of *producing goods or services* for the market that may be a source of *profit or another financial gain* to its owner(s), being collectively *owned* by shareholders who have the authority to appoint directors responsible for its general management" (UNSD 2008; EC 2010). Quasi-corporations "are unincorporated entities engaged in the production of market goods and

services, managed as a corporation, having their own set of accounts" (EC 2010; IPSASB 2014; UNSD 2008). SNA and ESA divide public companies into financial and non-financial, depending on their activity (UNSD 2008), and this approach is also identified in the CP provided by IPSASB. However, the approaches of these two international organisations also include, alongside key elements as control, ownership, and activity, a common point of view: the SOEs must have the power to contract in their name, although in certain countries, this cannot be applied, due to national regulations. National accounts statisticians use a rather broad definition of SOEs, including in this type of organisations, all autonomous government companies (*ownership criteria*) with independent budgets and balance sheets that generate at least half of their income through the commercialisation of goods and services (*activity criteria*). The national authorities apply a restrictive concept, which is, in many cases, braced in SOE-related legislation (OECD 2014).

**World Trade Organisation** (WTO) is another international organisation that pays attention to SOEs due to the government's influence on world trade. It refers to SOEs using the term "state-owned transnational companies", and includes in this category all state trading enterprises that deal with goods for export or import (WTO 1994). The definition provided by WTO is not restrictive, and it uses just two key characteristics of SOEs identified in the academic literature: *ownership* and *activity*.

World Bank provides the most complex approach among international organisations concerning SOEs' definitions. Despite the SOEs' definition provided in the Glossary of Key Terms being based only on two key elements identified in the academic literature, *legal form* and *activity (commercial)*, the World Bank created through its toolkit "Corporate Governance of State-Owned Enterprises – a Toolkit" an overview which comprises the majority of the issues identified in the first section of this research paper: *areas* in which SOEs operate, their *importance* and *role* in economies, performance and the *ownership* and *control* issues. They assert that these entities are "commercial enterprises that use a distinct legal form and engage in commercial activities and that receive the bulk of their income from sales and fees" (WB 2014). Even if SOEs' definition provided in the Glossary of Key Terms is based only on two key elements identified in the academic literature, *legal form* and *activity (commercial)*, they created through their toolkit "Corporate Governance of State-Owned Enterprises" (WB 2014), an overview which comprise mostly all issues identified in the first section of this research: *areas* in which SOEs operate, their *importance* and *role* in economies, *ownership* and *control* issues. This guideline focuses on commercial SOEs at the national level in which the government has significant control through full, majority, or substantial minority ownership. World Bank concludes that these discrepancies caused by different visions of the countries hamper advancing a generally accepted definition of SOEs.

One conclusion of the study is that the concept of **ownership** is crucial when defining SOEs. Ownership implies the responsibility for actions regarding the entity, whose rights are usually protected by the law. Also, market and non-market-oriented **activities** are concepts used by international and professional organizations in defining SOEs. Discussing another significant key element, the notion of **control**, we identified two approaches analysed among international and professional organizations:

- Policy control – from a statistical perspective, a government exercises control under a corporation if the government can determine the general corporate policy;
- Financial control – from an accounting standpoint, a government controls a company if it has the power to manage its financial and operating policies to benefit from its activities.

Another conclusion of the study conducted is that international and professional organisations approached the SOE issue from governmental, accounting, or statistical perspectives, providing restrictive definitions based on key elements as ownership, control, and activity (market orientation). OECD, EC, and IPSASB define SOEs using key elements as control and ownership while IMF and UN, activity and ownership. Even if we identified some common approaches between academicians and international and professional organisations, some delicate areas require substantial clarifications.

## CONCLUSION

Based on the definitions presented above, we can conclude that SOEs are public entities controlled directly or indirectly by the government with a mixture of commercial and public policy objectives. SOEs have an adapted legal form, operate in commercial affairs, reach for the achievement of public policy objectives and financial goals.

Even though they are the same companies totally or partially owned by the state, the terminology used differs between countries. There are several different approaches to what types of entities are covered by SOE's definition. The biggest challenge for professional bodies is to find a unique definition to match the need of practitioners and capture the complexity of SOEs.

Overall, the international and professional organisations approach the SOE topic from governance, accounting, or statistical perspectives, based on key elements like ownership, control, market orientation. OECD, EC, and IPSASB define SOEs using key elements as control and ownership while IMF and UN, activity and ownership. Although we have identified some common approaches between international and professional organisations, some delicate areas require laborious efforts for clarifications considering the objective of each organisation. The biggest challenge for professional bodies is finding a unique definition to match all three main areas of interest.

So, we conclude that a definition is necessary. As we saw, significant national professional bodies consider it essential to use a definition, to present the characteristics and provide a guideline for SOE recognition. Emerging countries need to have clearly established boundaries of their financial statements. Most of the time, they do not have the necessary resources as professional bodies, qualified personnel to fulfil their obligations as regulators.

## REFERENCES

- Christiansen, H. (2011), "The Size and Composition of the SOE Sector in OECD Countries", *OECD Corporate Governance Working Papers*, No. 5, OECD Publishing.
- European Commission (2012), "EUROSTAT Foreign Affiliates Statistics Recommendation Material, Luxemburg, pp.32.
- European Commission (2010) European system of accounts. Luxemburg.
- International Monetary Fund (2014), "Government Finance Statistics Manual", Washington, p. 32.
- IPSASB (2012), Handbook of International Public Sector Accounting Pronouncements- Vol I,II, New York, available at: <http://www2.ifac.org/publications-resources/2011-handbook-international-public-sector-accounting-pronouncements>
- IPSASB (2014), Responses to GBEs Consultation Paper, New York, available at: <http://www2.ifac.org/system/files/meetings/files/GBE%20%20responses.pdf>

- Kloviene, R., Gimzauskiene, E. (2014), "Performance measurement model formation in state-owned enterprises", *Procedia Social and Behavioral Sciences*, 156, pp. 954-598.
- OECD (2005), *Corporate governance of state-owned enterprises: A survey of OECD countries*, Paris, OECD.
- OECD (2014) *OECD guidelines on corporate governance of state-owned enterprises – draft for public comment*, OECD, Paris
- Papenfuss, U., Schmidt, C. (2015), "Determinants of manager pay in German state-owned enterprises and international public policy implications: 3-years study for sectors, performance and gender", working paper, University of Leipzig, available at: <http://hdl.handle.net/10419/107708>, (accessed 10 April 2015).
- United Nations Statistics Division (2008) *System of national accounts*. New York
- United Nations Statistics Division (2008), *System of National Accounts*, New York
- World Bank (2014) *Corporate governance of state-owned enterprises – a toolkit*. WB, Washington, DC
- World Trade Organisation (1994) *The general agreement on tariffs and trade*. WTO, Geneva





# TESTING THE EMPIRICS OF WEAK FORM OF EFFICIENT MARKET HYPOTHESIS: EVIDENCE FROM LAC REGION MARKETS

Hortense Santos<sup>31</sup> 

Rui Dias<sup>32</sup> 

Paula Heliodoro<sup>33</sup> 

Paulo Alexandre<sup>34</sup> 

DOI:

---

**Abstract:** *The new coronavirus disease (Covid-19) evolved quickly from a regional health outbreak to a global collapse, stopping the global economy in a unprecedented way, creating uncertainty and chaos in the financial markets. Based on these events, it is intended in this paper to test the persistence of profitability in the financial markets of Argentina, Brazil, Chile, Colombia, Peru and Mexico, in the period between January 2018 to July 2020. In order to perform this analysis where undertaken different approaches in order to analyze if: (i) the financial markets of Latin America are efficient in their weak-form during the global pandemic (Covid-19)? ii) If so, the persistent long memories cause risks between these regional markets? The results suggest that the returns don't follow the i.i.d. hypothesis, from dimension 2, reinforcing the idea that returns of stock indexes have a non-linear nature or a significant non-linear component, exception made to the Argentina market, which was expected in virtue of the Ljung-Box (with the return squares) test results, and ARCH-LM. Corroborating the exponents Detrended Fluctuation Analysis (DFA), indicate the presence of persistent long memories, namely into the following markets: Colombia (0.72), Chile (0.66), Brazil (0.58) and Peru (0.57). The Argentina market does not reject the random walk hypothesis, while the Mexican market suggests some anti-persistence (0.41). This situation has implications for investors, once that some returns can be expected, creating arbitrage opportunities and abnormal income, contrary to the supposed from the random walk hypothesis and information efficiency. The t-test results of the heteroscedasticity form the two samples suggest that there is no risk transmission between these regional markets, with the exception to the BOVESPA / BOLSAA MX markets, that is, the existence of persistent long memories in the returns does not imply the risk transmission between markets. These finds allow the creation of strategies of diversification inefficient portfolios. These conclusions also open space for the market regulators to implement measures that guarantee a better informational information of these regional markets.*

**Keywords:** *Covid-19-19; LAC Region; long memories; arbitrage.*

---

<sup>31</sup> Escola Superior de Ciências Empresarias – Instituto Politécnico de Setúbal, Portugal

<sup>32</sup> Escola Superior de Ciências Empresarias - Instituto Politécnico de Setúbal, Portugal & CEFAGE, Universidade de Évora, Portugal

<sup>33</sup> Escola Superior de Ciências Empresarias – Instituto Politécnico de Setúbal, Portugal

<sup>34</sup> Escola Superior de Ciências Empresarias – Instituto Politécnico de Setúbal, Portugal

## 1. INTRODUCTION

The Covid-19 global pandemic affects negatively global trade, as well as social and cultural life, namely the tourism, trade in goods, production and sectors like transportation. The fast spread of the coronavirus (COVID-19) has dramatic impacts in the financial markets all over their world, causing significant loses to the investors in a very short period. Aligned with all this negative effects, it seems inevitable that the stock exchanges, economic growth and exchange rates have also been affected in equal matter (Liu, Manzoor, Wang, Zhang and Manzoor, 2020).

The subject of hypothesis of efficiency in the markets, shows if the actual price of the active reflects all the available information, in a certain moment, and price adjusts quickly, as new and unforeseen information gets to the market. The mean reversion hypothesis, also known as negative series correlation, has been interpreted; it has an efficient correlation mechanism in developed markets, and, a sign of speculative bubble in the financial emerging markets (Summers, 1986; Fama and French, 1988).

This investigation will test the persistence and risk of the financial markets of Argentina, Brazil, Chile, Colombia, Peru and Mexico, in the period between January 2018 to July 2020. The results suggest that the returns don't follow the i.i.d. hypothesis, from dimension 2, reinforcing the idea that returns of stock indexes have a non-linear nature or a significant non-linear component, exception made to the Argentina market. In order to validate the persistence, the exponents *Detrended Fluctuation Analysis (DFA)*, indicate the presence of persistent long memories, namely in the following markets: Colombia (0.72), Chile (0.66), Brazil (0.58) and Peru (0.57). The Argentina market does not reject the *random walk* hypothesis, while the Mexican markets suggest some anti-persistence (0.41). This situation has implications for investors, once that some returns can be expected, creating arbitrage opportunities and abnormal income, contrary to the supposed from the *random walk* hypothesis and information efficiency. The t-test results of the heteroscedasticity from the two samples suggest that there is no risk transmission between these regional markets, except for the BOVESPA / BOLSAA MX markets, that is, the existence of persistent long memories in the returns does not imply the risk transmission between markets.

These investigations present two contributions to the existing literature. The first contribution is regarding the study of efficiency, in its weak form, and risk transmission in the financial markets of Latin America, in the context of global pandemic (Covid-19). As far as we know some studies analyze the impact of the global pandemic in the financial markets (Ali, Alam, and Rizvi, 2020; Corbet, Larkin, and Lucey, 2020; He, Liu, Wang, and Yu, 2020; Sansa, 2020), however the approach was essentially distinct from the followed in this paper. The second contribution is related to the preference in these regional emerging markets; after the financial crisis of 2008 these regional markets became an important investment destination. In this context and having in mind that the large capital inflows are of a great importance to understand the persistence of returns and risk transmission between Latin-American markets, in order to provide international investors knowledge, they can implement efficient diversification strategies.

In terms of structure this paper is organized into 5 sections. In Section 2 is presented the literature review in concern of articles about the efficiency of market, in its weak form. Section 3 describes methodology and data. Section 4 presents the results. Section 5 concludes.

## 2. LITERATURE REVIEW

Several works have been approaching the matter of efficiency of the markets, analyzing the profitability predictability hypothesis through the analysis of average reversal patterns, inspired in the semi-final works of Poterba and Summers (1988) and Fama and French (1988), in which they documented reversion to the average in the stock markets, in periods above one year. According to the authors Malafeyev, Awasthi, S.Kambekar, and Kupinskaya (2019) when the random walk hypothesis and informational efficiency are rejected it cause extreme movements in stock prices. The occurrence of these phenomena can, eventually, decrease the implementation of diversification strategies of efficient portfolios.

The authors Nisar and Hanif (2012) analyzed the stock markets of India, Pakistan, Bangladesh and Sri Lanka, and evidence (in) market efficiency, in its weak form. Mehla and Goyal (2013) suggest that the Indian market does not show the characteristics of *random walk* and as such is not efficient in its weak form. El Khamlichi et al. (2014) show that Islamic indices have the same level of (in) efficiency as benchmarks, but MSCI and FTSE indices are less inefficient.

Righi and Ceretta (2011), Sierra Suárez, Duarte Duarte and Mascareñas Pérez-Iñigo (2013), Worthington and Higgs (2013), Duarte and Mascareñas Pérez-Iñigo (2014), Ruiz-Porras and Ruiz-Robles (2015) tested market efficiency in its weak form in Latin America. Righi and Ceretta (2011) analyzed the S&P500, Ibovespa, Merval and IPC indexes, showing that these regional markets are efficient in their weak form, except for the U.S. market. Sierra Suárez, Duarte Duarte and Mascareñas Pérez-Iñigo (2013) studied the Colombian market, showing hybrid results, that is, the assets show signs of chaotic behavior in ascending periods and random in descending periods. While the authors Worthington and Higgs (2013) examined the financial markets of Argentina, Brazil, Chile, Colombia, México, Peru, e Venezuela, suggesting that the efficient market hypothesis is rejected. Duarte and Mascareñas Pérez-Iñigo (2014) analyzed the main financial markets in Latin America. The authors show that the five main Latin American economies have undergone a change from non-efficiency to efficiency in recent years, according to, the following chronological order: México (2007), Brazil (2008), Colombia (2008), Chile (2011) e Peru (2012). Ruiz-Porras and Ruiz-Robles (2015) analyzed the Mexican stock market, suggesting that the stock market is (in) efficient in its weak form, and this efficiency has declined since 2007.

Andrianto and Mirza (2016), Hamid, Suleman, Ali Shah, and Imdad Akash (2017), Singh and Kumar (2018) examined efficiency of markets, in their weak form, in Asian markets. Andrianto and Mirza (2016) show that Indonesia's stock market is efficient in its weak form, suggesting that the daily movement of the stock price is random, and does not present autocorrelation. Hamid, Suleman, Ali Shah, and Imdad Akash (2017) analyzed the markets of Pakistan, India, Sri Lanka, China, Korea, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Thailand, Taiwan, Japan, e Australia. The authors show that prices do not follow the random walk hypothesis. Singh and Kumar (2018) show that the Kuala Lumpur Stock Exchange shows signs of (in) efficiency in its weak form. Given this evidence, investors can benefit from the arbitration process by achieving anomalous profitability without incurring additional risk.

Aggarwal (2018), Rehman, Chhapra, Kashif, and Rehan (2018), Karasiński (2020) tested the persistence of profitability in various financial markets. Aggarwal (2018) analyzed the efficiency and market and the persistence of the South Korean stock market (KOSPI), and suggests that the time series do not follow a process of *random walk*. Rehman, Chhapra, Kashif, and Rehan (2018) show that the stock indexes of Pakistan, India and Bangladesh are not

efficient in their weak form. While author Karasiński (2020) examined efficiency in its weak form in European markets and shows that overall efficiency tended to improve after the global financial crisis of 2008.

In summary, this work aims to contribute to the provision of information to investors and regulators in Latin American stock markets, where individual and institutional investors seek diversification benefits, as well as to help promote the implementation of policies that contribute to the efficiency of these markets in this period of global pandemic (Covid-19).

### 3. METHODOLOGY

#### DATA

Data on the closing prices of the financial markets in Argentina, Brazil, Chile, Colombia, Peru, and Mexico were obtained from the *Thomson Reuters* platform. The quotations are daily and between the period from January 2, 2018 to July 21, 2020, having been partitioned into two sub periods before and during Covid-19. Quotes are in local currency to mitigate distortions in exchange rates.

**Table 1.** The name of countries and their indices used in this paper

Index	Country
BOLSAA MX	Mexico
BVLAC	Peru
COLCAP	Colombia
IBOVESPA	Brazil
IPSA	Chile
MERVAL	Argentina

**Source:** Own elaboration

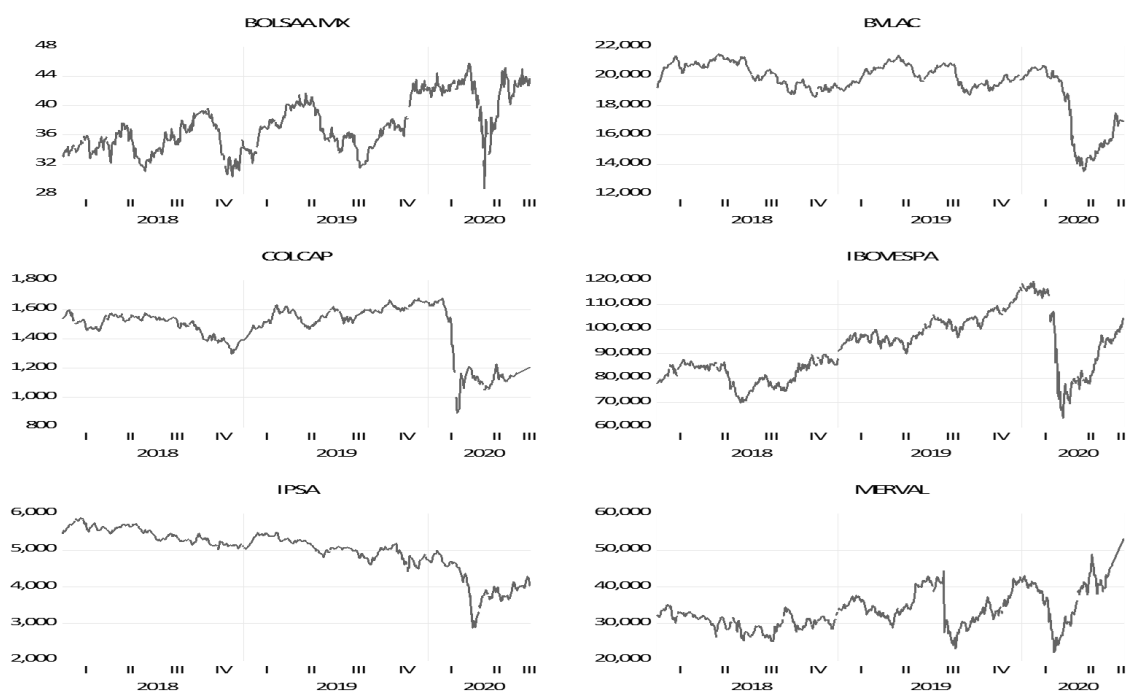
#### METHODOLOGY

The development of the research took place along several stages. The characterization of the sample used was performed through descriptive statistics, the Adherence Test of Jarque and Bera (1980). To answer the first question of investigation, we tested the persistence of profitability through the tests: Ljung-Box (with the squares of profitability); ARCH-LM (Engle, 1982) and BDS (Brock and De Lima, 1996). In order to validate the results of the persistence of profitability we will use the *Detrended Fluctuation Analysis (DFA)*. *DFA* is an analysis method that examines temporal dependence on non-stationary data series. This technique by assuming that time series are non-stationary avoids spurious results when the analysis focuses on the relationships of data series in the long term. The *DFA* model allows to examine the behavior of financial series, having the following interpretation: anti persistent series; series features  $0 < \alpha < 0,5$   $\alpha = 0,5$  random walk;  $0,5 < \alpha < 1$  persistent series. To answer the second question of investigation, that is, if the generalized increase in correlations had statistical significance, the heteroscedasticity t-test of two samples from Forbes and Rigobon (2002) will be applied. This type of correlations requires transformation through fisher's method. This test will show the results on the existence or not of risk transmission among the financial markets of the LAC Region, in the context of global pandemic (Covid-19).

#### 4. RESULTS

Figure 1 shows the evolution of the markets, at levels of the financial markets of Latin America, in the period from January 2, 2018 to July 21, 2020, being the same as the period of great complexity, due to the global pandemic outbreak (Covid-19). Index prices index clearly reveal the instability experienced in these markets in January, February, March and April 2020.

**Figure 1.** Evolution, in levels, of the 6 financial markets, in the full period



Source: Own elaboration

Table 2 shows the main descriptive statistics of the six financial markets in Latin America, referring to the full sample period. The average is positive in the stock indexes of Mexico (BOLSAA MX), Brazil, (IBOVESPA), and Argentina (MERVAL), except in the markets of Peru (BVLAC), Colombia (COLCAP), and Chile (IPSA). The Argentina market has the highest standard deviation (0.0351). The results obtained show that the series of profitability propose removals from the hypothesis of normality. This result arises through the Jarque and Bera test (1980) that allowed to reject the null hypothesis of normality ( $H_0$ ) in favor of the alternative ( $H_1$  - non-normality), for a significance level of 1%. Additionally, the coefficients of asymmetry and kurtosis are statistically different from those of a normal distribution, being the same leptokurtic and asymmetric.

**Table 2.** Descriptive statistics, in profitability, of the 6 financial markets in Latin America in the full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
Mean	0.000437	-0.000202	-0.000387	0.000463	-0.000478	0.000795
Std. Dev.	0.022153	0.010505	0.015441	0.020328	0.014879	0.035148
Skewness	0.922157	-2.418776	-2.190409	-1.587049	-2.287239	-4.231528
Kurtosis	16.68369	26.17456	42.93431	20.61187	31.90027	57.53034
Jarque-Bera	5012.373***	14735.48***	42433.19***	8419.984***	22509.65***	80062.89***
Observations	631	631	631	631	631	631

Source: Own elaboration

Table 3 shows the results of unit root tests, with structure breaks, by Clemente et al. (1998), suggesting marked structural breakdowns in January, February and April 2020, in a complex period of the global pandemic (covid-19). The Argentina market shows that the most significant structural collapse occurred in July 2019. This model identifies the most significant structure breakdown, which means that there may be smaller, structure breaks in the period January 2018 to July 2020. The results are in line with the findings of the authors Lahmiri and Bekiros (2020), Sansa (2020), He, Liu, Wang, and Yu (2020), which show sharp declines in financial markets resulting from the global pandemic (Covid-19).

**Table 3.** Unit root tests, with structural breakdowns, referring to the financial markets of Latin America, in the full period

Index	t-stat	Break Date
BOLSAA MX	-29.09(0) ***	27/04/2020
BVLAC	-26.50(0) ***	03/04/2020
COLCAP	-21.98(0) ***	22/01/2020
IBOVESPA	-31.21(0) ***	23/03/2020
IPSA	-26.67(0) ***	30/03/2020
MERVAL	-30.75(0) ***	31/07/2019

Note: Lag Length (Automatic Length based on SIC). Break Selection: Minimize Dickey-Fuller t-statistic. The lateral values in parentheses refer to lags. \*\*\*, \*\*, \* represent significance at 1%, 5% and 10%, respectively.

**Source:** Own elaboration.

In order to verify the existence of persistent profitability in the financial markets of Latin America, we will estimate the following methodologies: Ljung-Box (with the squares of profitability); ARCH-LM (Engle, 1982) and BDS (Brock and De Lima, 1996). Table 4 shows the Ljung-Box test results, applied to index yield rates, as well as squared yields. We performed in a first phase, and for lags 4 and 12, the Ljung-Box test and we verify as we increase the lags the autocorrelation becomes more persistent. To validate results, we used the same model, with the profitability squared, also for lags 4 and 12, and we proved that the autocorrelation becomes more persistent; the exception to these results is verified in the Argentina market (MERVAL) that indicates balance or anti-persistence.

**Table 4.** Results of Ljung-Box tests applied to time series waste for Latin American markets in the full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
LB (4)	15.889***	13.837***	67.198***	25.328***	31.968***	<b>5.7256</b>
LB (12)	74.395***	54.230***	82.955***	81.623***	49.439***	<b>16.115</b>
LB <sup>2</sup> (4)	149.60***	181.90***	166.99***	693.50***	216.03***	<b>2.2472</b>
LB <sup>2</sup> (12)	345.38***	225.81***	437.24***	951.86***	327.15***	<b>4.1862</b>

Note: The asterisk \*\*\*, \*\* represent significance at 1% and 5%, respectively.

**Source:** Own elaboration.

To analyze the presence of the phenomenon of conditional heteroscedasticity in financial series, it is customary to use the *Lagrange Multiplier* test (ARCH-LM test) (Engle, 1982). The ARCH-LM tests were applied to residues of first-order self-regressive processes and, for lag 10. Table 5 shows that the residues of the self-regressive processes of the financial markets under analysis exhibit conditioned heteroscedasticity, corroborating this characteristic frequently present in financial assets. The Ljung-Box tests, applied to the square of the profitability (table 4), for these lags 4 and 12, prove the evidence of the ARCH-LM test, reinforcing the evidence of the presence of ARCH effects in the time series. The markets of Brazil (IBOVESPA) and Mexico show more significant heteroscedasticity, while Colombia

(COLCAP) and Chile the signal is less pronounced. The Argentina market (MERVAL) shows that the data series has no ARCH effects.

**Table 5.** ARCH-LM test for waste applied to time waste series for Latin America markets in full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
ARCH LM (10 lags)	126.1958***	36.26859***	14.24187***	306.5358***	5.409216**	<b>2.289060</b>

Note: The LM test was applied to the residues of a first-order self-regressive process of each series. Asterisk\*\*\*, \*\* represent significance at 1% and 5%, respectively.

**Source:** Own elaboration.

Table 6 shows the BDS test results, and we can verify that the chances that the yields are i.i.d. is rejected, with statistical significance, from dimension 2, reinforcing the idea that the profitability of stock indices have a nonlinear nature or have a significant nonlinear component, except for the Argentina market, which was expected due to the results of the Ljung-Box (with the squares of profitability) and ARCH-LM tests. According to author Taylor (1986) the significant presence of greater autocorrelation between the squares of profitability than among the original values of profitability is also an indication of the presence of nonlinearity. Table 4 shows the results of the autocorrelation tests of the squares of the profitability, for lags 4 and 12 and all indexes reject the null hypothesis, identifying autocorrelation in series, except for the Argentina market. The results of the autocorrelation tests are totally coincident with those obtained by the BDS test. The rejection of the null hypothesis, i.i.d., can be explained, among other factors, by the existence of autocorrelation or by the existence of heteroscedasticity in the series of scholarship indices, cases in which the rejection of the null hypothesis is explained by nonlinear dependence on the data. These results are in line with studies by the authors Pernagallo and Torrisi (2019) that show the existence of persistence in the profitability of financial markets.

**Table 6.** BDS test applied to time series waste, referring to Latin America markets in the full period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
Dimension (2)	6.5566***	6.0448***	3.9619***	9.0055***	8.3832***	<b>-0.04015</b>
Dimension (3)	6.9686***	7.7242***	6.8186***	9.4047***	11.5163***	<b>-0.05405</b>
Dimension (4)	7.0610***	8.7397***	8.9511***	9.2726***	13.3075***	<b>-0.06481</b>
Dimension (5)	7.1258***	9.3107***	10.3755***	9.3957***	14.6851***	<b>-0.07403</b>
Dimension (6)	7.1959***	9.6764***	11.3864***	9.9429***	15.9209***	<b>-0.08228</b>

Notes: The method considered in the BDS test was the pair fraction, for a value of 0.7. The first column concerns the size of the dive (embedding dimension). The values shown in the table refer to the z-Statistic, \*\* represent significance at 1% and 5%, respectively.

**Source:** Own elaboration

Table 7 shows the results of the exponents  $\alpha$  DFA, and we found that the Latin American markets indicate persistence in profitability, i.e. the presence of sharp long memories, particularly in the markets of Colombia (0.72), Chile (0.66), Brazil (0.58) and Peru (0.57). The Argentina market does not reject the *random walk* hypothesis, while the Mexican market suggests anti persistence (0.41). These findings show that prices do not fully reflect the information available and that price changes are not i.i.d. This situation has implications for investors, since some returns can be expected, creating opportunities for arbitrage and abnormal income, contrary to what is supposed by the assumptions of *random walk* and informational efficiency. These results are mostly corroborated by the Ljung-Box tests (with the squares of profitability); ARCH-LM (Engle, 1982) and BDS (Brock and De Lima, 1996) that show persistence in profitability.

**Table 7.** DFA exponent for return. The hypotheses are  $H_0: \alpha = 0.5$  and  $H_1: \alpha \neq 0.5$

Index	DFA exponent (Covid-19)
BOLSAA MX	0.41 $\cong$ 0.0238
BVLAC	0.57 $\cong$ 0.0239
COLCAP	0.72 $\cong$ 0.0014
IBOVESPA	0.58 $\cong$ 0.0224
IPSA	0.66 $\cong$ 0.0030
MERVAL	0.52 $\cong$ 0.0052

Note: The values of the linear adjustments for  $\alpha$ DFA always had  $R^2 > 0.99$

**Source:** Own elaboration.

In order to analyze the risk transmission among the financial markets of the LAC Region, non-conditional correlations were estimated, and the statistical significance was examined. One way to test the statistical significance of the correlation coefficient is to resort to *t statistics*, which follows the distribution *t*, with  $n - 2$  degrees of freedom, in which *r* is the correlation coefficient between two series and *n* is the number of observations. To test whether the matrix of correlation coefficients is globally different from the identity matrix, we use the verisimilitude ratio test, suggested by Pindyck and Rotemberg (1990).

Table 8 shows the non-conditional correlation coefficients of the statistics for the Pre-Covid sub period, and we can verify the existence of non-significant correlation coefficients (BVLAC-IBOVESPA; BVLAC-MERVAL), negative correlation coefficients (BOLSAA MX-IPSA; IBOVESPA-IPSA; IPSA-MERVAL). Additionally, we can also verify that the positive correlation coefficients are not high.

**Table 8.** Non-conditional correlation coefficients, pre-covid-19 period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
BOLSAA MX	###					
BVLAC	0.134108***	###				
COLCAP	0.119942**	0.578708***	###			
IBOVESPA	0.234242***	0.021255	0.160407***	###		
IPSA	-0.100876**	0.439219***	0.132402***	-0.545241***	###	
MERVAL	0.165000***	-0.069380	0.144528***	0.583039***	-0.203724***	###

Note: Asterisks \*\*\*, \*\* represent significance at 1% and 5%, respectively.

**Source:** Own elaboration

Table 9 shows the non-conditional correlation coefficients in the Covid-19 period, and we can see that the market pairs BOLSAA MX-COLCAP, BOLSAA MX-IPSA, BVLAC-MERVAL, COLCAP-MERVAL, IPSA-MERVAL present negative correlation coefficients (in 15 possible). In addition, we can also see the increase in correlations when compared to the previous period.

**Table 9.** Non-conditional correlation coefficients, Covid-19 period

	BOLSAA MX	BVLAC	COLCAP	IBOVESPA	IPSA	MERVAL
BOLSAA MX	###					
BVLAC	0.179370***	###				
COLCAP	-0.216833***	0.697127***	###			
IBOVESPA	0.069303	0.672792***	0.746810***	###		
IPSA	-0.218262***	0.730612***	0.808306***	0.796805***	###	
MERVAL	0.271763***	-0.408585***	-0.079134	0.168842**	-0.167217**	###

Note: Asterisks \*\*\*, \*\* represent significance at 1% and 5%, respectively.

**Source:** Own elaboration



Table 10 shows the results of risk transmission between Latin American markets through the t-test of heteroscedasticity of two samples of Forbes and Rigobon (2002) between the Pre-Covid and Covid sub periods. The results suggest that there is no risk transmission between these regional markets, except for BOVESPA / BOLSAA MX markets, i.e. the existence of persistence of profitability, and long memories do not imply the transmission of risk between markets. These results open doors to the existence of possibilities for diversification of efficient portfolios.

**Table 10.** Results of risk transmission, between Pre / Covid-19 sub-period

Markets	t-Statistic	Results	Markets	t-Statistic	Results
MERVAL / BOVESPA	-0.34	Nonexistent	BOL.MX / BOVESPA	0.23	Nonexistent
MERVAL / IPSA	-1.25	Nonexistent	BOL.MX / IPSA	-0.90	Nonexistent
MERVAL / BVLAC	-2.59	Nonexistent	BOL.MX / BVLAC	-2.66	Nonexistent
MERVAL / COLCAP	-2.46	Nonexistent	BOL.MX / COLCAP	-2.64	Nonexistent
MERVAL / BOL.MX	-0.62	Nonexistent	BOL.MX / MERVAL	-0.09	Nonexistent
BOVESPA / MERVAL	1.21	Nonexistent	IPSA / MERVAL	0.96	Nonexistent
BOVESPA / IPSA	0.35	Nonexistent	IPSA / BOVESPA	1.06	Nonexistent
BOVESPA / BVLAC	-0.61	Nonexistent	IPSA / BVLAC	-0.67	Nonexistent
BOVESPA / COLCAP	-0.28	Nonexistent	IPSA / COLCAP	-0.38	Nonexistent
BOVESPA / BOL.MX	<b>1.42*</b>	Existent	IPSA / BOL.MX	1.11	Nonexistent
BVLAC / MERVAL	1.14	Nonexistent	COLCAP / MERVAL	0.91	Nonexistent
BVLAC / BOVESPA	1.23	Nonexistent	COLCAP / BOVESPA	1.02	Nonexistent
BVLAC / IPSA	0.42	Nonexistent	COLCAP / BVLAC	-0.72	Nonexistent
BVLAC / COLCAP	-0.18	Nonexistent	COLCAP / IPSA	0.21	Nonexistent
BVLAC / BOL.MX	1.30	Nonexistent	COLCAP / BOL.MX	1.06	Nonexistent

Notes: Critical values correspond to a one-tailed significance on the right, 2.7638 (1%), 1.8125 (5%) and 1.3722 (10%). \*\*\*, \*\*, \* indicate significant results at 1%, 5% and 10%, respectively.

**Source:** Own elaboration

## 5. CONCLUSION

The general conclusion to be retained and, supported by the results obtained, through the tests carried out with econometric and econophysical models demonstrates that the global pandemic has a significant impact on the memory properties of the indices of the financial markets in Latin, America. We believe that the profitability does not follow the hypothesis i.i.d., from dimension 2, reinforcing the idea that the yields of stock indices have a nonlinear nature or have a significant nonlinear component, with the exception made to the Argentina market, which was expected due to the results of the Ljung-Box (with the squares of profitability) and ARCH-LM tests. Corroborating the exponents of *Detrended Fluctuation Analysis (DFA)*, it indicates the presence of long memories. These findings show that prices do not fully reflect the information available and that price changes are not i.i.d. This situation has implications for investors, since some returns can be expected, creating opportunities for arbitrage and abnormal income, contrary to what is supposed by the assumptions of *random walk* and informational efficiency. The results of the t-test of heteroscedasticity of two samples suggest that there is no risk transmission between these regional markets, except for BOVESPA / BOLSAA MX markets, i.e. the existence of persistence of profitability, and long memories do

not imply the transmission of risk between markets. These findings allow the implementation of strategies for diversification of efficient portfolios. These findings also make room for market regulators to take steps to ensure better informational information in these regional markets.

## REFERENCES

- Aggarwal, D. (2018). Random walk model and asymmetric effect in Korean composite stock price index. *Afro-Asian J. of Finance and Accounting*. <https://doi.org/10.1504/aajfa.2018.10009906>
- Ali, M., Alam, N., & Rizvi, S. A. R. (2020). Coronavirus (COVID-19) — An epidemic or pandemic for financial markets. *Journal of Behavioral and Experimental Finance*. <https://doi.org/10.1016/j.jbef.2020.100341>
- Andrianto, Y., & Mirza, A. R. (2016). A Testing of Efficient Markets Hypothesis in Indonesia Stock Market. *Procedia - Social and Behavioral Sciences*. <https://doi.org/10.1016/j.sbspro.2016.04.048>
- Brock, W. A., & de Lima, P. J. F. (1996). 11 Nonlinear time series, complexity theory, and finance. In *Handbook of Statistics* (Vol. 14, pp. 317–361). [https://doi.org/10.1016/S0169-7161\(96\)14013-X](https://doi.org/10.1016/S0169-7161(96)14013-X)
- Clemente, J., Montañés, A., & Reyes, M. (1998). Testing for a unit root in variables with a double change in the mean. *Economics Letters*, 59(2), 175–182. [https://doi.org/10.1016/S0165-1765\(98\)00052-4](https://doi.org/10.1016/S0165-1765(98)00052-4)
- Corbet, S., Larkin, C. J., & Lucey, B. M. (2020). The Contagion Effects of the COVID-19 Pandemic: Evidence from Gold and Cryptocurrencies. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3564443>
- Duarte Duarte, J. B., & Mascareñas Pérez-Iñigo, J. M. (2014). Comprobación de la eficiencia débil en los principales mercados financieros latinoamericanos. *Estudios Gerenciales*. <https://doi.org/10.1016/j.estger.2014.05.005>
- El Khamlichi, A., Sarkar, K., Aroui, M., & Teulon, F. (2014). Are Islamic equity indices more efficient than their conventional counterparts? Evidence from major global index families. *Journal of Applied Business Research*. <https://doi.org/10.19030/jabr.v30i4.8660>
- Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, 50(4), 987. <https://doi.org/10.2307/1912773>
- Fama, E. F., & French, K. R. (1988). Dividend yields and expected stock returns. *Journal of Financial Economics*. [https://doi.org/10.1016/0304-405X\(88\)90020-7](https://doi.org/10.1016/0304-405X(88)90020-7)
- Forbes, K. J., & Rigobon, R. (2002). No Contagion, Only Interdependence: Measuring Stock Market Comovements. *The Journal of Finance*, 57(5), 2223–2261. <https://doi.org/10.2307/3094510>
- Hamid, K., Suleman, M. T., Ali Shah, S. Z., & Imdad Akash, R. S. (2017). Testing the Weak Form of Efficient Market Hypothesis: Empirical Evidence from Asia-Pacific Markets. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2912908>
- He, Q., Liu, J., Wang, S., & Yu, J. (2020). The impact of COVID-19 on stock markets. *Economic and Political Studies*. <https://doi.org/10.1080/20954816.2020.1757570>
- Jarque, C. M., & Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters*, 6(3), 255–259. [https://doi.org/10.1016/0165-1765\(80\)90024-5](https://doi.org/10.1016/0165-1765(80)90024-5)
- Karasiński, J. (2020). The Changing Efficiency of the European Stock Markets. *Annales Universitatis Mariae Curie-Skłodowska, Sectio H – Oeconomia*.

- <https://doi.org/10.17951/h.2020.54.1.41-51>
- Lahmiri, S., & Bekiros, S. (2020). The impact of COVID-19 pandemic upon stability and sequential irregularity of equity and cryptocurrency markets. *Chaos, Solitons and Fractals*. <https://doi.org/10.1016/j.chaos.2020.109936>
- Lawrence H. Summers. (1986). Does the stock market rationally reflect fundamental values. *The Journal of Finance*. <https://doi.org/10.2307/2328487>
- Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 outbreak and affected countries stock markets response. *International Journal of Environmental Research and Public Health*. <https://doi.org/10.3390/ijerph17082800>
- Malafeyev, O., Awasthi, A., S.Kambekar, K., & Kupinskaya, A. (2019). Random Walks and Market Efficiency in Chinese and Indian Equity Markets. *Statistics, Optimization & Information Computing*. <https://doi.org/10.19139/soic.v7i1.499>
- Mehla, S., & Goyal, S. K. (2013). Empirical Evidence on Weak Form of Efficiency in Indian Stock Market. *Asia-Pacific Journal of Management Research and Innovation*. <https://doi.org/10.1177/2319510x1200800107>
- Nisar, S., & Hanif, M. (2012). Testing weak form of efficient market hypothesis: Empirical evidence from South-Asia. *World Applied Sciences Journal*.
- Pernagallo, G., & Torrisi, B. (2019). An empirical analysis on the degree of Gaussianity and long memory of financial returns in emerging economies. *Physica A: Statistical Mechanics and Its Applications*. <https://doi.org/10.1016/j.physa.2019.121296>
- Pindyck, R. S., & Rotemberg, J. J. (1990). Do Stock Prices Move Together Too Much? *National Bureau of Economic Research Working Paper Series, No. 3324*.
- Poterba, J. M., & Summers, L. H. (1988). Mean reversion in stock prices. Evidence and Implications. *Journal of Financial Economics*. [https://doi.org/10.1016/0304-405X\(88\)90021-9](https://doi.org/10.1016/0304-405X(88)90021-9)
- Rehman, S., Chhapra, I. U., Kashif, M., & Rehan, R. (2018). Are Stock Prices a Random Walk? An Empirical Evidence of Asian Stock Markets. *ETIKONOMI*. <https://doi.org/10.15408/etk.v17i2.7102>
- Righi, M. B., & Ceretta, P. S. (2011). Random walk and variance ratio tests for efficiency in the sub-prime crisis: Evidence for the U.S. and latin markets. *International Research Journal of Finance and Economics*.
- Ruiz-Porrás, A., & Ruiz-Robles, B. (2015). La hipótesis de eficiencia y la modelación de series bursátiles mexicanas: un análisis multivariado. *Economía Informa*. [https://doi.org/10.1016/s0185-0849\(15\)30003-7](https://doi.org/10.1016/s0185-0849(15)30003-7)
- Sansa, N. A. (2020). The Impact of the COVID-19 on the Financial Markets: Evidence from China and USA. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3567901>
- Sierra Suárez, K. J., Duarte Duarte, J. B., & Mascareñas Pérez-Iñigo, J. M. (2013). COMPROBACIÓN DEL COMPORTAMIENTO CAÓTICO EN BOLSA DE VALORES DE COLOMBIA. *Revista Estrategia Organizacional*. <https://doi.org/10.22490/25392786.1480>
- Singh, D. S. K., & Kumar, L. (2018). Market Efficiency in Malaysia: An Empirical Study of Random Walk Hypothesis of Kuala Lumpur Stock Market (Composite Index) Bursa Malaysia. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3095176>
- Taylor, S. J. (1986). Modelling Financial Time Series. In *Wiley New York*.
- Worthington, A. C., & Higgs, H. (2013). Tests of random walks and market efficiency in Latin American stock markets: An empirical note. *Pathogens and Global Health*. <https://doi.org/10.1179/204777213X13869290853977>



# THE IMPACT OF THE COVID-19 ON THE FINANCIAL MARKETS: EVIDENCE FROM G7

Paula Heliodoro<sup>35</sup> 

Rui Dias<sup>36</sup> 

Paulo Alexandre<sup>37</sup> 

Maria Jesus Mizeley<sup>38</sup> 

DOI:

---

**Abstract:** *This essay aims to analyse the impact of the 2020 global pandemic on the stock indexes of France (CAC 40), Germany (DAX 30), USA (DOW JONES), United Kingdom (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225) and Canada (TSX 300), from January 2018 to June 2020, with the sample being divided into two sub periods: first sub period from January 2018 to August 2019 (Pre-Covid); second period from September 2019 to June 2020 (Covid-19). In order to carry out this analysis, different approaches were taken in order to analyse whether: (i) the global pandemic (Covid-19) increased the persistence of the G7 financial markets? In the Pre-Covid period, we can verify the presence of long memories in the Canadian market (TSX), while the markets in France (CAC 40) and Italy (FTSE MID) show signs of balance, since the random walk hypothesis was not rejected. The German (DAX 30), USA (DJI), United Kingdom (FTSE 100) and Japan (NIKKEI 225) markets have anti-persistence ( $0 < \alpha < 0.5$ ). In period II, the Covid-19-time scale is contained, and we verified the presence of significant long memories, except for the US stock index (0.49). These findings make it possible to show that the assumption of the market efficiency hypothesis may be called into question, because these markets are predictable, which validate the research question. The results of the pDCCA correlation coefficients, in the Pre-Covid period, show 14 pairs of median markets ( $0.333 \rightarrow \cong 0.666$ ). We can also see 7 pairs of markets with strong correlation coefficients ( $0.666 \rightarrow \cong 1,000$ ), showing that these markets have a tendency towards integration, this evidence may call into question the hypothesis of portfolio diversification. In period II (Covid-19) the  $\lambda$ \_DCCA correlation coefficients have 7 strong market pairs ( $0.666 \rightarrow \cong 1,000$ ), 5 pairs have weak pDCCA coefficient ( $0.000 \rightarrow \cong 0.333$ ), 5 market pairs show anti-correlation ( $-1.000 \rightarrow \cong 0.000$ ), and 4 market pairs show median coefficients (pDCCA) ( $0.333 \rightarrow \cong 0.666$ ) (out of 21 possible). When compared to the previous subperiod, we found that the majority of the pDCCAs decreased, which shows that the markets have decreased their integration, making it possible to diversify portfolios in certain markets, especially in the Japanese market (NIKKEI 225). These conclusions open space for market regulators to take measures to ensure better informational information, in the stock markets, in the 7 most advanced economies in the world.*

**Keywords:** *Covid-19; G7; persistence; long memories; arbitration.*

---

<sup>35</sup> Escola Superior de Ciências Empresarias, Instituto Politécnico de Setúbal, Portugal

<sup>36</sup> Escola Superior de Ciências Empresarias, Instituto Politécnico de Setúbal, Portugal & CEFAGE, Universidade de Évora, Portugal

<sup>37</sup> Escola Superior de Ciências Empresarias, Instituto Politécnico de Setúbal, Portugal

<sup>38</sup> Escola Superior de Ciências Empresarias - Instituto Politécnico de Setúbal, Portugal

## 1. INTRODUCTION

The efficient market hypothesis (HME) argues that bond prices reflect all available information and that investors cannot obtain anomalous returns by trading based on this information (Fama, 1970). HME is an essential concept for financial institutions, individual and institutional investors, and government regulators. An investor's investment strategy is greatly influenced by market efficiency. Market efficiency also determines the regulatory measures to be developed to ensure the development and organized management of a country's markets (Dsouza and Mallikarjunappa, 2015; Shirvani and Delcoure, 2016).

The huge amount of data caught the attention of the audience of academics. Statistical physicists began to analyse financial data, creating an interdisciplinary research area called Econophysics (Gallegati, 2016; Pereira, da Silva and Pereira, 2017).

In this work, we will test the persistence of the profitability of the G7 financial markets, having the sample been divided into two sub-periods: Pre-Covid and Covid. To answer the research question, we will use the DFA methodology and the DCCA cross-correlation coefficient, to analyse the dependency pattern between the various indices under analysis. First, the objective is to assess the degree of efficiency of these indices; the individual analysis can provide information on the profitability of this type of investment. As we will use a sliding window approach, we can also assess how this efficiency has evolved over time. Second, with the *pDCCA*, we want to assess how these markets relate to each other. This can be important, as it can analyse the correlation between the indices and reveal the existence (or not) of connections between the markets, which could also be important for existing and potential investors. The results suggest that the global pandemic (Covid-19) has increased the persistence of profitability in the G7 financial markets, which could jeopardize efficiency, in its weak form. Additionally, we verified that the *pDCCA* correlation coefficients decreased in this period of the pandemic, that is, the level of integration has slowed down, making it possible to diversify portfolios in certain markets, mainly in the Japan market (NIKKEI 225).

This investigation adds contributions to the literature, specifically testing the fractal analysis in the G7 markets, that is, assessing the presence of long memories, in the context of the pandemic of the COVID-19 outbreak. As far as we know, this is the first study to analyse these financial markets in isolation. However, there are recent studies that have analysed the diversification of risk and the impact of the global pandemic, namely the authors Liu, Manzoor, Wang, Zhang and Manzoor (2020), Zeren and Hizarci (2020). However, the approach was quite different from that followed in this essay.

In terms of structure, this essay is organized in 5 sections. Section 2 presents a literature review on the hypothesis of an efficient market in international financial markets. Section 3 describes the methodology and data. Section 4 contains the results. Section 5 concludes.

## 2. LITERATURE REVISION

Different studies have addressed the issue of market efficiency, analysing the hypothesis of predictability of returns, through the analysis of patterns of reversion to the average of stock prices, inspired by the seminal works of Poterba and Summers (1988), Fama and French (1988), who documented the reversal to the average in the returns of the stock markets, over time horizons of more than one year.

This theme has motivated other studies to analyse the implications in the hypothesis of efficiency of the markets, according to which the current price of the assets reflects all the available information, in a given moment, and the price adjusts quickly, as new and unforeseen information is reaching the market. The mean reversion hypothesis, also known as negative series correlation, has been interpreted as an efficient correction mechanism in developed markets and a sign of a speculative bubble in emerging financial markets (Lawrence H. Summers, 1986; Fama and French, 1988)

Ayentimi, Mensah, and Naa-Idar (2013), Dourado and Tabak (2014), Robinson (2016), Ngene, Tah, and Darrat (2017) tested the random walk hypothesis in the stock markets. Ayentimi, Mensah, and Naa-Idar (2013) examined the efficiency of companies listed on the Ghana Stock Exchange (GSE). The authors suggest that the market is inefficient and recommend that transaction costs be reduced in order to improve market activities (GSE). Dourado and Tabak (2014) evaluated the efficiency of the São Paulo stock exchange, from January 1995 to December 2012. The authors show that the RWH hypothesis cannot be rejected, showing signs of efficiency. Robinson (2016) investigated the Jamaica Stock Exchange (JSE), evidencing that the random walk hypothesis was rejected. Ngene, Tah, and Darrat (2017) examined 18 emerging markets in the presence of multiple, unforeseen and successive structural breaks. Random walk hypothesis is rejected. However, when using double-level change tests on the average and due tolerance to various structural breaks is made, the results are consistent with the random walk hypothesis in most markets.

Hamid, Suleman, Ali Shah and Imdad Akash (2017), Awan and Subayyal (2018), Fernando and Gunasekara (2018), Chaker and Sabah (2018) tested market efficiency, in its weak form, in the stock markets. Hamid, Suleman, Ali Shah and Imdad Akash (2017) show that the financial markets of Pakistan, India, Sri Lanka, China, Korea, Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Thailand, Taiwan, Japan and Australia, do not follow the random walk hypothesis. Awan and Subayyal (2018) analysed the stock exchanges of Oman, United Arab Emirates, Kuwait, Saudi Arabia, Bahrain and Qatar, and show that these markets show signs of (in) efficiency, in their weak form. Fernando and Gunasekara (2018) show that the ASPI index (All Share Price Index) of the CSE market, shows signs of (in) efficiency, in its weak form, although the market efficiency is mostly dynamic. Chaker and Sabah (2018) tested efficiency in the GCCC, United Arab Emirates, Saudi Arabia, Oman, Kuwait and Bahrain markets, except in Qatar. The results suggest that none of the five stock markets follow the random walk hypothesis.

Mphoeng (2019), Pernagallo and Torrisi (2019), Malafeyev, Awasthi, S. Kambekar, and Kupinskaya (2019), tested efficiency, in its weak form, and tested whether markets are predictable. Mphoeng (2019) tested the efficient market hypothesis in the Botswana stock market, showing that the random walk hypothesis was rejected, which maintains that the market is inefficient in the analysed period. Pernagallo and Torrisi (2019) analysed whether the behaviour of the daily returns of the stock market indexes of 12 emerging economies corroborates the hypothesis of “fat tails” and whether these series show long memory. Hurst's exponents range from 0.51 to 0.62 showing significant long memories. Malafeyev, Awasthi, S. Kambekar, and Kupinskaya (2019) show that the stock markets of China and India do not show efficiency, in their weak form, in the first three periods (1996 to 2015).

Tebyaniyan, Jahanshad, and Heidarpour (2020), Karasiński (2020), Aslam, Mohti, and Ferreira (2020) tested the presence of long-term memories in the financial markets. Tebyaniyan, Jahanshad, and Heidarpour (2020) analysed the share prices of companies on the Tehran stock

exchange. The test results indicate that stock prices have a multifractal property, and have long memories, which implies market inefficiency, in its weak form. Karasiński (2020) examined the efficiency of European stock markets; the results show a partial rejection of the random walk hypothesis, noting that, in the long run, the efficiency of European stock markets tends to improve in the post-2008 financial crisis. Aslam, Mohti, and Ferreira (2020) assessed how the coronavirus pandemic (Covid-19) affects the memory properties of 8 European stock exchanges, with five-minute data. The authors show that the Spanish stock market remains the most efficient, while the least efficient is that of Austria. The Belgium, Italy and Germany markets show 0.5 results.

### 3. METHODOLOGY

#### DATA

Closing price data on the stock indices of France (CAC 40), Germany (DAX 30), USA (DOW JONES), United Kingdom (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225) and Canada (TSX 300), were obtained from the Thomson Reuters platform. The quotations are daily and cover the period from January 3, 2018 to June 1, 2020, with the sample being divided into two sub periods: first sub period from January 2018 to August 2019 (Pre-Covid); second period from September 2019 to June 2020 (Covid-19). Quotations are in local currency, to mitigate exchange rate distortions.

**Table 1.** The name of countries and their indices used in this paper

Country	Index
France	CAC 40
Germany	DAX 30
USA	DOW JONES
United Kingdom	FTSE 100
Italy	FTSE MID
Japan	NIKKEI 225
Canada	TSX 300

**Source:** Own elaboration

#### METHODOLOGY

The development of the research took place over several stages. In order to answer the research question, we will use the methodology Detrended Fluctuation Analysis (DFA), and Detrended Cross-Correlation Analysis (*pDCCA*). DFA is an analysis method that examines time dependency on non-stationary data series. This technique, assuming that the time series are non-stationary, avoids spurious results when the analysis focuses on the relationships of the data series in the long run. The DFA has the following interpretation:  $0 < \alpha < 0.5$ : anti-persistent series;  $\alpha = 0.5$  series has a random walk;  $0.5 < \alpha < 1$  persistent series. The function of this technique is to examine the relationship between the  $x_k$  and  $x_{(k+t)}$  values at different times (Guedes et al., 2018). Zebende's (2011) trendless cross correlation coefficient (*pDCCA*) is a method for quantifying the level of cross correlation between two non-stationary time series. The coefficient is based on the DFA (Peng et al., 1994) and DCCA (Podobnik and Stanley, 2008) methods. The cross-correlation coefficient depends on the length of the box  $s$  (time scale). One of the advantages of this cross-correlation coefficient is centred on the possibility of measuring the correlations between two non-stationary time series at different time scales. The function of this technique is to examine the relationship between the  $x_k$  and  $x_{(k+t)}$



values at different times (Ferreira, Dionísio, Guedes and Zebende, 2018). Tables 2 and 3 show the interpretation of the exponents  $\alpha_{DFA}$  and  $pDCCA$ .

**Table 2.** Detrended Fluctuation Analysis  $\alpha_{DFA}$

Exponent	Type of signal
$\alpha_{DFA} < 0.5$	long-range anti-persistent
$\alpha_{DFA} \approx 0.5$	uncorrelated, white noise
$\alpha_{DFA} > 0.5$	long-range persistent

Source: Own elaboration

**Table 3.** Detrended cross-correlation coefficient,  $pDCCA$ , levels

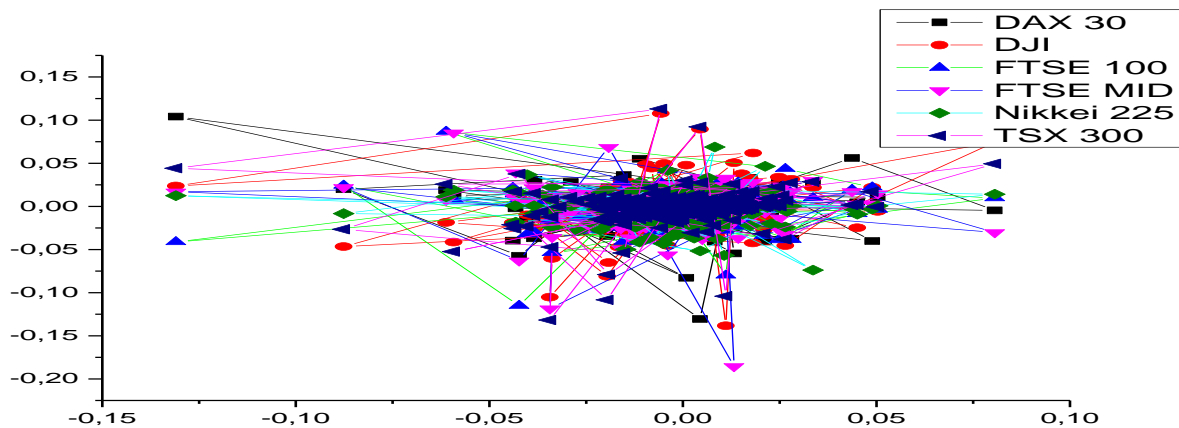
Weak	Medium	Strong
$\cong 0.000 \rightarrow \cong 0.333$	$\cong 0.333 \rightarrow \cong 0.666$	$\cong 0.666 \rightarrow \cong 1.000$

Source: Own elaboration

#### 4. RESULTS

Figure 1 shows the evolution of the markets, in terms of profitability, of the G7. The sample comprises the time lapse from January 2018 to June 2020, being a period of considerable complexity, due to understanding the outbreak of the global pandemic (COVID-19). Yields clearly reveal volatility in February, March and April 2020.

**Figure 1.** Evolution, in profitability, of the G7 financial markets, in the period of 03/01/2018 to 01/06/2020



Source: Own elaboration

Table 4 shows the main descriptive statistics for the G7 financial markets. The analysis of descriptive statistics allows us to ascertain that profitability shows negative daily averages, except for the US market (DJI). Asymmetries are negative in the 7 markets, especially in the Italian market (FTSE MID). Short-circuits are above 3, which shows signs of deviation from the hypothesis of normality, with a greater incidence in Italy (FTSE MID). Additionally, the asymmetry and kurtosis coefficients are statistically different from those of a normal distribution.

**Table 4.** Descriptive statistics on returns, of the G7 financial markets, in the period of 03/01/2018 to 01/06/2020

Index	N	Mean	Standard Deviation	Skewness	Kurtosis	Minimum	Maximum
CAC 40	615	-1.78E-04	0.01368	-1.92015	19.68111	-0.13098	0.08056
DAX 30	615	-1.92E-04	0.01416	-1.21737	18.98176	-0.13055	0.10414
DJI	615	8.36E-06	0.01623	-0.95021	18.16517	-0.13842	0.10764
FTSE 100	615	-3.59E-04	0.01232	-1.56484	19.83532	-0.11512	0.08667
FTSE MID	615	-2.92E-04	0.0158	-3.22624	37.12553	-0.18541	0.08549
NIKKEI 225	615	-3.39E-04	0.01179	-0.62377	6.87018	-0.07391	0.06879
TSX 300	615	-1.12E-04	0.01374	-1.96528	37.4476	-0.13176	0.11294

**Source:** Own elaboration

Table 5 shows the DFA exponents referring to the stock market indices of the G7 markets. The period I comprises the Pre-Covid time scale and we can verify the presence of long memories in the Canada market (TSX), while the markets in France (CAC 40), and Italy (FTSE MID) show signs of balance, since the random walk hypothesis was not rejected. The German (DAX 30), USA (DJI), United Kingdom (FTSE 100) and Japan (NIKKEI 225) markets have anti-persistence ( $0 < \alpha < 0.5$ ). In period II, the Covid-19-time scale is contained, and we verified the presence of significant long memories, except for the US stock index (0.49). These findings make it possible to show that the assumption of the market efficiency hypothesis may be called into question, since the forecast of market movement can be improved if the lagged movements of the other markets are considered, allowing arbitrage operations to occur. These results are in line with the findings of the authors Tebyaniyan, Jahanshad, and Heidarpour (2020), Karasiński (2020), Aslam, Mohti, and Ferreira (2020).

**Table 5.** DFA exponent for index and return. The values of the linear adjustments for  $\alpha$  DFA always had  $R^2 > 0.99$ .

Stock market	DFA exponent (before crisis)	DFA exponent (crisis period)
CAC 40	0.50 $\cong$ 0,0009	0.64 $\cong$ 0.0031
DAX 30	0.47 $\cong$ 0.0036	0.64 $\cong$ 0.0041
DJI	0.46 $\cong$ 0.0016	0.49 $\cong$ 0.0054
FTSE 100	0.47 $\cong$ 0.0010	0.55 $\cong$ 0.0064
FTSE MID	0.52 $\cong$ 0.0340	0.66 $\cong$ 0.0088
NIKKEI 225	0.49 $\cong$ 0.0033	0.64 $\cong$ 0.0031
TSX 300	0.56 $\cong$ 0.0012	0.54 $\cong$ 0.0272

**Source:** Own elaboration.

Note: The hypotheses are  $H_0: \alpha = 0.5$  and  $H_1: \alpha \neq 0.5$ .

Table 6 shows the Detrended cross-correlation coefficient pDCCA for the period from 02 January 2018 to 30 August 2019 (Pre-Covid-19). The G7 financial markets have 14 median cross-correlation coefficients without trend ( $\lambda\_DCCA$ ) median (0.333  $\rightarrow$   $\cong$  0.666) (out of 21 possible). We can also see 7 pairs of markets showing strong correlation coefficients (0.666  $\rightarrow$   $\cong$  1,000). These findings show that these markets have marked levels of integration, which may jeopardize efficient portfolio diversification.

**Table 6.** Summary table of the pDCCA coefficients peaks, in the G7 financial markets, in the sub period 01/02/2018 to 08/30/2019 (Pre-Covid-19)

Index	$\lambda_{DCCA}$	Time scale (days)	Trend
CAC 40 - DAX 30	0.75	n > 92 days	Strong correlation
CAC 40 - DJI	<b>0.58</b>	n > 92 days	<b>Mean correlation</b>
CAC 40 - FTSE 100	0.71	n > 63 days	Strong correlation
CAC 40 - FTSE MID	0.68	n > 76 days	Strong correlation
CAC 40 - NIKKEI 225	<b>0.41</b>	n > 92 days	<b>Mean correlation</b>
CAC 40 - TSX 300	<b>0.56</b>	n > 76 days	<b>Mean correlation</b>
DAX 30 - DJI	0.65	n > 76 days	<b>Mean correlation</b>
DAX 30 - FTSE 100	0.77	n > 76 days	Strong correlation
DAX 30 - FTSE MID	<b>0.66</b>	n > 63 days	<b>Mean correlation</b>
DAX 30 - NIKKEI 225	<b>0.42</b>	n > 92 days	<b>Mean correlation</b>
DAX 30 - TSX	0.68	n > 76 days	Strong correlation
DJI - FTSE 100	<b>0.58</b>	n > 76 days	<b>Mean correlation</b>
DJI - FTSE MID	<b>0.46</b>	n > 63 days	<b>Mean correlation</b>
DJI - NIKKEI 225	<b>0.51</b>	n > 92 days	<b>Mean correlation</b>
DJI - TSX 300	0.77	n > 92 days	Strong correlation
FTSE 100 - FTSE MID	<b>0.59</b>	n > 63 days	<b>Mean correlation</b>
FTSE 100 - NIKKEI 225	<b>0.44</b>	n > 92 days	<b>Mean correlation</b>
FTSE 100 - TSX	0.67	n > 92 days	Strong correlation
FTSE MID - NIKKEI 225	<b>0.36</b>	n > 76 days	<b>Mean correlation</b>
FTSE MID - TSX 300	<b>0.52</b>	n > 43 days	<b>Mean correlation</b>
NIKKEI 225 - TSX 300	<b>0.49</b>	n > 92 days	<b>Mean correlation</b>

Source: Own elaboration

Table 7 shows the Detrended cross-correlation coefficient pDCCA for the period from September 2, 2019 to June 1, 2020 (Covid-19). The G7 financial markets have 7 pairs of strong markets ( $0.666 \rightarrow \cong 1,000$ ), 5 pairs have a weak coefficient pDCCA ( $0.000 \rightarrow \cong 0.333$ ), 5 pairs of markets show anti-correlation ( $-1000 \rightarrow 000 0.000$ ), and 4 pairs of markets show median ( $\lambda_{DCCA}$ ) coefficients ( $0.333 \rightarrow \cong 0.666$ ) (out of 21 possible). When compared to the previous subperiod, we find that the pDCCAs have mostly decreased, which shows that the markets have decreased their integration, making it possible to diversify portfolios in certain markets, namely in the Japanese market (NIKKEI 225).

**Table 7.** Summary table of pDCCA coefficients peaks, in the G7 financial markets, in the subperiod 02/09/2019 to 01/06/2020 (Covid-19)

Index	$\lambda_{DCCA}$	Time scale (days)	Trend
CAC 40 - DAX 30	<b>0.18</b>	n > 43 days	<b>Weak correlation</b>
CAC 40 - DJI	<b>0.24</b>	n > 43 days	<b>Weak correlation</b>
CAC 40 - FTSE 100	0.58	n > 43 days	Mean correlation
CAC 40 - FTSE MID	<b>0.31</b>	n > 43 days	<b>Weak correlation</b>
CAC 40 - NIKKEI 225	<b>0.07</b>	n > 29 days	<b>Weak correlation</b>
CAC 40 - TSX 300	<b>0.31</b>	n > 43 days	<b>Weak correlation</b>
DAX 30 - DJI	0.86	n > 43 days	Strong correlation
DAX 30 - FTSE 100	0.59	n > 43 days	Mean correlation

DAX 30 - FTSE MID	0.85	n > 43 days	Strong correlation
DAX 30 - NIKKEI 225	<b>-0.33</b>	n > 43 days	<b>Anti correlation</b>
DAX 30 – TSX 300	0.88	n > 43 days	Strong correlation
DJI - FTSE 100	0.57	n > 43 days	Mean correlation
DJI - FTSE MID	0.77	n > 43 days	Strong correlation
DJI - NIKKEI 225	<b>-0.31</b>	n > 43 days	<b>Anti correlation</b>
DJI - TSX 300	0.93	n > 29 days	Strong correlation
FTSE 100 - FTSE MID	0.67	n > 43 days	Strong correlation
FTSE 100 - NIKKEI 225	<b>-0.13</b>	n > 43 days	<b>Anti correlation</b>
FTSE 100 – TSX 300	0.62	n > 43 days	Mean correlation
FTSE MID - NIKKEI 225	<b>-0.24</b>	n > 29 days	<b>Anti correlation</b>
FTSE MID - TSX 300	0.77	n > 35 days	Strong correlation
NIKKEI 225 - TSX 300	<b>-0.20</b>	n > 24 days	<b>Anti correlation</b>

Source: Own elaboration

## 5. CONCLUSION

The general conclusion to be retained and sustained by the results obtained, through tests carried out with econophysical models, show that the global pandemic has a significant impact on the adjustment of the analysed financial markets. The results indicate that the G7 markets show significant persistence during the Covid period, which causes some arbitrage opportunities. Additionally, Detrended cross-correlation coefficient pDCCA decreased in the Covid period when compared to the previous subperiod, which improves the possibilities for portfolio diversification. These conclusions also open space for market regulators to take measures to ensure better informational information among international financial markets. In conclusion, we believe that investors should diversify their portfolios, and invest in less risky markets, in order to mitigate risk and improve the efficiency of their portfolios.

## REFERENCES

- Aslam, F., Mohti, W., & Ferreira, P. (2020). Evidence of Intraday Multifractality in European Stock Markets during the Recent Coronavirus (COVID-19) Outbreak. *International Journal of Financial Studies*. <https://doi.org/10.3390/ijfs8020031>
- Awan, U., & Subayyal, M. (2018). Weak Form Efficient Market Hypothesis Study: Evidence from Gulf Stock Markets. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2787816>
- Ayentimi, D., Mensah, A., & Naa-Idar, F. (2013). Stock market efficiency of Ghana stock exchange: An objective analysis. *International Journal of Management, Economics and Social Sciences (IJMESS)*.
- Chaker, M. N., & Sabah, A. (2018). Testing the weak form of efficiency of the stock markets in Gulf Cooperation Council countries. *Journal for Global Business Advancement*. <https://doi.org/10.1504/JGBA.2018.096334>
- Dourado, G. de A., & Tabak, B. M. (2014). Testing the adaptive markets hypothesis for Brazil. *Brazilian Review of Finance*.
- Dsouza, J. J., & Mallikarjunappa, T. (2015). Does the Indian Stock Market Exhibit Random Walk? *Paradigm*. <https://doi.org/10.1177/0971890715585197>
- Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*. <https://doi.org/10.2307/2325486>
- Fama, E. F., & French, K. R. (1988). Dividend yields and expected stock returns. *Journal of*

- Financial Economics*. [https://doi.org/10.1016/0304-405X\(88\)90020-7](https://doi.org/10.1016/0304-405X(88)90020-7)
- Fernando, P. N. D., & Gunasekara, A. L. (2018). Is the Market Efficiency Static or Dynamic – Evidence from Colombo Stock Exchange (CSE). *Kelaniya Journal of Management*. <https://doi.org/10.4038/kjm.v7i1.7551>
- Ferreira, P., Dionísio, A., Guedes, E. F., & Zebende, G. F. (2018). A sliding windows approach to analyse the evolution of bank shares in the European Union. *Physica A: Statistical Mechanics and Its Applications*, 490, 1355–1367. <https://doi.org/10.1016/j.physa.2017.08.095>
- Gallegati, M. (2016). Beyond econophysics (not to mention mainstream economics). *European Physical Journal: Special Topics*. <https://doi.org/10.1140/epjst/e2016-60105-6>
- Guedes, E. F., Brito, A. A., Oliveira Filho, F. M., Fernandez, B. F., de Castro, A. P. N., da Silva Filho, A. M., & Zebende, G. F. (2018). Statistical test for  $\Delta p$ DCCA: Methods and data. *Data in Brief*. <https://doi.org/10.1016/j.dib.2018.03.080>
- Hamid, K., Suleman, M. T., Ali Shah, S. Z., & Imdad Akash, R. S. (2017). Testing the Weak Form of Efficient Market Hypothesis: Empirical Evidence from Asia-Pacific Markets. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2912908>
- Karasiński, J. (2020). The Changing Efficiency of the European Stock Markets. *Annales Universitatis Mariae Curie-Skłodowska, Sectio H – Oeconomia*. <https://doi.org/10.17951/h.2020.54.1.41-51>
- Lawrence H. Summers. (1986). Does the stock market rationally reflect fundamental values. *The Journal of Finance*. <https://doi.org/10.2307/2328487>
- Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 outbreak and affected countries stock markets response. *International Journal of Environmental Research and Public Health*. <https://doi.org/10.3390/ijerph17082800>
- Malafeyev, O., Awasthi, A., S.Kambekar, K., & Kupinskaya, A. (2019). Random Walks and Market Efficiency in Chinese and Indian Equity Markets. *Statistics, Optimization & Information Computing*. <https://doi.org/10.19139/soic.v7i1.499>
- Mphoeng, M. (2019). Testing for Weak-Form Market Efficiency in the Botswana Stock Market. *Archives of Business Research*. <https://doi.org/10.14738/abr.79.6640>
- Ngene, G., Tah, K. A., & Darrat, A. F. (2017). The random-walk hypothesis revisited: new evidence on multiple structural breaks in emerging markets. *Macroeconomics and Finance in Emerging Market Economies*. <https://doi.org/10.1080/17520843.2016.1210189>
- Peng, C. K., Buldyrev, S. V., Havlin, S., Simons, M., Stanley, H. E., & Goldberger, A. L. (1994). Mosaic organization of DNA nucleotides. *Physical Review E*, 49(2), 1685–1689. <https://doi.org/10.1103/PhysRevE.49.1685>
- Pernagallo, G., & Torrisi, B. (2019). An empirical analysis on the degree of Gaussianity and long memory of financial returns in emerging economies. *Physica A: Statistical Mechanics and Its Applications*. <https://doi.org/10.1016/j.physa.2019.121296>
- Podobnik, B., & Stanley, H. E. (2008). Detrended cross-correlation analysis: A new method for analyzing two nonstationary time series. *Physical Review Letters*, 100(8). <https://doi.org/10.1103/PhysRevLett.100.084102>
- Poterba, J. M., & Summers, L. H. (1988). Mean reversion in stock prices. Evidence and Implications. *Journal of Financial Economics*. [https://doi.org/10.1016/0304-405X\(88\)90021-9](https://doi.org/10.1016/0304-405X(88)90021-9)
- Robinson, C. J. (2016). Stock Price Behaviour in Emerging Markets: Tests for Weak-Form Efficiency on the Jamaica Stock Exchange. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2845446>
- Tebyaniyan, H., Jahanshad, A., & Heidarpoor, F. (2020). Analysis of weak performance hypothesis, multi-fractality feature and long-term memory of stock price in Tehran stock

- exchange. *International Journal of Nonlinear Analysis and Applications*.  
<https://doi.org/10.22075/ijnaa.2020.4412>
- Zebende, G. F. (2011). DCCA cross-correlation coefficient: Quantifying level of cross-correlation. *Physica A: Statistical Mechanics and Its Applications*, 390(4), 614–618.  
<https://doi.org/10.1016/j.physa.2010.10.022>
- ZEREN, F., & HIZARCI, A. (2020). THE IMPACT OF COVID-19 CORONAVIRUS ON STOCK MARKETS: EVIDENCE FROM SELECTED COUNTRIES. *Muhasebe ve Finans İncelemeleri Dergisi*. <https://doi.org/10.32951/mufider.706159>

# THE DOW JONES INDUSTRIAL AVERAGE (DJIA) STOCK MARKET INDEX AND THE CHAOTIC GROWTH MODEL

Vesna Jablanovic<sup>39</sup> 

DOI:

---

**Abstract:** *The Dow Jones Industrial Average (DJIA) index includes the stocks of 30 of the largest companies in the United States. It represents about a quarter of the value of the entire U.S. stock market. The changes in the DJIA index are often considered to be representative of the entire stock market. The basic aims of this paper are: firstly, to create the simple chaotic the DJIA stock market index growth model that is capable of generating stable equilibria, cycles, or chaos; secondly, to analyze the local stability of the DJIA index movements in the period 1982-2009; and thirdly, to discover the equilibrium level of the DJIA index in the observed period. This paper confirms the existence of the stable convergent fluctuations of the DJIA index in the observed period. Also, the golden ratio can be used to define the equilibrium level of the DJIA index in the presented chaotic model.*

**Keywords:** *The DJIA index, Stability, Elliot waves, Chaos.*

---

## INTRODUCTION

The Dow Jones Industrial Average (DJIA) includes the stocks of 30 of the largest companies in the United States. It is a price-weighted index. It represents about a quarter of the value of the entire U.S. stock market. The changes in the index explain the entire stock market dynamics. The Dow Jones Industrial Average (DJIA) was started on May 26, 1896 by Charles Dow, the editor of the *Wall Street Journal* and co-founder of Dow Jones & Co. On May 26, 1896, the Dow Jones industrial average began measuring stocks (12). Further, in 1928, the sum of the prices of the 30 stocks was divided by a special number called the “divisor” rather than by 30. This index was still identified as an “average.” The Dow Jones Industrial Average (DJIA) is now based on the prices of the stocks of 30 major U.S. companies. The Dow Jones Industrial Average (DJIA) has following characteristics: (i) each company in the index is weighted by the price of its stock; (ii) the companies in the index are not representative of the market as a whole; (iii) the DJIA excludes dividend distributions; and (iv) the DJIA has evolved to include large tech and financial-services players.

Chaos theory started with Lorenz's (1963) discovery of complex dynamics arising from three nonlinear differential equations leading to turbulence in the weather system. Li and Yorke (1975) discovered that the simple logistic curve can exhibit very complex behavior. Further, May (1976) described chaos in population biology. Chaos theory has been applied in economics by Benhabib and Day (1981,1982), Day (1982, 1983), Grandmont (1985), Goodwin (1990), Medio (1993), Lorenz (1993), Jablanovic (2011, 2012, 2013, 2016), Puu, T. (2003), Zhang W.B. (2006), etc.

---

<sup>39</sup> University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11081 Belgrade, Serbia

**Figure 1.** Interactive chart of the Dow Jones Industrial Average (DJIA) stock market index for the last 100 years. Historical data is inflation-adjusted using the headline CPI and each data point represents the month-end closing value. The current month is updated on an hourly basis with today's latest value. The current price of the Dow Jones Industrial Average as of July 02, 2020 is **25,827.36**.



Source: <http://www.macrotrends.net/1319/dow-jones-100-year-historical-chart>

## THE MODEL

The chaotic stock price and /or the Dow Jones Industrial Average (DJIA) growth model is presented by the following equations:

$$D_t = \alpha - \beta P_t \quad \alpha > 0, \beta > 0 \quad (1)$$

$$S_t = \gamma P_t \quad \gamma > 0 \quad (2)$$

$$\frac{P_{t+1} - P_t}{P_t} = \mu(D_t - S_t) \quad \mu > 0 \quad (3)$$

Where  $P_t$  – stock price;  $S_t$  – supply function of stock;  $D_t$  – demand function for stock;  $\mu$  – the adjustment coefficient;  $\alpha, \beta$  – the coefficients of the stock demand function;  $\gamma$  – the coefficient of the stock supply function.

(1) defines demand function for stock; (2) defines supply function of stock; (3) determines the relation between stock price growth rate and surplus of demand for stock.

By substitution one derives:

$$P_{t+1} = (1 + \mu \alpha) P_t - \mu (\beta + \gamma) P_t^2 \quad \alpha, \beta, \mu, \gamma > 0 \quad (4)$$

Further, it is assumed that the current value of the stock price is restricted by its maximal value in its time series. This premise requires a modification of the growth law. Now, the stock price growth rate depends on the current size of the stock price,  $P$ , relative to its maximal size in its time series  $P^m$ . We introduce  $s$  as  $s = P/P^m$ . Thus  $s$  range between 0 and 1. Again we index  $s$  by



$t$ , i.e. write  $s_t$  to refer to the size at time steps  $t = 0, 1, 2, 3, \dots$ . Now growth rate of the stock price is measured as

$$s_{t+1} = (1 + \mu \alpha) s_t - \mu (\beta + \gamma) s_t^2 \quad \alpha, \beta, \mu, \gamma > 0 \quad (5)$$

This model given by equation (5) is called the logistic model. For most choices of  $\alpha, \beta, \gamma$ , and  $\mu$  there is no explicit solution for (5). This is at the heart of the presence of chaos in deterministic feedback processes. Sensitive dependence on initial conditions is one of the central ingredients of what is called deterministic chaos.

The logistic map is often cited as an example of how complex, chaotic behavior can arise from very simple non-linear dynamical equations. The map was popularized by the biologist Robert May (1976). The logistic model was originally introduced as a demographic model by Pierre François Verhulst.

It is possible to show that iteration process for the logistic equation

$$z_{t+1} = \pi z_t (1 - z_t), \quad \pi \in [0, 4], \quad z_t \in [0, 1] \quad (6)$$

is equivalent to the iteration of growth model (5) when we use the identification

$$z_t = \frac{\mu (\beta + \gamma)}{(1 + \mu \alpha)} p_t \quad \text{and} \quad \pi = (1 + \mu \alpha) \quad (7)$$

Using (5.) and (7.) we obtain:

$$\begin{aligned} z_{t+1} &= \frac{\mu (\beta + \gamma)}{(1 + \mu \alpha)} p_{t+1} = \frac{\mu (\beta + \gamma)}{(1 + \mu \alpha)} \left\{ (1 + \mu \alpha) p_t - \mu (\beta + \gamma) p_t^2 \right\} = \\ &= \mu (\beta + \gamma) p_t - \left[ \frac{\mu^2 (\beta + \gamma)^2}{(1 + \mu \alpha)} \right] p_t^2 \end{aligned}$$

On the other hand, using (6.) and (7.) we obtain:

$$\begin{aligned} z_{t+1} &= \pi z_t (1 - z_t) = (1 + \mu \alpha) \left[ \frac{\mu (\beta + \gamma)}{(1 + \mu \alpha)} \right] p_t \left\{ 1 - \left[ \frac{\mu (\beta + \gamma)}{(1 + \mu \alpha)} \right] p_t \right\} = \\ &= \mu (\beta + \gamma) p_t - \left[ \frac{\mu^2 (\beta + \gamma)^2}{(1 + \mu \alpha)} \right] p_t^2 \end{aligned}$$

Thus, we have that iterating (5) is really the same as iterating (6) using (7). It is important because the dynamic properties of the logistic equation (6) have been widely analyzed (Li and Yorke (1975), May (1976)).

It is obtained that: (i) For parameter values  $0 < \pi < 1$  all solutions will converge to  $z = 0$ ; (ii) For  $1 < \pi < 3,57$  there exist fixed points the number of which depends on  $\mu$ ; (iii) For  $1 < \pi < 2$  all solutions monotonically increase to  $z = (\pi - 1) / \pi$ ; (iv) For  $2 < \pi < 3$  fluctuations will converge to  $z = (\pi - 1) / \pi$ ; (v) For  $3 < \pi < 4$  all solutions will continuously fluctuate; (vi) For  $3,57 < \pi < 4$  the solution become "chaotic" which means that there exist totally aperiodic solution or periodic solutions with a very large, complicated period. This means that the path of  $z_t$  fluctuates in an apparently random fashion over time, not settling down into any regular pattern whatsoever. Also, for  $\pi = 2.6178$  then fluctuations will converge to  $z = 0.618$ .

The Fibonacci sequence, starting with zero and one, is created by adding the previous two numbers (0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, ...). This sequence is significant because of the golden ratio. The ratio of any number in the Fibonacci sequence relative to the number directly to its right is approximately 0.618. The Golden Ratio (golden mean, golden number, golden proportion) is 0.618. Adding the number 1 to the Golden Ratio = Phi ( $\Phi = 1.618$ ). Both 0.618 and 1.618 are used interchangeably to represent the golden ratio because they represent the same geometric relationship. (Lidwell, Holden, and Butler, 2010, p.114).

## EMPIRICAL EVIDENCE

The main aim of this analysis is to present stock market index (DJIA) growth stability in the period 1982-2009, by using the presented non-linear, logistic model (8) because stock market index is computed from the prices of selected stocks.

In this sense,

$$s_{t+1} = \omega s_t - v s_t^2 \quad \omega, v > 0 \quad (8)$$

where  $s$  - stock market index,  $\omega = \pi = (1 + \mu \alpha)$  and  $v = \mu (\beta + \gamma)$

Firstly, we transform data on stock market index from 0 to 1, according to our supposition that actual value of stock market index,  $P$ , is restricted by its highest value in the time-series,  $P^m$ . Further, we obtain time-series of  $s = P / P^m$ . Now, we estimate the model (8). Secondly, data on the Dow Jones Industrial Average (DJIA) are transformed (Source: <http://www.macrotrends.net/1319/dow-jones-100-year-historical-chart>) from 0 to 1, according to our supposition that actual values of DJIA,  $P$ , is restricted by its highest value in the time-series,  $P^m$ . Further, we obtain time-series of  $s = P / P^m$  (see Table 1). Also, the Fibonacci ratios are associated to Elliott wave pattern.

It is supposed that the basic Elliott wave pattern exists in the period Jun 1982-March 2009. This wave pattern consists of an impulse wave and a corrective wave. Impulse waves consist of 5 waves and moves in the direction of the trend. Waves 1, 3, and 5 moves in the direction of the trend, while Waves 2 and 4 move opposite to the trend. Corrective waves can be simple or complex. A simple correction consists of 3 waves (Wave A, B and C) which retrace a portion of impulse. The Elliot Wave Theory identifies (Frost A.J. & R.P. Prechter, 2006): (i) impulse waves that set up a pattern; and (ii) corrective waves that oppose the larger trend. The stock price movements are divided into: (i) trends (five waves in the direction of the main trend); and (ii) corrections (three corrective waves) (see Fig.2.and Fig.3).

The model (8) is estimated. The results are presented in Table 2.

Table 1. Data on the Dow Jones Industrial Average (DJIA) are transformed and Fibonacci ratios

		DJIA	P/P <sup>m</sup>	Fibonacci	ratios
	<b>Jun-82</b>	2145.93	0.122554	0.125	1/8
<b>1</b>	<b>Sep-87</b>	5789.7	0.330649	0.333	1/3
<b>2</b>	<b>Nov-87</b>	4074.15	0.232674	0.231	3/13
<b>3</b>	<b>May-98</b>	14017.42	0.800533	0.8	2/5+2/5
<b>4</b>	<b>Aug-98</b>	11828.80	0.675541	0.663	2/3
<b>5</b>	<b>Dec-99</b>	17510.11	1	1	1/1
<b>A</b>	<b>Sep-02</b>	10757.76	0.614374	0.618	34/55
<b>B</b>	<b>Sep-07</b>	17091.62	0.9761	0.993	34/55+3/8
<b>C</b>	<b>Mar-09</b>	9168.75	0.523626	0.5	1/2

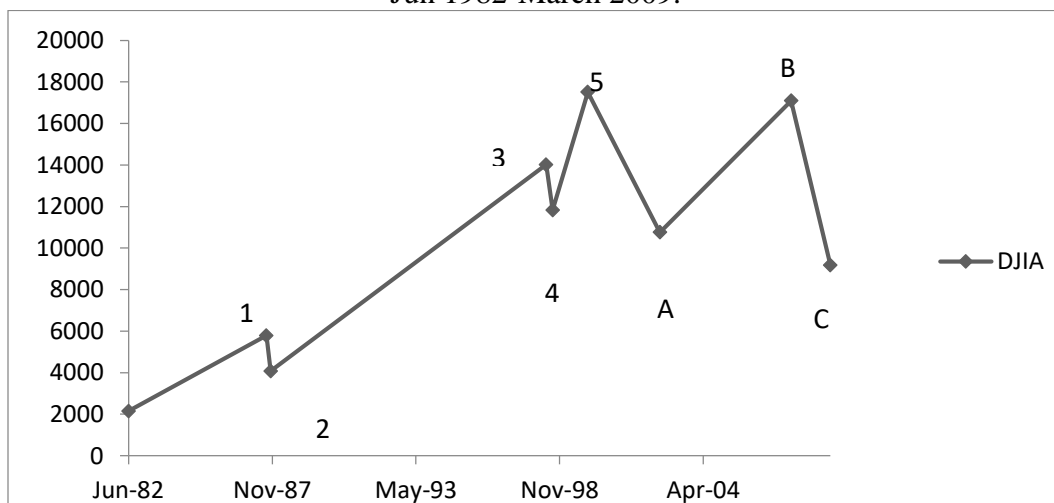
Source: <http://www.macrotrends.net/1319/dow-jones-100-year-historical-chart>

Table 2. The estimated model (8): DJIA, Jun 1982-March 2009.

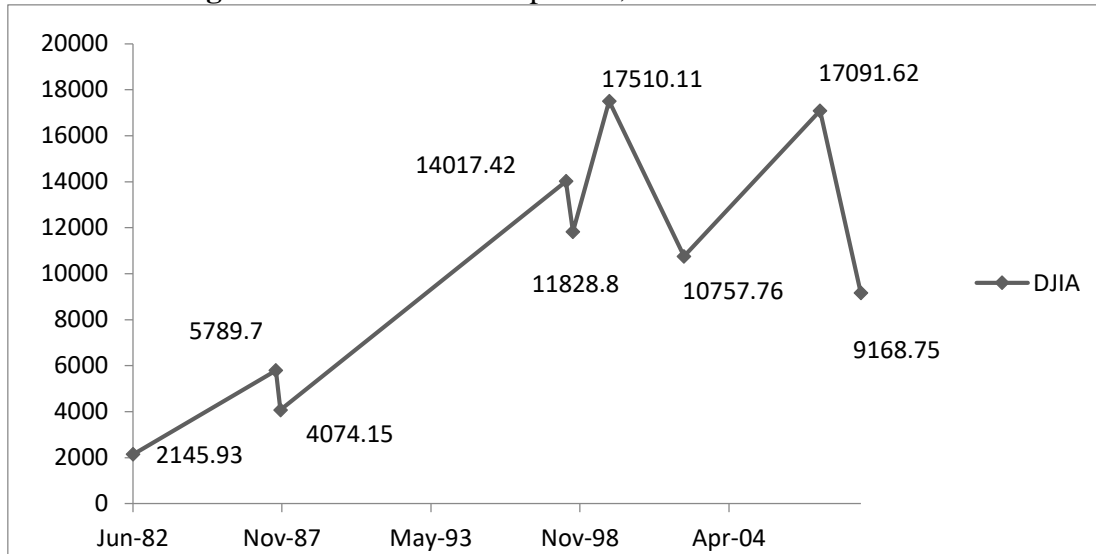
R=0.63435 Variance explained 40.240%		
N=8	$\omega (\pi)$	$\upsilon$
<b>Estimate</b>	<b>2.722287</b>	2.165967
<b>Std.Err.</b>	0.553709	0.641759
t(6)	4.916454	3.375047
<b>p-level</b>	0.002606	0.014949

From Jun 1982 to March 2009, the Dow Jones Industrial Average moved from 2145,93 to 9168,75. As we can see the pattern exactly follows the wave pattern described by Elliot Wave Theory. According to the logistic equation, for  $2 < \pi < 3$  fluctuations converge to  $z = (\pi - 1) / \pi$ , or  $(2.722287-1)/2.722287=0.63266$ . According to (7.), the equilibrium value of the Dow Jones Industrial Average was  $0.63266 / (2.165967/2.722287)$ , or  $0.63266 / 0.795642$  or  $0.795157$  in the observed period. The equilibrium value of the Dow Jones Industrial Average was  $0.795157 \times 17510.11 = 13923.287$  in the observed period.

Figure 2. The Elliott wave pattern consists of an impulse wave and a corrective wave, DJIA, Jun 1982-March 2009.



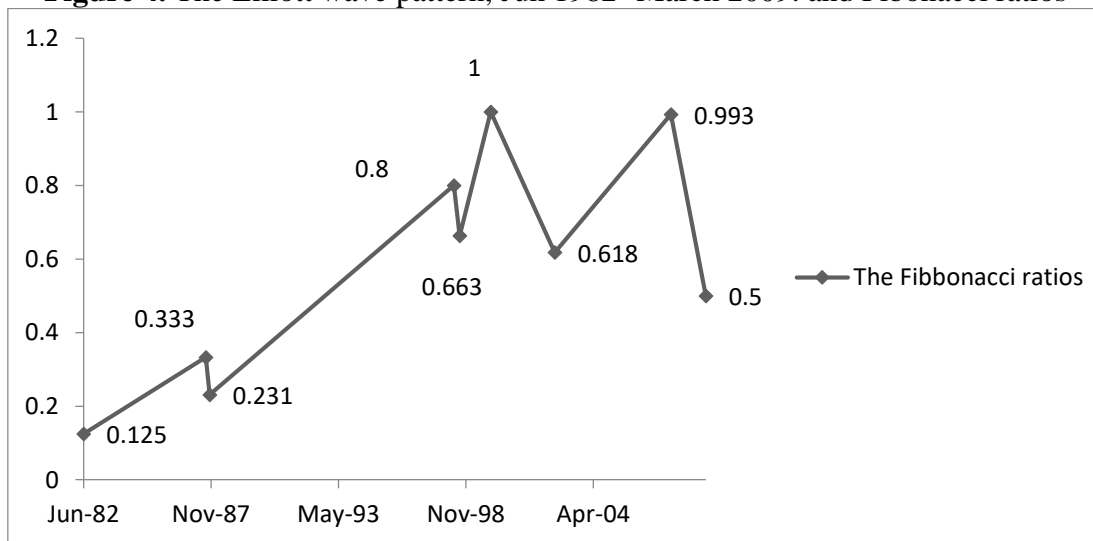
**Figure 3.** The Elliott wave pattern, Jun 1982- March 2009.



Source: <http://www.macrotrends.net/1319/dow-jones-100-year-historical-chart>

Further, the Elliott wave pattern, Jun 1982- March 2009. and Fibonacci ratios are shown in Figure 4. The Fibonacci ratios are included in the model (8). The model is estimated (see Table 3).

**Figure 4.** The Elliott wave pattern, Jun 1982- March 2009. and Fibonacci ratios



**Table 3.** The estimated model (8.): DJIA, Jun 1982-March 2009. (with Fibonacci ratios)

R=0.63126 Variance explained 39.849%		
N=8	$\omega (\pi)$	$\upsilon$
<b>Estimate</b>	<b>2.732233</b>	2.177989
<b>Std.Err.</b>	0.554037	0.637897
t(6)	4.931498	3.414329
<b>p-level</b>	0.002626	0.014243

From Jun 1982 to March 2009, the Dow Jones Industrial Average (unit measure: the Fibonacci ratios) moved from 0.125 to 0.5. As we can see the pattern exactly follows the wave pattern

described by Elliot Wave Theory. According to the logistic equation, for  $2 < \pi < 3$  fluctuations converge to  $z = (\pi - 1) / \pi$ , or  $(2.732233-1)/2.732233=0.634$ . According to (7.), the equilibrium value of the Dow Jones Industrial Average was  $0.634 / (2.177989/2.732233)$ , or  $0.634 / 0.797146$  or  $0.79534$  in the observed period. The equilibrium value of the Dow Jones Industrial Average (unit measure: the Fibonacci ratios) was  $0.79534 \times 1 = 0.79534$  in the observed period.

## CONCLUSION

This paper suggests the use of the chaotic stock price growth model in predicting the fluctuations of the stock price, or the Dow Jones Industrial Average (DJIA). The model (5) has to rely on specified parameters  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\mu$ , and initial value of the stock price, and /or the Dow Jones Industrial Average (DJIA),  $p_0$ . But even slight deviations from the values of parameters:  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\mu$  and initial value of the stock price and/or the Dow Jones Industrial Average (DJIA),  $p_0$ , show the difficulty of predicting a long-term stock price and/or DJIA.

A key hypothesis of this work is based on the idea that the coefficient  $\pi = (1+\mu \alpha)$  plays a crucial role in explaining local stability of the stock price, and/or DJIA, where,  $\mu$  is the adjustment coefficient;  $\alpha$  is the coefficient of the stock demand function. The estimated value of the coefficient  $\pi$  is **2.722287**. This result confirms continuous fluctuations of the stock price and/or DJIA in the period 1982-2009. The equilibrium price of the Dow Jones Industrial Average was 13923.287 in the observed period. Also, the Elliott wave pattern is observed. The Fibonacci ratios are included in the model. The equilibrium value in the modified model was 0.79534, while the golden ratio is 0.618.

## REFERENCES

- Benhabib, J., & Day, R. H. (1981). Rational choice and erratic behaviour. *Review of Economic Studies*, 48, 459-471.
- Benhabib, J., & Day, R. H. (1982). Characterization of erratic dynamics in the overlapping generation model. *Journal of Economic Dynamics and Control*, 4, 37-55.
- Day, R. H. (1982). Irregular growth cycles. *American Economic Review*, 72, 406-414.
- Day, R. H. (1983). The emergence of chaos from classical economic growth, *Quarterly Journal of Economics*, 98, 200-213.
- Frost A.J. & R.P. Prechter, (2006) Elliott Wave Principle: A Key to Market Behavior. [https://0104.nccdn.net/1\\_5/1d1/31d/37b/A.J.-Frost--Robert-Prechter---Elliott-Wave-Principle.pdf](https://0104.nccdn.net/1_5/1d1/31d/37b/A.J.-Frost--Robert-Prechter---Elliott-Wave-Principle.pdf)
- Goodwin, R. M. (1990). *Chaotic economic dynamics*. Oxford: Clarendon Press.
- Grandmont, J. M. (1985). On endogenous competitive business cycle. *Econometrica*, 53, 994-1045.
- Jablanović V. (2011). A Chaotic Unemployment Rate Growth Model. *Hyperion International Journal of Econophysics & New Economy*, Volume 4, Issue 1, 45-51.
- Jablanović, V. (2012). *Budget Deficit and Chaotic Economic Growth Models*. Aracne editrice S.r.l, Roma.
- Jablanovic, V. (2013) *Elements of Chaotic Microeconomics*. Roma: Aracne editrice S.r.l.
- Jablanovic, V. (2016) *A Contribution to the Chaotic Economic Growth Theory*. Roma: Aracne editrice S.r.l .
- Li, T., & Yorke, J. (1975) Period three implies chaos. *American Mathematical Monthly*, 8, 985-992.
- Lidwell, W, Holden K., & J. Butler (2010) *Universal Principles of Design, Revised and Updated*, Rockport Publishers, Inc.

- Lorenz, E. N. (1963). Deterministic nonperiodic flow, *Journal of Atmospheric Sciences*, 20, 130-141.
- Lorenz, H. W. (1993). *Nonlinear dynamical economics and chaotic motion* (2nd ed.). Heidelberg: Springer-Verlag.
- May, R. M. (1976). Mathematical models with very complicated dynamics. *Nature*, 261, 459-467.
- Medio, A. (1993). *Chaotic dynamics: Theory and applications to economics*. Cambridge: Cambridge University Press.
- Puu, T. (2003). *Attractors, Bifurcations, and Chaos - Nonlinear Phenomena in Economics*. Springer.
- Zhang W.B. (2012). *Discrete Dynamical Systems, Bifurcations and Chaos in Economics*, Elsevier B.V.

# RANDOM STRATEGY VERSUS TECHNICAL ANALYSIS STRATEGY IN THE US MARKET

Miroslav Svoboda<sup>40</sup>   
Martina Sponerová<sup>41</sup> 

DOI:

---

**Abstract:** *Random strategy is currently an interesting alternative to traditional trading of financial instruments. The paper builds on existing research into the trading of investment instruments through random strategy and strategies based on technical analysis. The highly liquid USD/CAD currency pair was chosen for the US market research. We analyze five years of data, and in every intraday trading session, only a single position will be opened. Technical analysis strategy uses essential indicators such as Bollinger Bands, relative strength index (RSI), moving averages (MA) and other. Every trading position will have the risk-reward ratio (RRR) 3 to 1. In addition, another trading positions on the USD/CAD currency pair will be opened without technical analysis. The time of entry into position will be indicated randomly with a similar risk-reward ratio (RRR) 3 to 1. The aim of this paper is to assess which of the above strategies is more suitable for the investor. In other words, this paper aims to compare the strategy of technical analysis and the random strategy in intraday trading concerning the profitability of these trades. We expect that a random strategy will be more suitable for the investor in many points.*

**Keywords:** *Investment Decisions, Foreign Exchange Markets, Moving Average, Backtesting, US Market, Relative Strength Index.*

---

## INTRODUCTION

Technical analysis, together with fundamental analysis, ranks among the basic analyzes in trading on financial markets. This paper extends the knowledge gained from the data presented in the authors' paper entitled RANDOM STRATEGY VERSUS TECHNICAL ANALYSIS STRATEGY: THE CASE OF EUR / USD INTRADAY TRADING to American markets. The authors deal with the comparison of trading strategies of technical analysis and trading strategies based on market randomness. The use of technical analysis has been presented in many disgusting publications in Taylor and Allen (1992), Menkhoff (1997), Lui and Mole (1998), Oberlechner (2001), Gehrig and Menkhoff (2004) and Menkhoff and Taylor (2007).

There are studies that contain large amounts of trading position data based on technical analysis indicators. For example, the study by Hsu and Taylor (2013) and Coakley, Marzano and Nankervis (2016) deals with testing technical analysis in the foreign exchange market using the SPA test. The study reports a very low rate of profitability of trading positions based on some indicators of technical analysis. Zarrabi, Snaith and Coakley (2017) used FDR analysis

---

<sup>40</sup> Masaryk University, Faculty of Economics and Administration, Department of Finance, Lipová 41a, 603 00 Brno, Czech Republic

<sup>41</sup> Masaryk University, Faculty of Economics and Administration, Department of Finance, Lipová 41a, 603 00 Brno, Czech Republic

in their study and found that the predictive power of technical analysis is possible. The study used data for 20 years when the trading strategy had to be updated at least once a month, otherwise the predictive ability of technical analysis is not sustainable in the long run.

Following the above study, a trading strategy in foreign exchange markets based on technical analysis is not sustainable in the long term. However, some studies report the profitability of technical analysis when trading in foreign exchange markets. These are, for example, the studies of Sweeney 1986, Levich and Thomas, 1993, Neely, 1997, LeBaron, 1999, 2002. A study by Sager and Taylor, 2006, Menkhoff and Taylor, 2007 examines the efficiency of the foreign exchange market with respect to small investors influencing the market. Small investors are also important for our research, because our strategies are based on use for small investors. According to the authors, there is a lot of space for further knowledge and studies in this segment.

This paper builds on the authors' long-term research in the field of random strategy in combination with a strategy based on technical analysis. The paper aims to test selected strategy based on technical analysis and compare the results with simple random strategy for US market. The authors used a long period to obtain additional information on the research.

## 1. METHODOLOGY AND DATA

In this article, the authors identified two investment strategies. These strategies have been applied to the foreign exchange market of the USD / CAD currency pair, which reflects the US Market. The strategy (SMA/RSI strategy) based on technical analysis uses the Simple Moving Average (SMA) indicator together with the Relative Strength Index (RSI) indicator. The strategy based on randomness (Random strategy) does not use any indicator of technical analysis.

For backtesting, we choose currency pair, with regard to the US market, USD/CAD from 1/2/2015 to 12/23/2019. Trading positions were determined with a Risk-reward-ratio (RRR) of 1 to 3. Trading positions therefore showed a profit of 60 pips or a loss of 20 pips from the opening price of each position. Both sell and buy orders were used in the research. Due to the fact that the research compared 2 investment strategies on the same currency pair, it was not necessary to include fees in the research data. If we included the fees in the dataset, it would be 1-2 pips for each position. The amount of the fee, of course, depends on the specific service provider. The following Table 1 shows the basic characteristics of our analysis.

**Table 1.** Basic characteristics of both strategies

	<b>Term</b>	<b>Value</b>
<b>1.</b>	• Currency pair	• USD/CAD
<b>2.</b>	• Time frame	• H1
<b>3.</b>	• Period	• 1/2/2015 – 12/23/2019
<b>4.</b>	• Currency of the account	• USD
<b>5.</b>	• Demonstrative account value	• 10 000 USD
<b>6.</b>	• RRR	• 3/1
<b>7.</b>	• Profit (target)	• 60 pips
<b>8.</b>	• Loss (stop loss)	• 20 pips
<b>9.</b>	• Time zone	• UTC + 1

**Source:** Author's calculations



## 1.1 SMA/RSI STRATEGY

A simple moving average (SMA) is usually used to determine the trend. It is a popular indicator of technical analysis for many investors. The calculation of a given indicator is calculated as the arithmetic average of the asset price for a certain period. A period of 250 weeks was used in the research. We have incorporated another indicator of technical analysis into our strategy, namely the relative strength index. The relative strength index is a momentum oscillator, which determines the change and speed of price movements. The conditions for buying a position were defined by a price increase above 250 SMA and at the same time a movement of RSI (25) above 0.7 (70). The conditions for the sale of the currency were defined by a price drop below 250 SMA and at the same time a movement of RSI (25) below 0.3 (30). In this research, we used the trend following strategy, where these investors expect/believe that when the price rises, it will grow even more and vice versa.

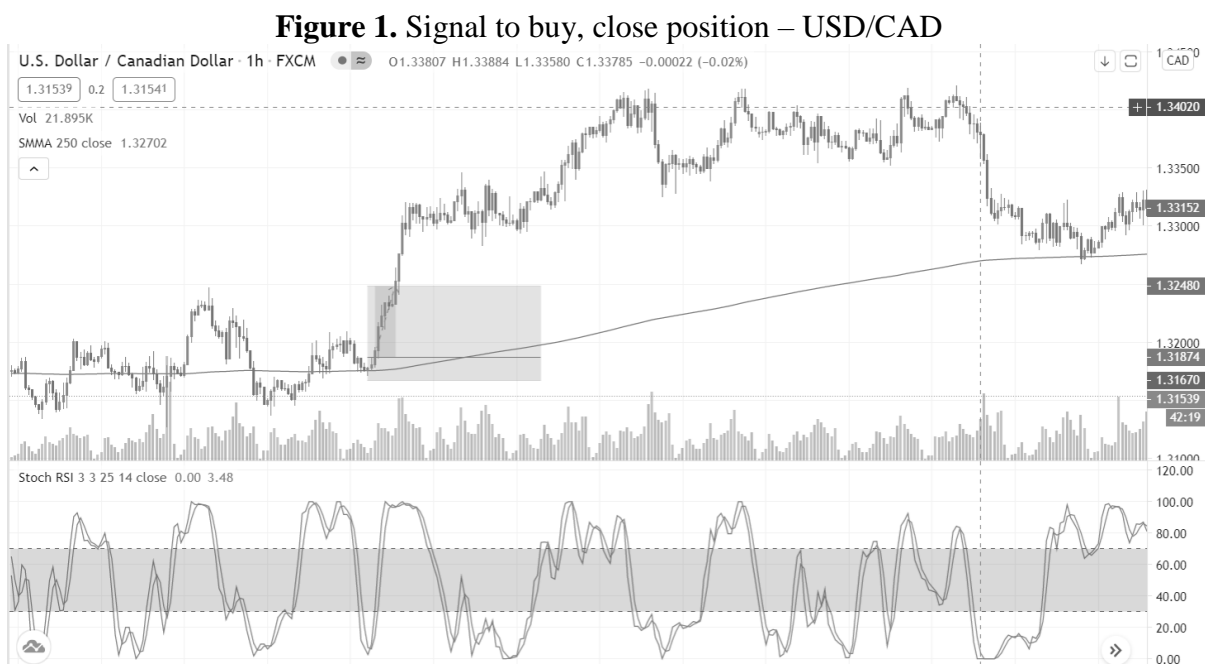
Our SMA/RSI strategy is summarized in Table 2.

**Table 2.** Characteristics of SMA/RSI strategy

	Term	Value
1.	• Signal to buy	• First closed candle after candle rise above SMA (250) and a movement of RSI (25) above 0,7
2.	• Signal to sell	• First closed candle after candle drops below SMA (250) and a movement of RSI (25) below 0,3
3.	• Close position	• Breakthrough stop loss or target

Source: Author's calculations

The following Figure 1 demonstrates the signal to open the position (buy position in this example) and signal to close the position for our SMA/RSI strategy (breakthrough target).



Source: Author's calculations, tradingview.com

## 1.2 RANDOM STRATEGY

Our random strategy is based on trading without technical and fundamental analysis. We choose random parameters to enter trading positions. Trading positions are executed at 2 p.m. (UTC +1) every trading day. The designated hour to enter the position predicted a higher rate of traders entering the market due to the early opening hour for the US Market. The determination of the long or short position was programmed randomly (50:50).

Table 3 shows the basic characteristics of the random strategy:

**Table 3.** Characteristics of Random strategy

	Term	Value
1.	• Signal to buy	• Random on a daily basis at the selected time (14:00, UTC + 1)
2.	• Signal to sell	• Random on a daily basis at the selected time (14:00, UTC + 1)
3.	• Close position	• Break through stop loss or target

Source: Author's calculations

The figure below illustrates a trading position according to a random strategy. This is a selling position where the position was opened according to the selected time and in this case the stop loss was terminated.

**Figure 2.** 14:00, UTC + 1, sell position (at random), close position



Source: Author's calculations, tradingview.com

## 2 RESULTS AND DISCUSSION

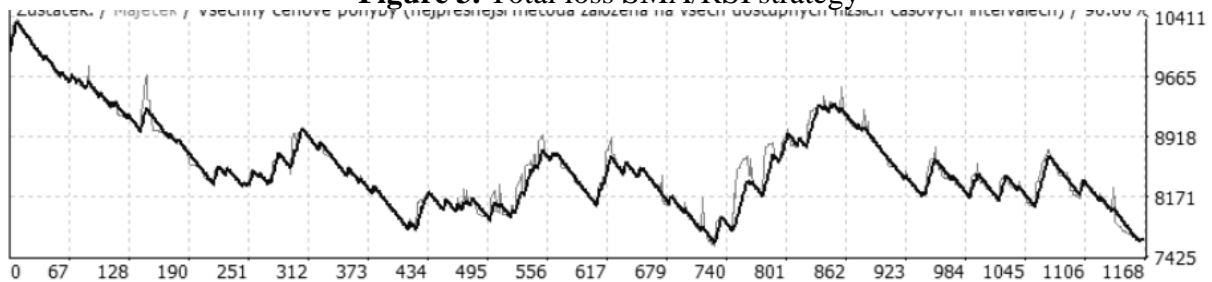
We use almost 5 years of data and backtest our strategies presented in the previous Chapter 1. In Table 4, our results for both strategies are presented. The random strategy opened one position every trading day, and it resulted in 1296 positions in total. For SMA/RSI strategy we have 1163 observations.

**Table 4. Results**

	<b>SMA/RSI strategy</b>	<b>Random strategy</b>
<b>Number of open positions</b>	• 1163	• 1296
<b>Number of long positions</b>	• 604	• 663
<b>% of success – long positions</b>	• 21,36	• 24,59
<b>Number of short positions</b>	• 559	• 633
<b>% of success – short positions</b>	• 22,9	• 24,33
<b>Number of profitable positions (60 pips profit)</b>	• 257	• 317
<b>% of profitable positions (60 pips profit)</b>	• 22,1	• 24,46
<b>Number of loss positions (20 pips loss)</b>	• 906	• 979
<b>% of loss positions (20 pips loss)</b>	• 77,9	• 75,54
<b>% total profit/loss</b>	• - 23,4	• - 5,34
<b>Total profit/loss</b>	• - 2340,91	• - 534,24

Source: Author's calculations

The Random strategy was less loss-making in our research. In this case, the strategy for the investor performed better than the strategy based on technical analysis. The research builds on our previous research on strategies based on technical analysis versus random strategy. In the case of the SMA strategy of the EUR/USD currency pair, this strategy, based on technical analysis, showed almost double the percentage of profit in the same trading account. A random strategy also had similar results. Previously, we also examined another GBP/USD currency pair, which showed similarly profitable results as the mentioned EUR/USD pair, with the difference that a random strategy was more profitable.

**Figure 3. Total loss SMA/RSI strategy**

Source: Author's calculations, MetaTrader

**Figure 4. Total loss Random strategy**

Source: Author's calculations, MetaTrader

## FUTURE RESEARCH DIRECTIONS

With the ever-evolving research of technical analysis strategies versus random strategies, we gain important knowledge in terms of investment decisions of small investors trading in currency markets. The data obtained show us that a random strategy can show better results than a strategy based on technical analysis. The question is therefore whether it is necessary for the investor to use complex strategies based on technical analysis or to use randomness, of course, provided that money management and RRR are complied with. Another question is whether the random strategy we present only works in currency markets or we can apply it to other markets, such as the commodity market, stocks, etc. These questions predispose us to further research in the field of financial markets.

## CONCLUSION

Two trading strategies were addressed in the submitted paper. The first strategy was based on technical analysis indicators. Specifically, it was a joint use of SMA and RSI indicators. The second strategy was random. This means that only one position was opened each day, randomly at the chosen time. The trading strategies have been tested on the USD / CAD currency pair for almost 5 years. Subsequently, both strategies were compared and the results from the obtained data were evaluated.

In this case, both strategies ended in a loss. However, the random strategy showed a loss significantly lower than the loss based on technical analysis indicators. Thus, an important question arises as to whether a random strategy in the event of an unfavorable market situation is not safer than a strategy based on technical analysis. Therefore, it is important in the future to apply these strategies to situations where market developments do not support indicators based on technical analysis. The results presented in this paper build on the authors' previous research and prove that there is a high potential for further research in this segment. It is mainly an examination of other investment instruments and also research into the effectiveness of both approaches in creating trading strategies.

## ACKNOWLEDGMENT

*This research was supported by the Masaryk University internal grant MUNI/A/1081/2019.*

## REFERENCES

- Coakley, J. & Marzano, M. & Nankervis, J. (2016). How profitable are FX technical trading rules?. *International Review of Financial Analysis*, vol. 45, pp. 273-282.
- Gehrig, T., & Menkhoff, L. (2004). The use of flow analysis in foreign exchange: Exploratory evidence. *Journal of International Money and Finance*, vol. 23, pp. 573–594.
- Hsu, P. H., & Taylor, M. P. (2013). Forty years, thirty currencies and 21,000 trading rules: A large-scale, data-snooping robust analysis of technical trading in the foreign exchange market. *Working paper*, thirty currencies and 21.
- Läidi, A. (2008). *Currency Trading And Intermarket Analysis*. 1nd ed. Wiley Trading, pp. 279.
- LeBaron, B. (1999). Technical trading rule profitability and foreign exchange intervention. *Journal of International Economics*, vol. 49, pp. 125-143.
- LeBaron, B. (2002). Technical trading profitability in foreign exchange markets in the 1990s. *Working paper*, Brandeis University.

- Levich, R. M., & Thomas, L. R. (1993). The significance of technical trading-rule profits in the foreign exchange market: A bootstrap approach. *Journal of International Money and Finance*, vol. 12 (5), pp. 451-474.
- Lui, Y. H., & Mole, D. (1998). The use of fundamental and technical analysis by foreign exchange dealers: Hong Kong evidence. *Journal of International Money and Finance*, vol. 17, pp. 535–545.
- Menkhoff, L. (1997). Examining the use of technical currency analysis. *International Journal of Finance and Economics*, vol. 2(4), pp. 307–318.
- Menkhoff, L., & Taylor, M. P. (2007). The obstinate passion of foreign exchange professionals: Technical analysis. *Journal of Economic Literature*, vol. 45, pp. 936–972.
- Neely, C. J. (1997). Technical analysis in the foreign exchange market: A layman's guide. *Federal Reserve Bank of St. Louis Review*, vol. 79(5), pp. 23-38.
- Oberlechner, T. (2001). Importance of technical and fundamental analysis in the European foreign exchange market. *International Journal of Finance and Economics*, vol. 6(1), pp. 81–93.
- Taylor, M. P., & Allen, H. (1992). The use of technical analysis in the foreign exchange market. *Journal of International Money and Finance*, vol. 11, pp. 304–314.
- Sager, M. J., & Taylor, M. P. (2006). Under the microscope: The structure of the foreign exchange market. *International Journal of Finance and Economics*, vol. 11, pp. 81-95.
- Sweeney, R. J. (1986). Beating the foreign exchange market. *Journal of Finance*, vol. 41(1), pp. 163-182.
- Wilder, J. W. (1978). New concepts in technical trading systems. *Trend Research*, McLeansville, NC.
- Zarabi, N. & Snaith, S. & Coakley, J. (2017). FX technical trading rules can be profitable sometimes!. *International Review of Financial Analysis*, vol. 49, pp. 113-127.



# CASH FLOW FORECASTING FOR INTERNATIONAL PROJECTS IN THE PROCESS OF CAPITAL BUDGETING DURING THE COVID-19 PANDEMIC

Biljana Pejović<sup>42</sup>   
Dragana Trifunović<sup>43</sup>   
Aleksandra Živaljević<sup>44</sup> 

DOI:

---

**Abstract:** *By predicting cash flows in the capital budgeting procedure, the profitability of an investment at the international level is determined in advance. Although investing globally provides greater opportunities for earnings, cost reduction and business diversification, all risks posed by international business must be considered when choosing a discount rate. In addition to the risks inherent in cross-border business such as exchange rate risk, country risk, the risks caused by the pandemic crisis, which relate primarily to measures taken by states to protect the population by introducing quarantine, restricting the flow of people, goods and capital, as well as activities that are endangered by a pandemic, must be considered too. If all the risks that determine the discount rate are well assessed, the cash flow forecast will be more accurate.*

**Keywords:** *cash flows, capital budgeting, discount rate, pandemic.*

---

## INTRODUCTION

Globalization as a process of great economic changes (Glushkova, Lomakina, Sakulyeva, 2019, pp. 876-884), that are reflected in the social, political and cultural aspect of overall life has been greatly stimulated by the emergence and development of international corporations. High concentration of capital and business in several countries are their main characteristic. The development of technology and the removal of barriers to the free flow of products, services, people and capital have contributed to the fact that two thirds of the world capital market are in their possession.

Cross-border business has brought greater opportunities for more cost-effective business but also greater challenges in the management process. Some of the advantages of cross-border business are: obtaining and using cheaper resources, conquering new markets, establishing cost centers in countries with high tax rates, and profit centers in countries with low tax rates, in order to optimize the tax burden. The existence of the possibility of production diversification and the relocation of production capacities to countries with more favorable conditions, cheaper resources are other advantages of their business. Investing in other countries increases sales outside the country of establishment, increases market shares and makes extra profit. International diversification additionally affects the reduction of corporate exposure to the economic conditions of the country in which they were initially established, but it also

---

<sup>42</sup> Faculty of Social Sciences, Bulevar umetnosti 2<sup>a</sup>, Belgrade, Serbia

<sup>43</sup> Faculty of Social Sciences, Bulevar umetnosti 2<sup>a</sup>, Belgrade, Serbia

<sup>44</sup> Higher Colleges of Technology, Abu Dhabi, United Arab Emirates

additionally affects the exposure of corporations to business risks imposed by the international environment.

The earning capacity of corporations is determined by a good assessment of investment opportunities at the global level (Putra, 2019, p.818-826). Decisions about the return of investment must be consistent in order to maximize the value of the shares. Capital budgeting or evaluation of economic efficiency of investments includes the process of identification, analysis and selection of investment projects whose returns are expected to last longer than a year. It includes the development of investment project proposals that are consistent with the goals of corporations, the assessment of cash flows for each project individually, the selection of projects based on value maximization as eligibility criteria.

The pandemic crisis caused by the Covid-19 virus also pointed to some negative effects of international investment (Adegboye, Adekunle, Eisen, McBryde, Pak, Rahman, 2020.). The health threat to the population has caused the re-establishment of borders and the introduction of limits by states that can cause a slowdown and significantly higher costs of project implementation. If the implementation of previously contracted projects cannot be postponed due to the current situation, it is necessary to apply a discount rate when projecting cash flows, which represents all additional risks caused by the pandemic. Although it is still too early to draw conclusions because the pandemic is still going on, many countries will enter a period of recession and falling GDP and there will be a large increase in the number of unemployed.

## **CAPITAL BUDGETING**

Capital budgeting is used to assess the profitability of investments, as a technique that can indicate in advance to investors the extent to which the selected investment is profitable (Justice, Pious, Yeboah, 2020, p. 33). The four alternative methods used to evaluate and select investment projects in practice are the following: net present value, internal rate of return, payback period, and profitability index. Discounted cash flow methods provide the best measure of the real returns of projects because they are based on future cash flows and consider the time value of money.

These methods pay special attention to accounting reports (balance sheet, income statement and cash flow statement) from the past, because they are used to project future cash flows, and have proven to be one of the best valuation methods in market economies. The most commonly used method of capital budgeting involves calculating the net present value, which is determined by discounting the projected cash flows that will be generated by a particular investment. The net present value is a monetary measure of return, and the internal rate of return is a percentage measure of return of investment.

The inputs necessary for capital budgeting are: initial investment, demand forecast, price at which products will be placed on the market, fixed and variable costs, payback period, residual value and expected rate of return (Messer, 2020, p. 302). All parameters are highly dependent on exchange rate fluctuations, the tax legislation of the country in which it is invested, as well as the ban on transfers between the parent company and the branch, if any.

International capital budgeting is an identical procedure that requires a more complex analysis. Internationally, there are many more factors that affect the level of the discount rate, which includes all risk exposures. The process of estimating the direct costs of a project begins with



a reference to experience, if similar projects have been carried out in the past, by market research or by scenario analysis.

The Net Present Value (NPV) method involves discounting of future cash flows back to present value (Blaset Kastro, Kulakov, 2020.) Based on this criterion, those projects whose net present value is higher than zero are eligible. The present value of the initial investment is the sum of discounted net inflows, because the investment is made at the beginning of the period. The Net Present Value is the amount by which the present value of the cash inflows exceeds the present value of the cash outflows. A positive Net Present Value means that the rate of return of capital investment is greater than the discount rate used in the analysis.

The internal rate of return is represented as a metric used in financial analysis to estimate the profitability of potential investments. The internal rate of return is a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discount cash flow analysis. The internal rate of return for an investment project is the discount rate that equates the present value of expected cash flows with the initial expenditure. If the internal rate of return is higher than the required rate of return the project is eligible, otherwise the project is rejected. When deciding between projects with the same degree of risk, a project with a higher internal rate of return is a better investment.

Payback Period represents the amount of time required for the cash flows generated by the investment to repay the cost of the original investment. The number of years required to recoup the investment is the payback period. The payback period is the period required for the cumulative cash flows from the invested project to equal the initial cash outflow. If the calculated return period is less than the maximum acceptable, the project is accepted, and if not, then it is rejected.

The discount rate is an integral part of the analysis and it must reflect the risk level of the capital investment. The discount rate can represent several different approaches for the company. It may represent the cost of capital such as the cost of borrowing money to finance the capital expenditure or the cost of using the company's internal funds, or it may represent the rate of return needed to attract outside investment for the capital project. It must cover all risks that may affect the implementation of the project. Choosing the proper discount rate is important for an accurate Net Present Value analysis.

Another measure to determine the acceptability of a capital investment is the Profitability Index (PI). The Profitability Index is computed by dividing the present value of cash inflows of the capital investment by the present value of cash outflows of the capital investment. If the Profitability Index is greater than one, the capital investment is accepted. If it is less than one, the capital investment is rejected.

## **CASH FLOW FORECASTING**

Discounted cash flow methods provide the best measure of the real returns of projects because they are based on cash flows and consider the time value of money. For good estimates, it is necessary to consider all the risks that determine the discount rate.

Determining the value that will be generated from an investment includes predicting cash flows and the period expected to return the initial investment, determining the internal rate of return, discounting the projected cash flows, adding the present values to determine the profitability

of the initial investment. At the beginning, the construction of financing is determined and the weighted average cost of capital is determined.

The most important factors influencing the choice of discount rate are the financial condition of the company in which it is invested, the financial mix, in terms of the price of borrowed resources and the price of own sources, the economic situation, trends in the industry in which the company operates, supply and demand ratio and country risk. If starting from cash flow after debt servicing, the discount rate will be based on the opportunity price of capital, while discounting the cash flow before servicing debts will use a discount rate based on the weighted average cost of capital. Choosing the appropriate discount rate requires to consider all revenues and expenses in accordance with market prices. Cash flow before servicing debts is used by investors in purchase or takeover transactions, because the cash flow defined in this way provides an insight into credit capacity and considers all the possibilities of financing transactions from a new loan. Cash flow after debt service is important for creditors, management and shareholders, given that the cash flow defined in this way takes into account financial needs (Putri, 2020, p. 79).

Discount rates may vary over time. The first reason is that the level of interest rates on borrowed funds can change over time. This usually happens if the interest rate is linked to one of the reference rates whose movement is conditioned by the supply and demand for financial resources. Another reason is that risk characteristics can be expected to change over time. The third reason is that the financial mix of a project can change over time, resulting in changes in the cost of equity and borrowed capital.

If invest in countries that have high inflation rates, it is difficult to reliably determine the amount of net present value. Although inflation affects both costs and revenues in the same direction (causes them to rise), the end result may be different. This is especially pronounced in projects involving the import of components and the sale of finished products in the local market. In that case, inflation has a greater impact on revenues than on project costs.

There are a number of reasons that affect the emergence of risk, including the project itself. Risk is also affected by competition, industry trends, international developments, macroeconomic factors and prices of resources in the global market. However, it is not necessary to perform an analysis of all types of risks when estimating the discount rate. Initially, differentiation of risk sources is performed at the project level. Among the various sources of risk that are analyzed during capital budgeting, only those risks that cannot be diversified should be considered. This type of risk varies from company to company depending on whether it is a company whose shares are publicly traded or not. After identifying the risk at the company level, the risk at the project level is determined and measured. If companies invest in homogeneous projects, with similar risk profiles, the cost of the company's share capital is used. If the company is diversified and engaged in different activities, and projects within each activity have a similar risk, the cost of share capital is also used for that activity. If the project is unique in terms of risk, the cost of share capital that is specific to that project is calculated and used. After assessing the risk of share capital and the risk of default on the company's debt, there are two ways to include the risk in the analysis. One way is to calculate the cost of share capital and debt that will reflect the risk of the project. Riskier projects will have higher costs. Another way is to adjust cash flows using a risk-reflecting discount rate.

The combined effect of inflation and exchange rate fluctuations on net cash flow may act neutrally from the parent company's perspective. The exchange rate of countries with high

inflation weakens over time. Although the branch's earnings are expressed in local currency due to the impact of inflation, when converted into the parent company's currency, the effect of growth is lost (the currency of the country in which the branch is weak in relation to the parent company's currency). This effect of exchange rate neutralization and inflation rarely occurs in practice because inflation is only one of the factors influencing the exchange rate, and in addition there is no guarantee that the local currency will depreciate when the inflation rate is relatively high.

Since the introduction of the pandemic caused by the Covid-19 virus, business conditions in the international arena have changed. The behavior of the virus is atypical, in terms of the duration of the infection, the way it is transmitted, the behavior of the virus at high summer temperatures, so that many predictions of even the most eminent experts were wrong. A large number of people have become infected and a state of emergency has been declared in many countries. Regardless of the measures taken by the states in order to protect the spread of the infection, the mortality rate in almost all countries is extremely high.

According to data released by the World Health Organization on September 19, 2020, there have been 30,369,778 confirmed cases of COVID -19, including 948,795 deaths (World Health Organization, 2020.). Some countries have introduced a state of quarantine and bans on the movement of the population, not only within state borders, but also within cities, as is the case in Italy. Some had a much more liberal stance, such as Sweden. The final conclusion on how to behave in a pandemic will be made when the pandemic is stopped or at least brought under control. Acquiring global immunity through vaccination of the population is still not feasible, because until practical application, vaccines must pass a phase of testing that requires time.

Many companies, whether privately or state-owned, have had to provide conditions for their employees, which would protect them against infection. Companies had a better organization of their business, which could enable employees to do their jobs online, if it was feasible, from home. It turned out that high-tech activities were in the lead.

An additional problem is the increase in the unemployment rate. All over the world, employers have laid off surplus labor, both due to the reduction in the volume of business and the inability to provide the conditions prescribed by state regulations for the protection of employees in the workplace. All over the world, many employees are expected to lose their jobs. Cash flow forecasting costs will be further increased by employee health care requirements during a pandemic. It is still too early to consider these figures, but it should be borne in mind that these developments will affect the cost of labor used in forecasting cash flow costs.

Why is this information important for international projects? The discount rate used in the process of calculating the net present value should include all risks that may directly or indirectly affect the implementation of projects and affect the formation of the price of input and outputs. Higher risk requires a higher discount rate which affects the reduction of the net present value and profitability of the project. The state of panic and fear affects the human psyche in terms of savings, reduced consumption and limited movement.

The pandemic did not affect all industrial areas equally. The biggest changes in business have occurred in the field of tourism, transport, hotel services, catering, real estates' rental, organization of events that involve numerous gatherings of people, such as sports events, concerts, etc. In some industries they have found a transitional solution. Traders and restaurant

owners delivered the ordered products online to the home address, in order to maintain good traffic as much as possible.

If it is impossible to delay all investments in these industries, a discount rate should be carefully formed and it would include all the risks already mentioned.

Based on research conducted to create the most effective policies to overcome the harmful effects of Covid-19 on the economy and the wider community in March 2020, based on the views of representatives of companies, local governments and civil society organizations, the biggest challenges they face are problems with collection and liquidity (for as many as 63% of respondents), drop in demand (45%), but also problems with regular payment of wages to workers (32%), organization of work (29%) and the possibility of regular settlement of obligations to the state (Nacionalna alijansa za lokalni ekonomski razvoj, 2020, p.4)

According to data published by the World Health Organization, the number of deaths in the world is constantly increasing. The number of deaths in the world due to the Covid-19 virus pandemic, on September 19, 2020: Americas 15,333,470, South-East Asia 5,973,186, Europe 5,149,121, Eastern Mediterranean 2,199,096, Africa 1,141,044 and Western Pacific 573,120 (World Health Organization, 2020.). It is expected that the measures introduced by countries to protect the population will be even more rigorous, which should affect the discount rate in the future.

## CONCLUSION

The realization of international projects during the pandemic caused by the Covid-19 virus poses new challenges for investors. Determining whether and to what extent projects are profitable can be correctly calculated only if a discount rate is applied when forecasting future cash flows, which, in addition to all the risks caused by international business, also include all additional risks brought by the pandemic. Investments in the field of tourism, transport, hotel services, catering, organization of events that include numerous gatherings of people, such as sports events, concerts require higher discount rates. All projects that require the gathering of a larger number of people, their movement during the pandemic are additionally risky. Until the pandemic is over, or at least not brought under control, due to the health protection of the population, investment in these industrial areas should be postponed or in the calculation of their profitability one should be realistic. When choosing the discount rate used to estimate future cash flows, the most important thing is to include all the risks that may affect the implementation of the project.

## REFERENCES

- Blaset, Kastro, A., N., Kulakov, N., Y., (2020). Risk-adjusted discount rates and the present value of risky non-conventional projects, *The Engineering Economist*. <https://doi.org/10.1080/0013791X.2020.1815918>
- Glushkova, S., Lomakina, O., Sakulyeva, T., (2019). The Economy of Developing Countries in the Context of Globalization: Global Supply Chain Management, *International Journal of Supply Chain Management*, 8(1), 876-884.
- Justice, A., Pious, O., Yeboah, E., N., (2020). Capital Budgeting as a Tool of Management Decision Making: A Case Study of National Investment Bank Limited, *Research Journal of Finance and Accounting*, 11(4), 33-41.

- Messer, R. (2020). *"Making a Lot of Decisions"*, *Financial Modeling for Decision Making: Using MS-Excel in Accounting and Finance*. Emerald Publishing Limited. <https://doi.org/10.1108/978-1-78973-413-320201018>
- Nacionalna alijansa za lokalni ekonomski razvoj (2020). Covid-19, *Uticaj na privredu i lokalne zajednice; Percepcija predstavnika privatnog, javnog i civilnog sektora*
- Adegboye, O. A., Adekunle, A. I., Eisen, D. P., McBryde, E. S., Pak, A., Rahman, K. M., (2020). Economic Consequences of the COVID-19 Outbreak: the Need for Epidemic Preparedness, *Front Public Health*, 8(241). <https://doi.org/10.3389/fpubh.2020.00241>
- Putra, Y. M., (2019). Analysis of Factors Affecting the Interests of SMEs Using Accounting Applications. *Journal of Economics and Business*, 2(3), 818-826. <https://doi.org/10.31014/aior.1992.02.03.129>
- Putri, R., S., T., (2020). The Effect of Return on Assets, Free Cash Flow, and Debt to Equity Ratio on Company Value, *EPRA International Journal of Multidisciplinary Research (IJMR)*, 6(10), 76-84. <https://doi.org/10.36713/epra5329>
- World Health Organization (2020) *WHO Coronavirus Disease (COVID-19) Dashboard*, <https://covid19.who.int/>, Accessed on: 2020/09/19



# ANALYSIS OF RESEARCH AND DEVELOPMENT EXPENDITURE IN EUROPEAN UNION COUNTRIES

Eubica Hurbánková<sup>45</sup> 

DOI:

---

**Abstract:** *Paper deals with the analysis of research and development expenditure. Expenditure per capita in European Union countries in years 2009 - 2018 and total research and development expenditure in million Euro are analyzed. The aim of the paper is to find out in which countries expenditure per capita increased the most during the observed period and in which it decreased, what was the average annual growth rate of this indicator. Contribution method will help to analyze how the total research and development expenditure in 27 European Union countries has changed, what was the share of each country in this expenditure, which countries contributed the most to this change and which the least. Research and development expenditure per capita increased average annually between 2009 and 2018 in all analyzed countries, except Luxembourg and Finland, where it decreased. The highest average annual growth was recorded in Poland (12.48%), Latvia (10.50%), Slovakia (10.47%) and Bulgaria (10.38%). Total research and development expenditure increased in 2018 compared to 2009 by 41.65%, Germany (18.11%) and France (4.29%) contributed the most to this increase.*

**Keywords:** *Research and Development Expenditure, European Union Countries, Contribution Method*

---

## INTRODUCTION

**R**esearch and development expenditure is an indicator, which includes expenditure on research and development by business enterprises, higher education institutions, government and private non-profit organizations (Eurostat, 2020).

Research and development expenditure comprise total amount of expenditures spent in organization on research and development activities, i.e. they are internal expenditures. Expenditures spent out of the organization include only those serving for support to the internal research and development (e.g. purchase of equipment for R&D institutions). Depreciation of buildings, machines and equipment is excluded from the statistical survey of internal expenditures on research and development (Štatistický úrad Slovenskej republiky, 2019).

Research and development expenditure is associated directly with the research and development of a company's goods or services and any intellectual property generated in the process. They are direct expenditures relating to a company's efforts to develop, design, and enhance its products, services, technologies, or processes. The industrial, technological, health care, and pharmaceutical sectors typically incur the highest degree of R&D expenses (Investopedia, 2020).

---

<sup>45</sup> University of Economics in Bratislava, Dolnozemska cesta 1, 852 35 Bratislava, Slovak Republic

The aim of the paper is to find out in which countries in the years 2009 – 2018 research and development expenditure per inhabitant increased the most and in which decreased, what was the average annual growth rate of this indicator. Next, we will analyze how the total research and development expenditure in 27 European Union countries has changed, what was the share of each country in this expenditure, which countries contributed the most to this change and which the least. We will use contribution method for this analysis.

## USING METHOD

To find out how the analyzed indicator developed, we use the characteristics of time series – basic index and average growth rate (see Pacáková et al., 2009).

As our goal is to find out how individual countries have contributed to the total change in research and development expenditure, we will use contribution method.

**Contribution method** is used for the analysis of additive indicator  $Y$ , which arise from the sum of individual components:

$$Y = \sum_{i=1}^n y_i \quad (1)$$

where:  $Y$  is additive indicator,  
 $y_i$  are individual components.

The procedure of this method is as follows (Hurbánková, Sivašová, 2018):

We calculate the relative increase of additive indicator, which expresses how the given indicator has changed:

$$k_{dt} = \frac{Y_t - Y_{t-1}}{Y_{t-1}} = \frac{d(Y)}{Y_{t-1}} = (k_Y - 1) \quad (2)$$

We calculate the relative increases of the individual components, which express how the individual components developed:

$$k_{dt}^i = \frac{y_t^i - y_{t-1}^i}{y_{t-1}^i} = \frac{d(y)}{y_{t-1}^i} = (k_y^i - 1) \quad (3)$$

We determine the structural numbers that express the share of individual components in additive indicator. We calculate the structural numbers in the period  $t-1$ , assuming that the analogous share of the component on the additive indicator is maintained during the continuous development of the additive indicator:

$$s_{t-1}^i = \frac{y_{t-1}^i}{Y_{t-1}} \quad (4)$$

We calculate the contribution to which  $i$ -th component contributed to the relative increase of the additive indicator:

$$\left( \frac{y_t^i - y_{t-1}^i}{y_{t-1}^i} \right) * \frac{y_{t-1}^i}{Y_{t-1}} = (k_y^i - 1) * s_{t-1}^i \quad (5)$$

The contribution of each additive component is equal to multiply of its relative increase and the share of this component in the additive indicator in the previous period.



The relative increase of the additive indicator is equal to the sum of the relative contributions of the individual components (Hindls, Hronová, 1997):

$$\sum_{i=1}^n \left( \frac{y_t^i - y_{t-1}^i}{y_{t-1}^i} \right) * \frac{y_{t-1}^i}{Y_{t-1}} = \frac{1}{Y_{t-1}} \sum_{i=1}^n (y_t^i - y_{t-1}^i) = \frac{1}{Y_{t-1}} \left( \sum_{i=1}^n y_t^i - \sum_{i=1}^n y_{t-1}^i \right) = \frac{Y_t - Y_{t-1}}{Y_{t-1}} \quad (6)$$

## ANALYSIS OF RESEARCH AND DEVELOPMENT EXPENDITURE IN EUROPEAN UNION COUNTRIES

Table 1 shows data on research and development expenditure per inhabitant in European Union countries in years 2009 – 2018 in Euro. The trend of this indicator in 2018 compared to 2009 and the average annual growth rate are calculated.

**Table 1.** Research and development expenditure per inhabitant in European Union countries in 2009 – 2018 in Euro, its trend in 2018 compared to 2009 and average annual growth rate

GEO/TIME	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2018 /2009	Average annual growth rate
EU 27	473,7	490,8	519,0	537,2	543,9	558,2	582,7	594,9	629,2	661,9	1,3973	1,0379
Belgium	644,0	690,7	742,8	795,3	822,1	854,3	900,4	959,5	1 045,5	1 115	1,7314	1,0629
Bulgaria	24,7	29,0	29,8	34,6	36,6	46,9	60,4	52,5	54,7	60,1	2,4332	1,1038
Czechia	184,6	200,3	243,4	273,9	285	294,0	308,4	280,8	324,5	377,6	2,0455	1,0828
Denmark	1 282	1 281,6	1 312,7	1 360,0	1 371,8	1 376,2	1 473,7	1 534,2	1 551,4	1 580,9	1,2332	1,0236
Germany	818,0	855,9	942,0	984,8	990,1	1 043,1	1 093,4	1 121,7	1 206,4	1 266,3	1,5480	1,0498
Estonia	147,8	174,6	289,1	287,3	247	217,9	230,3	205,4	231,3	277,2	1,8755	1,0724
Ireland	605,0	586,8	583,2	595,7	610,3	639,8	664,6	671,8	768,2	769,5	1,2719	1,0271
Greece	133,9	121,6	125,1	120,7	133,2	136,2	156,9	162,7	189,3	202,5	1,5123	1,0470
Spain	315,4	313,8	303,9	286,0	278,5	275,6	283,6	285,5	302,2	320,3	1,0155	1,0017
France	665,7	672,3	694,3	712,6	722	724,2	749,9	745,1	757,7	773,6	1,1621	1,0168
Croatia	88,3	77,9	78,4	77,2	83,2	80,0	88,7	96,0	101,9	122,2	1,3839	1,0368
Italy	325,6	331,6	333,7	345,2	351,6	358,3	364,5	382,0	392,7	406,4	1,2482	1,0249
Cyprus	104,1	105,2	107,0	99,0	101,0	104,3	100,7	116,5	128,9	134,0	1,2872	1,0285
Latvia	39,2	51,2	67,8	71,7	69,1	81,3	76,6	56,1	70,7	96,3	2,4566	1,1050
Lithuania	70,2	69,9	92,6	99,3	111,9	128	133,4	113,4	133,0	151,8	2,1624	1,0895
Luxembourg	1 256,9	1 202,4	1 233,6	1 069,6	1 127,9	1 146,7	1 204,4	1 235,8	1 220,1	1 208,3	0,9613	0,9956
Hungary	106,4	112,4	120,6	126,6	142,8	144,7	153,3	139,5	170,8	209,8	1,9718	1,0784
Malta	77,3	96,7	111	141,9	139,8	141,0	162,6	130,3	143,2	148,8	1,9250	1,0755
Netherlands	631,3	657,1	734,6	747,9	759,6	788,4	810,4	833,0	857,0	974,8	1,5441	1,0495
Austria	897,4	965,9	988,2	1 104,6	1 132,4	1 207,7	1 223,0	1 279,9	1 286,9	1 388,1	1,5468	1,0497
Poland	55,0	68,6	74,5	90,1	90,3	101,6	113,6	108,3	127,3	158,5	2,8818	1,1248
Portugal	262,4	260,8	242,7	220,1	215,4	214,1	215,4	231,0	250,7	269,1	1,0255	1,0028
Romania	27,2	28,2	32,5	32,1	27,9	28,8	39,4	41,4	48,1	52,5	1,9301	1,0758
Slovenia	323,2	364,4	436,2	451,6	454,1	431,9	413,5	393,4	388,4	431,8	1,3360	1,0327
Slovakia	56,3	77,2	86,9	108,3	112,9	123,6	171,0	118,1	137,8	138,0	2,4512	1,1047
Finland	1 274,1	1 302,7	1 332,7	1 264,9	1 231,7	1 194,6	1 109,5	1 080,0	1 121,7	1 167,7	0,9165	0,9904
Sweden	1 154,1	1 270,8	1 397,4	1 464,9	1 507,6	1 411,3	1 504,3	1 537,0	1 615,0	1 544,6	1,3384	1,0329

Source: Eurostat, 2020 and own calculations

As can be seen from Table 1, the highest research and development expenditure (more than 1,000 € per inhabitant) was in Denmark (1,580.9 € per capita in 2018), Sweden, Finland and Luxembourg throughout the analyzed period. The lowest was in Bulgaria (only 24.7 Euro per inhabitant in 2009), Romania, Latvia, Slovakia, Poland, Lithuania and Malta. In 2018, compared to 2009, expenditure increased in all countries except Luxembourg and Finland, where it decreased - in Luxembourg by 3.87%, which represents an average annual decrease of 0.44% and in Finland it decreased by 8.35%, on average by 0.96% per year. This indicator grew the most in Poland in 2018 compared to 2009 by 188.18%, which is an average annual increase of 12.48%. In Slovakia, the third highest increase was recorded by 145.12%, which is an average annual increase of 10.47%.

In order to be able to calculate how countries have contributed to the total change in research and development expenditure, we need to have an absolute indicator. Therefore, we chose the indicator of total research and development expenditure, not per inhabitant. Input data and calculation using contribution method are shown in Table 2.

**Table 2.** Application of contribution method on research and development expenditure in European Union countries in 2009 and 2018

GEO/TIME	2009	2018	Relative increase	Structural number	Contribution
Belgium	6 924,591	12 709,638	0,8354	0,0332	0,0278
Bulgaria	184,610	423,818	1,2957	0,0009	0,0011
Czechia	1 924,518	4 006,462	1,0818	0,0092	0,0100
Denmark	7 065,873	9 139,430	0,2935	0,0339	0,0099
Germany	67 078,121	104 836,000	0,5629	0,3218	0,1811
Estonia	197,393	365,650	0,8524	0,0009	0,0008
Ireland	2 735,556	3 716,800	0,3587	0,0131	0,0047
Greece	1 485,940	2 174,670	0,4635	0,0071	0,0033
Spain	14 581,676	14 946,000	0,0250	0,0700	0,0017
France	42 834,917	51 768,559	0,2086	0,2055	0,0429
Croatia	380,677	501,756	0,3181	0,0018	0,0006
Italy	19 209,000	24 581,681	0,2797	0,0921	0,0258
Cyprus	82,988	115,800	0,3954	0,0004	0,0002
Latvia	84,882	186,200	1,1936	0,0004	0,0005
Lithuania	223,471	426,306	0,9077	0,0011	0,0010
Luxembourg	620,280	727,400	0,1727	0,0030	0,0005
Hungary	1 067,166	2 051,375	0,9223	0,0051	0,0047
Malta	31,761	70,792	1,2289	0,0002	0,0002
Netherlands	10 408,000	16 748,200	0,6092	0,0499	0,0304
Austria	7 479,745	12 246,010	0,6372	0,0359	0,0229
Poland	2 095,827	6 018,489	1,8717	0,0101	0,0188
Portugal	2 771,600	2 769,072	-0,0009	0,0133	0,0000
Romania	555,887	1 024,770	0,8435	0,0027	0,0022
Slovenia	656,882	892,399	0,3585	0,0032	0,0011
Slovakia	302,994	750,947	1,4784	0,0015	0,0021
Finland	6 786,472	6 437,900	-0,0514	0,0326	-0,0017
Sweden	10 682,826	15 631,342	0,4632	0,0512	0,0237
EU 27	208 453,653	295 267,466	0,4165	1,0000	0,4165

**Source:** Eurostat, 2020 and own calculations

From Table 2 we found out that total research and development expenditure in EU-27 increased by 41.65% in 2018 compared to 2009, with the largest increase in Poland by 187.17% (similar to research and development expenditure per inhabitant) and in Slovakia by 147.84%. They decreased only in Portugal (by 0.09%) and Finland (by 5.14%). Germany (32.18%) and France (20.55%) had the highest share in total expenditure in 2009. Germany (18.11%) and France (4.29%) contributed the most to the 41.65% increase in total expenditure. In 2009, Slovakia had only a 0.15% share in this indicator for all EU-27 countries and contributed only 0.21% to the increase.

## CONCLUSION

From the realized analysis we can draw the following conclusions:

- The highest research and development expenditure was in Denmark in 2018 (1,580.9 € per capita). The lowest was in Bulgaria (only 24.7 Euro per inhabitant in 2009).
- In 2018, compared to 2009, expenditure increased in all countries except Luxembourg and Finland, where it decreased - in Luxembourg by 3.87% (average annual decrease of 0.44%) and in Finland by 8.35% (on average by 0.96% per year). This indicator grew the most in Poland in 2018 compared to 2009 by 188.18% (average annual increase of 12.48%). In Slovakia, the third highest increase was recorded by 145.12% (average annual increase of 10.47%).
- Total research and development expenditure in EU-27 increased by 41.65% in 2018 compared to 2009, with the largest increase in Poland by 187.17% and in Slovakia by 147.84%. They decreased only in Portugal (by 0.09%) and Finland (by 5.14%). Germany (32.18%) and France (20.55%) had the highest share in total expenditure in 2009. Germany (18.11%) and France (4.29%) contributed the most to the 41.65% increase in total expenditure. Slovakia contributed only 0.21% to the increase.

## ACKNOWLEDGMENT

*This research was supported by the Grant Agency of Slovak Republic [KEGA grant number 007EU-4/2020 Interactive and interdisciplinary teaching of Services and Tourism Innovation subjects using information technology].*

## REFERENCES

- Eurostat (2020) [https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=rd\\_e\\_gerdtot&lang=en](https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=rd_e_gerdtot&lang=en) (cited 22.9.2020).
- Eurostat (2020) <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do> (cited 22.9.2020).
- Eurostat (2020) [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Gross\\_domestic\\_expenditure\\_on\\_R\\_%26\\_D\\_\(GER\\_D\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Gross_domestic_expenditure_on_R_%26_D_(GER_D)) (cited 22.9.2020).
- Hindls, R. & Hronová, S. (1997). Vývoj domáciho produktu z hľadiska príspevní jednotlivých faktorú. *Politická ekonomie*, 1997 (5), pp. 699-707.
- Hurbánková, L. & Sivašová, D. (2018). *Hospodárska štatistika I*. Bratislava: Vydavateľstvo EKONÓM. pp. 140.
- Investopedia (2020) <https://www.investopedia.com/terms/r/research-and-development-expenses.asp> (cited 22.9.2020).

- Pacáková, V. et al. (2009). *Štatistické metódy pre ekonómov*. Bratislava: Iura Edition. pp 405.
- Štatistický úrad Slovenskej republiky (2019). *Štatistická ročenka Slovenskej republiky 2019*. Bratislava: Veda.

# EUROPEAN UNION, ROMANIA AND RAILWAY TRANSPORT

Clara Elena Muț<sup>46</sup>  
Ciprian Benjamin Benea<sup>47</sup>  
Adrian Negrea<sup>48</sup>  
Secara-Onita Adina<sup>49</sup>  
Catariș Andra<sup>50</sup>

DOI:

---

**Abstract:** *This paper aims to present the role railway transport plays in European Union and in Romania. The importance of this mode of transport is shortly put to the reader forefronts, while at the same time there is presented its share in land transport market. Road transport has its advantages, but its market share cannot be motivated only by market considerations; there are other factors which put this type of transport on a predominant position. The advantages of rail transport are presented face-to-face with road transport especially for passengers' transport, how railway transport can gain a greater share in land transport market, and how it can contribute to create the conditions of a more sustainable future.*

**Keywords:** *railway transport, land transport, sustainable future.*

---

## INTRODUCTION

This paper aims to present an analysis with a component focused upon a specific market case in railway transportation area, due to this type of transport's peculiarities in a competitive environment. It will present the railway transportation market regarding passengers' transport, in order to provide clues and development opportunities for this economic activity and to understand the development potential this market has.

As it is the case in other areas, Romania as a European Union member state must bring into harmony its national interest with that of the EU; this is a pressing phenomenon in railway transport area, because the EU's common policy on this subject is focused on the creation of a single railway, as a key-element of European economic integration and a base for future economic development in Europe.

The Romanian railway transport faces great challenges, especially regarding the integration in the European railway system and exploiting opportunities brought by the quality of being a European member; missing determination points to the incapacity to exploit the position and potential offered by the Romanian market, and in the same time reducing the existing discrepancies.

In the last years the Romanian railway transportation system registered numerous changes such as restructuring, liberalization, aspects specific to administrative and legal areas; but in the

---

<sup>46</sup> SC Interregional SRL - (private railway transport operator)

<sup>47</sup> University of Oradea, Strada Universității nr. 1, Oradea 410087, Romania

<sup>48</sup> University of Oradea, Strada Universității nr. 1, Oradea 410087, Romania

<sup>49</sup> University of Oradea, Strada Universității nr. 1, Oradea 410087, Romania

<sup>50</sup> University of Oradea, Strada Universității nr. 1, Oradea 410087, Romania

technical area – where upgrading needs huge and sustained efforts – Romanian railway infrastructure continues to be in a visible and continuous decay, placing Romania in a weak position face-to-face with other European states.

As a matter of fact, railway transportation is interconnected with national interest at large, and as a consequence, strategic objectives regarding railway transport system derives from national interest connected to improving national mobility and the state's capacity to administrate better its territory. Railway transport system is a key-component in this regard; from this point of view transportation and geopolitics overlap.

Furthermore, the stimulation of railway transport in order to move persons has become a high priority in the European Union framework, which was underscored by the White Paper in 2001; this strategic document presented the importance and the advantages of railway transportation related to climate changes and environmental protection (White Charta, 2015). Ten years later, the White Paper of 2011 has specified that greenhouse emissions should be reduced by 80-95% until 2050 related to their level in 1990 (White Charta, 2015). This document presents main steps to be taken in order to rise railway transport efficiency, to rise its competitiveness related to resources' use, and to become a sustainable alternative to road transport.

In Romania, the main direction of development and types of transport's balance promoted both at institutional level, and by active companies operating in the transport sector, sustain national policies in transport sector in correlation with this European strategic document.

Seeing the gap between the situation where the Romanian railway transport system is located and the ascending trend identified in Western Europe in this field of transport, it is of outmost importance to identify the strategies and resources in order to equilibrate the balance among types of transport in Romania, with the aim of reducing pollution, rising mobility, and the decongestion of roads.

The only way to recover and revitalize railway transport must be centered on improving its competitiveness, and in this way, it would become an important part among other continental types of transport, rising its capacity to recover its lost clients, and to attract new ones.

The current situation in Romania points to the fact that there exists a great potential regarding the possibility to rise railway transport share on Romanian domestic transport market for passengers' movement: railway can attract both people which currently use public road transport when traveling between cities, and people which use their car.

Railway transport can become a key-player on domestic transport market, as over 90% (Development strategy 2018-2020 Ministry of Transport, p. 13) of total railway transport is done on domestic area.

If this would be the case in the future, the success of railway transport on Romanian domestic market, it would strengthen international railway transport, too; this would contribute directly also to the European Union's success related to the creation of European unique railway area. Integration in this unique area is the strategic objective which derives from the quality of being an EU member state.

## CONTEXT AND CHALLENGES

The importance that the railway has on economic, social and political fields determines all states to develop their domestic transportation systems, and pushes them to collaborate in order to identify border points where these networks meet each other.

The level of transport system's development directly determines the degree and capacity to attract material and human resources located in different areas, territorial repartition of production capacities and their specialization, distribution of urban centers and domestic population, size and shape of human settlements, technological, cultural and scientific development; it improves a country's defense capacity and determines the degree a specific society contributes to globalization. (Gherasim T., 2007, p. 12) Shortly, greater mobility means that in the same span of time the society with greater mobility rotates money faster, creates greater wealth, and brings greater incomes to the national budget, because if the goods/services are sold/bought faster so does the taxes imposed on them are collected faster. In this way, transportation and civilization are the two faces of the same coin.

Public interests connected to transport activity determine governments get involved in this strategic sector. Good or bad public policies in the transport sector are decisive for encouraging or blocking the transportation activity's success. This policy should aim:

- rising efficiency of transport activities;
- be sensitive to market trends and needs;
- attract passengers;
- be affordable and take into account the best environmental standards.

Efficiency in transportation – or its absence – is a central element for economic development – or it can morph into a hindrance for economic development. The best way to rise transport efficiency is to promote the cheap types of transport, as to provide the minimization of logistical costs at domestic level.

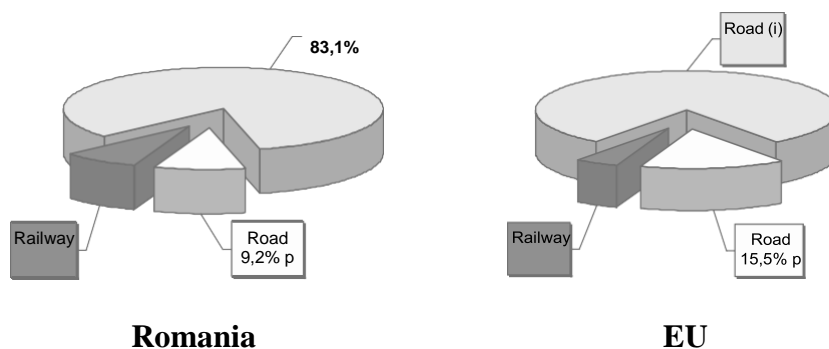
The repartition of different types of transport is given by the evolution of different technologies and of economic interests.

The following analysis provides clues to see general distribution of different types of transport in Romania, the data being taken from Romanian National Institute of Statistics, and appraisals made by Romanian Railways Company (CFR). (Development strategy 2018-2020 Ministry of Transport, p. 23)

In Romania, the main share of passengers' transport over land is taken by road transport, 80% respectively. At European Union level the share of road transport in land transport is 83%, a little higher than in Romania due to higher capacity of Western societies to get access to cars, and a better road infrastructure.

In the following figure, there are presented the specific situations of land transport use in EU, and in Romania respectively.

**Figure 1.** Different types of transport's market share in Romania and the EU



**Source:** [http://mt.ro/web14/documente/acte-normative/2018/07\\_03/Strategie](http://mt.ro/web14/documente/acte-normative/2018/07_03/Strategie), accessed at 10.04.2020; Development strategy 2018-2020 Ministry of Transport, p. 24

The mobility requirements of the population overland are distributed between road transport of passengers using their individual transport options (i), and the public transport (p) provided by road transport operators by bus and coach, and of course or by rail transport operators.

The road transport preeminence over railway transport points to the fact that it seems (at first sight) to be superior from an economic point of view and more attractive to transport beneficiaries.

But a study with global perspectives created together with International Railways Union (IUC) and International Energy Agency (IEA) (Railway Handbook 2014, p. 5) indicates that railway transport is *much more efficient* than road transport (Development strategy 2018-2020 Ministry of Transport, p. 25), because:

- under the energy efficiency perspective, railway uses per transport unit 11 times less energy than road transport;
- from environmental point of view, the costs generated to fight greenhouses gases are very small: railway transport generates only 2% of greenhouses gases generated by transport sector, while road transport gives 73% (European Environment Agency); this means 36 times more pollution by cars/buses than railway;
- road is much more dangerous than rail. For road transport it was taken the average of 259 deadly accidents/billion passengers/ km (Transport Master Plan 2014), while for rail transport the average is 1,34 deadly accidents/billion passengers/ km (ERA Report). Road gives 193 times more bad accidents than rail per billion/passengers/km; as a consequence, medical costs due to road accidents are around Euro 1.2 billion/year only in Romania, meaning 0.8% of GDP. (Development strategy 2018-2020 Ministry of Transport, p. 27)

As we can observe, rail transport is much more efficient from economic and environmental points of view, and the safest one. As a direct deduction, the optimization of economic activity is better fulfilled when railways get a bigger market share. This means lower costs for national economy, which determines a higher competitiveness on global stage and a stimulus for economic development. (Development strategy 2018-2020 Ministry of Transport, p. 26)

Put it synthetically, national transportation system should be characterized by equilibrium among different types of transport, being capable to assure maximum benefits for national economy and the potential for rising through direct cost reduction and their externalizations; to



rise energy security, and oil consumption's reduction in transport sector; to reduce negative effects of transport activity upon the environment.

The causes for the present situation where road transport has preeminence is due to political decisions at highest level. Road transport means at first sight freedom – freedom to choose what, how, when and where to travel – while railways means at first sight rigidity and discipline. But in the long run, road transport means a dispersed society which generates higher costs to administrate, while rail means industry and easier and cheaper way to administrate territory and to centralize the forces of society. We can shortly note that even from military point of view rail is far more strategic than road: in geopolitical fight among nations – which is a constant of world politics – railways and fleet fights to control the area close to their meeting points, in world ports, respectively. But as political men are in constant search for votes, they promoted the idea of freedom through the acquisition of a personal car, and ordinary men jump into it fast. This was one of the most important elements which gave road the present position. Of course, the oil industry wants to sell its products, so it needs buyers, more buyers. In this way big oil interests overlapped with political men interests.

But railway transport is of utmost importance, whose advantages could decisively contribute to national transport system's efficiency improving and its sustainability.

Romania's integration in EU and the reduction of gaps among Romania and other EU member states depends on railway transport system's gradual integration in a unique European transport system; the alignment to European policy and strategy in transportation field is not an option, but a necessity. (Development strategy 2018-2020 Ministry of Transport, p. 16)

## **THE PECULIARITIES OF RAILWAY TRANSPORT OF PASSENGERS IN ROMANIA**

The organization of the Romanian railway transport system is in line with the European policy and legislation in this field, in order to provide an optimal working in a competitive environment; the principle of complete administrative separation of railway infrastructure management and railway transport services is fully applied. The railway operator provides the commercial relation with the client using his own resources, while the management of infrastructure provides necessary activities which sustain train circulation, providing railway infrastructure, too.

The asymmetric public financing of road and rail transports, characterized by funds 10 times smaller for railways (Development strategy 2018-2020 Ministry of Transport, p. 29), has generated a significant competitive loss, because of railway infrastructure's decay, which has severely limited the trains' performances reflected in commercial speed and punctuality.

Great parts of the railway system in Romania have registered constant decay, generating speed limits, while only 40% of the railway system is electrified (Development strategy 2018-2020 Ministry of Transport, p. 123). The commercial speed limit is around 50 km/h for passengers' trains, 40 to 60% less than the speed for which that railway had been constructed (Development strategy 2018-2020 Ministry of Transport, p. 91).

Due to these deficiencies, it has become a necessity to find a strategy which would define the Romanian railway transport's evolution, taking account of national financial capacities, European financial support, and Romania's national and administrative capacities.

A great project had been initiated in 2006, regarding the modernization of the rail line between Bucharest and Constanta aiming at rising maximum speed from 140 km/h to 160 km/h, which had been concluded in 2014. Another national project began in 2017 and its purpose is to create the technical capacities along the 4-th European Corridor, to facilitate the jump from 50 km/h to 120 km/h, while between Simeria and Sighisoara the passengers' train would run even with 160 km/h.

To make business in rail transport in Romania one needs to take into account that there are, from administrative point of view, quite high barriers, due to special and important administrative conditions and expensive investments (licenses, safety certificates, rolling material).

The structure of railway market regarding passengers' transport reflects the specific legislation, both from access to infrastructure point of view, and from the way one can operate on that infrastructure.

The number of private companies is small, because of peculiarities of rail transport and the way it is regulated. The market share of private railway operators is around 20% in Romania (<http://www.consiliulferoviar.ro/>, p.85), meaning that this country has one of the top position in Europe, but the market share of rail transport of passengers has significantly been diminishing in the face of road transport (individual or public), nowadays being situated around 16% (Development strategy 2018-2020 Ministry of Transport, p. 57).

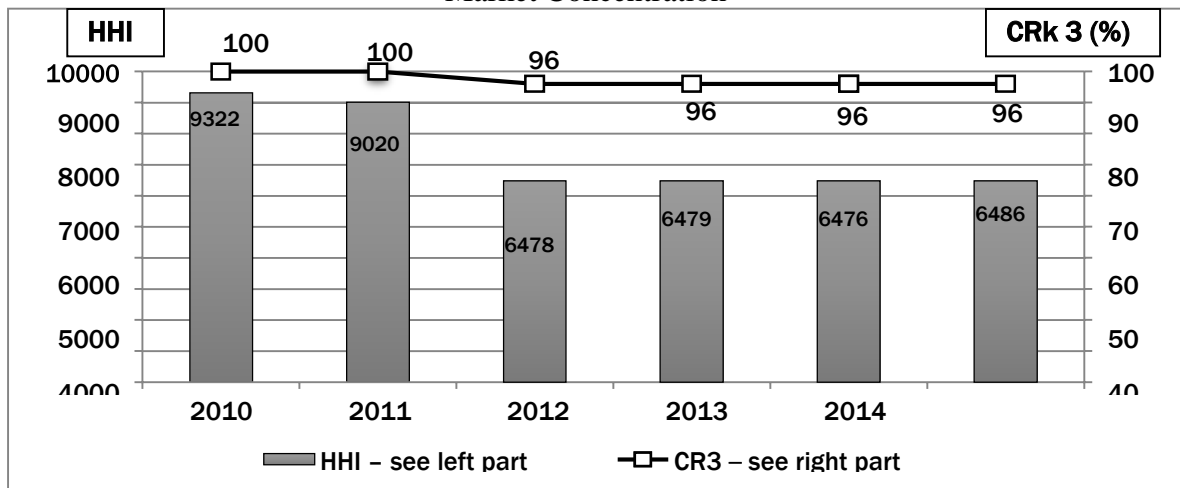
Between 1990 and 2012 the number of railway passengers had been constantly decreasing (from 408 mil passengers/km to 54,5 mil passengers/km), but after that it has been registering a constant increase, and in 2019 it had got to 66 mil passengers/km (<http://www.consiliulferoviar.ro/>, p.8).

Romanian railway market has the peculiarities of oligopoly, being dominated by an important leader – CFR Calatori – share of 80 to 86 %, and asymmetric quotas, 80% facing 10-14%, or even less for other operators, put together (<http://www.consiliulferoviar.ro/>, p.47).

The market structure is characterized by a high concentration using Herfindahl-Hirschman Index (HHI) calculations, which is used to measure the degree of concentration on a specific market. It used the cumulus of square market quotas of all companies on a specific market. A poor concentrated market has an HHI Index smaller than 1000, a medium concentrated one has HHI between 1000 and 2000. Over 2000 the market is a concentrated one and Concentration Ratio (CRk) points to the figure of over 6000 (HHI) and 3% (CRk), indicating the peculiarities of a strong oligopoly (<http://www.consiliulferoviar.ro/>, p.47).

A point to be mentioned is the fact that the elasticity of demand is not uniform on the whole market; there are passengers which show different degrees of sensitivities regarding price. The main factors determining such differences are trip's aim, incomes level, or the accessibility (financial and geographical) of another type of transport.

The consumers negotiation's power is reduced, market being characterized by an atomized demand, with a significant number of people without alternatives. The low level of price in comparison with other countries in Western Europe constitutes a hindrance for potential competitors, and doesn't stimulate competition's intensification through rising profitability on the most used networks.

**Graph 1:** Regarding the Evolution Herfindahl-Hirschman Index and CR3 and the Degree of Market Concentration

Source: CFR Calatori, <http://www.consiliulferoviar.ro/> accessed at 15.03.2020

The degree of market transparency is limited; although the level of tariffs can be observed by competitors; while a significant part of the costs is quite symmetrical, the costs' structure is difficult to identify; the railway transport's dynamic depends even on employees' skills, qualifications, and motivation.

From an economic point of view, the only path for rail transport to regain its central position depends on rising its competitiveness.

In the EU there has been registered a moderate increase in the number of passengers using railway transport, while the situation in Romania is lower than the European average, due to missing investments, and fierce competition for road transport.

From administrative point of view, Romania is well positioned in respect with liberalization degree, but the main disadvantages are brought by decaying railway infrastructure and rolling material.

The demand for railway transport is determined by endogenous and exogenous factors; the endogenous elements are railway infrastructure's quality, the way companies administrate railway transport services, doubled by network density, inter-connectivity, quality of transport services, pricing. Exogenous factors have demographical character, being influenced by the number of people in a specific geographical area, unemployment, incomes level and a commercial character such as number of jobs, touristic activities, and the psychological availability to use a specific type of transport.

## CONCLUSION

The action measures taken by the competition are quite timid due to structural peculiarities in railway transport area, the main one being complicated barriers hindering market entry strategies. But when a specific level of passengers' transport is overcome, the commercial incomes are bigger than the costs, the profit being directly influenced by railway transport activity's intensification. In that moment the railway system would become efficient on commercial base only, without needing to attract public financing.

*But* in order to get to this point, there are necessary initial investments in infrastructure, while in order to revitalize railway transport (Development strategy 2018-2020 Ministry of Transport, p. 34), there are needed some measures such as:

- limiting public spending (through subsidies) of road transport, and the internalization of all costs generated by transport activity, including environmental costs;
- creation of necessary prerequisites in order to provide the framework for the railway transport's development, in an open and competitive environment;
- limiting necessary subsidies for railway transport until it gets to its own minimum intrinsic efficiency.

One main premise of European transport policy is: „*The continent's prosperity will depend on all European regions' capacities to stay fully integrated in world economy, in a competitive manner. Efficient transports are a vital prerequisite for this.*” (Development strategy 2018-2020 Ministry of Transport, p. 2)

## REFERENCES

- Carta Albă (2015)- Foaie de parcurs pentru un spațiu european unic al transporturilor – Către un sistem de transport competitiv și eficient din punct de vedere al resurselor <https://eur-lex.europa.eu/legal-content/RO/LSU/?uri=celex:52011DC0144>
- Development strategy 2018-2020, Ministry of Transport, Bucharest, Romania
- Gherasim T. (2007) Sisteme de transport, Transporturi feroviare, Editura Bacovia, Bacău, Romania
- Railway Handbook (2014) - Energy Consumption and CO2 Emissions - Focus on Infrastructure  
European Environment Agency
- CFR Calatori, <http://www.consiliulferoviar.ro/>; Studiu de piață în transportul de călători

# BASIC ELEMENTS OF THE FINANCIAL FUNCTION IN BUSINESS ENTITIES

Slobodan Bracanović<sup>51</sup>

DOI:

---

**Abstract:** *Finance and accounting are the essences and the lifeblood of the business doing of business entities. Classical financial mechanisms and instruments are adapted to the contemporary conditions of profitable business doing. The real economy is the basis of the financial economy. Public finance is a special field. Virtual, parallel finance is manifested in contemporary business doing.*

**Keywords:** *Finance, Accounting, Function, Market, Flow, Capital, Virtual.*

---

## 1. PRIOR DETERMINANTS

**F**inance, i.e. the financial function (apart from the supply, production and sales functions), is of special and priority significance in all business entities. The financial function of a business entity (an enterprise, a company) is possible to perceive as the flow and process of the management of monetary jobs and tasks, i.e. the collection, accumulation, concentration and securing of financial assets for manufacturing, service, commercial and marketing goals and purposes, and so forth. The financial function is the underpinning for the achievement of financial decision-making (analyses, research studies, business operation and profitable business doing rating and assessment), as well as strategic, tactical and operational decision-making, investing - and personnel-related decisions (in the short, medium and long terms), and so forth.

The role, place, and significance of finance in the management system can be perceived in a complex and differentiated manner, bearing in mind a very complex set of factors: manufacturing, capital, a structure, costs and changes, an increase in value; business and financial decision-making; the distribution of own funds; anticipated changes and an increase in monetary flows; the creation and modelling of projections, concepts and strategies; the management of riskiness, a salary (stimulus) payment policy; the estimation and assessment of effects, the results of profitable business doing, and so on. Finance is the lifeblood of the economic mechanism.

Each one of the existing functions in business entities contains and includes the management of the function itself as well. Analogously, there is also the management of the management system itself (“meta management”). The place, role and significance of finance in general management are important. More specifically, apart from general management in the supply, manufacturing and sales functions (enterprises), it is also possible to observe financial management in each one of these individual business functions. Namely, the connectedness between the financial function and goods and monetary flows, on the one hand, and the other functions in the management of business entities crystallizes itself. Circulation and the “circular

---

<sup>51</sup> Faculty of Economics in Priština, Kosovska Mitrovica

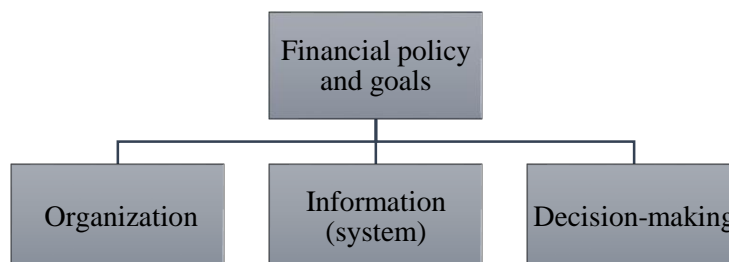
flow of reproduction” is traced from money, goods (raw materials and reproduction materials), manufacturing and goods again (finished products), realized money etc.

The financial goals that can be classified in a principled way into the following groups: initial, interim (interphase and interstate) and final assume special significance. “Initial goals” include the optimal structure of assets and sources of funds, liquidity, rational and purposeful investments. “Interim goals” include financial stability and balance, cost (expense) minimization and the maximization (optimization) of income, revenue and a profit (accumulation), solvency, asset turnover (favoring the speed of such turnover) and so on. Final goals incorporate the financial strength, power and independence (i.e. autonomy); the maximization of gains and a profit (profitability) as a target function; an increase in property (assets). The structure of said financial goals and the interactive connections existing between them are perceived. The role and significance of these goals achieve both for the financial function and overall management, guidance and decision-making in a concrete business and social, or state (public) entity crystalize themselves. (6; 2015, 325 – 326).

## 2. THE INTER-CAUSALITY OF FINANCIAL DETERMINANTS

The connectedness, interdependence and inter-conditionality of financial determinants in business and social entities are perceived bearing in mind the financial goals, organization, policy, concept and strategy, the information system, and decision-making flows.

**Diagram 1.** The connection of the factors: the financial goals and policy, information and decision-making:



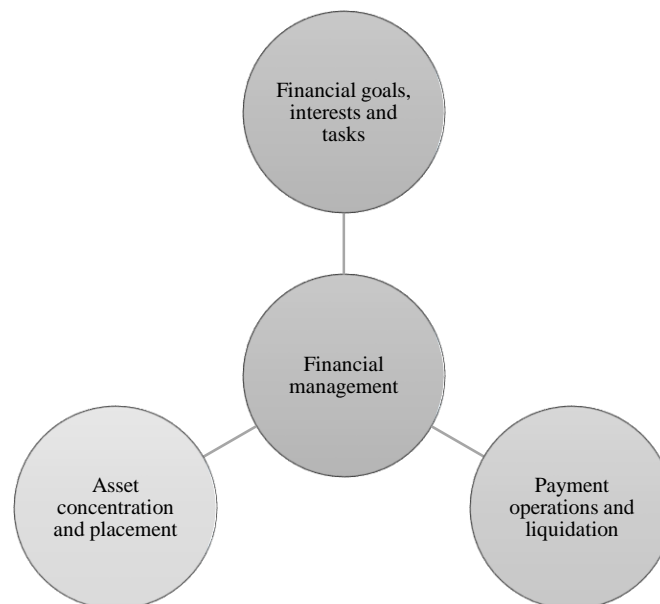
The main, basic tasks of the financial function encompass a panoply including planning the financial assets of profitable business doing, the provision of assets (own, credit, donations, etc.) for all business functions, the use and functional use of assets (inflow and/or outflow dynamics), placement (forms, time, riskiness, anticipated yields) and potential transformations (the circular flow) of assets from one form into another, the collection of realization and claims based upon products and/or services (manufacturing, nonmanufacturing, combined), the monitoring of all the monetary asset flows through the control system (cashier operations, securities received and issued, giro accounts, liabilities and receivables (claims), unfinished production, buyers, suppliers, stocks, interests, insurance, integration, etc.).

There are also derived and accompanying tasks of the financial function that include the recording and control of financial documentation, the financial analysis of business operations (the analysis of the balance, ratio analysis, the analysis of productivity, profitability and cost effectiveness, liquidity, solvency), the payment modality (cash, noncash, etc.), informing, reporting, and so forth. The close connectedness between the bookkeeping-accounting and the financial functions as the “more passive” activity and the “more active” activity, respectively,

is crystallized; it is quite frequently the case that, in practice, these two functions are performed as one, the so-called financial-accounting function.

The goals and tasks of financial activities indirectly economic, or social and/or state-owned entities, determine constant programming, the designing and planning of diverse activities and actions integrally including diverse balance positions (in the Balance Sheet and the Profit and Loss Account), planning different flows and processes (of cash, total assets, the basic and working funds, i.e. capital, in a contemporary complex interpretation, etc.). For said reasons, the financial function performed in business entities is carried out in connection with the scope, complexity and sophistication of financial tasks, and in compliance with different principles of the organization, such as centralization, decentralization, mixed forms, etc., also depending upon numerous (internal and external) factors, the form of the activity, the technical-technological equipment of work and personnel potentials, marketing, etc. and that function is becoming ever-stronger in contemporary conditions. (6; 327-328)

**Diagram 2:** The model of the organization of the financial function and jobs in business entities:

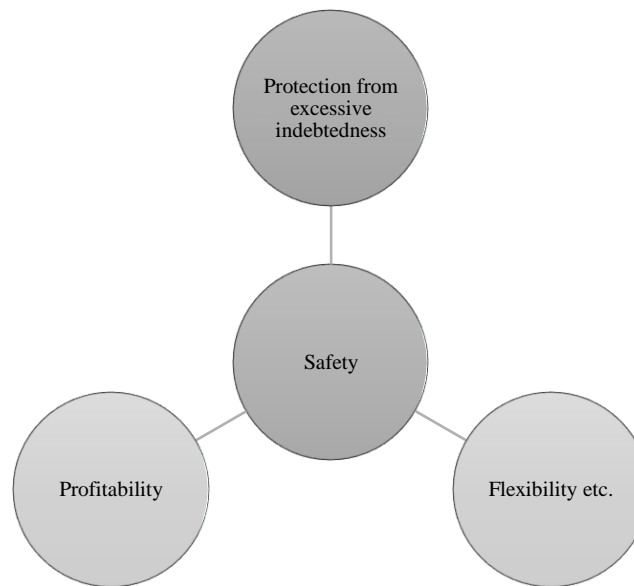


The activities of the raising, collection and placement of assets include financial business operations, (5), making investments in research and development, the activities in the financial market (capital), and asset insurance and channeling activities. Payment operation and liquidation jobs include obligations (liabilities) towards suppliers and receivables from buyers, liquidation (“depot”), cash-in-hand, and so forth. The activities of financial management include planning (the plan), analysis, control and reporting. There are also interim jobs. (6; 328).

The connection between and inter-conditionality, intertwinement and the crisscross nature of the flows and actors in financial planning are indicative, bearing in mind the complex multidimensional, dynamic plan set of factors and elements, such as fixed assets, the stocks of raw materials, materials (reproduction materials), manufacturing in progress, the stocks of finished products, salaries and other costs of labor, amortization, buyers and suppliers, receivable collection, cash flows, sales and administrative costs, cash and loan sales, sales

assets and purchase assets, investment, shareholders and lenders, the use of loan arrangements, loan placement payoff, dividends, inflationary tendencies and the reality of nominal indicators, and so on. There are cash flows from business, investment activities, funding (collection and payout, asset inflows and outflows). Cash flows are realized as the net changes in cash assets during a business period (6; 329-330). Finance and accounting are the very backbone of business operations.

**Diagram 3:** The principles/rules of financing as the norms of the application of a financial policy



“The Profitability Principle” expresses a positive financial effect, which implies that it expresses optimal, maximum results on a longer- or longtime horizon. “The Safety Principle” assumes that the business from which the spent monetary assets will be valorized with a (relative) certainty are financed. A business entity aspires to a reduction in and the minimization of costs and the strengthening of its own sources of financing (in closing the “funding construction”). The impossibility of the collection of receivables that must necessarily be minimized is also a risk. There are also suspicious and/or disputed receivables. “The Flexibility (Elasticity) Principle” denotes the ability to adapt to changed market and conjunctural conditions quickly or more slowly in a short term. The additional capital conditioned by an increase in the scope of and/or changes in the business operation structure is also a necessity. “The Excessive Indebtedness Protection Principle” implies the funding brought into compliance with riskiness, i.e. the share of own capital necessarily has to be proportional to riskiness, i.e. risk should necessarily be accompanied by a greater share of own capital (with an increase in the share of own capital, the independence and autonomy of a business entity - enterprise also increases). The rules of financing imply norms for the implementation of a financial policy. The financing principles include a) a relationship between own and foreign capital (vertical rules), b) the relationships between parts of assets and capital (horizontal rules), and c) related factors (cross-elements). This is the domain of classical finance. The purport of financial analysis implies offering an information base for the tendencies of the development of the analyzed or investigated phenomenon through the decomposition of phenomenal forms and comparison, all aimed at and for the purpose of decision-making, making correct decisions, and undertaking adequate activities and procedures. The capital market, which is favored in contemporary conditions of profitable



business doing, denotes the place in which the offer of and demand for capital, (4), i.e. different forms of financial mechanisms and instruments, confront with each other, the place where a larger number of participants (the state, issuers, investors, etc.) appear. The movement flows are uncertain. (6; 329-332).

Public finance and the sources of financing budgetary assets, public income, expenses, short- or long-term capital investments, etc. are a special field.

The contemporary era is also characterized by the existence of parallel and virtual finance, the building of pyramidal and fictitious, nonexistent financial power structures. (1,2,3).

### 3. INDIVIDUAL MONETARY FLOWS IN SERBIA

Certain indicators belonging to the financial, i.e. credit-monetary sphere relevant for profitable business doing in Serbia were indicative for the duration of the prior development period.

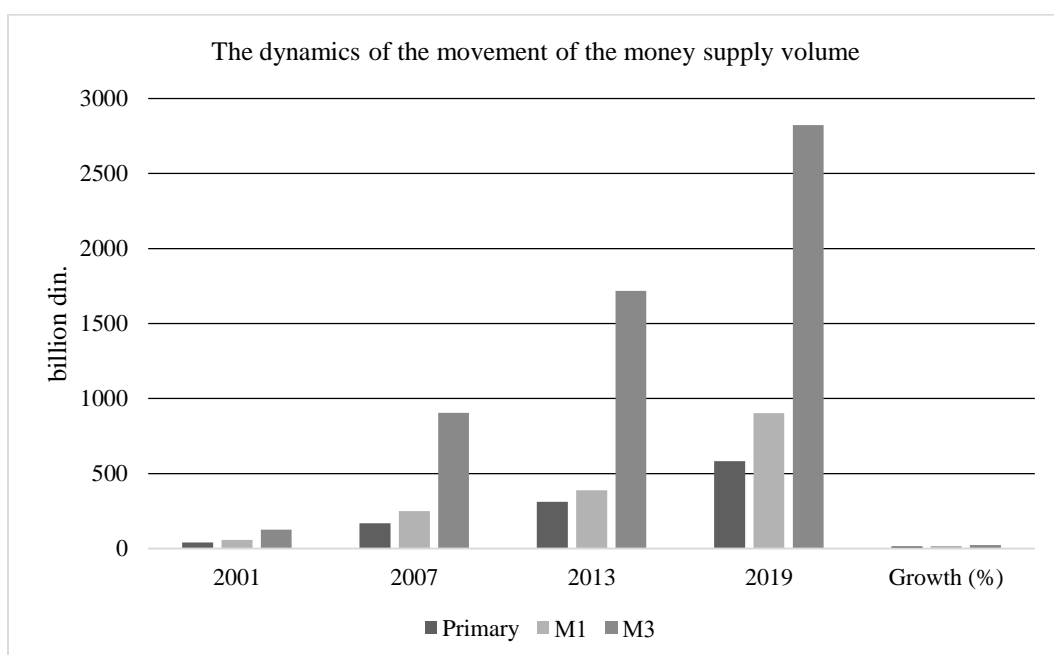
**Table 1.** The crystallized indicators of cash flows and the money supply (in billion dinars):

Elements	2001	2007	2013	2019	Growth (%)
Primary	41.643	169.020	311.159	581.717	15.78
M1	58.233	248.873	388.265	903.603	16.46
M3	125.414	903.871	1,716.882	2,823.516	23.43

**Source:** Ministry of Finance of the Republic of Serbia (May 2020), “The Public Finance Bulletin”, Belgrade, pp. 12 – 14.

A fact is established of the dynamic nominal growth of the primary money in the domestic (dinar) currency (at an average annual long-term growth rate of 15.78%). There is also a dynamic trend of the growth of the money supply (M1) at the synchronous rate of 16.46%. Apart from this, the money supply (M3) achieves the most dynamic growth (at the rate of 23.43%). It is necessary to point out the existing inflationary tendencies affecting the reality of the increase in the monetary indicators.

**Graph 1:** The quantitative parameters of the monetary supply presented graphically



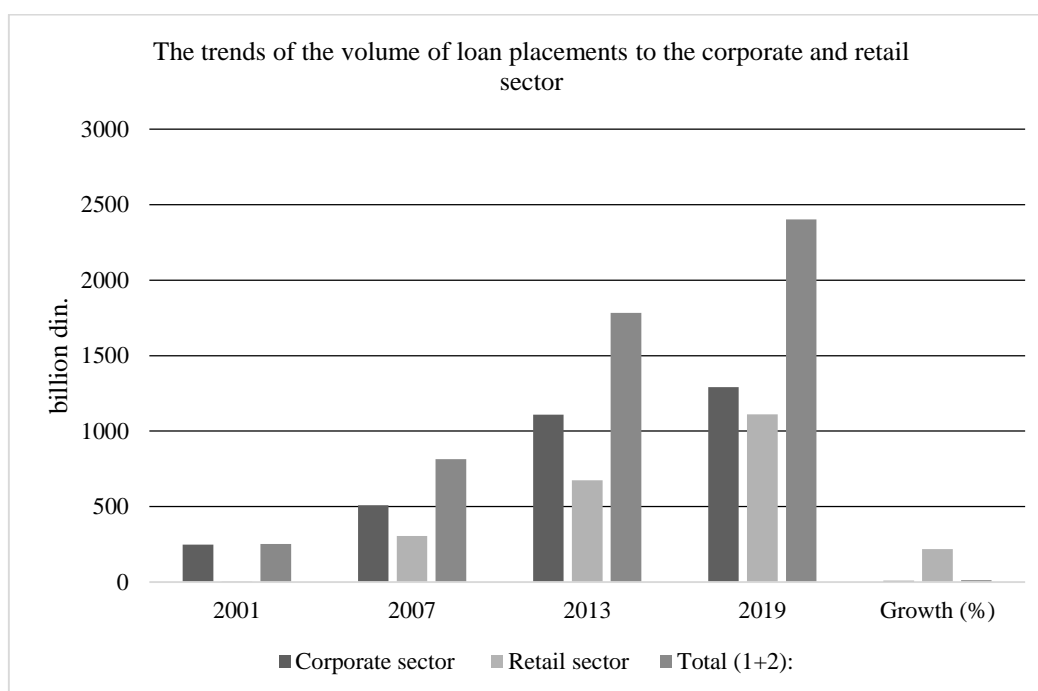
**Table 2.** The volume of loan placements to the corporate sector and the retail sector (in billion dinars):

Elements	2001	2007	2013	2019	Growth (%)
Corporate sector	247.829	508.167	1,110.016	1,290.788	9.60
Retail sector	5.277	305.967	673.696	1,111.392	219.17
Total (1+2):	253.106	814.134	1,783.712	2,402.180	13.32

**Source:** Ministry of Finance of the Republic of Serbia (May 2020), “The Public Finance Bulletin”, Belgrade, pp. 12 – 14.

It is possible to perceive the dynamic long-term growth of financial loan placements (arrangements) to the institutional (individual) corporate and retail sectors, and in the total volume as well. The most dynamic growth is achieved by the loan assets directed with a special purpose towards the retail sector. Again, it is needed to highlight the inflationary trends affecting a reduction in the real value of the nominal parameters in this period. Inflation (expressed by the retail consumer price growth rate) was on average 91.8% and 1.7% in 2001 and 2019, respectively. In the latest available period (May 2020), inflation was reduced (0.7% at the interannual level), and this trend was significantly affected by the movement of the oil derivative prices. Synchronously, the comparative inflation of the EU countries is lower (0.6%).

**Graph 2.** Clearer presentation of the loan volume numerical parameters



In the current period, the biggest formative share in the structure of the placements to the corporate sector was achieved by loans for working assets (38.9%) and investment loans (43.3%), with the interannual growth of the working asset loans (12.2%) and investment loans (24.5%). Comparatively, when the placements to the retail sector are concerned, the biggest structural share was achieved by cash loans (43.8%) and residential loans (36.3%), with the interannual growth of cash loan assets (16.5%), as well as residential loan arrangement (6.4%).

Regarding the structure of the sources of the bank assets, the share of the assets lent dominates (85.3% at the end of May 2020). Comparing that with the same period of the previous year, the lent assets increased (1.4%). The structure could also be substantially more favorable.

From the aspect of the currency structure of the asset sources, too, the foreign-exchange sources prevail, participating with a share exceeding one-half (50.6%); however, the share was reduced in comparison with the identical period of the last year (1.9%), which is the question of the optimality of the share of the domestic sources.

The “inflow of (foreign-exchange) assets” was also achieved by issuing state (public) bonds in the international financial market to accomplish operational goals.

The money supply was covered (M1, 159%) even considerably more than the half-year imports. In May 2020, the NBS retained the level of the reference interest rate (1.5%). The movements in the foreign exchange market are a determinant of the real depreciation of the domicile currency in comparison with the EUR currency (0.1%), whereas nominally, the Dinar did not fluctuate. In comparison with the same period in the last year, the foreign-exchange rate achieved a nominal appreciation (0.3%) and a real appreciation (0.9%). With the aim of amortizing enormous current oscillations, the financial institution, i.e. the NBS, intervened at the interbank foreign-exchange market with a greater amount of money (i.e. 250 million euros) in May 2020.

Banks are also the largest individual investors in state securities.

Speaking about financial markets, the trade of securities, stocks and bonds was reduced by one-third in May 2020 in relation to the same period in 2019 on the Belgrade Stock Exchange. Furthermore, the total market capitalization at the end of May 2020 was considerable (510.1 billion dinars); however, it was reduced by 2.6% in comparison with the identical period in 2019. Besides, this year in May, foreign investors did not have a big share in the total turnover on the Stock Exchange (6.15%), the same being reduced by 7.25% in comparison with the same period in 2019. The share of foreign investors in trade flows and stocks was synchronously significant (28.74%, with a comparable growth of 18.59%), whereas this share in the trade of the public bonds of the RoS was smaller (4.17%, with a comparable significant reduction 10.30%). The oil price (for the Urals oil type) was over 30.65 dollars/barrel, and the price has been reduced by 41.7% since the beginning of 2020 in comparison with the same period in the previous year (7; 7-10).

#### **4. CONCLUSION**

Finance and accounting are the backbone, depth and “lifeblood” of the business operations of a business entity. Financial goals and principles have theoretically and practically been elaborated. Namely, for example, the liquidity principle shows whether a business entity is capable of valorizing (i.e. paying for) its liabilities that have come due and payable simultaneously maintaining the necessary volume and/or structure of working (monetary and other) assets and maintaining a solid “credit rating, i.e. financial reliability”.

The financial indicators of activities are expressed by the relations of the total income and costs, individual and total investments in business assets, and so on. These relations represent the coefficients of the turnover of such business (basic and working) assets (which can be different). A financial constellation is denoted by the ownership structure of the source of assets. This structure has a goal to perceive the proportion of own and borrowed sources of

financing. The indicators of the market value are indicative for enterprises (especially so for joint-stock companies), and they encompass the indicators of the market price per share, net earnings per share, dividends and so on.

Efficiency is reduced to the “minimax” principle, i.e. the principle implying minimum investment and maximum effects. The real economy is the basic of the financial economy. “Virtual finance” is the contemporariness.

## REFERENCES

- Bulatović M. (2004), *Pravila ćutanja*, Narodna knjiga, Alfa, Beograd;
- Bulatović M. (2011), *Ekonomija i demokratija - Držati glavu iznad*, Jumedica Mont, Podgorica;
- Bulatović M. (2018), *Nevidljivi lanci - Moć nepostojećeg novca*“ Laguna, Beograd;
- Dragutinović D., Filipović M., Cvetanović S. (2005), *Teorija privrednog rasta i razvoja*, Centar za izdavačku djelatnost Ekonomskog fakulteta u Beogradu, Beograd;
- Jančetović M., Đurić Z. (2005), *Strategijski i operativni menadžment*, Beogradska poslovna škola, Beograd;
- Mašić B., Dželetović M. (2015), *Uvod u menadžment*, Inovacioni centar fakulteta bezbjednosti Univerziteta u Beogradu, Akademska knjiga, Novi Sad, Beograd;
- Ministarstvo finansija Republike Srbije (maj, 2020), *Bilten javnih finansija*, Beograd, str. 7-14.

# HUNGARIAN IFRS IMPLEMENTATION FROM TAX PERSPECTIVE

Gábor Fehér<sup>52</sup>   
Éva Karai<sup>53</sup> 

DOI:

---

**Abstract:** *The influence of corporate income taxation on financial statements presented on a domestic accounting standards basis differ by countries in a wide range. Corporate income taxation in Hungary has a strong connection to the Hungarian Accounting Act. From 2016 it is prescribed or allowed for specific companies to present their financial statements on IFRS basis. The transition represented not only a challenge in the accounting system of the companies, but the state had to face new tasks because the taxation of IFRS companies had to meet the tax principle of horizontal equity and ensure the proper tax revenue. Research data arise from financial statements of Hungarian companies listed on the Budapest Stock Exchange. The average effective tax rate of Hungarian listed companies decreased after the transition. Temporary tax rules for IFRS companies were applied to reach the tax level of the companies that prepare their financial statements following the Hungarian Accounting Law. Authors compare the results with empirical findings of other European countries.*

**Keywords:** *IFRS, corporate income taxation, listed companies.*

---

## INTRODUCTION

In Hungary, from January 2016 on a range of companies have the opportunity, and since 2017, the obligation to apply the International Financial Reporting Standards (IFRS) by preparing their separate financial statements. To prepare transition, reconciliation with the various areas affected, such as e.g. accounting, taxation, collection of statistical data, has started from the very outset (Molnár, 2015).

In Hungary, the calculation of corporate tax relies strongly on the information obtained in the course of the derivation of accounting profits; therefore, the taxation issues of transition to the IFRS had utmost importance. The member states of the European Union are of divergent views whether they approve or not the use of IFRS on the level of separate financial statement<sup>54</sup> (Bíró, 2015). The Anglo-Saxon countries and those Central and Eastern European countries that have joined later the EU would allow the application of the IFRS for a much broader circle of companies. On the other hand, Germany, France and Austria, where taxation and accounting are traditionally closely related, would allow only for the narrowest circle prescribed in the IAS regulation to prepare their separate financial statements in conformity with the IFRS (Guggiola, 2010; Procházka and Molín, 2016).

---

<sup>52</sup> Eotvos Lorand University Institut of Business Economics, 1088 Budapest, Rákóczi út 7, Hungary

<sup>53</sup> Eotvos Lorand University Institut of Business Economics, 1088 Budapest, Rákóczi út 7, Hungary

<sup>54</sup>

[https://ec.europa.eu/info/sites/info/files/business\\_economy\\_euro/company\\_reporting\\_and\\_auditing/documents/ias-regulation-use-of-options-overview\\_en.pdf](https://ec.europa.eu/info/sites/info/files/business_economy_euro/company_reporting_and_auditing/documents/ias-regulation-use-of-options-overview_en.pdf) (European Committee, 2019)

The situation of the Central European countries and, among them, Hungary, is peculiar because so far as the relation between accounting and corporate taxation are concerned they are conventionally much closer to the stringent German approach; still, as regards the application of the IFRS they tend to be much more allowing and stand closer to the Anglo-Saxon practice. The more widespread the application of the IFRS becomes on the level of the member states, the more important it is to find out how can IFRS-based accounting be harmonised with taxation (Brüggemann et al., 2012; Cuzdriorean and Matis, 2012; Jacobs et al., 2005).

Several empirical studies have examined actual or theoretical corporate taxation in the member states with taxes computed according to the IFRS or local accounting principles (Eberhartinger & Klostermann, 2007; Gavana et al., 2015; Haverals, 2007; Jirásková, 2013). However, partly due to the vast differences in the methodology of the studies the conclusions significantly differ in whether the introduction of the IFRS would result in tax deficit or tax surplus for the respective exchequers of the different member states. The doubt raised before the introduction of IFRS in Hungary, namely whether transition shall or not have any negative impact on taxation, coincide with these quite diverse empirical results (Mészáros, 2015).

## **TAXATION OF IFRS COMPANIES**

In Hungary, the most significant of all taxes levied on profits is the corporate tax. Earlier all companies in Hungary calculated the corporate tax based on the profit before tax as per the local GAAP, but after the transition, IFRS companies declare their corporate tax on the PBT as per IFRS.

As at the transition the parties set as a goal the principle of fiscal neutrality (Molnár, 2015), it had to be achieved that the tax liabilities of the companies should be more or less the same irrespective of their accounting systems. To reach this goal, adjusting items were required (Borók, 2015), and finally, amendments to the tax act were adopted. Companies under the domestic accounting system use adjusting items for modifying the tax basis. These adjusting items arise from the different requirements of the Act on Accounting and the Corporate Tax Act. The IFRS companies need further adjusting items to balance the differences between accounts prepared according to the IFRS and the Act on Accounting.

In the preparatory phase, the proper level of tax revenue was also formulated as a requirement in the transition process. A minimum tax was applied to maintain the stability of state revenues. Accordingly, in the fiscal year of transition and the consecutive tax year companies shall pay a corporate tax at least the same that paid in the last fiscal year preceding transition. When the company, due to unfavourable economic processes, should pay a significantly lower amount of corporate tax than the amount paid before the transition, a special exemption can be applied.

The legislator tries to eliminate the above anomaly of the minimum tax by a temporary solution. If the corporate tax liability of the company as calculated according to the Hungarian accounting rules would be less than in the year before the transition, then it can lodge a special request for its tax liability to be established according to the acts on accounting. This remedy is therefore available only temporarily as the exemption can be requested only in the year of transition and the consecutive one. In that case, companies shall have a bookkeeping system that meets the requirements of both IFRS and Hungarian Accounting Act (hereinafter; Hungarian Accounting Standards, HAS).

Companies that establish their tax liabilities from the profit before tax as per IFRS incorporate into their calculations the differences between the two accounting systems with the help of a multi-phase corporate tax calculation process. As the Hungarian accounting rules treat the changes in the equity in a way different from the IFRS, therefore these differences shall need to be adjusted. The accounting treatment of expenses and incomes shows differences in the two systems, either; so, these differences must be adjusted, too, still before the establishment of the adjusted pre-tax profit.

Adjusted PBT shall be further modified because of the differences stemming from the different approaches of the statutory provisions regulating accounting and taxation. This modification circle has impacts on several points on the tax expense of those applying the IFRS. The switch from HAS to IFRS causes transition differences which also have to be considered on this level. After the consideration of the previously mentioned tax base adjustments, companies determine the corporate tax, which can be reduced potentially by tax benefits.

## METHODOLOGY AND DATA

In our study, we analysed data on the corporate taxes paid between 2016 and 2018 by companies transitioning to the IFRS in 2017. According to the data published by the Hungarian National Tax and Customs Authority in 2017 (NAV, 2017), 142 companies that have transitioned to IFRS and preparing their accounts thereunder have filed corporate tax returns. We have confined our study only to companies listed on the Budapesti Értéktőzsde (Budapest Stock Exchange) as of 01 January 2020. The reason for this is that listed public companies are the only well identifiable group, that were uniformly obliged to adopt the use of IFRS.

On 01 January 2020 shares of 43 companies were listed on the Budapest Stock Exchange. Among these companies, 35 were listed in both 2017 - at the date of the obligatory IFRS transition. So, these companies have data relevant for our study. We removed the data of an association of savings banks, as it transitioned to IFRS in 2019. As a result, the 34 enterprises taken into account in the study represent only 24% of the transitioning companies, but they collectively account for 67% of the cumulated pre-tax profits of all. Therefore, the changes that can be observed in the sample well represent trends in state revenues as a result of the transition.

As regards their legal forms, out of the 34 companies, 33 are public companies limited by shares and 1 is a European company. As regards their business, industrial production companies, services providers and financial firms have a more or less equal share among them, and there are a small number of real estate companies, one bank and one insurer among them.

In our studies, we examined data in the financial statements of the 34 companies above for the period between 2016 and 2018. Using these we have obtained for each year the actual effective tax rates by the help of formula 1.

$$\text{effective tax rate} = \frac{\text{Corporate tax for the year of assessment}}{\text{IFRS profit before taxation} - \text{Other profit taxes}} \quad (1)$$

Thus, from the period before the transition, from among the financial statements prepared in 2016 as per Hungarian Act on Accounting those were taken into account that had a positive pre-tax result in 2016, and their profit and loss statement showed corporate tax expense. Thus, out of the pre-selected 34 companies, the data of 17 could be used regarding 2016. From FYs 2017 and 2018, i.e. the period after the transition, we have collected the corporate tax liability

and the pre-tax profit in the IFRS financial statements. We have taken into account companies that had tax liabilities in the given years and a positive pre-tax result. Seventeen listed companies met these criteria in 2017, and 24 in 2018.

The IFRS income taxes differ from those computed as per the Hungarian Act on Accounting; therefore, they had to be adjusted. The Act on Accounting interprets only corporate tax as an income tax expense in the year of assessment. Several IFRS companies in Hungary classify local business tax and innovation tax as an income tax under IAS 12 and other companies present these tax types as other operating expenses, which is the right treatment on the basis of the local GAAP. In 2017 were 20 and in 2018 22 cases, where these taxes were treated as income taxes. We filtered them from the pre-tax profits.

**Table 1.** Accounting for "other income taxes" at the companies studied

Year	2017	2018
Accounted for as income tax	21	23
Accounted for as other operating expense	12	11
No data available/no IFRS FS	1	0
<b>Total</b>	34	34

The average amount of the effective corporate tax could be determined from the effective corporate tax rates of the companies using formula 1. The results of the calculations are summarised in Table 2.

**Table 2.** Rate of the average effective corporate tax

	2016 eff. CT	2017 eff. CT	2018 eff. CT
<b>Average effective corporate tax</b>	6.72%	3.35%	7.33%
<b>The cleaned average effective tax rate</b>	5.76%	3.10%	4.97%

The averages presented in the first row of Table 2 contain some extreme values that considerably distorted our results; we cleaned our database. As a result, we calculated the cleaned effective tax rates, in which the highest and the lowest effective tax rate values of the respective companies were not included. The cleaned average effective tax rates can be found in the last row of Table 2. We have compared the data obtained with national tax authority data for IFRS taxpayers published by Tóth-Takács (2018).

**Table 3.** Computation of the corporate tax of companies using the IFRS in 2017 (data in HUF)

<b>1.</b>	Profit before tax as per IFRS (IFRS PBT)	895,014
<b>2.</b>	IFRS PBT adjusting items (a+b)	-36,909
<b>a.</b>	Other income taxes (local business tax, innovation tax, etc.)	-33,645
<b>b.</b>	IFRS adjustments	-3,264
<b>3.</b>	Adjusted profit before tax (APBT) (Lines 1+2)	858,105
<b>4.</b>	Total APBT adjustments – not including Line 5	-559,364
<b>5.</b>	IFRS transition difference	-9,459
<b>6.</b>	Tax base (Lines 3+4+5) or minimum income	286,542
<b>7.</b>	Corporate tax payable or minimum tax	20,815

**Source:** Authors processing based on data of Tóth-Takács (2018)



## RESULTS

From the results of the cleaned data, it is obvious that from the first year of the transition to IFRS, i.e. from 2017, the average tax rate of public listed companies has considerably decreased. It must, however, be examined whether it comes from the transition or other processes could also contribute to the considerable decrease experienced in 2017.

An explanation for the decrease can, on the one hand, be that from 2017 the rate of corporate tax has changed. As opposed to the progressive taxation applied before (the rate of the corporate tax was 10 % up to a tax base HUF 500 million and 19% after that), a fixed rate 9% corporate tax was introduced. Thus, in order to make the data for 2016 to be comparable with data from subsequent periods, it was justified to recalculate the corporate taxes for 2016 by the tax rate introduced in 2017. In 2016, the financial statements complied the Act on Accounting, and they also include a detailed breakdown of the calculation of the corporate tax; thus, the theoretical, 9% tax can be derived from these.

**Table 4.** The impact of the change in the nominal rates on the effective tax rate

Tax base	Eff.tax_10-19%	Eff.tax_9%	Change of rate	Change of tax burden
<b>HUF 0-500 million</b>	4.41%	2.60%	-1.81%	-43.53%
<b>HUF 500 million &lt;</b>	7.68%	6.91%	-0.77%	-10.00%
<b>Eff- CT tax_total</b>	6.72%	5.64%	-1.07%	-16.84%
<b>millionCleanef CT_total</b>	5.76%	4.73%	-1.03%	-17.92%

Although it seems to be an apparent explanation as the tax rate was reduced from 19% to less than its half, i.e. to 9 %, it is important to note, that out of the 17 companies with data relevant to 2016, there were only five whose tax base exceeded the HUF 500 million limits, accordingly, the remaining 12 companies could apply the lower, 10% tax rate for their entire tax base.

In this way, the tax burdens of the twelve companies with a tax base under HUF 500 million decreased by a mere 10% as a result of the recalculation of the data for 2016, while their effective tax rates have decreased by 0.77-point percentage. For tax income, however, the figures for the five "key accounts", who in 2016 have accounted for 95% of the total amount of the tax liabilities of the above 17 companies are crucial. Their tax liabilities decreased by 43.53% on average, and their average effective tax rates from 4.41% to 2.6%.

As shown in table 4, the impact of the tax rate reduction introduced in 2017 on the effective tax rates and the tax burdens of the companies is smaller than the decrease experienced in the year of transition. Thus, the change in the tax rates in itself could not result in a drop of the average effective tax rates of companies to almost the half in the year of transition compared to these in the preceding year, i.e. 2016.

Although to allow their comparison, all other profit taxes except corporate tax were already reclassified into the profit before tax; there are still differences that result from the different accounting approaches. The IFRS adjusting items in PBT are aimed to treat this difference. In order that their impact and efficiency could be examined, we had to compare the pre-tax profits computed in two different ways. We can use as a point of reference the pre-tax profits for the year 2016.

IFRS 1 requires the presentation of the data for the business year preceding transition for comparative purpose, in the first financial statements prepared based on International Financial Reporting Standards. Thus, the financial statements of those who transitioned in 2017 also include the comparative data for 2016. In these, we can find the profit before tax for 2016 that shall be adjusted as aforesaid by the other income taxes accounted for in the income tax expenses.

We compared the two types of data of those listed companies whose calculated pre-tax profits and corporate tax liabilities had a positive value in 2016 both in IFRS, and HAS. 15 of the 34 companies (seven listed on BUX and eight other traders) met this criterion. Using the data, we examined how the difference between the pre-tax profits estimated according to the IFRS and by the method prescribed by the Hungarian Act on Accounting impacted the average effective tax rate.

**Table 5.** Theoretical impact of the average effective tax rate change in 2017 on 2016

	<b>Av. diff.PTP (Act on Acc./IFRS)</b>	<b>IFRS 2016 Eff.tax rate</b>	<b>Act on Acc. 2016 Eff.tax_10-19%</b>
<b>Other</b>	+27.93%	7.52%	7.97%
<b>BUX</b>	+14.77%	2.49%	2.89%
<b>Total</b>	+21.79%	5.17%	5.60%

From Table 5, it is apparent that, on average, the IFRS profit before taxation is higher than in HAS. It is not only valid for the averages but also the single companies: as a result of the IFRS transition, the PBT decreased by only three companies, out of the 14 examined companies.

We also further examined other IFRS tax adjustments from the data of the national tax authority (Tóth-Takács, 2018), presented in Table 3. The total IFRS adjustments, other than the other income tax corrections, result in a much lesser decrease in the IFRS profit before tax. On the level of the adjusted PBT, essential adjustments are the adjusting effects of the transition differences. If we examine their increasing or decreasing impact on the tax base separately, then they are relatively significant. If, however, we consider them on their net values, their impacts amending the tax base become less significant compared to the other adjusting items associated with the IFRS.

Following their transitions to the IFRS, these companies have, as a non-recurring effect, a transition difference. According to IFRS 1, transition difference is accounted for directly in the equity; therefore, it does not affect the profit or loss. Although this difference is accounted for within equity, according to the Act on Personal Income Tax, it is still considered as an adjusting item of the tax base. According to the 2017 data, the predominant part of the transitioning companies availed themselves of the opportunity to decrease their tax base by the transition differences. The negative difference can be accounted for as a decreasing item in three years, while the positive difference can either be accounted for in three years or all in one sum, in the year of transition. The transition difference is a one-off effect in the tax of the IFRS companies. The adjusting effect of the transition difference ceases in the third year, at the latest, following the transition, and from then on it causes no difference compared to the tax determination of companies of the Hungarian Act on Accounting.

There are also adjusting items which both affect IFRS and the Hungarian Act on Accounting companies; however, the adjustment affects the two circles differently: e.g. IFRS companies

more frequently use fair value measurement in their financial statements than local GAAP companies.

Among the examined companies, there were several holding companies, participants of the real estate market and financial services providers; by whom fair value measurement is a usual accounting practice, the impacts may cause a significant difference in the pre-tax profits of the two accounting systems.

By 2016, compared to the local GAAP, the pre-tax profit items were extended according to IFRS. Among the real estate companies, the profit before tax as per the IFRS was always higher than per local GAAP. During 2016 a steady price growth could already be observed on the real estate market (MNB Lakásárindex, 2020; Statisztikai Tükör, 2019), then this price increase could manifest through the fair valuation in the IFRS pre-tax profits. These surplus profits appear as a decreasing item in the tax base by the same amount as the profits originating from the fair valuation.

Thus, due to the adjusting items, the fair valuation had no impact on the amount of the corporate tax. It, however, decreased the effective tax rate calculated from the pre-tax profits obtained according to the IFRS.

## CONCLUSION

In our paper, we examined corporate tax data obtained from the financial statements of Hungarian companies listed on the Stock Exchange. Our research question focused on the tax revenues of IFRS companies after the transition.

In Hungary, IFRS companies may use the profit before tax presented according to the international standards as the basis for the calculation of their corporate taxes.

In Hungary, the corporate tax base is determined on a domestic accounting basis. IFRS companies apply tax base adjusting items, taking into consideration also the domestic adjusting items and tax benefits.

According to data regarding share issuers listed on the Budapest Stock Exchange, in the year of transition, i.e. in 2017, the average effective tax rates of the companies decreased significantly, and this lower value also remained in 2018, i.e., the year following the transition. The decrease was larger than the considerable decrease in 2017 of the nominal corporate tax rate.

The PBT adjustments and the recognition of the transition differences also explain the decrease of the effective tax rate. The tax base adjustments secured the steadiness of tax revenues and the tax neutrality of taxpayers.

We identified the adjustments resulting from the fair value method as significant adjusting items by financial services providers, real estate and holding companies. The elimination of the positive effects of fair valuation on the profit before tax led to a considerable decrease in the effective tax rate but not in the tax revenue of the state.

In 2017, several impacts had resulted in a lower effective tax rate. These are partly attributable to transitioning to the IFRS and partly to the change of the tax rate. Their cumulative effect is the reason for the decrease. Although, by 2018, the average effective tax rate has increased,

still, it did not reach its level of 2016. Thus, part of the decreasing impacts has remained, but the one-off tax-reducing effect of transition difference was less significant. The change in the effective tax rate was not the result of the fact that due to transitioning, the tax payment liabilities of the companies have decreased.

Due to the transition, the change in the effective corporate tax rate is significant. The results show significant differences in the pre-tax profits calculated under the two different accounting systems. If the tax law regulations would not treat this difference then the effective tax rate would remain unchanged. The adjustment rules secure the tax revenue of the state and the neutrality of the taxpayers.

The study cover, however, only the data of the year of transitioning (2017) and the consecutive business year; therefore, the impact on the long run cannot be ascertained. Results referring to FY 2020 shall be highly interesting because of the trends contrary to those that have existed during the studied period.

## REFERENCES

- Bíró, J. (2015). IFRS áttérés az egyedi beszámolók tekintetében. A törvényi szabályozás állása és az áttérési szabályok [IFRS Transition from Separate Financial Statements Perspective. Legal position and the Laws of the Transition.]. MKVK conference paper.
- Borók T. (2015). Az IFRS-ek miatt szükséges változások a társasági adóban és az energiaellátók jövedelemadó-jában [Necessary Changes in Corporate Income Tax and Energy Supplier Tax Due to IFRS]. *Számvitel, adó, könyvvizsgálat*, 57(10), 455-457.
- Brüggemann, U., Hitz, J. M., & Sellhorn, T. (2013). Intended and unintended consequences of mandatory IFRS adoption: A review of extant evidence and suggestions for future research. *European Accounting Review*, 22(1), 1-37.
- Cuzdriorean, D. D., & Matis, D. (2012). The relationship between accounting and taxation insight the European Union: The influence of the international accounting regulation. *Annales Universitatis Apulensis: Series Oeconomica*, 14(1), 28.
- Eberhartinger, E., & Klostermann, M. (2007). What if IFRS were a Tax Base? New Empirical Evidence from an Austrian Perspective. *Accounting in Europe*, 4(2), 141.
- Gavana, G., Guggioli, G., & Marenzi, A. (2015). Aligning taxation and international financial reporting standards: evidence from Italian listed companies. *Politica Economica*, 31(1), 77-96.
- Guggioli, G. (2010). IFRS adoption in the EU, accounting harmonisation and markets efficiency: a review. *International Business & Economics Research Journal (IBER)*, 9(12).
- Haverals, J. (2007). IAS/IFRS in Belgium: Quantitative analysis of the impact on the tax burden of companies. *Journal of International Accounting, Auditing and Taxation*, 16(1), 69-89.
- Jacobs, O. H., Spengel, C., Stetter, T., & Wendt, C. (2005). EU company taxation in case of a common tax base: A computer-based calculation and comparison using the enhanced model of the European Tax Analyser. *Intertax*, 33, 414.
- Jirásková, S. (2013). Range data reported to the requirements of the IAS 12 and impact of the IFRS adoption for tax purposes in the tax collection of the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 61(4), 961-966.
- Mészáros L. (2015): A kormány döntött az IFRS-ek egyedi beszámolási célokra történő alkalmazásáról. *Számvitel, adó, könyvvizsgálat*, 57(6), 276-278.

- Molnár, Cs. (2015). Döntés-előkészítő folyamat az IFRS-ek hazai bevezetésére [Process of Preparation of the Domestic IFRS Transition]. *Számvitel, adó, könyvvizsgálat*. 57(2), 65-67.
- Procházka, D., & Molin, J. (2016). Book-tax conformity: the review of recent research and its implication for the IFRS adoption in Europe. *eJTR*, 14, 96.
- Tóth-Takács G. (2018). Az IFRS-alkalmazók 2017. évi társasági adó-adatai [Corporate Income Tax Data of IFRS Taxpayers 2017]. *Számvitel, adó, könyvvizsgálat*. 60(9), 19-21.



# CLASSIFICATION OF FINANCIAL MECHANISMS OF HEALTHCARE SYSTEMS IN THE COUNTRIES OF EUROPEAN UNION

Nadiya Dubrovina<sup>55</sup> 

Stanislav Filip<sup>56</sup> 

Vira Dubrovina<sup>57</sup> 

DOI:

---

**Abstract:** *In the article the problems of the classification of financial mechanisms of healthcare systems were considered. The well-known types of the financial mechanisms of healthcare systems were described and the authors argued the importance of the development of new classification of financial mechanism of healthcare systems in the EU, which will be based on the application of quantitative methods. The purpose of the research is cluster (or regimes of funding healthcare system) analysis and development for EU countries over long-term period of 2000-2017. The authors used k-means method for the cluster analysis and revealed 5 clusters (groups) for the characteristics of the different regimes of funding healthcare system in the EU countries.*

**Keywords:** *Healthcare system, Funding, Classification, Cluster analysis*

---

## INTRODUCTION

Health of population is a highest value of citizens in the developed democratic countries and the one of the prior target of social policy of the governments in the EU countries (European Commission, 2010). One of the important task for the government is to develop an efficient mechanism of funding healthcare based on the optimal allocation of public resources, social equity and access to the main healthcare services needed for support of public and individual health, prevention and treatment of the diseases, high quality of the health services and good performance of the healthcare institutions. For these reasons strategies of health policy should be based on the targets of society, in one of the hand, and features of the socio-economic capacities and political background, in other hand. Health policy as a mirror of the values of the society or communities, and it is relative with socio-economic systems, traditions, national strategical programs of the development, etc. (Greer et al, 2013, Gottlieb et al, 2019).

Kostičová et al. noted that “a health system is the ensemble of all public and private organizations, institutions and resources mandated to improve, maintain or restore health” (Kostičová et al, 2011, p. 84.). That is why is relatively difficult to compare national health systems in the different countries, because it is necessary to take into account main indicators

---

<sup>55</sup> School of Economics and Management in Public Administration in Bratislava, Furdekova 16, 851 04 Bratislava, Slovakia

<sup>56</sup> School of Economics and Management in Public Administration in Bratislava, Furdekova 16, 851 04 Bratislava, Slovakia

<sup>57</sup> Kharkiv Institute of Trade and Economics of KNTEU, Otakara Yarosha Ln, 8, Kharkiv, Kharkiv, 61000, Ukraine

characterizing economic, socio-demographic, political and institutional background in each country. Nevertheless, some typologies or classification of the healthcare systems to its funding are described in the books and papers (Mossialos et al, 2002, Kostičová et al, 2011, Benova et al., 2014). The authors characterize well-known types of the financing of health systems as: Bismarkian health insurance or public contract model, Beveridge model or public-integrated model, Douglas national health insurance model, Semashko national health system or mixed private/public system (Kostičová et al, 2011), or develop own classification based on the multidimensional analysis of the set of the main indicators characterizing health systems (Benova et al., 2014). Beveridge model is based on the public finance by general taxation. This model is implemented in the UK, Norway, Sweden, Denmark, Italy, Spain, Portugal, Greece. The features of this model are: central planning, integrated district health system with capitation financing, general physicians service. Bismarckian model has compulsory social insurance and it is included contracts with providers or patient reimbursement. This model was developed in Germany and it occurs now in Netherlands, France, Austria, Belgium, Slovakia, etc. Douglas national health insurance model is based on taxation and cost sharing between provincial and federal government. In this system the federal government regulation and provincial government administration are implemented, medical services are paid by fee-for-service and hospitals have block budgets. This system works in Canada and Australia. In mixed private/public system private insurance through employment is used, but public insurance exists for specific groups (children, elderly, poor) and private voluntary insurance is possible. This system is realized in the USA, some countries of Latin America, Asia and Africa. Semashko national health system uses revenue from state budget, it characterizes by strong central government planning and control and financing by fixed norms per population. This system was created and works in the USSR (Kostičová et al, 2011).

Nowadays the tendencies of mix and variation of these models are observed, and cost-sharing by patients contributes to health care finance in all countries of the EU (Santo et al, 2020).

Thus, for more complete characteristic of financing mechanisms of healthcare systems in the EU countries and for their comparative analysis it is insufficient just distinguish such models as: state public health care system; social health insurance system; private medicine or mixed system. Even among the countries with similar general principles of financing of public health care system there are essential differences in providing the sources and funds of national public health care system, payment for various medical services, full or part their covering, etc. That is why classification of financial mechanism must be enhanced and expanded by means including other additional principles and approaches.

It is important to design classification system based on the quantitative methods and application of the set of main indicators.

## **THE PURPOSE AND METHODOLOGY OF RESEARCH**

The purpose of the research is cluster (or regimes of funding healthcare system) analysis and development for EU countries over long-term period.

For this study the database from Eurostat for main indicators for period of 2000-2017 was used and k-means as one of the method of cluster analysis was applied.



## MAIN RESULTS

In our research three macroeconomic indicators such as: total government expenditure on health as % of GDP (TGEH1); total government expenditure on health as % of total general government expenditure (TGEH2); total government expenditure on health per capita (TGEH3) were used.

Thus, first indicator TGEH1 characterizes the government policy in healthcare; second indicator TGEH2 describes budget policy and social policy of the government in its relation to healthcare; third indicator TGEH3 shows the level of economic development of the country, well-being and relative values of the expenditure on health per capita, which are higher in rich and well-developed countries.

The graphical analysis of the plots for the dynamics of the indicators TGEH1, TGEH2 and TGEH3 for each country of the EU-28 during period of 2000-2017, as well as the study of their basic descriptive statistics for mentioned indicators showed that for many countries of the EU-28 the tendencies to increase values were observed. In some countries the values of these indicators were varied near average level, in other countries the more complicated changes in the values of the indicators were revealed (Dubrovina et al, 2020).

These facts proved that on the dynamics of the main macroeconomic indicators (total government expenditure on health as % of GDP - TGEH1; total government expenditure on health as % of total general government expenditure - TGEH2; total government expenditure on health per capita - TGEH3) a lot of social, economic, political factors can have an impact. Of course, for many countries in transition, post socialist countries, which join to the EU since 2004 and later the initial values of total government expenditure on health per capita were essentially lower, in comparison with well-developed countries from Western Europe (Jakubowski, Busse 1998, Docteur, Oxley, 2003, Boulhol et al., 2012). Due to the crucial reforms in healthcare sector, structural investment programs from the EU, rapid economic growth in these countries the tendencies of the increasing total government expenditure on health per capita or total government expenditure on health as % of GDP were observed. Nevertheless, in some countries of the EU the change in the political impact for leading political parties, political or economic crises influenced on essential changes in national models of funding healthcare (Mossialos et al, 2002, Dixon, 2006, Joumard, 2010, Eurostat, 2020).

In our research we grouped the countries of the EU-28 to similar groups or clusters according to their values of the indicators TGEH1, TGEH2 and TGEH3. For the grouping the countries of the EU-28 we used data for period of 2000-2017 and k-means method of cluster analysis. This method is described in many books devoted the applied statistical methods and is realized in such software as: Statistica, SPSS, Matlab, etc. (Borovikov, 2001, Dostal, 2008, Kozlíková, 2018). On the basis of the analysis of dendrograms and results of the analysis of variance for the different number of clusters, as well due to the results of their qualitative interpretation, we concluded that number of 5 clusters is the best variant according to the interpretation and results of the analysis of variation. The results of analysis of variation for 5 clusters are given in table 1.

In the table 2 the descriptive statistics is shown for clusters and in table 3 the results of grouping countries of the EU-28 are presented for period of 2000-2017.

**Table 1.** Analysis of Variance

	Between		Within			signif.
	SS	df	SS	df	F	p
X	470,4755	4	518,6642	499	113,1596	0
Y	945,9238	4	2235,044	499	52,79716	0
Z	5,5E+08	4	25739546	499	2667,019	0

**Source:** own elaboration in Statistica

As it is seen from table 2, cluster No.1 contains 21 cases, this cluster characterizes the highest value of total government expenditure on health per capita (indicator TGEH3 or Z), the means for other indicators TGEH1 or X (total government expenditure on health as % of GDP) and TGEH2 or Y (total government expenditure on health as % of total general government expenditure) have relatively high values, but not the biggest.

**Table 2.** The characteristics of clusters for grouping the EU-28 countries according the different regimes of funding healthcare during period of 2000-2017

Variable	Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5	
	Cluster contains 21 cases		Cluster contains 92 cases		Cluster contains 93 cases		Cluster contains 111 cases		Cluster contains 187 cases	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
X	6,75	1,86	7,23	0,92	6,64	0,77	6,34	0,79	4,8	1,16
Y	13,58	2,26	15,12	1,97	14,03	1,41	14,36	2	11,71	2,5
Z	4007,39	342,64	2860,85	251,59	2030,03	237,06	1141,22	214,57	446,22	199,42

**Source:** own elaboration in Statistica

Cluster 2 contains 92 cases, the mean of indicator TGEH1 or X (total government expenditure on health as % of GDP) and mean of indicator TGEH2 or Y (total government expenditure on health as % of total general government expenditure) are the biggest, the countries of the EU-28 with extremely high values of TGEH1 and TGEH2 were concentrated in this cluster. Also countries of the EU-28 included in this cluster have very high value of TGEH3 or Z (total government expenditure on health per capita) in comparison with countries in other clusters, such as: cluster No.4 and Cluster No.5.

Cluster 3 contains 93 cases, in this cluster are relatively high all values of indicators: TGEH1 or X (total government expenditure on health as % of GDP,) TGEH2 or Y (total government expenditure on health as % of total general government expenditure) and TGEH3 or Z (total government expenditure on health per capita). But the mean for indicator of TGEH3 is essentially lower than in cluster No.1 and cluster No.2, and more than 1,7 times mean value for cluster No.4, more than 4,5 times mean value for cluster No.5

Cluster 4 contains 111 cases and characterizes relatively high values for indicators TGEH1 or X (total government expenditure on health as % of GDP), and TGEH2 or Y (total government expenditure on health as % of total general government expenditure), but relatively low level of TGEH3 or Z (total government expenditure on health per capita).

Cluster 5 contains 187 cases and the features of this cluster are the lowest mean values for all indicators, such as: TGEH1 or X (total government expenditure on health as % of GDP,)

TGEH2 or Y (total government expenditure on health as % of total general government expenditure) and TGEH3 or Z (total government expenditure on health per capita).

It should be noted that most of the EU-28 countries switched the regimes of the funding healthcare systems. It is proved that over period of 2000-2017 they moved from one kind of cluster to another one. For most countries this switch from one type of cluster to another one occurred after long period, so it is possible to suggest the results of the economic development, new strategies of government, maybe after change of leading political party and other priorities in social or budget policies. Nevertheless, some countries demonstrated the stable policy in funding their national healthcare and over all period these countries were in the same cluster.

For example, cluster No.5 or “trap of poverty” included post socialist and emerging countries which were in this cluster all period of 2000-2017 or long period.

Such countries as: Bulgaria, Croatia, Cyprus, Latvia, Hungary and Poland were in this cluster all period of 2000-2017. Other countries were in this cluster for long period: Czechia (2000-2005), Estonia (2000-2014), Lithuania (2000-2016), Malta (2000-2005), Slovakia (2000-2007). After some improving the funding healthcare systems and increasing total government expenditure on health per capita these countries moved to cluster No.4. Thus, Greece started from cluster No.5 in 2000 to better cluster No.4, nevertheless as a reaction on the global economic and financial crisis of 2008-2012 and internal political and economic crisis this country returned to cluster No.5 in 2014 and in 2015. Portugal was in cluster No.5 in 2000 and then moved to cluster No.4. In cluster No.5 Slovenia was in 2000 and 2001, then it moved to cluster No.4.

For all period of 2000-2017 in cluster No.4 only one country was, this is Spain. In cluster No.4 a lot of countries of the EU-28 stayed long period, such as: Czechia (2006-2017), Greece (2001-2013, 2016, 2017), Malta (2010-2017), Portugal (2001-2017), Slovenia (2002-2017), Slovakia (2008-2017). In 2000 such countries as: Belgium, Ireland, Italy, Netherlands, Finland and the United Kingdom were in cluster No.4.

In cluster No. 3, cluster No.2 and cluster No.1 no countries were for all period of 2000-2017, nevertheless, a lot of countries were for long period. In cluster No.3 a lot of countries were for long period: France (2000-2009), Belgium (2001-2008), Italy (2004-2017), Austria (2000-2006), Sweden (2000-2006), the United Kingdom (2001-2013).

In cluster No.2 some countries were for long time period: Belgium (2009-2017), Ireland (2004-2017), Netherlands (2007-2017), Austria (2008-2016), Finland (2008-2017) and Sweden (2010-2017). Some countries of the EU-28 were in this cluster a shorter period: Denmark (2002-2007), Germany (2013-2017), Luxembourg (2003-2007), the United Kingdom (2014-2017).

In long period cluster No.1 with the highest level of total government expenditure on health per capita includes cases from two counties of the EU-28: Denmark (2008-2017) and Luxembourg (2008-2017). Austria had occurred in this cluster only in 2017.

**Table 3.** Grouping the EU-28 countries to the clusters during period of 2000-2017

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Belgium	CL4	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2
Bulgaria	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5
Czechia	CL5	CL5	CL5	CL5	CL5	CL5	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4
Denmark	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL1	CL1	CL1	CL1	CL1	CL1	CL1	CL1	CL1	CL1
Germany	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2
Estonia	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL4	CL4	CL4
Ireland	CL4	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2
Greece	CL5	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL5	CL5	CL4	CL4
Spain	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4
France	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2
Croatia	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5
Italy	CL4	CL4	CL4	CL4	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3
Cyprus	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5
Latvia	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5
Lithuania	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL4
Luxembourg	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL1	CL1	CL1	CL1	CL1	CL1	CL1	CL1	CL1	CL1
Hungary	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5
Malta	CL5	CL5	CL5	CL5	CL5	CL5	CL4	CL5	CL5	CL5	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4
Netherlands	CL4	CL4	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2
Austria	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL1
Poland	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5
Portugal	CL5	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4
Romania	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5
Slovenia	CL5	CL5	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4
Slovakia	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL5	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4	CL4
Finland	CL4	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2
Sweden	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL3	CL2	CL2	CL2	CL2	CL2	CL2	CL2	CL2
United Kingdom	CL4	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL3	CL2	CL2	CL2	CL2

Source: own elaboration in Excel

## CONCLUSION

On the base of the analysis of variance for the different number of clusters, as well as results of their qualitative interpretation, we concluded that number of 5 clusters is the best variant according to the interpretation and results of the analysis of variation. For the qualitative interpretation of these clusters we called them “regimes of funding healthcare system”.

It is proved that over period of 2000-2017 countries moved from one kind of cluster to another one. For most countries this switch from one type of cluster to another one occurred after long period, so it is possible to suggest the results of the economic development, new strategies of government, probably after change of leading political party and other priorities in social or budget policies. Nevertheless, some countries demonstrated the stable policy in funding their national healthcare and over all period these countries were in the same cluster.

It should be noted that in some countries the policy of financing health systems was quite flexible and changed, while in other countries this policy was stable for a long term period. At the same time, a number of social, economic, political and institutional factors influence the policy of financing health systems, which should also be taken into account and studied in connection with the changing characteristics of financing the health system in the country.

## ACKNOWLEDGEMENT

The paper is the output of a scientific project IGA 3/2020-M “Improving Healthcare efficiency: new trends and challenges”. (Funder: VSEMs IGA VSEMs, i.e. School of Economics and Management in Public Administration)

## REFERENCE

- Benova E., Dubrovina N., Boyko V., Zamyatin P. (2014). Classification and cluster analysis of health care systems in the OECD countries // Public Administration and Regional Development. School of Economics and Management in Public Administration. No.2. December, 2014. Vol. X, pp.45-56.
- Borovikov V. (2001). Statistica: iskustvo analiza dannykh na kompjutere. – SPb.: Piter, 2001. – 656 s.
- Boulhol H. et al. (2012). Improving the Health-Care System in Poland. OECD Economics Department Working Papers, No. 957, OECD Publishing. <http://dx.doi.org/10.1787/5k9b7bn5qzvd-en>
- Dixon A. (2006). Learning from international models of funding and delivering health care. Oxford Handbook of Public Health Practice. Oxford University Press. 2006.
- Docteur E., Oxley H. (2003). Health-Care Systems: Lessons from the Reform Experience. OECD Health Working papers. No. 9, 2003.
- Dostal, P. (2008). Pokročilé metody analýz a modelování v podnikatelství a veřejné správě. Brno, CERM. 340 s.
- Dubrovina N., Tulai O., Neuvauerova E. (2020). Tendencies of funding health care in EU countries: the features and perspectives/ In Monograph “Theoretical and applied aspects of sustainable development”. Ed. T. Nestorenko and A. Ostenda. Katowice School of Technology. Katowice. 2020. pp. 12-22.
- European Commission (2010). Joint Report on Health Systems. Occasional Papers, No. 74. Eurostat. Database is available at: <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>

- Funding health care: options for Europe. (2002). Edited by E. Mossialos, A. Dixon, J. Figueras, J. Kutzin. Open University Press. Philadelphia. USA, 2002. – 327 p.
- Gottlieb N, Bozorgmehr K, Trummer U, Rechel B. (2019). Health policies and mixed migration – lessons learnt from the ‘refugee crisis’. *Health Policy* 2019; 123: 805–08.
- Greer SL, Hervey TK, Mackenbach JP, McKee M. (2013). Health law and policy in the European Union. *Lancet* 2013; 381: 1135–44.
- Highest proportion of government expenditure goes to social protection and health (2020). Eurostat newsrelease No. 33/2020 from 27 February 2020. Available at: <https://ec.europa.eu/eurostat/documents/2995521/10474879/2-27022020-AP-EN.pdf/4135f313-1e3f-6928-b1fd-816649bd424b>
- Jakubowski E., Busse R. (1998). Health Care Systems in the EU. A Comparative Study. Working Paper. European Parliament. Luxembourg. 1998. 130 p.
- Joumard, I., C. André and C. Nicq (2010), “Health Care Systems: Efficiency and Institutions”, OECD. Economics Department Working Papers, No. 769.
- Kostičová M., Ozorovský V., Badalík L., Fabian G. An Introduction to Social Medicine. Bratislava, 2011. – 150 s.
- Kozlíková K, Trnka M. (2018). Úvod do spracovania a prezentovania dát v medicíne. Equilibria, s.r.o., Košice, 2018. 226 s.
- Santos, J. V., Lobo, M., Neiva, R. M., Viana, J., Souza, J., Dias, C. C., Cylus, J., Ricciardi, W., & Freitas, A. (2020). European Union state of health from 1990 to 2017: time trends and its enlargements' effects. *International journal of public health*, 65(2), 175–186. <https://doi.org/10.1007/s00038-020-01335-0>

# PREPARING SCHOOL GRADUATES FOR THE LABOUR MARKET

Mária Nováková<sup>58</sup>   
Silvia Capíková<sup>59</sup> 

DOI:

---

**Abstract:** *Despite their determination to work and build their careers, school graduates are not sufficiently prepared to look for work and the opportunities to search a job. In most cases they are well prepared in theory and language and are literate in modern technologies. Their biggest handicap is the lack of practical skills and work experience. At the same time, graduates have to face the challenges of accelerated globalization and digitization. It is necessary to find answers to questions about what professional knowledge, practical skills, attitudes and values will be shaped by today's graduates and how education systems can develop the required knowledge and skills. The ambition of our contribution is to identify the main disparities that must be overcome in order to achieve the goal of the country's economic development strategy, in which the education system must inevitably correspond to the labour market requirements.*

**Keywords:** *Labour market, school graduates, skills.*

---

## 1. INTRODUCTION

**A**ccelerated globalization and, as a result, the pandemic crisis are bringing about societal change and have affected a wide range of areas from industry to technical standardization, security, education system, science, research to the labour market or the social system.

The reality of the national labour market, but also of the global labour market, is one of the most complex objects of research. It is absolutely essential that the theory, based on careful observation, analysis and generalization, comes up with new recommendations for improving the organization of the education system and for implementing a successful social policy.

The subject of the paper is mainly the analysis and research of professional competencies, which are crucial and useful for the labour market.

## 2. PROFILE OF YOUNG PEOPLE APPLYING FOR JOBS

There is no doubt that each generation has certain specifics that are only a manifestation of the dominants of historical development.

While previous generations have become accustomed to the stability and security of employment, the current driving force prefers greater flexibility in working conditions and

---

<sup>58</sup> Faculty of Law, Comenius University in Bratislava, Šafárikovo námestie 6, 810 00 Bratislava, Slovak Republic

<sup>59</sup> Faculty of Law, Comenius University in Bratislava, Šafárikovo námestie 6, 810 00 Bratislava, Slovak Republic

favours of "freelance" work. Their goal in the work process is primarily to achieve a work-life balance.<sup>60</sup>

### **3. EMPLOYERS' REQUIREMENTS**

Digitization, automation and robotics are processes that began to have a significant impact on the labour market before the pandemic crisis.

However, it was not until the onset of the pandemic crisis, which is a global public health crisis that the digitization of the private and public sectors accelerated enormously.

Rapid technological progress raises a number of concerns and panics about the threat to the existence of today's jobs and at the same time about the uncertainty of the unknown possibilities of shaping future labour markets.

Enormously changing technological changes must adapt employers' requirements for new jobs.

At present, it is unthinkable that an employee does not have technological and digital skills. Employers also appreciate soft skills, such as analytical thinking, communication, creativity, the ability to process complex information. Employers are also placing increasing emphasis on social skills.

### **4. ALTERNATIVES TO PREPARING SCHOOL GRADUATES FOR THE LABOUR MARKET**

Global challenges also require global solutions to prepare school graduates for the global labour market.

Accredited training institutions must be prepared to flexibly reflect the needs of the labour market.

The education system must support the adaptation of theoretical knowledge, skills and qualifications to demand and job opportunities. This means that it must facilitate the possibility of the traditional transition from school to work.

In this regard, it is extremely important not only at the national, but also at the global level to support research in the field of shaping the work environment, especially research that is aimed at identifying promising study programs shaping graduates.

Educational institutions are expected to develop competencies that are focused primarily on verbal communication, analytical critical thinking, creativity, complex problem-solving in teamwork, the ability to establish relationships, etc. These skills are referred to in practice as soft skills.<sup>61</sup>

---

<sup>60</sup> NEVICKÁ, D.: Graduate and Digitization of the Labour Market. Reviewed. In: Labour law in digital form: conference with international participation. -: 1<sup>st</sup> ed. ISBN 978-80-7502-259-2. – Prague: Printing house Leges, 2017.-p. 216-226 ((Theoretical)).

<sup>61</sup> NEVICKÁ, D.: Graduate and Digitization of the Labour Market. Reviewed. In: Labour law in digital form: conference with international participation. -: 1<sup>st</sup> ed. ISBN 978-80-7502-259-2. – Prague: Printing house Leges, 2017.-p. 216-226 ((Theoretical)).



The preparation of a quality graduate proving successful on the labour market depends not only on the acquisition and development of soft skills, but above all on vocational training and the acquisition of practical skills, which we call hard skills.

However, without real practice, it is not possible to create space in the academic environment to acquire sufficient and suitable practical skills.

Within academic education, there is an urgent need to develop competencies in a real work environment. It is necessary to create a space for mutual cooperation of educational institutions with institutions in a real work environment. The close cooperation and mutual interaction of these two entities is a sufficient guarantee of quality preparation of young people for proving successful in the work environment.

Such close cooperation can be seen in the medical fields, but in other fields the acquisition of practical skills is more of a formal nature. This negative phenomenon in the process of acquiring practical skills is unacceptable, and there are alternatives to reverse this.

One possible solution can be given for illustration. Every individual can find himself in an unfavourable life situation, which will change his life by 180 degrees in a few seconds. As a result, his status changes from an economically active member of society to a socially stigmatized and socially excluded one. The handicap is all the greater because the current generation professes the values of profit and capital. The given trend is striking on social networks, where only those who present themselves as young, beautiful and rich are successful. The task of every developed society should be to strive for the greatest possible socialization of disabled people, in the form of community rehabilitation. The aim of community rehabilitation is the renewal or development of physical abilities, mental abilities and work abilities of an individual in an unfavourable social situation and support of his integration into society.

If, as a result of a sudden injury or illness, an individual finds himself in a state of severe or permanent impairment of the body's functional ability, it legally requires care that falls within the health care system. Depending on the type and extent of the damage to health, the disabled individual will be provided with an adequate form of institutional health care. The fact that the form of institutional health care is limited in time by health insurance companies can be assessed negatively. It is often the case that hospitalization is terminated even in untreated patients. After the end of hospitalization, i.e. the institutional care, the patient is discharged to home treatment. By ending the health care process, the disabled person does not become self-sufficient. With a disability, special needs and dependence on the help of another person occur at the same time. A disabled person requires another form of care, namely social care.

Entry into the social care system is significantly more complicated than entry into the health care system. Social care is not provided immediately, but presumes an administrative initiative from the disabled person or another person on which the disabled person is dependent. It represents an enormous bureaucratic, time and financial burden for the disabled, but also for his loved ones, who are not yet emotionally balanced with a permanently unfavourable social situation.

Depending on the unfavourable social situation and the degree of dependence on the assistance of another natural person, the disabled person has the right to choose a social service and the form of its provision. Dependence on social services is proved by a valid decision on

dependence on social services, while the issuance of a decision is preceded by a lengthy process of health assessment activity and subsequently social assessment activity.

There is an unnecessarily long vacuum between the end of the provision of health care and the start of the provision of social care, which deepens the hopeless situation of the disabled person and his loved ones. They lack orientation in the material, personal and territorial scope of social regulations. They have no experience of which institutions to turn to or what form of assistance to ask for. Nor are there isolated cases where disabled people have to cope with the reluctance and impatience of the staff of the institutions.<sup>62</sup> Under the influence of such unpleasant circumstances, people with disabilities often have suicidal tendencies.

There is still a tendency in society to help the disabled in the form of one-time in-kind and monetary benefits, associated with a spectacular media presentation. Of course, financial assistance is also extremely important, but this method of assistance is not permanent and is counterproductive for people with disabilities. They are pushed into a passive position, thus eliminating their ambition to cope with the situation and the ability to handle self-service activities as much as possible.<sup>63</sup>

In this case, space is opening up for community rehabilitation, which could fill the gap in the absence of care for a disabled person, due to the time-consuming transition from the health care system to the social care system. The social need is essentially calling for the creation of some kind of community rehabilitation centres, in which disabled people would be placed, who, although the process of providing institutional health care has ended, still require some form of outpatient specialized care for general treatment. It is necessary to emphasize the fact that, due to their disability, they also have special needs, while they are dependent on the help of another natural person. The role of community rehabilitation centres would be to ensure the provision of health care and start the process of providing social care, until their complete transition to the social care system. In community rehabilitation centres in particular, people with disabilities should acquire, as far as possible, self-service skills. They would acquire practical skills in simulated home conditions, which means that they would acquire them under professional supervision in specially adapted flats. The benefit for disabled people would be the fact that during their stay in the community rehabilitation centre, the professional staff would also ensure a suitable construction of their household. The length of stay in a community rehabilitation centre would not be limited in time and would depend on the physical and mental abilities of the disabled person. Bridging the two systems would ensure the continuity of care for the disabled.

It can be assumed that, as with the health care and social care system, the biggest obstacle to providing community rehabilitation will be the lack of funding sources, but this would not be so significant if the organization of community rehabilitation were linked to the need for practical teaching in academic education. Community rehabilitation centres would create specialized teaching facilities, where practical training of students would be carried out in order

---

<sup>62</sup> BEŇO, P. & CAPIKOVÁ, S. (2014). Social debarierization in healthcare from the point of view of patients with hearing impairment. In: The patient in the health system and in society. Proceedings of the international scientific conference held on December 11, 2012 in Bratislava. Bratislava: Section of Sociology of Health of the Slovak Sociological Society at the Slovak Academy of Sciences. p.81. ISBN 978-80-85447-22-4.

<sup>63</sup> TREĽOVÁ, S.: A tool to support the employment of people with disabilities in the labour market. In: Legal and economic aspects of long-term unemployment in the Slovak Republic 2014. Proceedings of a scientific conference held on October 24, 2014 organized by the research team of the project VEGA reg. no. 1/0935/12. p. 114. ISBN 978-80-7160-388-7.

to acquire professional competence to perform professional work activities in the relevant field of study and, as a result, the centres would have to go through the accreditation process. Practical teaching of students in community rehabilitation centres would be mutually beneficial. A meaningful space for acquiring practical skills in the chosen field of study is offered to students of medical faculties, nursing faculties, construction faculties, theological faculties, law faculties, etc. For example, students of construction faculties would participate in the preparation of proposals, but also the implementation of construction modifications of households of disabled people, students of law faculties would provide advice and overall administration resulting from relevant legislation, etc. High school students would also find application for practical training.

Through a form of community rehabilitation, one of the holes in the social network through which disabled people fall and "drown in the mud" of social exclusion would be "repaired."

This form of care provision could be used not only by disabled people, but also by other natural persons in an unfavourable social situation.

## 5. VULNERABLE PERSONS

In connection with the issue of training graduates employed in the labour market, the unemployed are demonstrated as a specific problem. These are vulnerable people who have achieved only low qualifications as a result of the accumulation of social disadvantages. The impact of the social background on the initial results of their education and on the level of their skills is not negligible. Social inequality and inequality of opportunity are a particular problem for this workforce. Even a tool of further education aimed at increasing the qualification or retraining of low-skilled people is proving impossible. There is virtually no impact on vulnerable groups who suffer from cumulative social disadvantages, with the emphasis that they do not even register as jobseekers.<sup>64</sup> This negative trend signals an acute risk factor for economic growth. More needs to be done to develop a comprehensive long-term strategy to activate vulnerable low-skilled graduates to engage in further education.

## 6. ACTIVE LABOUR MARKET MEASURES

It must be stated that active labour market measures in relation to vulnerable and disadvantaged jobseekers are unsystematic and ineffective. They can be described as inactive or passive without any exaggeration. They do not create space for job seekers to be active in solving their social situation, or provide opportunities for their self-realization, but they have a demotivating effect on them.<sup>65</sup>

Not only does the concept of social inclusion of jobseekers fail, but the unprecedented waste of public funds spent on inefficient further education can be assessed very negatively. The implementation of such non-systemic measures does not take into account the needs of practice and certainly has no impact on employment growth.

<sup>64</sup> ŠTEFÁNIK, M. et al. LABOUR MARKET IN SLOVAKIA 2019+. Centre of Social and Psychological Sciences, Slovak Academy of Sciences (CSPS SAS), Institute of Economic Research, Slovak Academy of Sciences (IER SAS), Faculty of Arts, Comenius University in Bratislava (FA CU): ŠEVT, as, Bratislava, Bratislava 2018, ISBN 978-80-7144-296-7

<sup>65</sup> HAMULÁK, J. Legal or illegal. Legal-theoretical and application problems of illegal work and illegal employment in the Slovak Republic. – 1<sup>st</sup> ed. - Bratislava: Wolters Kluwer, 2017. - 139 p., ISBN 978-80-8168-688-7

## 7. CONCLUSION

Accelerated digitization and the advent of new technologies should be accompanied by innovation in the education system, which would enable the comprehensive development of the theoretical and practical skills of future jobseekers. Only highly qualified and educated individuals with skills that are applicable in the digital economy will have a chance to enter the labour market.

Educational institutions need to be more active and more flexible in adapting their curricula to the demand for current and future technological skills. It is more than desirable to ensure the development of digital skills at all levels of the education system, including lifelong education programs.

The pandemic crisis made it impossible for students to attend full-time teaching, and educational institutions had to transform their teaching to distance education. As a result, measures need to be taken to ensure that the vulnerable people also cope with the distance form of teaching. As such, it is necessary for the public and private sector to create and ensure access to technical and electronic equipment for economically and socially disadvantaged people, who unfortunately include the teachers themselves.

The health care system, the social care system and the education system are considerably materially, technically, personally and financially undersized. Their combination would at least partially solve their undersizing and at the same time the requirement would be met of acquiring quality theoretical knowledge, but also practical skills of future job seekers. One of the goals of achieving and maintaining a high socio-economic level of society is to eliminate the various types of disadvantages suffered by its members. It is essential to strive for a system that promotes employment and enables development at regional level. As a result, the integration of jobseekers, in particular disadvantaged jobseekers, who are most at risk of social exclusion, could also be implemented.

### REFERENCES:

- BEŇO, P. & CAPIKOVÁ, S. (2014). Social debarrierization in healthcare from the point of view of patients with hearing impairment. In: *The patient in the health system and in society. Proceedings of the international scientific conference held on December 11, 2012 in Bratislava*. Bratislava: Section of Sociology of Health of the Slovak Sociological Society at the Slovak Academy of Sciences. Pp.72-84. ISBN 978-80-85447-22-4.
- HAMULÁK, J. (2017). *Legal or illegal. Legal-theoretical and application problems of illegal work and illegal employment in the Slovak Republic*. - 1<sup>st</sup> ed. - Bratislava: Wolters Kluwer. 139p., ISBN 978-80-8168-688-7.
- NEVICKÁ, D. (2017). Graduate and Digitization of the Labour Market. Reviewed. In: *Labour law in digital form: conference with international participation*. -: 1<sup>st</sup> ed. ISBN 978-80-7502-259-2. - Prague: Printing house Leges. pp. 216-226 ((Theoretical)).
- ŠTEFÁNIK, M. et al. (2018). *LABOUR MARKET IN SLOVAKIA 2019+*. Centre of Social and Psychological Sciences, Slovak Academy of Sciences (CSPS SAS), Institute of Economic Research, Slovak Academy of Sciences (IER SAS), Faculty of Arts, Comenius University in Bratislava (FA CU): ŠEVT, a.s. Bratislava, Bratislava 2018, ISBN 978-80-7144-296-7.
- TRELOVÁ, S. (2014). A tool to support the employment of people with disabilities in the labour market. In: *Legal and economic aspects of long-term unemployment in the Slovak*

*Republic 2014*. Bratislava: Comenius University in Bratislava. pp. 114–119. ISBN 978-80-7160-388-7.

Act No. 131/2002 Coll. on Higher Education Institutions and on Amendments to Certain Acts, as amended.

Act No. 553/2003 Coll. on Remuneration of Certain Employees in the Performance of Work in the Public Interest and on Amendments to Certain Acts as amended.

Act No. 576/2004 Coll. on Health Care, Services Related to the Provision of Health Care and on Amendments to Certain Acts, as amended.

Act No. 578/2004 Coll. on health care providers, health care workers, professional organizations in health care and on the amendment of certain laws as amended.

Act No. 448/2008 Coll. on social services and on the amendment of Act No. 455/1991 Coll. on Trade Licensing (Trade Licensing Act) as amended.

Government Regulation No. 296/2010 Coll. on professional competence for the performance of the medical profession, the method of further education of medical staff, the system of specialized departments and the system of certified work activities, as amended.

Decree of the Ministry of Health of the Slovak Republic No. 84/2016 Coll., which establishes the determining features of individual types of medical facilities.



# THE INFLUENCE OF KNOWLEDGE MANAGEMENT ON THE DEVELOPMENT OF INNOVATION IN THE ENTERPRISES IN THE REPUBLIC OF NORTH MACEDONIA-SELECTED RESULTS

Marija Pendevska<sup>66</sup> 

DOI:

---

**Abstract:** *Business community faces rapid change due to the technology development. Its influence on business environment causes change in the knowledge base and its possibilities on achieving new solution as innovation thus gaining new knowledge. Enterprises are managing these continuous changes using the knowledge of its unique set of enterprise's knowledge infrastructure, employee's knowledge skills and business environment. This implies that fast knowledge development from technology development and innovation makes high pressure on the enterprises and on its employees as well. The manner how this is used and utilized within enterprise becomes dominant challenge for every enterprise and its respective management globally. Many researches in the past years have shown that innovations as commercialisation of new knowledge development and knowledge management practices can assist facing those challenges remarkably. Creating the balance between them is unique for every enterprise, for every respective management.*

*This research paper consists of the following parts: introduction, selected theoretical and empirical framework and conclusion.*

*The theoretical framework gives selected overview of the relevant researches in the field of knowledge management and innovation and their respective interrelation in new knowledge creation and commercialising of this new knowledge as innovation.*

*The empirical framework describes the research design and gives the selected results obtained through the research of selected enterprises based on Questionnaire that covers key parameters previously discussed in the theoretical framework. Research focus is measuring the existence, the exchange, the creation of knowledge within enterprises and its usage in terms of new product development and/or improved products of the respective enterprises. Finally, in the conclusion, the study results are elaborated and their contribution to the existing body of knowledge and industry practices is discussed.*

**Keywords:** *knowledge management, new knowledge creation, innovation, open innovation, closed innovation, radical innovation, and incremental innovation.*

---

## I. INTRODUCTION

The purpose of this paper is to explore the readiness of enterprises to work with the challenges of a globally connected economy, which is pushing / demanding continuous development of both individual knowledge and knowledge of the enterprise, pushed into ever changing market by constantly generating new products, improved products and services that arise from the application of new knowledge in enterprises. This signifies finding and maintaining the delicate balance of knowledge and knowledge flows in the enterprise, on the one hand, by creating own new knowledge in the enterprises and, on the other, tracking

---

<sup>66</sup> Komercijalna Banka AD Skopje, ul. Orce Nikolov br. 3, 1000 Skopje, R. North Macedonia

outside knowledge and market needs by continually adapting the products, processes and services required by users, customers, partners.

The purpose of this research is to enlighten the elements that enable enterprises to apply appropriate knowledge management practices, as well as to enhance understanding of how these practices impact the development of new products and services in the form of successful enterprise innovations.

## II. THEORETICAL BACKGROUND

Nowadays, there is high demand on skilled workers and flexible enterprises that are willing to invest in their development. Technological progress and globalization are widening the gap between developed countries and others by automating and digitizing services and production. Technological progress in practice replaces the workforce. Global trade and investment flows are homogenizing production flows, and this puts pressure on companies and workers to compete in global markets. If they do not incorporate and adopt the high capability and competitiveness of their enterprises, they simply lose the edge and are left behind. This research aims to enhance the capabilities in terms of knowledge and innovation in enterprises, in order assist them to work with the pressures of global challenges and changes.

According to Schumpeter's description, innovative competitiveness is the engine of economic development and prosperity. New products and services increase the labour productivity of innovating enterprises by changing the distribution of labour nationally and internationally (cited in Witt, 2016; Metcalfe et al. 2006).

This research is in terms of knowledge flow in the enterprise, i.e. the existence / exchange / creation of knowledge in the enterprise and the relation between knowledge management and the creation and application of new knowledge, i.e. how the enterprise applies / uses knowledge in the form of radical, disruptive new or incremental, improved products / services or processes. This applies both to products and services from the same enterprise, made independently with internal knowledge, and to products and services that result from external knowledge collaboration in the form of collaboration with the university, the user, and other enterprises. Knowledge is a value embedded in a product / service / process and stays in the enterprise; depending on how it is used further on, the intensity/persistence of the innovation activity within the enterprises is, whether the knowledge creation cycle stops with the realization of single product/service or continues through controlling and monitoring through the product life. The research herewith is looking for answers to how enterprises in the Republic of N. Macedonia add new value through their operation. Is the innovation process open semi-open or closed, using own knowledge, semi-open, cooperating in gaining new knowledge and incorporation of outside knowledge within the enterprise, in order to adjust / improve products / services, what novelty bring their respective innovative product, service or process that is being realised?

The only resources that cannot simply be replaced or imitated are individual work professionals and their skill and overall knowledge along with their interaction and successful integration throughout the enterprise. Their unique knowledge is what makes the difference of enterprises. It is the different knowledge structure and enterprises readiness for further knowledge expansion, which over certain a period of time explains the different speed in developing appropriate solutions for different enterprises.



Employee knowledge can be explicit, easily recognizable and transmitted, both through personal contact and through other synchronic or asynchronic communication channels, such as through picture, audio and video, chart, sketch etc. text or table. It can also be tacit knowledge, unconscious knowledge. Both forms make the basis for the total knowledge (learned theoretical and experiential knowledge) that is unique to every individual, and is different, some of it not conscious (if conscious, it could be transmitted), simply obtained by working on a particular activity or pursuing particular interest.

The duration of the cognitive process is personal feature, some individuals learn faster, some need more time for creating deeper understanding. This indicates that the personal characteristics of the employee are important for the environment, since it is the essence of their full involvement and further engagement in the work in the enterprises. This indicates that for smooth transfer of necessary knowledge within or into the enterprise, there is a need of developing working environment that fosters smooth exchange with individuals, groups, where the inexperienced is ready to learn and apply knowledge and the reverse, the more experienced ready to transfer and share necessary knowledge. Previous large experience can sometimes be an obstacle to learning new skills, especially when changing new technologies or work processes, but sometimes it is crucial in recognizing the operation patterns. It means fostering work environment that nurtures employees' willingness to learn, whether by working or exploring new methods of work, that is, to track the results of work, to control and monitor of applied solutions, concepts that facilitate, trying to simplify the work bottlenecks.

Since knowledge is not a value if it is not used, the key interest is whether and how knowledge within enterprises is used in building new value for the enterprise.

The enterprise in which this is achieved is a prepared one. It adds value, knowledge is continually built and engaged, by everyone in the enterprise (sometimes using outsourced solutions, but in their own implementation, the so-called semi-open or open innovation system). Knowledge can enter from various sources; every effort to add value is welcome. Self-engagement and willingness to acquire exchange and re-apply knowledge is becoming crucial capability at the individual and organizational level.

As long as the enterprise nurtures its persistence in innovation activities, new knowledge, an idea / solution, the likelihood of new product / service / process occurring, and the knowledge of how it is achieved, even if it is discarded and isolated, brings value for the enterprise; the knowledge how to get there remains in the enterprise and can be used for a new cycle of innovation.

## **1. Enterprise Knowledge Management Framework**

Selected elements of knowledge management practices that foster knowledge development and the emergence of new knowledge within enterprises are identified and in detail analysed, being observed through the implementation of innovative products / services / processes and their respective novelty implemented by enterprises.

The current state of the art of technology solutions are simplifying workflows and increasing efficiency, but building organizational and human readiness throughout this ever-changing process is an even greater challenge for any enterprise. Some companies do better than others, and this is clearly reflected in their persistence and readiness to introduce new products and services, or to introduce customizations of existing products / services. Therefore, a key

element is to establish a genuine attitude in the enterprise towards knowledge sharing and applying it in new knowledge development. According to Desouza (2003) "The biggest obstacle to effective knowledge management is not the realization of the latest ICT solutions, but the failure of the preparation and readiness of the people involved in the process to share their know-how (Desouza, 2003). Monitoring and guiding change and engaging the people involved is the key to make the change process successful. This is especially so in terms of the personal nature of knowledge (for example it is shown that knowledge cannot be imparted to someone in the form of a finished product). It turns out that one must be fully motivated / willing to accept and apply it.

To create an organizational environment in which people are willing to share knowledge, most natural is to develop principles and the concept of continuous improvement, and to nurture a culture of learning. Learning by itself at the individual level signifies an awareness of adaptation, of consciously seeking a solution to a particular situation, or seeking to resolve any conflict between two completely different and dialectically opposed ways of thinking, and conscious and purposeful finding of a solution, or conscious adaptation. Learning as a process in and of itself for the individual as well as the group concerned is a conscious overall personal engagement, a holistic journey, seeking and clearing the unknown, consciously going back and forth, using different ways of reflection and action, of feeling and thinking and application, all in a certain period. It involves the integrated functioning of the whole person - thinking, feeling, understanding and its behaviour towards acquiring new knowledge.

Through learning as a process, there is a synergistic connection between the person / group and the environment. The way the possibilities of each new experience are dealt with determines the range of choices and decisions we see. The choices and decisions we make to a certain degree determine the knowledge we strive to achieve, and this influences our future choices. In essence, learning is a process of knowledge creation (Kolb and Kolb, 2008).

## **2. Knowledge management framework researched**

Knowledge management methods are used to enable the enterprise to utilize and develop employee knowledge in a rational and complete way simultaneously. Knowledge management comes as a goal and does not mean only knowledge production, but as a goal-oriented use and development of knowledge and skills that improve the performance of the organization, in order that one becomes more competitive, efficient, and innovative.

Nonaka and Takeuchi (1995) emphasize the difference, departing from the traditional definition of knowledge as "justified true belief", by defining knowledge as "a dynamic process of man towards justified personal belief about "the truth ". (Nonaka and Takeuchi, 1995: 58) According to them, in order to produce new knowledge / innovation, it is necessary to enable knowledge creation beforehand. For them, organizational knowledge creation is "the ability of the company" as a whole to create new knowledge, to spread it too through the organization to incorporate it into its products, services and systems" (Nonaka and Takeuchi, 1995: 58) and explain it through their dynamic "spiral of knowledge concept".

## **3. Customized Knowledge Management Cycle Model**

By integrating the LH cycles outlined in the Heisig (2009) reviews one can make a simple, practical and comprehensive LH cycle model. Building on the Evans and Ali's (2013) Lifecycle Model The Knowledge Management Cycle (KMC) is advanced and consists of 7 phases: 1. to

identify, 2. to preserve, 3. to share, 4. to use, 5. to learn, 6. improve and 7. Create new knowledge here modified into Innovate.

### **Phase 1. Identifying and / or creating knowledge**

When designing for a specific knowledge request, the researcher must identify whether there is adequate "in-house" knowledge or that necessary knowledge should be created or acquired (either through purchase or through building or both). This is why these two phases are linked and grouped in the Knowledge Management cycle model.

#### **Phase 1.1: Identify knowledge**

What do we want to achieve? What knowledge do we need to have to achieve the desired result? Do we have it and who should transfer / acquire it?

It is a phase in which the intellectual capital and needs of the organization are assessed in defining critical-to-mission-of-organization knowledge and mapping the existing intellectual base for future needs. With effective search for specific knowledge, the identifying phase involves analysing and evaluating specific organizational rules, work cultures and evaluation criteria. According to Wiig (1993), analysis involves looking at and removing / separating what is shown to have value for a viable solution to a particular problem or decision to an existing situation, and breaking down / separating to the end to discover potentially useful knowledge.

#### **Phase 1.2. Development of knowledge, creation of new knowledge**

The knowledge requirement may require a need for new knowledge and has to be built if it is not found in the search phase. Also new knowledge may need to be created, if existing knowledge only partially meets the knowledge needs.

#### **Phase 2: Storage / Storage**

Once the knowledge is judged to be valuable to the organization, based on the analysis and evaluation in the identify phase and the creation phase, it is stored as an active integral part of the organizational memory (in the minds of employees in the form of experience or bases of knowledge data or both). This stage indicates the preservation of a codified form of knowledge in the enterprise databases and embedded knowledge in the products / services of the enterprise. Generally speaking, not all knowledge that holds value for individuals or organizations can be stored in databases. The way they are structured is to help them find the knowledge they want, to find and share the knowledge they want.

Most often these are activities that involve meta-tagging (tagging according to defined tags, or according to a general association for easy retrieval) classification, archiving, linking and optimizing search and retrieval.

#### **Phase 3: Knowledge Sharing**

Knowledge is retrieved / used from organizational memory, and shared / disseminated (shared / shared) both inside and outside the enterprise. The time and frequency (how often) of sharing can be pre-determined (for example, immediately and often as new knowledge is preserved) or on an ad hoc basis (from time to time). Explicit, dynamic and flexible (Wiig, 1993; Meyer and

Zack, 1999) network of expertise (e.g., a community of shared practice) fosters collaboration and can specifically contribute to organizational knowledge sharing. Sharing tacit knowledge can be done through a variety of initiatives and activities, through mentoring, training, or apprenticeship programs. A balanced selection of technologies and deployment channels should be established in each enterprise according to their strengths and weaknesses (Dalkir, 2011)

#### **Phase 4: Using knowledge**

Once shared, knowledge can be activated, its value can be set apart and applied across the enterprise, and it can serve to solve problems, make decisions, improve efficiency or foster innovative thinking. Knowledge can be embedded (Wiig, 1993), and there will always be some degree of tacit knowledge that is applied. The knowledge application stage is crucial for internalizing the tacit form of knowledge. According to Yuasa (1987: 25) who describes it as a phase so called "learning with the body" and according to Boisot (2002: 73) "learning-through-doing".

#### **Phase 5: Learning**

The knowledge that was shared and used in the previous stages can be used as a basis for creating new and refining existing knowledge. The use of knowledge, especially in situations where professionals provide contextual understanding, leads employees to gain experience that enables them to interpret the impact of knowledge on their work environment (Evans and Ali, 2013). This stage involves deconstructing (applying) the "blocks" with knowledge, integrating, connecting, combining and internalizing knowledge.

#### **Phase 6: Improving knowledge**

Learning that takes place in the previous phase leads next phase that is further refinement of knowledge. New value is either identified or created by them and additions or updates are made to keep them current in Organizational Memory, to be applicable in the context of organizational performance. Knowledge is repackaged to be stored, archived or labelled (in the case of multiple forms of tacit knowledge) so that their value can be used effectively in the future.

In this model (KMC Model) the improvement phase is the decision about which knowledge is archived, stored or transferred outside the organization / enterprise for future use. Some general activities that help with the improvement phase include: for example, post-crisis review, reflection time, and adaptation lessons learned.

#### **Phase 7: Innovate / create**

This stage is also connected to the first phase by the mere creating and delivering new organizational-level knowledge in innovative enterprise products / services / processes. Creation occurs when prior knowledge is applied or linked in a new way, or a new combination, reflecting new cognitive concepts that arise when employees, inventors, researchers, builders, or entrepreneurs (re) combine most often through teamwork, social interaction, and already existing cognitive concepts acquire new knowledge, which in turn can bring new meaning or meaning.

In addition to the scope of technological knowledge that it must undoubtedly have, crucial and essential for successful innovation, is the ability of the organization to apply that knowledge (Hansen, Perry, Reese, 2004; Taylor and Greeve, 2006; Volberda and Van Den Bosch, 2005). Knowledge related to innovation activities is analysed in terms of how innovations arise, are created and how knowledge can be organized to influence innovation activities.

The creative process of transferring from the individual to the organization and vice versa, the process of coming up with a feeling to realize a new combination or integrate several existing concepts is a challenge that cannot be fully understood or foreseeable, but if certain practices are used it is likely to happen.

#### **4. Innovation as a creation**

Here, below, are selected some knowledge management practices that enable the emergence of an innovative process.

Usually, for innovations to be realised, there are previous causes and consequences of new concepts and they certainly do not occur immediately. They are discovered in the process of trial and error, elimination of error, re-examination of concepts, which can take years and are regularly associated with a need for increasing the knowledge base. (Witt Ulrich, 2016)

According to the Oslo Manual (2005), business innovation is defined as "a product, process, marketing method or organizational method that must be new (or significantly improved) for enterprises", while according to Kline and Rosenberg (1986) innovation should be considered "as a series of changes in a system"; Freeman and Soete (1997) distinguish innovation from invention, with the former defining it as "the creation of a new idea and latter bringing it into practice - which includes all the activities needed to commercialize new products / services".

Above mentioned different definitions of innovation state the most important message, which is that innovation must bring something *new* to the enterprise, national market and global market in order to be considered innovative. Simply said, innovating or being involved in innovation activities helps companies to stay competitive, and that knowledge brings them forward in their respective industries or markets.

Technological, Product and Process (TPP) innovation activities represent all the scientific, technological, organizational, financial and commercial steps that are actually taken to bring about the implementation of technologically new or improved products and processes. Some are highly innovative; others are not so new but needed for realization (Oslo Manual, 2005: 32).

The Oslo Manual (2005) defines innovative activities based on two concepts / approaches, subjective and objective: an innovative enterprise and an innovative activity. According to the subjective approach, an innovative enterprise is an organization that has realized at least one innovation whether it is a product, technology, marketing or process or their combination (Oslo Manual, 2005: 31).

According to the objective approach, the enterprise can have innovative activities without any innovation. All innovative activities can be classified into three categories:

1. "Successful with the result of realizing innovation (although this innovation may also be commercially unsuccessful).

2. In progress, work in progress that has not yet resulted in the realization of innovation.
3. Abandoned before the realization of innovation” (Oslo Manual, 2005: 10).

The survey undertaken includes innovative activities in enterprises under the previous three categories. Below are the selected samples of the research questions, which are included for measuring the innovative activities of the first category.

An innovative enterprise is defined as an entity that has successfully implemented a technologically new or significantly improved product / service / process or combination of previous ones over a period of time under investigation. This category can be divided into companies that have only "passive" innovative products / services / processes, i.e. those that have exclusively innovated by importing embedded technology into new machinery or equipment. (OECD Oslo Manual, 2005: 11)

### **III. RESEARCH METHODOLOGY**

#### **1. Primary data collection methods:**

##### **1 .1. Quantitative methods:**

- Survey method of the survey herewith is aimed to obtain primary data from the employees of the selected enterprises with their perception of business practices regarding Knowledge Management and Innovation activities in their respective field of work and enterprises. The primary data obtained are processed and analysed using appropriate statistical methods, such as:
  - Method of descriptive analysis - in order to determine the individual demographic and contextual determinants in the enterprises;
  - Statistical analysis method using Chi-Pearson distribution - in order to check the observation and perform a fullness test, to determine how well the model and the observation are validated;

### **IV. EMPIRICAL SURVEY AND FINDINGS**

The research data is collected and analysed from enterprise employees, which in the period under study have introduced an innovative product / service / process in the period from June to December 2017 within selected enterprises (in total 38). Enterprise representatives were contacted and notified by the author via personal contact, telephone or email in addition to a written notice of the purpose of the work. An electronic link was then sent to the firms and / or respondents to the questionnaire created for this survey. Each respondent answered the questions to the best of their knowledge and experience working within the respective company.

Total number of respondents who completed the questionnaire is 176, whereas 165 responds were complete or 93.75% of the respondents.

More general approach is applied in order to obtain as much as possible information from the employees of the contacted enterprises that were participating in this research, based on selected key thesis questions, selected from Oslo Manual (2005) , and made adjustments to obtain as relevant and qualitative data as possible from the participants.

## 1. Measurement of knowledge management practices

Question number 4 of the Questionnaire, measuring knowledge management on a personal level: How long does it take to find the information I need?

This states a response at a firmly established or expected time interval (approx.: <5 min, 5-15 min, up to 30 min, and over 30 min ...) for a clearer analysis of the data. If the retrieval of the required data and information from your data base is fast, it is likely that knowledge is used regularly on an individual level – regular data / information management and technical and operational infrastructure knowledge.

**Table 1.** Survey Question 4 with obtained results

IV	How long does it take to find the information I need from my file?	Number of respondents	%
1	5 minutes	108	65.45%
2	5-15 minutes	44	26.67%
3	up to 30 minutes	8	4.85%
4	longer than 30	5	3.03%

**Source:** M. Pendevska, 2019

At the organizational level:

This parameter measures the time it takes to find the information needed in individual database. This enables to obtain additional features for knowledge management practices on an individual level, i.e. accessibility and ease (or lack thereof) in finding the required knowledge, existence or non-existence of a method of finding documents and files to obtain satisfactory or unsatisfactory search results.

At the organizational level: how long does it take to find the information I need from the shared file?

These results probably indicate that established organizational practices and ways of structuring information are clear and easily accessible to their employees. The quick and easy way to get the information you really need, indicates frequent and regular use of established procedures in order to obtain the needed information.

**Table 2.** Survey Question 5 with obtained results

V	How long does it take for me to find the information I need from a shared file in the organization?	Number of respondents	%
1	5 minutes	53	31.52%
2	5-15 minutes	77	46.67%
3	up to 30 minutes	32	19.39%
4	longer than 30	4	2.42%

**Source:** M. Pendevska, 2019

These results show that established organizational practices, accessibility and frequency of structured information are clear to the ones that need them and are easily accessible on the enterprise level and are regularly used.

## 2. Measuring the results of innovative business activity

As we try to measure a particular innovation activity, an objective approach is chosen (Oslo Manuel, 2005: 49), i.e., to collect selected data on an innovative activity in an enterprise.

According to the previous definition, the selected questions should be answered:

In accordance with knowledge management practices, what is the result of the operation of enterprises in our country in terms of successful (commercial) realization of innovation, which degree of novelty brings with it the product / service / process that is produced / is provides as a service / technological or organizational process?

This includes the innovations undertaken by enterprises to fulfill certain product / service improvement, manufacturing process or service for more profitable operation. It shows the enterprise's commitment to incremental product / service / process improvement or the introduction of a radically new product / service / process. It is assumed that incremental innovation / improvement of product / service / process quality extends the product / service / process life cycle. Most of the innovations are probably in this section.

To get initial information on enterprise innovation activities complete the following basic company information and innovative product or services:

**Table 3.** Survey Question 14 with obtained results

XIV	Realized innovation in the company where I work?	Number of respondents	%
1	Product	62	37,58%
2	Service	66	40.00%
3	Working process	37	22.42%

**Source:** M. Pendevska, 2019

Measuring the novelty incorporated in their respective products indicates the knowledge incorporated within the product / service / process.

How new are the product / service / process in the company, product / service / process?

**Table 4.** Survey Question 15 with obtained results

XV	This product/service/process is:	Number of respondents	%
1	New worldwide	23	13.94%
2	New to the market in the state	52	31.52%
3	New for the organization	90	54.55%

**Source:** M. Pendevska, 2019

This shall indicate if the commitment within the enterprise is crowned with a product that is new to the enterprise, to the national market or worldwide. A new product for the organization shows low level of the applied knowledge (knowledge already used and known in the near environment) that organization can process and apply.

New product in the country means bringing new knowledge in the national market that is applied in a product and does not exist within the country, in the near environment. This means



the enterprise has contacts with wider business environment and is competitive in wider region bringing its knowledge base higher. When an enterprise develops this kind of knowledge / product, i.e. has a wide range of in-state and out-of-state contacts / associates, it indicates that the enterprise is competitive at the state or regional level.

A new product globally demonstrates enterprise-wide knowledge base with cutting edge of technology development and their application in practice. The role of these enterprises is considered as leaders in their field and their activity makes them globally recognizable.

The degree of novelty indicates whether the product is radically new, that is, it creates its own new market, or making incremental adjustments in order to maintain its market longer.

What degree of innovation a product / service / process has, and a novelty of innovation?

**Table 5.** Survey Question 16 with obtained results

XVI	Level of innovation in a new product/service/process:	Number of respondents	%
1	High degree (over 60%)	47	28.50%
2	Intermediate degree (or 30-60%)	89	53.90%
3	Low (or up to 30%)	29	17.60%

**Source:** M. Pendevska, 2019

These parameters measure the novelty of the product, whether it is incremental innovation in the products / services / processes or is it radical.

### **Analysis of the Relationship between Knowledge Management and the Level of Innovation with Chi-square Analysis**

Previous data show business performance of surveyed enterprises with selected research questions.

From the survey sample obtained, enclosed are selected questions from the Survey Questionnaire cross-checked to establish a relation, to determine more clearly if there exists a relation between the selected questions from the Questionnaire.

This indicator is taken as a starting point, as it can show more clear defining tendency between obtained results.

Below one tests the null hypothesis and the alternative hypothesis as following:

H.0.1: There is no correlation of the answers to question 4, the speed of finding the necessary information on a personal level with question 14, i.e. they are independent (no relation).

H.1.1: There is a correlation of the answers to question 4, the speed of finding the necessary information on a personal level with question 14, i.e. they are dependent (there is a relation).

The analysis of the Likelihood Ratio p value is 0.027 which means that it is at the 95% significance level and the H.1.1 hypothesis for interdependence or existence of interdependence will be accepted; or, there is a relation on the speed of finding information with delivering an innovative product / service / business process.

This may indicate that from the sample analysed the high degree of knowledge management system at an individual level influences the realization of an innovative product / service / business process within the enterprises.

**Table 6.** Relation between survey question 4 and survey question 14

Factor 1*Factor 2							
Factor 1	Factor 2		The innovation from your enterprise			Total	
			product	process	service		
How long do I need to find information that I need from my data base?	5 minutes	replies	42	22	44	108	
		% of total	25.5%	13.3%	26.7%	65.5%	
	5-15 minutes	replies	16	7	21	44	
		% of total	9.7%	4.2%	12.7%	26.6%	
	up to 30 minutes	replies	2	5	1	8	
		% of total	1.2%	3.0%	0.6%	4.8%	
	longer than 30 minutes	replies	2	3	0	5	
		% of total	1.2%	1.8%	0.0	3.0 %	
Total			replies	62	37	66	165
			% of total	37.6%	22.4%	40.0%	100.0%

**Source:** M. Pendevska, 2019

Below one tests the 2.0 hypothesis and the alternative hypothesis 2.1 as following:

H.2.0: There is no correlation of the answers to Survey Question 4, the speed of finding the necessary information at personal level with Survey Question 15, i.e. they are independent (no relation).

H.2.1: There is a correlation of the answers to Survey Question 4, the speed of finding the necessary information on a personal level with Survey Question 15, i.e. they are dependent (there is a relation).

**Table 7.** Relation between survey question 4 and survey question 15

Factor 1*Factor 2							
Factor 1	Factor 2		This product/service/process is:			Total	
			new to the organization	new to the national level	new on a global level		
How long do I need to find information that I need from my data base?	5 minutes	replies	59	33	16	108	
		% of total	35.8%	20.0%	9.7%	65.5%	
	5-15 minutes	replies	23	18	3	44	
		% of total	13.9%	10.9%	1.8%	26.7%	
	up to 30 minutes	replies	4	0	4	8	
		% of total	2.4%	0.0%	2.4%	4.8%	
	longer than 30 minutes	replies	4	1	0	5	
		% of total	2.4%	0.6%	0.0%	3.0%	
Total			replies	90	52	23	165
			% of total	54.5%	31.5%	13.9%	100.0%

**Source:** M. Pendevska, 2019

The analysis of the Likelihood Ratio p value is 0.021 which means that it is at the 95% significance level and the hypothesis H.2.1 for interdependence or existence of interdependence will be accepted.

Innovation in a product / service / process brings different levels of innovation, in-built knowledge or how much new knowledge is used in the relevant innovative products / processes / service and defines categories "new to the organization.", "New to the market in the country" and " new worldwide ".

The knowing where to find knowledge needed and used in innovative products shows the tendency of persistence of the company to develop its own business. The higher the knowledge applied to their products shows probably higher the novelty of innovation embedded in the products / services / business process.

It is noticeable the relatively low level of knowledge embedded in the innovative product or most of the answers with 54.5%, and the level of utilization of the knowledge management system with 35.8% or 13.9%, but up to 30 min. with 2.4% and over 30 min. with 2.4%.

It is also noticeable that in the categories "new to the state market" and "new to the world level" the search for information belongs to the two high groups, i.e. "up to 5 min" with 20.0% and 9.7% respectively, and for the "5-15 min" category 10.9% and 1.8%;

## CONCLUSION

Starting from the humanistic approach that every change starts from the individual and his knowledge and ability, and by identifying the established knowledge management infrastructure in the enterprise, the current situation in the enterprises is identified. The model used clearly reflects the ability of enterprises to utilize their knowledge, foster a personal and organizational system for creating, transferring, storing and reusing knowledge. This section shows the level of use of systems, creating, transmitting, storing and reusing information, gives a good explanation of the level of mutual understanding at different levels in the enterprise. The framework provided aims to identify the current situation in order to provide a basis for explaining the key elements that describe operational and strategic compliance. The results are in line with previous research in this area. Namely, it indicates that there are knowledge management practices, but they are used at a very low level.

Knowledge management practices in a broad sense do not exist for themselves. The purpose of knowledge is to be used. For enterprises this dimension of knowledge is especially critical for their survival and further development, that is, capturing as much as possible of the knowledge of their employees, incorporating it with existing ones or outside them into new enterprise products / services.

Since new knowledge does not occur by accident nor does it appear, it means that it exists somewhere and should be used in the interest of the enterprise. Their level and the way companies do it are dimensions that are explored and included in last part of the Questionnaire. Logically, this part explores various parameters for the existence of innovative activities in the enterprise, i.e. commercialization of new knowledge of the enterprise.

The second part of the Questionnaire actually completes the research in enterprises, which is the result of using their (and external) knowledge in innovative activity.

In management literature, innovative activities are elaborated as the main strategy for gaining competitive advantage and generating sustainable profits. The criterion for positive evaluation of innovation and its effects is based on the innovations that pass the market test successfully.

The willingness of the enterprise to deal with rapid change is related to the creation of new knowledge / innovative products / services, it is the path that enables continuous learning. Every technological change result in innovative activities, raising the level of knowledge, including intangible investments such as research and development. The main challenge, of course, is to create conditions within the enterprise for long-term sustainable efforts for innovative activities.

The empirical research data mark changes at the enterprise level, the interaction between different stakeholders, both at the individual level and the organizational level. It shows different types of collaboration and knowledge-sharing in terms of new knowledge, practices that lead to the realization of new products / services / processes in the form of innovation in the current business environment.

For that to happen, there is probably a demand for those innovations. There are cases where they offer solutions to problems that have not previously been satisfactorily resolved. In most cases, the demand for innovation is simply due to lower cost, better quality and / or more favourable supply conditions. If innovations pass the market test successfully, it means that the demand for innovation pays off, and the innovator can make a profit. For this reason, innovations that successfully pass the market test are considered to improve well-being and are therefore highly desired.

Finally, recommendations arising from the empirical research on knowledge management practices and their impact on the creation of new knowledge in the form of new products / services / processes in enterprises in the Republic of North Macedonia show that this area is under-researched and has substantial practical value to enterprises in order to enhance their ability to perform successful innovation.

## REFERENCES

- Dalkir, Kimiz. 2005. *Knowledge Management in Theory and Practice*. Butterworth Heinemann. Vol. 4. <https://doi.org/10.1002/asi.21613>.
- Evans, Max, Kimiz Dalkir, and Catalin Bidian. 2014. "A Holistic View of the Knowledge Life Cycle: The Knowledge Management Cycle (KMC) Model." *Electronic Journal of Knowledge Management* 12 (2): 85–97.
- Heisig, Peter. 2013. "Knowledge Management – Step by Step Knowledge Management – Step by Step • Background • Concepts • Knowledge Management – Step by Step Report from Business Practice • Concepts • Summary," no. January: 1–7.
- Heij C. V. 2015. *Innovating beyond Technology*, ERIM PhD Series in Research in Management, 370 ERIM reference number: EPS-2015-370-S&E ISBN 978-90-5892-418-6
- Kolb, Alice Y, and David a Kolb. 2008. "Experiential Learning Theory: A Dynamic, Holistic Approach to Management Learning, Education and Development." *Handbook of Management Learning, Education and Development*, 1–59. <https://doi.org/http://dx.doi.org/10.4135/9780857021038.n3>.
- Kok, J.A.2005, Can models for knowledge management be successfully implemented to manage the diversity of indigenous knowledge?
- Nonaka, I., Takeuchi, H. (1995): *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press, May, (1995:58)
- Nonaka, Ikujiro, and Noboru Konno. 1998. "The Concept of 'Ba.'" *California Management Review*. <https://doi.org/10.1016/j.otsr.2010.03.008>.

- Nonaka, Ikujiro, and Ryoko Toyama. 2003. "The Knowledge-Creating Theory Revisited: Knowledge Creation as a Synthesizing Process." *Knowledge Management Research & Practice* 1 (1): 2–10. <https://doi.org/10.1057/palgrave.kmrp.8500001>.
- Minbaeva, Dana B., Kristiina Mäkelä, and Larissa Rabbiosi. 2010. "Explaining Intra-Organizational Knowledge Transfer at the Individual Level" Center for Strategic Management and Globalization Copenhagen Business School -Working Paper No. 1/2010.  
[http://openarchive.cbs.dk/bitstream/handle/10398/8001/SMGWP2010\\_1.pdf?sequence=1](http://openarchive.cbs.dk/bitstream/handle/10398/8001/SMGWP2010_1.pdf?sequence=1).
- Mcelroy, Mark W. 2001. "Second-Generation Knowledge Management."
- North, K., Probst, G., Romhardt, K. (1998): *Wissensmessen – Ansätze, Erfahrungen und kritische Fragen*, in *Zeitschrift für Führung und Organisation*, Vol. 3
- Michailova, Snejina, and Kate Hutchings. (2004) "Knowledge Sharing and National Culture: A Comparison Between China and Russia" *Journal of Management Studies*.  
Oslo Manual, 2005, OECD 2005. "Oslo Manual."  
<http://www.oecd.org/science/inno/2367580.pdf>.
- Pendevska Marija, (2019), "The Influence of knowledge management on the innovation in the enterprises in Republic Macedonia", doctoral thesis, defended June 2019 at Faculty of Economy, University Cyril and Methodius Skopje.
- Probst, G., Raub, S., Romhardt, K. (2000): *Managing Knowledge*, John Wiley & Sons, Chichester
- Resatsch Florian, Faisst Ulrich 2003, "Measuring the Performance of Knowledge Management Initiatives." n.d.
- Wiig K.M, 1993, *Knowledge Management Foundations: Thinking about Thinking: How People and Organizations Create, Represent and Use Knowledge*.
- Willke H, 1998. *Systematisches Wissensmanagement*, Stuttgart: Lucius und Lucius 1998: 39
- Witt, Ulrich. 2016. "What Kind of Innovations Do We Need to Secure Our Future?" *Journal of Open Innovation: Technology, Market, and Complexity* 2 (1): 17.  
<https://doi.org/10.1186/s40852-016-0043-y>.
- Witt, Ulrich, Tom Broekel, and Thomas Brenner. 2007. "Knowledge and Its Economic Characteristics - A Conceptual Clarification." *Ssrn*.  
<https://doi.org/10.2139/ssrn.1019222>.



# OPERATION MANAGEMENT USING ITIL AND COBIT FRAMEWORK

Joaquina Marchão<sup>67</sup> 

Leonilde Reis<sup>68</sup> 

Paula Ventura<sup>69</sup> 

DOI:

---

**Abstract:** *Information and Communication Technologies management is now increasingly challenging in a highly digital and connected world, with different services emerging for different clients with heterogeneous infrastructures, software, assets, different service requirements, security risks increasing, organizational structures not flexible to adjust. These are some of the variables to manage in Information and Communication Technologies departments. This paper aims to present a literature review to support the design of an approach for service operation management in a medium-sized organization, to improve operational efficiency, cost optimization and stakeholder satisfaction, relevant topics in any organization strategy. The applied methodology includes a literature study related with the frameworks Control Objectives for Information and Related Technology (COBIT) and Information Technology Infrastructure Library (ITIL). The main results underlying the literature review were based on the use of keywords in the subject domain.*

**Keywords:** *ITIL, COBIT, Service Operation, Business Process, ITSM.*

---

## 1 INTRODUCTION

Information and Communication Technologies (ICT) Management in an organizational context can enhance or limit business development. In this context, the alignment between the organization's management and governance and the ICT department is considered essential. Medium-large size organizations are faced with difficulties underlying greater complexity in the daily service operation management and related processes. Towards improvement, it's important to implement universally accepted ICT management frameworks such as IT Infrastructure Library (ITIL) and/or Control Objectives for Information and Related Technology (COBIT). ITIL is highly used in organizations worldwide to align ICT with business needs through the management of service lifecycle (OGC, 2007).

The stages of the service life cycle are: Service Strategy, Service Design, Service Transition, Service Operation and Continual Service Improvement. COBIT is used to align the management and the governance of IT departments with the company goals. To be competitive, companies must implement information technology that is oriented to customers and stakeholders (Raharjana, Susmiandri & Justitia, 2018). Service operation is the ITIL stage in which the service quality is perceived by customers and stakeholders. This stage focuses on providing effective and efficient operational services to deliver the required business outcomes and value to the customer (OGC, 2007). ITIL bundle established best practices to support the

---

<sup>67</sup> Universidade do Algarve, Portugal

<sup>68</sup> Polytechnic Institute of Setúbal, Portugal

<sup>69</sup> Universidade do Algarve, Portugal

tasks of Information Technology (IT) service operating (Kubiak & Rass, 2018). Real-life IT support organizations usually implement very complex organizational, structural, and behavioral processes according to strategic objectives defined at the business management level (Bartolini, Stefanelli & Tortonesi, 2013).

Business processes are more and more dependent on ICT. A process consists of a coordinated set of activities using resources and capabilities to produce an outcome, which, directly or indirectly, creates value for an external customer or stakeholders (OGC, 2007). This paper aims to present a literature review to support the design of an approach for service operation management in a medium-sized organization. The structure of this paper has four sections. The first section is the introduction to the research theme. The second section presents the Research Methodology. In the third section, the results are discussed and in the last one, the fourth, conclusions are presented and recommendations are explained.

## **2 RESEARCH METHODOLOGY**

The research approach used is a literature review, began by planning review, identifying the needs and formulating questions and objectives. Next phase allows to define parameters and criteria, generate and refine keywords. The following step on this phase is conduct research and obtain studies, evaluate and record. In a loop process, these two steps will be applied until the achieve the desired results. The last phase is the report review.

### **2.1 RESEARCH SCOPE**

The definition of the research process scope is based on the literature found in conference abstracts and journals articles (IEEEExplore), conference abstracts and research articles (ScienceDirect), from 2010-2020. The focus is the evaluation of case studies implemented with COBIT and ITIL.

ITIL bundle established best practices to support the task of IT service operation (Kubiak & Rass, 2018), is the best practices guidance for IT Service Management (ITSM) and has been well accepted by organizations world-wide. ITILv3 presents five stages in the service lifecycle management: Service Strategy, Service Design, Service Transition, Service Operation and Continual Service Improvement (OGC, 2007).

Control Objectives for Information and Related Technology (COBIT) is an IT governance framework; it shows a clear distinction between IT management and IT governance. COBIT19 refers the possibility to define factors and components that should be considered by organizations to build and maintain a governance system: processes, organizational structures, politics, procedures, information flows, culture, ethic and behavior, skills, services, applications and infrastructure of an organization, not only in the ICT domain (ISACA, 2019).

Based on several studies and research it is considered that COBIT and ITIL frameworks are relevant references to support the design of an approach for service operation management in a medium-sized organization, to improve operational efficiency, cost optimization and stakeholder satisfaction.



## 2.2 RESEARCH QUESTIONS

The formulations of the research objectives are:

Could ITIL and COBIT bring benefit to a medium-sized organization?

Could ITIL and COBIT support implementation of service operation and related business processes?

## 2.3 RESEARCH PROCESS

The process of literature identification used the following resources:

- . IEEExplore Digital Library;
- . Science Direct;

Based on these two sources, several keywords were used in the search with Boolean operators in the abstract area. The keywords or group of keywords used to find the right literature are: “Implement”; “Case”; “Process”; “Framework”; “Approach”; “Model”; “ITIL”; COBIT; Operation. During the first execution, some similar expressions were detected, it was decided to use all. The search strings were the following:

- In IEEExplore: (“Implement” OR “Case” OR “Process” OR “Framework” OR “Approach” OR “Model”) AND “ITIL”. It was found 194 studies. Adding AND “COBIT”- to the previous selection, the number of studies decrease to 29. Applying addition again to the previous selection with - AND “Operation” - (related to ITILv3 service Operation) it results in 2 studies. Adding “medium-size”, it resulted in an empty set. It was decided to use the 2 studies previously selected.
- In Science Direct, the article types selected was research articles and conference abstracts; the terms selected were: (“Implement” OR “Case” OR “Process” OR “Framework” OR “Approach” OR “Model”) AND “ITIL”. It was found 307 studies. Adding - AND “COBIT”- to the previous selection, the number of studies decrease to 100, showing that is more usual ITIL implementation. Applying another addition to the previous selection with - AND “Operation” (related to ITILv3 service Operation) it results in 82 studies. Adding “medium-size” (related to the organization size) it results in 26 studies.

The complete string is: (((((((("Abstract":Implement) OR "Abstract":Case) OR "Abstract":Process) OR "Abstract":Framework) OR "Abstract":Approach) OR "Abstract":Model) AND "Abstract":ITIL) AND "Abstract":COBIT) AND "Abstract":Operation) AND "Abstract":medium-size).

## 2.4 DATA EXTRATION

The inclusion and exclusion criteria applied to the studies were:

Rejected repeated studies and Rejected studies whose abstracts could not answer the research questions or Scope.

**Table 6** presents the results of the research in theme based on the defined criteria.

**Table 6.** Results of the previous stage

Source	Studies Found	Candidate	Selected
IEE EXplore	194	29	2
Science Direct	307	100	9
<b>Total</b>	501	129	11

Table 6 shows the result of the interactions in online BD to select the studies considered relevant to the development of the framework.

## 2.5 RESULT ANALYSIS

The result of the studies identification was based on the analysis of the following criteria: Publishing Outlets (Conference/Journal); Most productive institutions and Author' academic backgrounds. It is considered that these results can contribute to enrich the framework in development.

## 3 RESULTS AND DISCUSSIONS

Section three presents the result and discussions of publishing outlets, most productive institutions and author' Academic Background.

### 3.1 TRENDS CHARACTERISTICS

Table 7 shows the publishing outlets from selected studies.

**Table 7.** Publishing Outlets

	<b>Conference/Journal Name</b>	<b>#</b>
<b>Conference</b>	2019 IST-Africa Week Conference (IST-Africa)	1
<b>Conference</b>	2018 5th International Conference on Behavioral, Economic, and Socio-Cultural Computing (BESC)	1
<b>Journal</b>	Computer Networks	1
<b>Journal</b>	International Journal of Accounting Information Systems	1
<b>Journal</b>	Procedia Technology	1
<b>Journal</b>	Computer Standards & Interfaces	1
<b>Journal</b>	Procedia - Social and Behavioral Sciences	1
<b>Journal</b>	Computers & Security	1
<b>Journal</b>	International Journal of Information Management	1
	<b>Total</b>	<b>9</b>

Table 7 identifies conferences and journals where selected studies were presented, it was considered that can add value to the framework in development.

### 3.2 AUTHORS' ACADEMIC BACKGROUNDS

From 32 researchers, they were categorized into 6 department/ knowledge groups. The results show most researchers are from Computer Science groups/departments.

Table 8 shows the author' Academic Backgrounds.

**Table 8.** Author' Academic Backgrounds

<b>Department</b>	<b>#</b>
Accounting	1
Computer Science	16
Software Engineering	3
Information Systems	6
Management	6
<b>Total</b>	<b>32</b>

Table 8 presents the different knowledge areas relevant to the theme. It shows the pertinence of the work proposed in the framework that is under development and its multidisciplinary character.

### 3.3 MOST PRODUCTIVE INSTITUTIONS

Table 9 presents, in an alphabetic order, the institutions considered in the studies selected with the criteria applied.

**Table 9.** Most Productive Institutions

<b>Institutions</b>	<b>#</b>
Beykent Üniversitesi, Istanbul, Turkey	1
Federal University of Rio Grande do Sul, Brazil	1
National Technological University of South Lima, Peru	1
NHH Norwegian School of Economics, Bergen, Norway	1
Oregon State University, EUA	1
Universidad Politécnica de Madrid, Spain	1
Universitetet i Agder, Kristiansand, Norway	1
University of Alcalá, Madrid, Spain	1
University of Economics, Prague, Czech Republic	1
University of Ferrara, Italy	1
University of Innsbruck, Austria	1
University of Johannesburg, South Africa	1
University of Manchester, UK	1
University of Southern Queensland, Australia	1
University of Tulsa, Oklahoma, EUA	1
<b>Total</b>	<b>15</b>

Table 9 shows the relevance of the theme; different institutions around the world are working and producing studies on that subject.

## 4 FUTURE RESEARCH DIRECTIONS

Further research needs to be conducted to align the framework objectives. Literature reviews should be conducted on other sources as well, because this paper only used two sources database (IEEEExplore Digital Library and Science Direct). More different sources will enrich the research and knowledge of the implementation of service operation based on ITIL and COBIT.

## 5 CONCLUSION

Due to the need for optimization processes in a medium organization, a framework is being designed, for which a review of the literature is being carried out. The paper presents a literature review from two digital databases (IEEEExplore and Science Direct). These publications discuss different aspects of ITIL and COBIT frameworks.

To answer the research questions based on the literature found could be said that ITIL is the most implemented ITSM framework all over the world, the use of IT Services Management

(ITSM) has provided many positive business impacts; although, there are several issues related to ITSM, such as data quality, process automation, IT as a service broker, etc. (Dharmawan, Sukmana, Wardhani, Ichسانی & Subchi, 2018) and with ITIL processes in place, it becomes considerably easier to resolve and fix the incidents reported (Mahalle, Yong & Tao, 2018). Besides the benefits, implementing ITIL and COBIT through an organization is challenging and complex, due a lack of alignment between both framework and the fact that literature provides only general guidance (Yamami, Mansouri, Qbadou & Illousamen, 2016).

## REFERENCES

- OGC, Office of Government Commerce, "The Official Introduction to the ITIL Service Lifecycle", London: TSO, 2007.
- ISACA, "COBIT 2019 Framework: Governance and Management Objectives". Schaumburg: ISACA, 2018.
- I. K. Raharjana, S. Susmiandri and A. Justitia, "Applying IT Services Business Relationship Management on Security Outsource Company" *2018 5th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, Malang, Indonesia, 2018, pp. 426-431.
- P. Kubiak and S. Rass, "An Overview of Data-Driven Techniques for IT-Service-Management," in *IEEE Access*, vol. 6, pp. 63664-63688, 2018, doi: 10.1109/ACCESS.2018.2875975.
- Y. Mahy, M. Ouzzif and K. Bouragba, "Supporting ITIL processes implementation using business process management systems," *2016 Third International Conference on Systems of Collaboration (SysCo)*, Casablanca, 2016, pp. 1-4, doi: 10.1109/SYSCO.2016.7831338.
- M. T. Dharmawan, H. T. Sukmana, L. K. Wardhani, Y. Ichسانی and I. Subchi, "The Ontology of IT Service Management by Using ITILv.3 Framework: A Case Study for Incident Management," *2018 Third International Conference on Informatics and Computing (ICIC)*, Palembang, Indonesia, 2018, pp. 1-5, doi: 10.1109/IAC.2018.8780478.
- Veronica, A., "Information Technology Service Performance management using COBIT and ITIL framework: A case study. International Conference on Information Management and Technology", (ICIMTech), 2018.
- A. El Yamami, K. Mansouri, M. Qbadou and E. H. Illousamen, "Toward a new multi-agents architecture for the adoption of ITIL framework by small and medium-sized enterprises," *2016 4th IEEE International Colloquium on Information Science and Technology (CiSt)*, Tangier, 2016, pp. 40-45, doi: 10.1109/CIST.2016.7805091.
- C. Bartolini, C. Stefanelli and M. Tortonesi, "Synthetic incident generation in the reenactment of IT support organization behavior," *2013 IFIP/IEEE International Symposium on Integrated Network Management (IM 2013)*, Ghent, 2013, pp. 126-133.
- A. Ekanata and A. S. Girsang, "Assessment of capability level and IT governance improvement based on COBIT and ITIL framework at communication center ministry of foreign affairs," *2017 International Conference on ICT For Smart Society (ICISS)*, Tangerang, 2017, pp. 1-7, doi: 10.1109/ICTSS.2017.8288871.
- Veronica and A. Debora Suryawan, "Information technology service performance management using COBIT and an ITIL framework: A systematic literature review," *2017 International Conference on Information Management and Technology (ICIMTech)*, Yogyakarta, 2017, pp. 150-155, doi: 10.1109/ICIMTech.2017.8273528.
- A. Mahalle, J. Yong and X. Tao, "ITIL Processes to Control Operational Risk in Cloud Architecture Infrastructure for Banking and Financial Services Industry," *2018 5th*

- International Conference on Behavioral, Economic, and Socio-Cultural Computing (BESC)*, Kaohsiung, Taiwan, 2018, pp. 197-200, doi: 10.1109/BESC.2018.8697294.
- LEKETI, Mpho & RABORIFE, Mpho. (2019). IT Governance Frameworks and their Impact on Strategic Alignment in the South African Banking Industry. 1-9. 10.23919/ISTAFRICA.2019.8764872.
- Nancy Judith Cruz-Hinojosa, José Antonio Gutiérrez-de-Mesa, “Literature review of the situation research faces in the application of ITIL in Small and Medium Enterprises”, *Computer Standards & Interfaces*, Volume 48, 2016, Pages 124-138, ISSN 0920-5489, <https://doi.org/10.1016/j.csi.2016.05.001>
- Juliano Araujo Wickboldt, Luís Armando Bianchin, Roben Castagna Lunardi, Lisandro Zambenedetti Granville, Luciano Paschoal Gaspary, Claudio Bartolini, “A framework for risk assessment based on analysis of historical information of workflow execution in IT systems”, *Computer Networks*, Volume 55, Issue 13, 2011, Pages 2954-2975, ISSN 1389-1286, <https://doi.org/10.1016/j.comnet.2011.05.025>
- Firoozeh Rahimian, Akhilesh Bajaj, Wray Bradley, “Estimation of deficiency risk and prioritization of information security controls: A data-centric approach”, *International Journal of Accounting Information Systems*, Volume 20, 2016, Pages 38-64, ISSN 1467-0895, <https://doi.org/10.1016/j.accinf.2016.01.004>.
- Michal Sebesta, “On ICT Services Outsourcing in the Context of Small and Medium Enterprises”, *Procedia - Social and Behavioral Sciences*, Volume 81, 2013, Pages 495-509, ISSN 1877-0428, <https://doi.org/10.1016/j.sbspro.2013.06.467>
- Michael Curry, Byron Marshall, Peter Kawalek, “IT artifact bias: How exogenous predilections influence organizational information system paradigms”, *International Journal of Information Management*, Volume 34, Issue 4, 2014, Pages 427-436, ISSN 0268-4012, <https://doi.org/10.1016/j.ijinfomgt.2014.02.005>.
- Sudi Apak, Sefer Gümüş, Zuhul Kurban, „Strategic Dimension of Outsourcing in the Information Technologies Intensified Businesses”, *Procedia - Social and Behavioral Sciences*, Volume 58, 2012, Pages 783-791, ISSN 1877-0428, <https://doi.org/10.1016/j.sbspro.2012.09.10561>
- Jon Iden, Tom Roar Eikebrokk, “Implementing IT Service Management: A systematic literature review”, *International Journal of Information Management*, Volume 33, Issue 3, 2013, Pages 512-523, ISSN 0268-4012, <https://doi.org/10.1016/j.ijinfomgt.2013.01.004>.
- Igor Aguilar Alonso, José Carrillo Verdún, Edmundo Tovar Caro, “Case Study of Strategic IT Demand Management in Organizations – Exploratory Results”, *Procedia Technology*, Volume 9, 2013, Pages 900-909, ISSN 2212-0173, <https://doi.org/10.1016/j.protcy.2013.12.100>.
- Michael Brunner, Clemens Sauerwein, Michael Felderer, Ruth Brey, “Risk management practices in information security: Exploring the status quo in the DACH region”, *Computers & Security*, Volume 92, 2020, 101776, ISSN 0167-4048, <https://doi.org/10.1016/j.cose.2020.101776>.



# HOW DATA ANALYTICS HELPS MANAGEMENT IN GLOBAL PANDEMIC SITUATION

Dimitar Dimitrov<sup>70</sup>   
Radko Radev<sup>71</sup>

DOI:

---

**Abstract:** *The ongoing COVID-19 pandemic is having a tremendous impact on the business organizations, governments and people around the Globe. No matter if it is a public, or private organization, the leaders and management have changed their approaches, standard operations, the way they communicate, processes and procedures. In this paper is analyzed the impact of Data Analytics on two main management pillars and more specifically: Business Operations and Human Resources Management; more precisely, how they are impacted and changed in the pandemics. We analyzed how Global IT Companies are reacting and using analytics as a tool that helps them in the day to day operations, representing some used models and patterns.*

**Keywords:** *Management, Corporate Management, data analysis.*

---

## INTRODUCTION

### COVID-19 outbreak

**D**ecember 31<sup>st</sup>, the World Health Organization (WHO) reports “Pneumonia of unknown cause”, detected in Hubei province in the city of Wuhan, China. This is how everything started at the close of 2019. The novel Coronavirus started with officially reported 44 cases in January 2020, out of which 11 severely ill and remaining 33 in “stable condition”, WHO (1, 2020, July 30).

Eight months later (as of end of July 2020) initially reported few cases in the China province became the fastest spreading world-wide virus declared by WHO as a pandemic situation.

The latest numbers are as follows WHO (2020, July 30):

- **33,502,430 Total Cases** (total cumulative count). The number include deaths, recovered and discharged patients;
- **~2.9% reported deaths**, calculated on the base of 1,004,421 deaths;
- **5,757,859 Currently infected**, of which ~99% (5,691,295) defined as mid-condition and ~1% (66,564) as serious or critical cases;
- ~0.5% (83,959) of the cases are from China Mainland and ~99.5% (16,566,611) from other countries. At this point of time the most impacted countries are as follows: United States 26,63% (4,433,410), Brazil 14,69% (2,446,397), India 8.91% (1,484, 136), Russia 4,91% (818, 120), South Africa 2,72% (452,592);
- **Total Cured 10,226,484** (Includes recovered and Discharged);
- **Total Critical and Serious cases** fluctuates between ~40,000(beginning of April) to 66,564 (end of July) which is the biggest absolute number since the beginning.

---

<sup>70</sup> University of National and World Economy, 1700 Sofia, Student Town, UNWE, Bulgaria

<sup>71</sup> University of National and World Economy, 1700 Sofia, Student Town, UNWE, Bulgaria

All these facts indicate a massive impact which goes beyond a single country or continent, small, medium or big corporation, or a single industry. Pandemic affected not only private companies and business owners but as well governments, non-profit organizations and people's lives.

It is no surprise that COVID-19 impacted every element in the macro-environment map: Political, Economic, Social, Technological, Environmental and Legal (PESTEL). Companies needed to change and adapt their operations, and the IT industry was not an exception. Global players had maybe a benefit of having a world-wide footprint which enabled them to be more flexible, but the local companies needed to act locally and be innovative in order to survive.

### **Data analysis**

So called Data Analytics 2.0 came in the mid-2000's when social network firms and internet-based companies like eBay, Google and Facebook started to collect and analyze new and extremely large volumes of data. The data was not only companies' internal data, but it has external sources as well e.g. sensors, internet, public data, audio and video.

With all this dramatic change, this phase raised the requirements for new more powerful tools and the opportunity was used by some companies to materialize and profit it. New products, skills, expertise and professions emerged out the new requirements and market. Hadoop, NoSQL, Apache Spark and many other solutions were started to be developed. Terms like Machine-learning and Artificial Intelligence started to form a real added value for the business.

In the 2.0 phase some very prominent observers have seen the beginning of the next phase (3, Thomas H. Davenport, 2013) which is described with not only further development of the products, service and features but when the large companies which are not just Internet and IT Companies started to adopt above principles to create new products and services in their industries.

From another angle, next to the three eras analytics can be defined by its type and capabilities:

1. Descriptive – “What happened?”

Descriptive analytics is used to describe and explain different relationships between various sources usually within the existing big data bases.

2. Diagnostic – “Why did it happen?”

As the name dictates Diagnostic Analytics gives answer on “Why this happen” question. It focuses on the root cause analysis investigating the sources, factors and causes of the results.

3. Predictive – “What will happen?”

Predictive analytics focuses on solving problems coming from forecasting and trends analysis. It gives answers and predicts future again based on sets of data and applying metaethical models.

4. Prescriptive – “What should be done?”

The logical sequence is prescription of the actions which needs to be taken in every individual case after analyzing what and why happened. This part of data analytics steps on the Predictive Analytics and uses very specific knowledge algorithms for every entity, organization or company. It might consist of Artificial Intelligence (AI) or Machine Learning algorithms or Data Driven Decision Making System. It usually provides



scenarios and based on the specific case it might be applied automatically or be suggested to respective management function which needs to take decision and act.

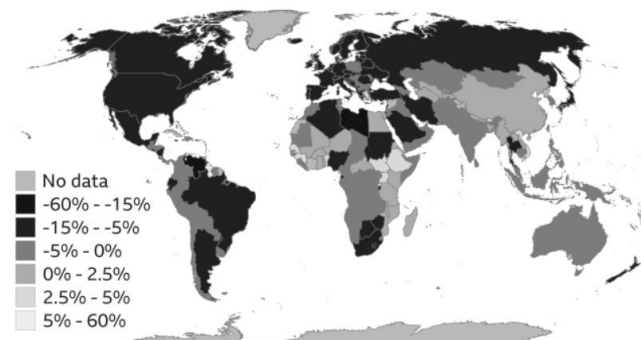
In the current global pandemic situation, the use of Data Analytics can be vital for organizations. Analytics can give quick answers to complex questions combining various, on the first look not connected data sources which cannot be analyzed with conventional methods and tools. It is also purely data driven, which means that in such unknown situations like the COVID-19 pandemic it is driven mainly from facts and data leaving emotions and legacy aside.

The other main advantage is that Big Data analytics can combine various sources of large unstructured data, combine and relate them providing trends and suggestions which might be totally radical or illogical and which might give competitive advantage for the organization.

### Management reaction

Economic impact was dramatic world-wide. After the pandemic spread, and the governments started implementing measures and restrictions, the impact on business was inevitable. GDP and economic forecasts collapsed all around. We have seen the majority of the biggest economies in the world reporting forecasts for more than -3% drop (USA, Germany, France, UK etc.). One of the biggest economic drivers like India and China report positive numbers +1.2% and +1.9%, which compared to their usual growth seems like recession.

**Figure 1. Q1 GDP**



Source: 4, Lora Jones, Palumbo and Brown, 2020

Another major factor for the impact on the global economy is stock markets reactions. Figure 2 (4, Lora Jones, Palumbo and Brown 2020) shows how the three main stock indexes plunged.

**Figure 2. The impact of COVID-19 on the Stock markets**



Source: 4, Lora Jones, Palumbo and Brown 2020

In such situation, management is under high pressure not only from the economic implications but as well from the social, political and technological factors. Revenue streams in many industries declined dramatically e.g. “Communications Media and entertainment” and “Gas & Oil”. Widely used as a marker Brent crude oil price dropped with more than 50% in the beginning of the crisis (5, Maria Nicola et al, June 2020) or (6, Amadeo November 2020); in the next months the price recovered with around 30% but it is still historically low, based on the decreased demand and macroeconomic situation. Other sectors were completely blocked, like “Travel & Transportation”. In this sector was reported dramatic decrease of 58%-78% which measures international tourist arrivals (7, Borko 2020). One of the biggest carriers Lufthansa and Air France/KLM reported year-over-year revenue slump of respectively 89% and 82% (7, Borko 2020). Food industry and Grocery needed to take a move toward digital, and supplying their goods to the front door of the customer. IT was challenged to provide quick and scalable solutions to many companies, markets and industries which was not an easy task.

The management layer of the companies needed to cope with their own challenges and problems and take quick decision based on limited information within quick timelines. In the analysis below, we will focus on two main management topics: Business operations and Human Resources management.

#### **a. Operations management**

The job of operations management (OM) consists of all the activities involved in transforming a product components or activities into a finished product or services. In addition, operations managers are involved in planning and controlling the systems that produce goods and services (8, J. Skripak 2016).

The following study will look specifically into IT sector represented by the following global companies: Alphabet, Cognizant, GoDaddy, Twitter, Zoom, DxC, IBM, HPE, HP Inc and ServiceNow.

As per provided definition, Operations Management might be a very broad term overseeing very wide range of activities; the study will focus on seven factors which clearly comes as consequence after COVID-19, and which impacts companies operations: 1) “Remote work and modified Schedules”, 2) “Customer Accommodation”, 3) “Health & Safety”, 4) “Supply chain impacts”, 5) “Closed Stores and suspended services”, 6) “Community Services”, 7) “Layoffs”. Below are listed the definitions provided by JustCapital Global tracker (9, JustReport 2020):

- 1) “Remote work and modified Schedules” – Company is voluntarily shifting its nonessential employees to a remote work or work-from-home arrangement in response to the pandemic or are enacting alternative scheduling practices.
- 2) “Customer Accommodation” – Company is offering special accommodations to customers. Drill down to explore whether companies are offering discounts or price cuts to their customers, allowing customers to defer payment of goods and services, continuing to provide essential utilities to customers who are unable to make payments at this time, and/or providing services to vulnerable populations such as reserving the first hour of shopping for high-risk customers.
- 3) “Health & Safety” – Company announced added health and safety measures during the pandemic to protect workers and customers alike.
- 4) “Supply chain impact” – Company has announced information about impacts or adjustments to its supply chain, including whether there have been job cuts, or the company has made a commitment to maintain business.

- 5) “Closed Stores and suspended services” – Company is voluntarily closing some or all its retail or branch locations or suspending some or all its operations or services.
- 6) “Community Services” – Company is providing direct in-person or in-kind community services to help with relief efforts, such as organizing food banks, blood drives, or even providing free software for schools.
- 7) “Layoffs” – Company announced layoffs in order to offset lost revenues.

Chosen ten Global IT companies represents significant part of the industry and can be taken as stable marker showing the impact and actions. The table below gives their answers regarding the seven factors they take into account and where they have taken actions.

**Table 1.** COVID-19 responses of selected IT Global companies

	Alphabet	Cognizant	GoDaddy	Twitter	Zoom	DxC	IBM	HPE	HP Inc.	ServiceNow
1) Remote work and modified Schedules	x	x	x	x	x	x	x	x	x	x
2) Customer accommodation	x		x		x	x	x	x	x	x
3) Health and safety	x									
4) Supply chain impacts	x			x		x	x	x	x	x
5) Closed stores and suspended services								x	x	x
6) Community services	x	x		x			x	x	x	
7) Layoffs						x	x			

**Source:** 9, JustReport 2020

With 100% answers, all selected companies choose to move towards remote way of work, which is expected, as this industry has all needed tools, knowledge and processes. Moreover, many of IT companies have already established practices and policies around remote workers.

The second answer where majority of the companies reported as impacting is “Customer accommodation” with 80%. This shows that customer focus, flexibility and willingness are considered a priority for the sector. This is not a surprise as the companies are service providers and they have impacted clients in a way that they should react and adopt the situation.

“Supply chain impact” is the third impacting category with 70% answers that this is a factor that have impact on their operations. COVID-19 impacted travel and transportation industry all around the globe as well as raw materials industry, and their supply due to the imposed lockdowns. Impact on the corporate value chain materialized in delayed production and shipments (10, Sallomi 2020).

The remaining three factors “5) Closed stores and suspended services”, “7) Layoffs” and “3) Health and safety” are considered with minor impact on IT Companies business operations due to the respective low rate answers – respectively 30%, 20% and 10%. Even with low response rate, these three factors should not be ignored as they have impact directly on companies’ clients or on their employees and respectively on the quality of product/service, customer satisfaction and (not on the last place) direct impact on the employees.

The last factor which will be reviewed, and which has direct impact on every IT company operations is “Business Continuity Planning” or BCP. Every global IT company need to have BCP in place, it needs to be practiced and adopted / updated regularly, which ensures its smooth and timely operations. Another angle is adopting company`s technology stack to the BCP, which needs to be scalable and flexible enough to address the respective situation and needs (10, Sallomi 2020). In global pandemic situation all of the included companies have implemented stringent BCP strategies (9, JustReport 2020) which clearly helped them in the quick reaction and proper answer.

## **b. Human Resources Management**

Human resource management is one of the key pillars in companies strategic and overall management. This is even more valid for IT companies, no matter if they are small Software Development houses with 10-100 employees, medium size companies who has couple of thousands or big global players having from tens thousands to more than one hundred thousand employees. Human capital is a key for companies` success and so-called total cost of workforce or TCOW accounts for big part of their cost structure. COVID-19 put extreme pressure on the people around the globe, which affected how business operates and approaches their human resources. HR processes and procedures needed to be adopted to the “new reality” which impacted their productivity, efficiency, motivation and engagement.

In the literature there are different HR management models (11, Armstrong and Tailor 2020). Beer et al (12, Beer at al 1984) structured framework which is now known as ‘Harvard framework’ where HRM ‘involves all management decision and actions that affect the nature of the relationship between the organization and employees’. There are two characteristics: 1) Direct managers are responsible and they ensure alignment between company strategy and HR policies, and 2) HR sets the policies and model how HR activities are developed and implemented.

There is as well ‘5-P model’ (13, Schuler 1992) where the author describes five topics where HRM operates: 1) HP philosophy, 2) HR Policies, 3) HR Programs, 4) HR Practices and 5) HR Processes.

The third model which we will review is so called ‘European Model’ (14, Brewster and Larsen 1992), which has the following logic: 1) Environment, 2) Objectives, 3) Focus, 4) Relationship with employees, 5) relationship with direct managers and 6) Role of HR.

It can be summarized by the reviewed models that there are two main drivers that play key roles in HRM, especially in the pandemic situation:

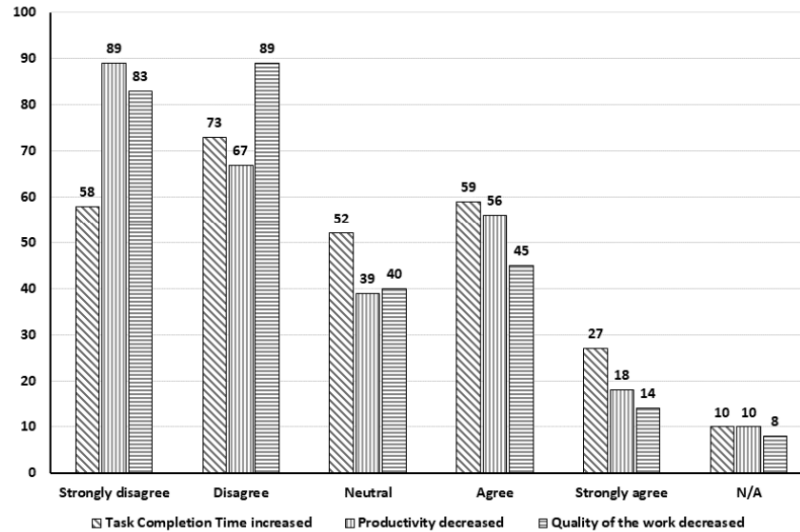
1. HR Processes & Policies,
2. Role of Direct Managers.

Relating back to the study shown in table 1, it is clear that all examined companies modified their work processes and policies moving towards ‘work from home’ or ‘flexible models’. This is not an easy task as every country has its own legal framework and required process and policies adoption from HR departments. Then the implementation passed though leadership and direct management that needs to communicate, implement, execute and monitor how this affects their employees in all aspects as: efficiency, motivation, engagement and so on. The other main factor which affects HRM is “Supply chain” effects which 70% of the companies think it was impacted. Here there are different factors starting from un-availability to deliver

the services / products, issues with performing their daily tasks and facing direct problems related to the clients.

At the beginning of the pandemic, companies took fast decisions without knowing how this will impact their operations and results, and during the course of the year they all started to analyze different data to see how these actions actually affect them. In his paper Paulo et al [15] shows how COVID-19 impacts outcome for software developers:

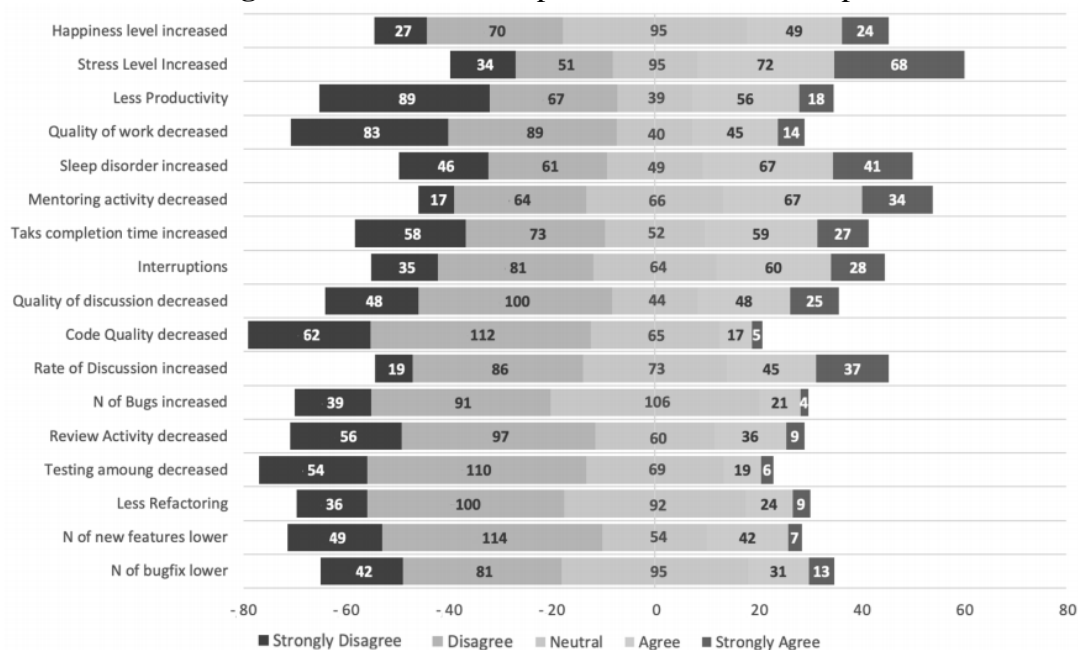
**Figure 3.** Summary of the survey results on the impact of COVID-19 on task completion time, productivity, and quality of the work



Source: 15, Paolo Anselmo et al, August 2020

This leads to an important conclusion that flexible work schedule and work from home don't impact their quality of work and productivity. The summarized result of the survey (Paolo Anselmo et al, August 2020) is shown in figure 4.

**Figure 4.** COVID-19 impact on software developers



Source: 15, Paolo Anselmo et al, August 2020

## Conclusion

Based on the above study, we can conclude that Corporate Management, as well as Human Resource Management, reacted fast and unedified to the global pandemic. They joined their forces and acted with great flexibility by:

- Adopting processes,
- Changing HR policies,
- Modifying their approach to Customers,
- Raised the level of safety,
- Adopting their value and supply chains.

The companies who focused on these factors stayed and became even more relevant for their clients and were able to increase customer and employee satisfaction. That is why the next steps will be bringing: 1) Measuring, 2) Analyze, 3) Change, 4) Adopt, and 5) Maintain of the newly implemented practices and processes, where actually data analytics will come to play. All of these factors can be monitored and analyzed no matter of the size of the company and its industry. However, Global IT companies have strategic advantages as: Infrastructure (Software and Hardware), Skill-full employees, Data Driven culture, which gives them fly-start and moreover position them better compared to the other industries where processes are slow, where companies don't have the needed infrastructure and the employees are not keen into digitalization. We believe that analytical approach and data driven approach into handling situations like COVID-19 global pandemic will rise the bar and will push the companies more towards digitalization and automation, as it gives enormous level of flexibility and adoptability as well as quick resolution to problems which they have never faced before.

## References

- [1] WHO publishes interactive timeline of its response. July 2020. Rolling updates on coronavirus disease (COVID-19). Retrieved from <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen>
- [2] World Health organization web site statistics. Retrieved from <https://www.who.int/news/item/29-06-2020-covidtimeline>
- [3] Thomas H. Davenport. 2013. "Analytics 3.0", Harvard business review 2013. Retrieved from <https://hbr.org/2013/12/analytics-30>
- [4] Lora Jones, Daniele Palumbo and David Brown Coronavirus, "A visual guide to the economic impact". BBC June 2020. Retrieved from <https://www.bbc.com/news/business-51706225>
- [5] Maria Nicola, Zaid Alsafi, Catrin Sohrabi, Ahmed Kerwan, Ahmed Al-Jabir, Christos Iosifidis, Maliha Agha, and Riaz Aghaf, "The socio-economic implications of the coronavirus pandemic (COVID-19): A review". June 2020. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7162753/>
- [6] KIMBERLY AMADEO, "Oil Price History—Highs and Lows Since 1970". November 2020. Retrieved from <https://www.thebalance.com/oil-price-history-3306200>
- [7] Seth Borko, Wouter Greet, Haixia Wang, "The travel industry turned upside down: Insights, analysis, and actions for travel executives". September 2020. Retrieved from <https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/the-travel-industry-turned-upside-down-insights-analysis-and-actions-for-travel-executives>

- [8] Stephen J. Skripak, Richard Parsons, Anastasia Cortes, Anita Walz, “Operations Management”. Pamplin College of Business and Virginia Tech Libraries. July 2016 p.12-13
- [9] JustReport. “The COVID-19 Corporate Response Tracker”. JustCapital, November 2020. Retrieved from <https://justcapital.com/reports/the-covid-19-corporate-response-tracker-how-americas-largest-employers-are-treating-stakeholders-amid-the-coronavirus-crisis/#methodology>
- [10] Paul Sallomi, “Understanding the impact of COVID-19 Technology Sector”. Deloitte, April 2020. Retrieved from <https://www2.deloitte.com/global/en/pages/about-deloitte/articles/the-heart-of-resilient-leadership.html>
- [11] Michael Armstrong and Stephen Taylor, “Armstrong’s Handbook of Human Resources Management Practice”, 15<sup>th</sup> edition, Kogan Page 2020 pp.10-14
- [12] Michael Beer, Bert Spector, Paul R. Lawrence, D. Quinn Mills, Richard E. Walton, “Managing Human Assets”. The free press, November 1984
- [13] Schuler, R.S., Strategic Human Resource Management: “Linking People with the Needs of Business. Organizational Dynamics”, 1992 pp.18-32
- [14] Brewster, C., & Larsen, H. H., “Human resource management in Europe”: evidence from ten countries”, International Journal of Human Resource Management, 1992 409–434
- [15] Paulo Anselmo da Mota Silveira Neto, Umme Ayda Mannan, Eduardo Santana de Almeida, Nachiappan Nagappan, David Lo, Pavneet Singh Kochhar, Cuiyun Gao, Iftekhhar Ahmed, “A Deep Dive on the Impact of COVID-19 in Software Development”, Aug. 2020





# PURCHASING BUSINESS IN THE CONDITIONS OF THE PANDEMIC CRISIS

Sandra Mrvica Mađarac<sup>72</sup>   
Zvonimir Filipović<sup>73</sup>   
Marko Eljuga<sup>74</sup> 

DOI:

---

**Abstract:** *Procurement is a function of the company that cares of everything about that is necessary for the realization of the goals of the business system and in particular it is very important for the successful operation of a trade company. Procurement is a function of the company and other business structures whose task is to supply the equipment, materials, services, products and energy needed to achieve goals of the business system. By pursuing the economic order quantities, decisions on expenditures and selection of the best suppliers we contribute to the business success. On the global level, companies are facing the impact and consequences of the COVID 19 pandemic, which also affects companies purchasing processes. In the paper are presented and analysed changes in the organization and functions of the purchasing business activities of the two companies as a consequence of the pandemic crisis.*

**Keywords:** *Purchasing business, the pandemic crisis, supply, organization, company.*

---

## INTRODUCTION

The pandemic crisis has brought completely new and until now, unprecedented and unknown circumstances not only for all of us who participate in social life as individuals but also for all the participants in business processes who have faced a series of challenges they have not encountered so far. Restrictive measures brought by states to protect their population from infection have caused many difficulties when carrying out daily activities. Due to the COVID-19 pandemic, it is necessary to adapt social and economic life to the new conditions. Companies that are engaged in sales due to the reduction of social contacts and measures brought by the Civil Protection Headquarters of the Republic of Croatia had to change their business organization. On 24th April 2020, the Civil Protection Headquarters of the Republic of Croatia has issued a Decision stipulating the working hours and the way of work in the trade activity during the Coronavirus epidemic; all stores and all sales facilities were obliged to organize their work in compliance with the general anti-epidemic measures and special recommendations and instructions brought by the Croatian Institute of Public Health (Koronavirus, 15.06.2020). On 19th March 2020, the Civil Protection Headquarters of the Republic of Croatia has issued a Decision on measures to restrict social gatherings, work in trade, services and sporting and cultural events (Official Gazette, 32/2020), therefore suspending working of all shops except those listed in the decision.

---

<sup>72</sup> College of Applied Sciences “Lavoslav Ružička” in Vukovar, Županijska 50, Vukovar, Croatia

<sup>73</sup> PIK Vrbovec plus d.o.o., Gospodarska zona 20, Antunovac, Croatia

<sup>74</sup> Agro – Honor d.o.o., Vrbaska 1c, Osijek, Croatia

Procurement is a major part of the organizational and business process of any trading company. The paper presents the changes in the supply business in two trading companies during the course of the pandemic: one is engaged in the production and sale of food products, and the other in the sale of agricultural machinery.

## **PROCUREMENT AS A FUNCTION OF TRADING COMPANY**

Procurement is function and activity of the company and other operating systems, which takes care of supplies, materials, equipment, services and energy that are necessary for the realization of the objectives of the business system. As an activity, it is extremely complex and important for the success of the company's business (Ferišak, 2006). Procurement tasks are:

- connecting companies with the market.
- procurement of means for production and its services in line with the production plan,
- organizing the process of circulating funds in reproduction,
- organizing work processes that ensure carrying out of individual procurements and the circulation of means of production in the previous phase of the production cycle (Karpati, 1975). By procurement in the narrower sense of the word is meant primarily running of operational activities in the process of acquiring the items of procurement. These are jobs that need to be performed on a daily basis in order to timely realize the defined needs and supply requirements of the business system for procurement facilities of appropriate quality, in the required quantity, at reasonable prices, with respect to deadlines, at a specific place and with the appropriate service. Operational functional procurement activities are as follows: examination and consolidation of procurement requests obtained from the preparation of work, development, warehouses, laboratories and other organizational units, observation and monitoring of the procurement market, making and setting inquiries to suppliers, receiving, examination and evaluation of suppliers' offers, negotiating with suppliers, selection of the most favourable offer and ordering, monitoring delivery deadlines and coordination of all direct connections with the suppliers, receiving and examination of the shipment, control of supplier's accounts, complaints due to inadequate fulfillment of the supplier's obligations, running records / files of procurement (Ferišak, 2002).

Procurement in a broader sense of the word encompasses strategic tasks on which depends the effect and profits of the business system. The tasks of procurement in a broader sense are to prepare the best possible use of procurement market opportunities, to positively influence to the production consumption and sales by defining types, forms of input structure when using the potential of suppliers and taking into account environmental protection, in order to better meet consumer demands, and to maximize the effects and profits of the business system (Ferišak, 2002). Marketing procurement significantly differs from the classic procurement system because here it does not run a typical "supplier-procurement" relationship, which is when the supplier motivates the customer to purchase certain goods or services, but the supplier and procurement party establish partnerships and thus facilitate the flow of procurement, that is, they realize short-term and long-term procurement tasks more efficiently and cost-effectively (Ružić, 2002). The organizational structure of procurement deals with human and other resources, and refers to (Ferišak, 2002, 317): division of tasks and procurement function, system of managerial and executive jobs and relations between them, system of obligations and authorities, system of work places responsibilities and system of communication between work places. When organizing procurement, it is necessary to adhere to certain principles, because non-compliance with them may bring many difficulties in business. These principles are: equal and fair division of labour among the employees,

specialization of jobs within the service itself, standardization of goods procured, solutions to the problem of centralization-decentralization, principles of cooperation when doing business and proper assignment of authority and responsibility when performing affairs (Karpati, 1975, p. 42). By choosing the optimal form of organizational structure, it can be influenced on the business and business results of the company (Krpan et al., 2015). The very process of procurement is carried out in the following order (Peričić, Kozina, 2001): initiating the process of procurement, additional analysis of requirements for procurement and its approval, selection of the supplier and sending a request, invitation to tender, the selection of suppliers and sending orders and verification of goods from the suppliers. The procurement process is important for (Purchase Control, 2020): efficient purchasing process (not only intended for direct consumption), successful supplier relationship management, optimal supply chain management, rationalization of all stages of the procurement process, establishment of the management models of the business process.

### **EXAMPLES OF BUSINESS PRACTICES OF PURCHASING ORGANIZATION DURING A PANDEMIC CRISIS**

Company X is a recognizable brand and market leader in Croatia in the production and sale of meat products, and its products are exported to foreign markets, with exports accounting for 10% of total annual sales. Since it is a manufacturing company that cannot perform its basic function of production without adequate supply of the raw materials, it is clear that the purchasing function is one of the most important functions of the company. Production results in the creation of added value, and in order for this added value to be competitive on the open market, it is necessary to ensure through the procurement function the highest quality of the raw material at the most competitive purchase price.

At the head of the company's procurement function is the procurement director who directly manages the procurement function and, according to the business organization, comes immediately below the company's director. The purchasing function of a company is roughly divided into two parts depending on the type of product being procured. The first group includes the procurement of raw materials that are directly necessary for the production process. The second group includes the procurement of everything else necessary for the smooth running of business processes in the company such as fixed assets, small inventory, etc. The procurement director manages the team of procurement managers for certain procurement groups, so the company has a procurement manager who cares for the purchasing of the raw materials and also the procurement manager who covers other group of procurements. In the procurement office they also have the procurement referents, which in coordination with their superior managers perform all the current activities related to the purchasing. It can be said that under normal circumstances before the pandemic, the procurement function took place almost routinely in accordance to the previously established schedules of activities. At the annual level, most of the procurement of key or basic raw materials necessary for the production is agreed upon. As this is the food industry, it is extremely important that the raw material for production is of exceptional quality and freshness, which in itself suggests that the preference is given to the domestic suppliers, i.e. the partners in the procurement process. The production process requires a certain time until the release of the finished product, so there is a need to conclude supply contracts for a longer period of time for at least a year, so that production can be planned in advance and proceed according to set plans and without production standstill. The aim of procurement is to supply raw materials of appropriate quality at the most competitive purchase price so that the final product itself will be as competitive as possible on the demanding domestic and foreign

markets. Together with the coordination between the procurement director, procurement manager and procurement officers, the procurement itself is agreed and the course of the procurement process is controlled, depending on the scope of responsibilities of each level of employees working on the procurement service. The products that the company sells on the market have a seasonal character, which also directly affects the procurement function. The biggest support for the procurement of raw materials is provided by the domestic suppliers, but due to the increase in seasonal demand for certain groups of products it is impossible to meet the market demands without the procurement of raw materials from other countries - mostly often from the European Union. The food industry, even in normal circumstances, requires quick reactions and adjustments to market trends and needs, which requires exceptional flexibility from employees working in procurement and readiness to immediately address the challenges that have arisen before them.

A company that is engaged in the production of basic food products in the conditions of a pandemic crisis has found itself in great challenges. The population under the influence of psychosis that was caused by the set of limitations began to react irrationally; the panic caused an increase in demand for the Company X's products and there was a rapid decline of finished goods in stock. All of these new circumstances put before the procurement service tasks that had not been encountered so far. The company at a given time should provide enough products to supply the increased market demands, and at the same time the procurement should provide enough raw materials for the uninterrupted production. The employees who are not necessary present in the production process or who do not work directly in production are redirected to work from home through modern technologies that enable them to use mobile communications. The complete procurement service personnel were relocated to work from home in the present circumstances. Regardless of the work from home, the service had to react promptly and provide the allowed quantities of the necessary raw materials. The pandemic has caused numerous imbalances in the supply and demand for primarily food products, which has resulted in an uncontrolled rise of the prices of both final products and the raw materials that were needed for its production. Coordination with all other services in the company has moved to the virtual world through video links and similar advanced tools, but also communication with the suppliers has taken place by means of virtual meetings. Prior to the procurement, new tasks were set which comprehended the procurement of a sufficient amount of raw materials, regardless of the procurement price. It was in such crisis that the conditions were characterized by the increased in demand when all the shortcomings of our business environment had come to light. The domestic raw material base proved insufficient to meet the increased needs of the producers that were demanded by the market. Restrictions that were in force during the first wave of the pandemic with regards to the movement of goods and people in interstate traffic made it even more difficult to procure the raw materials from other countries. When working from home for all the procurement staff was required a much greater commitment to be able to complete all the necessary procurement processes than has occurred during normal times before the pandemic. The procurement has proven to be crucial for the company's survival on the market and for keeping the jobs for all of employees.

Company Y is specialized in retail and wholesale and service of small agricultural machines such as motor cultivators, chainsaws, lawn mowers, motor mowers (trimmers), water pumps, aggregates and other small machines. The procurement business of company Y is organized in such a way that the procurement of certain devices and spare parts takes place on a daily basis. As the company has organized both retail and wholesale, and since a relatively large number of customers regularly order and buy products, purchasing business must always be up to date. In the period before the pandemic crisis, the procurement business was organized in

such a way that employees regularly collected orders from customers for the needs of service for their devices or to obtain the spare parts, which would be then forwarded to their warehouses to separate the items and to send them back to the company. Company Y orders a large amount of parts of devices and spare parts from companies operating within the Republic of Croatia, but it also orders and imports some goods directly from other countries, such as Germany, Italy, Serbia, Austria and other countries. Before the crisis, business with companies from the other countries has taken place without any problems, as well as business within the Republic of Croatia. The difference was exclusively in the duration of the time period spent for the delivery of the ordered goods. The crisis that began in March of this year has drastically changed the business of the company itself and businesses of all other companies with which the company cooperates. Namely, no one was prepared for what the crisis had caused. First of all, the delivery of ordered devices and spare parts and everything else started to be delayed, and apart from the fact that the delivery period has increased, an even bigger problem was that some deliveries were questionable and whether they would be realized at all. How the carriers were limited at the very beginning of the crisis to move to other countries, and the crisis itself has taken a big swing in the single countries (such as the case of Italy) - for the goods which have been ordered from those countries were put a lot of question marks (here, referring both to the production and distribution). Under these conditions, company Y had to change its current way of doing business and to adapt to the new situation. The first decision the company has made was to increase the stock of both the devices and the spare parts. Of course, this decision also had some negative consequences, because large stocks also result in the engagement of a more financial resources; it didn't do well in the crisis, but it was simply necessary to try to adjust the business. The second decision that has been taken - that it was necessary to clearly communicate this new way of doing business with the customers and service users. Namely, everyone needed to be explained why did exist a longer period of time for the delivery of devices from the service, but also for the delivery of spare parts and individual devices from the stores. Of course, this also had negative consequences, because it is understandable that some users did not show understanding, so in that case they gave up services. But since other companies had similar problems, finally there were not too many of discontented users. For the most part, customers and service users had an understanding and had remained loyal and they continued to buy items from the company Y. In addition to this, the company made several other adjustments in its business, all with the aim of realizing as much work as possible, and for them doing business and surviving on the market would not be put into question. At one point the crisis was showing signs of weakening and we all hoped it was about to end. Business began to return to normal and all the imposed measures slowly began to be abolished. So, business and movement of goods were allowed again to circulate as it was before the crisis. Unfortunately, again the situation has started to show up some negative trends related to the COVID 19 crisis. Yet again, there are introduced some limitations measures, but this time not as rigorous and businesses are more or less normally taking place, but again including a longer time interval. Uncertainty about how long this crisis will last has resulted for the company to focus exclusively on procuring those materials needed during this period, and is not willing to take any additional risks for the reason that no one can predict what tomorrow will bring. Purchasing business has normalized as much as possible, having larger stocks than before, but also, they offer narrower assortment. The company's goal is to provide its customers and service users with everything they need, to try to follow the trends, but the introduction and procurement of some new things has been currently put on hold.

## CONCLUSION

The COVID 19 pandemic crisis has been present for a long time and is causing great problems not only for economic entities, but also for all other activities. The consequences of the crisis, which is still going on day by day, are evident in the business operations of almost all companies. In these conditions, companies must find their way to organize their businesses as better as possible.

The main goal of the procurement business should be that procurement contributes as much as possible to the success of the company's business, and this can be achieved by using economies of scale and when choosing the right suppliers. Procurement tasks are to acquire materials and services of functionally appropriate quality, at the best price, in economical quantity, at the right time, from the most favourable sources, with high delivery service, when achieving the greatest possible protection of the environment and natural resources, with the least risks, with the lowest costs and with the good relationships with the suppliers. The procurement function in the company itself is extremely complex process even in the normal business conditions, and only in conditions such as the present pandemic crisis does the true importance of procurement in the organizational structure of each company come to light. The crisis has shown how extremely important it is to have a well-organized procurement service that will be able to perform all the tasks set before it even in difficult conditions, by the company's management. Developing partnerships with suppliers are needed that are not based on cooperation for only one delivery, but based on ongoing cooperation in which all participants in the supply process will be satisfied with the agreement that has proved to be crucial in time of the onset of the global pandemic crisis. It can be concluded that there is not much difference between procurement under normal circumstances and procurement during a pandemic crisis. Procurement is here to meet the needs of the company for the raw materials and other necessary resources that are necessary for business; it is only a question of how and with what employee engagement this can be achieved to be the most optimal solution for the company.

## REFERENCES

- Ferišak, V. (2006). *Procurement - policy - strategy - organization – management*. II updated edition, Zagreb, Croatia: Author's own edition.
- Karpati, T. (1975). *Procurement in the associated labour production organization*, Osijek, Croatia: NIP Press.
- Koronavirus, <https://www.koronavirus.hr/odluka-o-radnom-vremenu-i-nacinu-rada-u-djelatnosti-trgovine-za-vrijeme-trajanja-epidemije-koronavirusa/510>, retrieved 19 June, 2020.
- Krpan, Lj., Varga, D. & Maršanić, R. (2015). Organizational structure of procurement business process. *Technical Gazette*, Vol. 9, No. 3, 327-336.
- Official Gazette, 32/2020, Decision on measures restricting social gatherings, work in trade, service activities and holding sports and cultural events.
- Peričić, G., Kozina, G. (2011). Significance of logistics procurement process in business system. *Technical Gazette*, Vol.5 No.1, 134-138.
- Purchase Control, <https://www.purchasecontrol.com/uk/blog/purchasing-process/>, retrieved 27. September, 2020.
- Ružić, D., Tomičić, Z. & Turkalj, Ž. (2002). *Exchange Relationships in Marketing*. Osijek, Croatia: Faculty of Economics in Osijek.

# THE NECESSITY OF PSYCHOHYGIENE IN THE WORK OF TRADERS

Zuzana Birknerová<sup>75</sup>   
Dagmara Ratnayake Kaščáková<sup>76</sup> 

DOI:

---

**Abstract:** *The rapid economic growth of many companies brings with it the need to pay more attention to issues of management and leadership of people in the conditions of a centralized model of economic management, as well as mental readiness for work and social position in business. Mental balance is one of the most important mental equipment of traders in personal and professional life. Therefore, in the article we assess the necessity of psychohygiene in the work of traders. Its role is to support and create favorable psychological conditions. The aim of the research is to determine the existence of statistically significant differences in the assessment of the attributes of psychohygiene between customers and traders. The research sample, out of the total number of 177 respondents, consists of 125 (70.6%) women and 52 (29.4%) men aged 18 - 70 years, while the average age is 41.08 years, the standard deviation is 7.913 years. Of the total number of respondents, 97 (54.8%) were traders and 80 (45.2%) were customers. The length of the respondents' internship ranged from 1 to 40 years (average 17.25 years, standard deviation 8.679 years). The research results were processed in statistical program IBM SPSS Statistics 22.00 and assessed by t- test for two independent samples. The authors focused on mental health care, proper lifestyle, stressors, work environment and time management.*

**Keywords:** *Attributes, Psychohygiene, Traders*

---

## INTRODUCTION

The term psychohygiene is the equivalent of the terms mental, psychological and mental hygiene. It is a system of scientifically elaborated rules and councils used to maintain, deepen or regain mental health, mental balance (Míček, 1986). It has very close relations to psychotherapy (Ďurdiak, 2001). According to Szarková (2016), psychohygiene is a department of work psychology, which studies the possibilities and ways of adjustment or changes in living (thus also working) conditions of a person in relation to the creation and stabilization of his positive feelings and positive philosophy of life. Bedrnová et al. (2009; 2012) argues that it is an interdisciplinary subject covering the practical issues of our lives with a focus on maintaining physical and mental health, despite the adverse effects of many stimuli and situations. It is such an adjustment of a person's living conditions that would evoke in him a feeling of satisfaction, personal happiness, physical and mental fitness and performance (Bartko, 1990).

Mental hygiene focuses on the possibilities of self-regulation of the individual, acting on oneself and on the active transformation of one's environment (the focus is on self-education, mental regulation, hygiene of thinking, ideas, attention, etc.). It deals with the problems of

---

<sup>75</sup> University of Presov Faculty of Management, Konštantínova 16, 080 01 Prešov, Slovakia

<sup>76</sup> University of Presov Faculty of Management, Konštantínova 16, 080 01 Prešov, Slovakia

adaptation and mild cases of human maladaptation, i.e. mild mental disorders. It focuses mainly on prevention, dealing with the issue of strengthening mental health (Míček, 1986). Psychohygiene seeks to examine and ensure optimal mental health conditions and prevent the development of mental disorders (Kondáš, 1985).

Mental health is a desirable condition that results from conscious or unconscious adherence to the principles of psychohygiene (Ďurdiak, 2001). It is a state in which all mental processes take place optimally, correctly reflect the external reality, while the appropriate solution of tasks is accompanied by a feeling of satisfaction (Kondáš, 1985). A person is mentally healthy if he is reasonably satisfied with himself if he has good relations with others, and if he is able to solve the everyday problems that life brings (Melgosa, 1998).

## **RESEARCH PROBLEM**

At present, the business environment is increasingly convinced that the application of psychological sciences is not only beneficial for its development and comprehensive profit, but also increasingly necessary, both in terms of meeting economic and marketing goals. Traders are required to synergistically combine theoretical and practical knowledge and experience of applied psychological disciplines with theoretical knowledge and approaches to the theory of economics and marketing (Szarková, 2016). The author states that psychohygiene is a field of work psychology that studies the possibilities and ways of adjustment, living and working conditions of an individual, which are related to the creation and stabilization of one's positive feelings and positive philosophy of life. It focuses on identifying those factors that condition or influence the state of mental health in traders, which is given by a set of the following feelings. They are a feeling of satisfaction, a feeling of usefulness, a feeling of success, a feeling of mental and physical fitness, a feeling of personal happiness, a feeling of inner harmony. The degree of satisfaction of coping with the stress elements of work is an important component of overall life satisfaction (Kollárik, 2011).

Fatigue is a natural consequence of every job. It arises as a result of effort and is one of the main factors that affect the performance of traders. It manifests itself in mental and physiological changes in the sensory, emotional, mental, motor and mental processes. Depending on which functions or organs it affects, we distinguish between muscle, sensory, nervous and mental fatigue (Provazník et al., 2002). Feeling tired is subjective and has a protective function because it allows a person to register the symptoms of simple acute fatigue, which can develop into chronic fatigue.

Maladaptive mental states (mental stress, stress and frustration) arise in trade as a result of external and internal conflict situations, which the trader feels as unmanageable. They are the result of a disruption of one's adaptive abilities and a signal of a disturbance of one's mental balance. They can influence him negatively or positively, and it depends on his mental state, mental resistance to stress, temperament and personality, assertive and self-assertive abilities, and one's life philosophy or positive thinking. They can be managed by will mechanisms, autoregulatory personality system and autosuggestion, without drug treatment (Szarková, 2018). One of the possibilities of coping is psychohygiene as a guide, which needs not only to know, but also to respect and not separate theory from practice (Míček, 1986). It is needed and touches on many aspects of the trader's daily life. It is enough to follow psychohygienic principles and invest in reason and better interpersonal relationships (Bartko, 1990).



## METHODS AND DATA ANALYSIS

The aim of the research is to identify statistically significant differences in the assessment of psychohygiene attributes in business. We focused on mental health care, proper lifestyle, stressors, work environment and time management. Based on the stated goal of the research, we set the hypothesis: "We assume that there are statistically significant differences in the assessment of selected attributes of psychohygiene between traders and customers."

In order to collect data and information, we opted for a questionnaire focused on psychohygiene. It pays attention to attributes such as lifestyle, relaxation, rest, time management and work environment. It contains 20 items focused on psychohygiene, for which the respondents express the degree of their consent, resp. disagreement on a 7-point scale (1 - strongly disagree, 7 - strongly agree).

The information obtained from the respondents was processed and analyzed at the level of descriptive statistics (frequency of occurrence, arithmetic mean, standard deviation) and inductive statistics (difference analysis: t-test for two independent samples) in the statistical program IBM SPSS Statistics 22.00.

The research sample, out of the total number of 177 respondents, consists of 125 (70.6%) women and 52 (29.4%) men aged 18 - 70 years, while the average age is 41.08 years, the standard deviation is 7.913 years. Of the total number of respondents, 97 (54.8%) were merchants and 80 (45.2%) were customers. The length of the respondents' internship ranged from 1 to 40 years (average 17.25 years, standard deviation 8.679 years).

## RESULTS AND DISCUSSION

In order to verify the established hypothesis, we performed statistical analyzes in the statistical program SPSS22. We focused on identifying statistically significant differences in the assessment of psychohygiene attributes in business. The results of the analysis to verify the hypothesis: "We assume that there are statistically significant differences in the assessment of selected attributes of psychohygiene between traders and customers" is described in Table 1.

**Table 1.** Analysis of Differences in Selected Attributes of Psychohygiene in Business

Psychohygiene	Position in organisation	Average	Test criterion t	Significance
I am interested in mental health care.	<b>trader</b>	<b>5.81</b>	1.902	<b>.040</b>
	customer	5.03		
In business, it is important to regularly observe psychohygiene.	<b>trader</b>	<b>6.04</b>	2.144	<b>.033</b>
	customer	5.31		
I often feel that I am in a time crunch, I lack time management.	<b>trader</b>	<b>5.96</b>	1.909	<b>.028</b>
	customer	4.30		
I often do not follow a proper lifestyle during work.	<b>trader</b>	<b>5.29</b>	4.061	<b>.000</b>
	customer	4.25		
I also deal with my work duties outside of working hours and premises.	<b>trader</b>	<b>5.06</b>	3.841	<b>.000</b>
	customer	3.89		
I have the opportunity to adjust my work environment so that I feel good in it.	<b>trader</b>	<b>5.66</b>	2.301	<b>.023</b>
	customer	4.41		

Source: Own processing

The results of our research also tell us that the job of a salesperson is not only a job, but also a mission. We found statistically significant differences between traders and customers, where

traders scored higher in selected attributes of psychohygiene (mental health care, proper lifestyle, work responsibilities, environment and time management).

We found that salespeople pay attention to their work duties also outside working hours and outside working spaces more often, as they scored higher in these attributes compared to the addressed customers. Based on the results presented above, we can say that traders are more interested in the issue of psychohygiene, despite the fact that they admitted that they often do not follow a proper lifestyle during their work. They were also much more inclined to agree with the possibility that they could adjust their work environment to feel good in it. They often feel a time constraint in their work and are therefore more aware of the importance of regular psychohygiene and mental health care.

Based on the above analyzes, we can state that the hypothesis: "We assume that there are statistically significant differences in the assessment of selected attributes of psychohygiene between traders and customers" was confirmed.

As part of identifying statistically significant differences in the examined aspects, we recorded several statistically significant differences, with traders always scoring higher. They also take care of their work responsibilities outside working hours and outside working spaces, adjusting their work environment so that they feel good in it. However, they often feel a time constraint in their work and are therefore more aware of the importance of regular observance of psychohygiene.

## **CONCLUSION**

Traders are faced with complex tasks and are required to solve complex issues, so the right mental balance is one of the basic elements for achieving a successful business result. It is therefore necessary to integrate psychohygiene into their work and personal life and at the same time to increase interest in it. Various professional magazines for traders, various professional studies that are available on the Internet, or educational programs are also beneficial sources.

There are many companies that provide personnel and psychological counseling services in the form of business-oriented seminars, education and training courses. Since theoretical education and possible training in teaching is not enough, it is necessary to apply the acquired knowledge directly into practice as soon as possible and to create suitable conditions for this. In larger and financially stronger companies, there are opportunities to use the results of analyzes found by external consulting firms and to have psycho-hygienic principles and good habits developed and implemented into the work regime.

After acquiring theoretical and practical skills in this area, it is important to return to the beginning, to the family, and to transfer new good habits to it, which would become the right stereotype, the starting point for the future and serve to set the right priorities in life (Freidl , 2004; Holdau, 1999; Rantanen, et al., 2004; Rothmann, Rothmann, 2006; Ryff, 1989; Smith, 2008).

## **ACKNOWLEDGEMENT**

*This research was funded by the grant project KEGA No. 012PU-4/2020 "Trading Behavior – Creation of the subject and textbook for non-economic study programs" from The Ministry of Education, Science, Research and Sport of the Slovak Republic.*

## REFERENCES

- Bartko, D. (1990). *Moderná psychohygienu*. Bratislava: Obzor.
- Bedrnová, E. et al. (2009). *Management=osobního rozvoje: Duševní hygiena, sebeřízení a efektivní životní styl*. Praha: Management Press.
- Bedrnová, E., Jarošová, E., & Nový, I. (2012). *Manažerska psychologie a sociologie*. Praha: Management Press.
- Ďurdiak, Ľ. (2001). *Psychohygienu mladého človeka*. Nitra: Enigma.
- Freidl, C. (2004). *Wellness boom. Erholung oder zu viel des Guten?* Saarbrücken: VDM Verlag.
- Holdau, F. (1999). *Einfach gut drauf*. München: Gräfeund Unzer.
- Kollárik, T. (2011). *Sociálna psychológia + Psychológia práce = Sociálna psychológia práce?* Bratislava: Univerzita Komenského v Bratislave.
- Kondáš, O. (1985). *Psychohygienu všedného dňa*. Martin: Osveta.
- Melgosa, J. (1998). *Zvládni svoj stres! Vrutky*: Advent – Orion.
- Míček, L. (1986). *Duševní hygiena*. Praha: Státní pedagogické nakladatelství.
- Provazník, V. et al. (2002). *Psychologie pro ekonomy a manažery*. Praha: Grada Publishing.
- Rantanen, J., Lehtinen, S., & Savolainen, K. (2004). The opportunities and obstacles to collaboration between the developing and developed countries in the field of occupational health. *Toxicology*, 198(1/3), 63-74. <https://doi.org/10.1016/j.tox.2004.01.038>
- Rothmann, S., & Rothmann, J. C. (2006). *The South African employee health and wellness surfy*. User manual. Potchefstroom, South Africa: Afriforte (Pty) Ltd.
- Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of Personality and Social Psychology*, 57(6), 1069-1081. <https://doi.org/10.1037/0022-3514.57.6.1069>
- Ryff, C. D. (2014). Psychological well-being revisited: Advances in the science and practice of eudaimonia. *Psychotherapy and psychosomatics*, 83(1), 10-28. <https://doi.org/10.1159/000353263>
- Smith, S. (2008). Leadership's Effects on Employee Health, Well-Being. *Occupational Hazards*, 70(8), 18-19.
- Szarková, M. (2016). *Psychológia pre manažerov*. Praha: Wolters Kluwer.
- Szarková, M. (2018). *Komunikácia v manažmente*. Praha: Wolters Kluwer.



# SOCIAL NETWORKS, COGNITIVE BIASES AND FAKE NEWS: CAN A SIMPLE COMPUTER MODEL EXPLAIN A COMPLEX PHENOMENON?

Blaž Rodič<sup>77</sup> 

DOI:

---

**Abstract:** *Misinformation spread by individuals sharing fake news can cause problems in social, economic and democratic systems. The World Economic Forum considers the viral spread of misinformation online to be one of the main threats to our society. While the reasons why people spread misinformation likely haven't changed in the last millennia, the rise of Internet powered social networks has allowed news to spread rapidly among millions of users, and gave rise to new phenomena such as echo chambers. The question we ask in this paper is whether we can model the dissemination of fake news and the emerging phenomena using relatively simple rules in an agent-based model. We present the current state of research in the field of fake news, the agent-based modelling methodology, and the current state of our model development.*

**Keywords:** *Fake News, Disinformation, Cognitive Bias, Emergent Phenomena, Social Networks, Agent-based Modelling, Social Psychology.*

---

## INTRODUCTION

The viral spread of digital misinformation has become so severe that the World Economic Forum (Tedeneke, 2018) considers it among the main threats to human society. There is worldwide concern over false news and the possibility that it can influence political, economic, and social well-being (Törnberg, 2018). The scale and rapidity of sharing fake news and misinformation are having an impact on democratic processes. False news can drive the misallocation of resources during terror attacks and natural disasters, the misalignment of business investments, and can misinform elections (Vosoughi, Roy, & Aral, 2018)

The spreading of fake news in social networks is a complex social phenomenon. Unfortunately, the study of large-scale social systems is hampered by its subject – in contrast with modelling of problems typically examined in natural sciences, social science problems are much harder to analyse and model, as they involve real human beings. Consequently, it is nearly impossible to build coherent theories that would account for all empirical observations and which all scientists would agree on.

Currently, there is a lack of models explaining the behaviour of individuals spreading fake news, as the past research has been mostly focused on statistical analysis of the spread of individual articles or posts via sharing (retweeting) in social networks. The analysis of large datasets (e.g. 500 million tweets in (Yang & Leskovec, 2010)) can improve our understanding of the macro phenomena via the development of statistical models, which can provide a reference point for the validation of novel micro models of processes behind the current fake

---

<sup>77</sup> Faculty of Information Studies, Ljubljanska cesta 31a, SI-8000 Novo Mesto, Slovenia

news phenomena. Such micro models would allow us to develop and test new theories explaining and predicting the fake news phenomena using individual-level rules.

Agent based modelling (ABM) is currently the methodology of choice for the construction of micro models aiming to model the interaction of individual humans. In ABM, the focus is on individual agents, their decision processes, their interaction with other agents, and the effects of that interaction on decision processes. Differences between individuals can be introduced relatively easily, as ABM models operate on the micro abstraction level, with individuals represented as discrete agents. The aim of this paper is therefore to present the current state of research in the field of fake news, ABM methodology, and the current state of our model development.

## LITERATURE REVIEW

Social media platforms are often used as effective tools for constructive communication, but they also help disseminate false news (Tedeneker, 2018). Known examples of fake news disrupting democratic processes include the 2016 US presidential elections (Bovet & Makse, 2019), the UK Brexit referendum (Himma-Kadakas, 2017), 2019 European elections (Marianna Spring and Lucy Webster, 2019), and the 2018 Brazil election (Paraguassu, 2020; Trevisani & Seetharaman, 2018).

The paradigm of direct production of uncurated content and its uncritical consumption on online social media fosters the formation of homogeneous communities (echo-chambers) around specific worldviews, and has been demonstrated as a breeding ground for the creation and diffusion of fake news (Zollo et al., 2015). It seems that fake news become rife in times of crisis, as people seek simple explanations for complex truths and scapegoats, as evident in the ongoing Covid-19 pandemic (Hartley & Vu, 2020; Orso, Federici, Copetti, Vetrugno, & Bove, 2020). Furthermore, fake news 'factories' and 'troll farms' seem to have become a common weapon in psychological warfare used by state actors as well as a tool to generate web traffic and thus profit (Gorrell et al., 2019; Linvill & Warren, 2018) (Linvill & Warren, 2018).

Humans are biased in perceiving and understanding a semantic content. A person can verify grammatical correctness of a sentence faster if the subject matches his pre-existing opinion and can understand a sentence faster based on hierarchical structure of the content in brain (Collins & Quillian, 1969; Gilead, Sela, & Maril, 2018). In addition, an individual weakness, such as lack of analytical thinking, can result in significant inaccuracy in generating content and detecting fake content distributed in social networks (Pennycook & Rand, 2017). A recent study has shown that humans are extremely naive in distinguishing content generated by other humans from those by bots (Shao et al., 2017).

While all persons potentially succumb to cognitive biases, regardless of their political persuasion (Pelly, 2017; Tait, 2017), there is evidence that the political bias and demographic factors significantly influence individuals response to fake news and thus their dissemination of fake news (Bovet & Makse, 2019; Guess, Nyhan, & Reifler, 2018; Poynter Institute, 2018; Silverman & Alexander, 2016) (Tait, 2017; Silverman and Lawrence, 2016; Hern, 2018; Guess et al., 2018; Poynter Institute, 2018). The polls conducted during Brexit also show a stronger response to pro-Brexit propaganda, which focused on the immigration issues (“take control of our borders”) in districts with an older age profile, lower proportions of residents educated to the equivalent of a degree, lower median earnings and lower proportions employed in highly skilled occupations (Gunther, Nisbet, & Beck, 2018; Waldherr & Wijermans, 2013). Work of

Goyanes and Lavin (Goyanes & Lavin, 2018) further sheds light on the demographic factors and situational predictors that influence the probability to share political fake news through social media platforms.

## **METHODOLOGY**

### **Agent based modelling in social psychology**

The key properties of the multi-agent approach according to Smith and Conrey (Smith & Conrey, 2007) are as follows. First, agents are autonomous. Second, agents are interdependent. Third, agents in these models follow extremely simple rules. One frequent goal of ABM is to identify the simplest and best supported assumptions about individual agent behaviour (such as the motive to seek the most attractive partner) that will generate the overall pattern or outcome of interest. Agent-based models can be used to study the sensitivity of a system to path dependence, and to explore perturbations to social organization at various stages of group processes (Smaldino, Calanchini, & Pickett, 2015). While the concept of agent-based modelling is easy to grasp, defining an agent-based model is not an easy task. Common mistakes in ABM based research include the integration of too many features and the choice of the parameters. The results of models are often criticized for being either trivial (too much abstraction) or, on the other hand, too complex (insufficient abstraction) and therefore probably wrong because of their surprising results (Waldherr & Wijermans, 2013). Getting the level of abstraction right is therefore of paramount importance. It goes without saying that the modeller must have a good understanding of the problem or system that is being modelled, but a less obvious requirement for selecting the appropriate level of abstraction is a well-defined hypothesis. The hypothesis defines the goals of modelling and thus informs the selection of model variables, their level of detail (=abstraction) and the scenarios to be simulated.

Experiments in social psychology have to navigate the thin line between an experimental setup that mimics real-world situations at the risk of complicating later data analysis, and an over-controlled environment trying to eliminate all potentially interfering variables. In ABMs, we can create the experimental environment containing the exact amount of detail needed. However, a strong bias towards simplicity should be adopted, as overly complicated models are more difficult to analyse, and the number of model parameters can be prohibitive due to the dimensionality of the space of possible parameter settings, which can become too large to be searched efficiently (Eberlen, Scholz, & Gagliolo, 2017). Conte and Paolucci (Conte & Paolucci, 2014) offer a similar view, and advise that model designer should strive to create a model system that captures the aspects of the real-world system in which she is interested, with enough complexity to create a credible analogy between the model and real world systems, but otherwise as simple as possible so as to maximize generalizability and minimize obscuring artefacts.

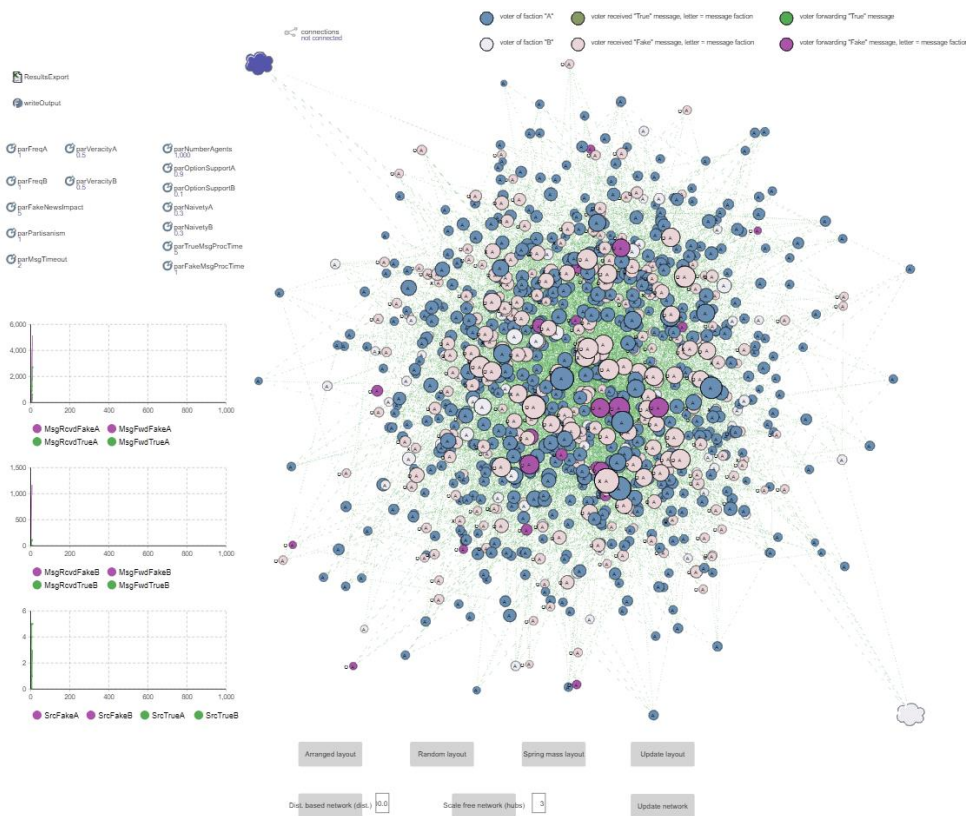
## **CURRENT STATE OF RESEARCH**

While the development of a complex human actor model may be unfeasible due to the complexities of human psyche, we aim to model the fake news dissemination processes with sufficient accuracy by leaning on a main premise of complex adaptive systems research and agent based modelling (ABM) in social systems: complex phenomena emerges from the interplay of a large number of autonomous actors employing a set of simple rules. An individual will be modelled from the aspect of an agent in the news dissemination process, and its decision-making model is to integrate representations of the relevant cognitive biases.

The current version of the model allows us to adjust the number of individual agents, and adjust the parameters governing the behaviour of the “news consumer” agents and several sources of legitimate and fake news (messages). Agent parameters include political partisanship (propensity to forward authentic messages supporting the favoured faction), naivety (likelihood to accept a false message as authentic), ration of fake/authentic messages and frequency of message generation per news source, processing time for fake and authentic news per agent, and the impact of a false message (affecting likelihood for it to be forwarded).

The model also allows us to adjust network type and layout during a simulation run. Available network layouts include arranged, random, and spring-weight, and network types distance-based and scale-free (Barabási & Bonabeau, 2003). The simulation interface with animation of agent communication is shown in Figure 1, while Figure 2 shows that nonlinear behaviour can appear even in the relatively simple current version of the model. News consumer agents are represented as circles and are divided among two factions (political options) A and B. There are two news source agents, represented as cloud icons, and each news source generates messages supporting a single faction. Colours are used to represent the political factions, state of agents (receiving/forwarding messages) and the authenticity of messages received or forwarded. Agent size is adjusted to indicate the number of their connections (links to other agents). Simulation experiment interface is shown on Figure 1. The current value of experiment parameters is shown in the top left, while the charts display the dynamics in the model, such as number of legitimate and fake messages received and forwarded by news consumer agents of factions A and B and the rate of message forwarding per adjustable time period. The agents, their state, network layout and connections are shown on the right.

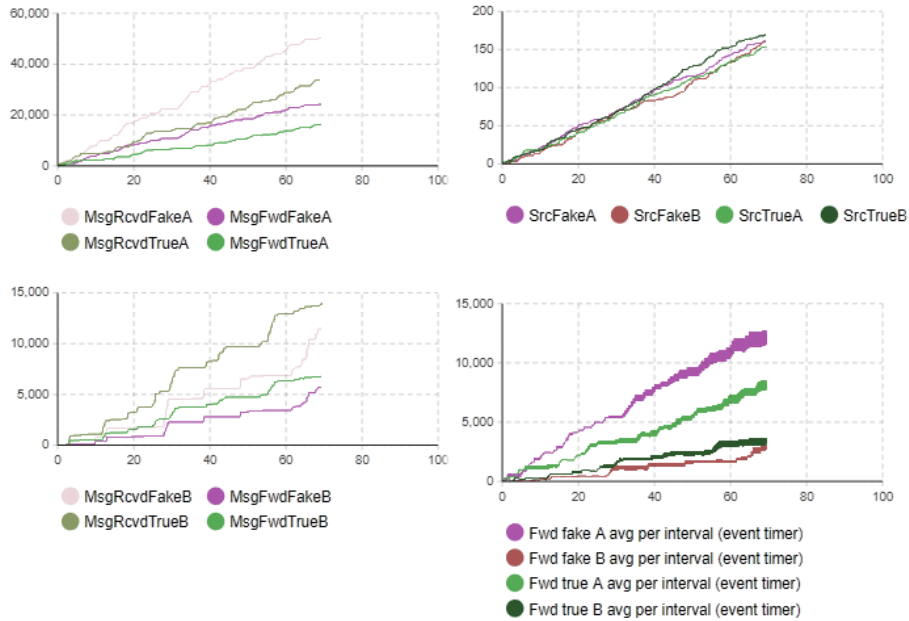
**Figure 1.** Simulation interface within the current model prototype





The charts in Figure 2 display the linear increase of the cumulative number of received and forwarded messages, with visible aberrations appearing between agent factions despite the equal number of agents per faction and the same values of agent parameters. This indicates that even a relatively simple model, containing only linear dependencies between variables can produce unpredictable, nonlinear and even counterintuitive behaviour under the right circumstances, such as network congestion.

**Figure 2.** Observed nonlinear behaviour within the current model prototype



We must note that the experiment results do not yet correspond to real world data, as the model is still under development and not yet calibrated with empirical data. The model's value in current state is in generating insight and new ideas for its further development.

## CONCLUSION

The current version of the fake news dissemination model allows use to vary the agent behaviour parameters, news generation and processing parameters as well as agent network type and layout in order to examine the influence of these parameters on the dynamics of message diffusion as well as visualize the diffusion of messages through the network. We have so far noticed that the increased frequency of messages can produce non-linear behaviour through network congestion. The development of the model prototype will utilize the findings from previous studies and literature review. Calibration, verification and validation of the model will be carried out using the rules identified through secondary sources and available databases of social network (e.g. Twitter, Facebook) and news website data. Originality and innovation of the planned simulation model is in the focus on the mechanisms at the level of individuals, which result in complex social dynamics present in the fake news phenomenon. We will use ABM to model and test new theories based on existing fake news research. The fake news phenomenon is a very relevant area of research, with a major potential scientific and applied impact. As the subject of our research is interdisciplinary, we are looking to cooperate with researchers from the field of network analysis, psychology and social psychology.

## ACKNOWLEDGMENT

Research supported by the Slovenian Research Agency (programme No. P1-0383, Complex networks).

## REFERENCES

- Barabási, A. L., & Bonabeau, E. (2003). Scale-free networks. *Scientific American*, 288(5), 60–69. <https://doi.org/10.1038/scientificamerican0503-60>
- Bovet, A., & Makse, H. A. (2019). Influence of fake news in Twitter during the 2016 US presidential election. *Nature Communications*, 10(1), 7. <https://doi.org/10.1038/s41467-018-07761-2>
- Collins, A. M., & Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Verbal Behavior*, 8(2), 240–247. [https://doi.org/10.1016/S0022-5371\(69\)80069-1](https://doi.org/10.1016/S0022-5371(69)80069-1)
- Conte, R., & Paolucci, M. (2014). On agent-based modeling and computational social science. *Frontiers in Psychology*, 5(JUL), 668. <https://doi.org/10.3389/fpsyg.2014.00668>
- Eberlen, J., Scholz, G., & Gagliolo, M. (2017). Simulate this! An Introduction to Agent-Based Models and their Power to Improve your Research Practice. *International Review of Social Psychology*, 30(1), 149. <https://doi.org/10.5334/irsp.115>
- Gilead, M., Sela, M., & Maril, A. (2018, April 4). That’s My Truth: Evidence for Involuntary Opinion Confirmation. *Social Psychological and Personality Science*, p. 194855061876230. <https://doi.org/10.1177/1948550618762300>
- Gorrell, G., Bakir, M. E., Roberts, I., Greenwood, M. A., Iavarone, B., & Bontcheva, K. (2019). *Partisanship, Propaganda and Post-Truth Politics: Quantifying Impact in Online Debate*. Retrieved from [https://www.researchgate.net/publication/330898845\\_Partisanship\\_Propaganda\\_and\\_Post-Truth\\_Politics\\_Quantifying\\_Impact\\_in\\_Online](https://www.researchgate.net/publication/330898845_Partisanship_Propaganda_and_Post-Truth_Politics_Quantifying_Impact_in_Online)
- Goyanes, M., & Lavin, A. (2018). The Sociology of Fake News. Factors affecting the probability of sharing political fake news online. In *Media and Communications*. <https://doi.org/10.2307/3331474>
- Guess, A., Nyhan, B., & Reifler, J. (2018). *Selective Exposure to Misinformation: Evidence from the consumption of fake news during the 2016 U.S. presidential campaign*. Retrieved from <http://www.dartmouth.edu/~nyhan/fake-news-2016.pdf>
- Gunther, R., Nisbet, E. C., & Beck, P. (2018). Trump may owe his 2016 victory to ‘fake news,’ new study suggests. Retrieved November 10, 2020, from The Conversation website: <https://theconversation.com/trump-may-owe-his-2016-victory-to-fake-news-new-study-suggests-91538>
- Hartley, K., & Vu, M. K. (2020). Fighting fake news in the COVID-19 era: policy insights from an equilibrium model. *Policy Sciences*, 53(4), 735–758. <https://doi.org/10.1007/s11077-020-09405-z>
- Himma-Kadakas, M. (2017). Alternative facts and fake news entering journalistic content production cycle. *Cosmopolitan Civil Societies: An Interdisciplinary Journal*, 9(2), 25. <https://doi.org/10.5130/ccs.v9i2.5469>
- Linvill, D. L., & Warren, P. L. (2018). *Troll Factories: The Internet Research Agency and State-Sponsored Agenda Building*. Retrieved from <https://www.rcmediafreedom.eu/Publications/Academic-sources/Troll-Factories-The-Internet-Research-Agency-and-State-Sponsored-Agenda-Building>
- Marianna Spring and Lucy Webster. (2019). European elections: How disinformation spread in Facebook groups. *BBC NEWS*. Retrieved from <https://www.bbc.com/news/blogs->

- trending-48356351
- Orso, D., Federici, N., Copetti, R., Vetrugno, L., & Bove, T. (2020). Infodemic and the spread of fake news in the COVID-19-era. *European Journal of Emergency Medicine*, pp. 327–328. <https://doi.org/10.1097/MEJ.0000000000000713>
- Paraguassu, L. (2020). Brazil finalizing bill to target financiers of “fake news” attacks. Retrieved November 11, 2020, from Reuters website: <https://in.reuters.com/article/us-brazil-politics-maia/brazil-finalizing-bill-to-target-financiers-of-fake-news-attacks-idUSKBN25Z2G5>
- Pelly, S. (2017). How fake news becomes a popular, trending topic - CBS News. Retrieved January 23, 2019, from CBS News website: <https://www.cbsnews.com/news/how-fake-news-find-your-social-media-feeds/>
- Pennycook, G., & Rand, D. G. (2017). Who falls for fake news? The roles of bullshit receptivity, overclaiming, familiarity, and analytic thinking. In *SSRN*. <https://doi.org/10.2139/ssrn.3023545>
- Poynter Institute. (2018). Fake news and fact-checking websites both reach about a quarter of the population – but not the same quarter. Retrieved March 10, 2018, from <https://www.poynter.org/fact-checking-research-database/fake-news-and-fact-checking-websites-both-reach-about-quarter>
- Shao, C., Ciampaglia, G. L., Varol, O., Yang, K., Flammini, A., & Menczer, F. (2017). The spread of fake news by social bots. *Undefined*, 1–16. <https://doi.org/1707.07592>
- Silverman, C., & Alexander, L. (2016). How Teens In The Balkans Are Duping Trump Supporters With Fake News. Retrieved January 23, 2019, from BuzzFeed News website: <https://www.buzzfeednews.com/article/craigsilverman/how-macedonia-became-a-global-hub-for-pro-trump-misinfo>
- Smaldino, P. E., Calanchini, J., & Pickett, C. L. (2015). Theory development with agent-based models. *Organizational Psychology Review*, 5(4), 300–317. <https://doi.org/10.1177/2041386614546944>
- Smith, E. R., & Conrey, F. R. (2007). Agent-based modeling: A new approach for theory building in social psychology. *Personality and Social Psychology Review*, 11(1), 87–104. <https://doi.org/10.1177/1088868306294789>
- Tait, A. (2017, February 11). Fake news is a problem for the left, too. *New Statesman*. Retrieved from <https://www.newstatesman.com/politics/media/2017/02/fake-news-problem-left-too>
- Tedeneke, A. (2018). Fake News Poses a Threat to Democracies across Latin America and Worldwide > Press releases | World Economic Forum. Retrieved January 23, 2019, from World Economic Forum website: <https://www.weforum.org/press/2018/03/fake-news-poses-a-threat-to-democracies-across-latin-america-and-worldwide/>
- Törnberg, P. (2018). Echo chambers and viral misinformation: Modeling fake news as complex contagion. *PLoS ONE*, 13(9), e0203958. <https://doi.org/10.1371/journal.pone.0203958>
- Trevisani, P., & Seetharaman, D. (2018). In Brazil Vote, Misinformation Spreads on Social Media Despite Efforts to Stop It. *Wall Street Journal*. Retrieved from <https://www.wsj.com/articles/in-brazil-vote-fake-news-spreads-on-social-media-despite-efforts-to-stop-it-1540566295>
- Vosoughi, S., Roy, D., & Aral, S. (2018). The spread of true and false news online. *Science*, 359(6380), 1146–1151. <https://doi.org/10.1126/science.aap9559>
- Waldherr, A., & Wijermans, N. (2013). Communicating social simulation models to sceptical minds. *JASSS*, 16(4). <https://doi.org/10.18564/jasss.2247>
- Yang, J., & Leskovec, J. (2010). Modeling information diffusion in implicit networks. *Proceedings - IEEE International Conference on Data Mining, ICDM*, 599–608. <https://doi.org/10.1109/ICDM.2010.22>

Zollo, F., Novak, P. K., Del Vicario, M., Bessi, A., Mozetič, I., Scala, A., ... Preis, T. (2015). Emotional dynamics in the age of misinformation. *PLoS ONE*, *10*(9), e0138740. <https://doi.org/10.1371/journal.pone.0138740>

# CHALLENGES IN MANAGING INTELLECTUAL PROPERTY RIGHTS DURING CORONAVIRUS PANDEMIC

Mario Lukinović<sup>78</sup>  
Larisa Jovanović<sup>79</sup>  
Vladimir Šašo<sup>80</sup>

DOI:

---

**Abstract:** *The socio-economic impact of the pandemic on all social spheres is huge, but like any crisis, for some it is an opportunity to create, develop and promote solutions. The coronavirus pandemic has brought many changes. It has forced us all to find new ways of working, interacting and living. The field of intellectual property is particularly affected by the coronavirus pandemic, its strong influence has affected all branches of intellectual property, especially the field of copyright and patents. During the COVID-19 Pandemic, numerous anomalies in the consumption of copyrights were observed, which coincided with the isolation measures, from drastically increased consumption of illegal pirated content via the Internet, especially in countries with lockdown, through a sharp increase of Disney+ and Netflix streaming platform users.*

*The identification of products that have the word Corona in their name – in their trademark, with the virus has led to a sharp drop in consumption of some products, but also to increased sales of others. The pharmaceutical industry has invested huge funds in the fight against this global challenge, especially in the field of treatment of viruses, new drugs for the prevention, as well as finding a vaccine against COVID-19. This paper discusses the challenges faced by the management of intellectual property rights and potential response measures.*

**Keywords:** *COVID-19, innovation, intellectual property, patents, coronavirus pandemic, generics, drugs, vaccines, cybersecurity.*

---

## 1. INTRODUCTION

Application of protective measures, that was introduced by the majority of governments world-wide in order to lessen the consequences of the pandemic, impacted them in different ways and to a different extent, depending on the nature of activities of given business subjects. Even though the pandemic is gradually subsiding in a significant number of countries, the vaccine still does not exist, and the fears are still growing stronger; people fear not only its return in the colder autumn and winter periods, but also the possible sudden spread in the southern hemisphere, especially in the regions with a common lower level of hygiene among local population. The impact it leaves behind itself is enormous, and it is especially significant in the field of intellectual property. Isolation of population had a great impact on the increase in consummation of authorship works (reading books, watching movies, listening to music, etc.), while the activity of scientists in the field of inventions is extremely grand.

---

<sup>78</sup> Faculty of Law, UNION University, Belgrade, Serbia

<sup>79</sup> ALFA BK University, Belgrade, Serbia

<sup>80</sup> ALFA BK University, Belgrade, Serbia

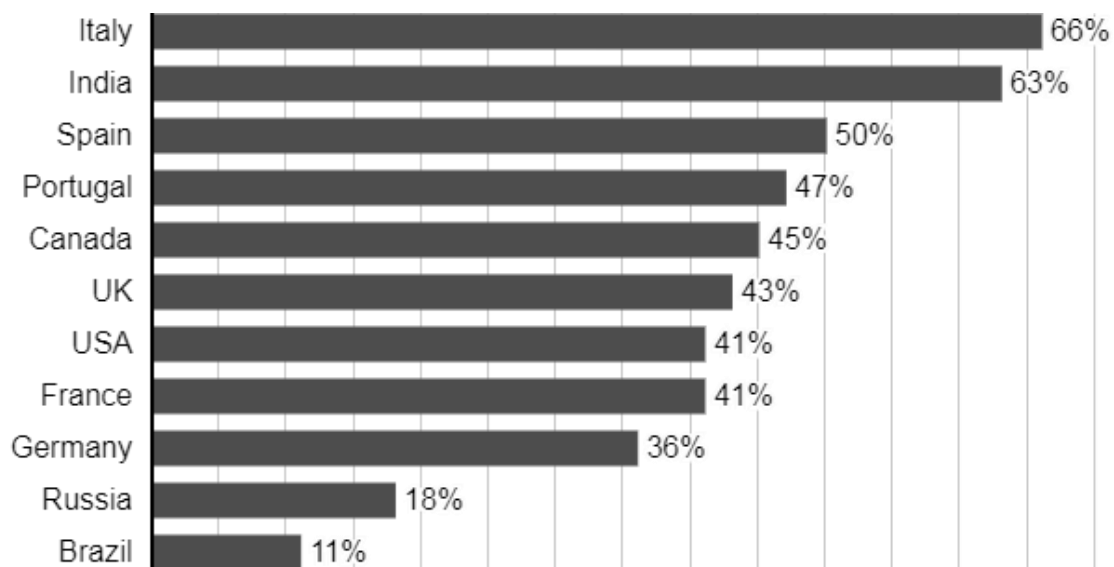
## 2. CHALLENGES OF MANAGING COPYRIGHTS DURING CORONAVIRUS PANDEMIC

The ban and restriction of movement directed the offer of content towards the Internet, many museums, galleries, theaters, etc. instead of classic tours, offered millions of users a virtual tour. Even some of the contents whose contents imply exclusively in vivo communication with visitors (virtual tours of national parks, children's camps, etc.), offered new types of communication which imply the consumption of author's works at a distance.

Everyone tried in their own way to be a part or to give their contribution; many companies, creators and traders offered protective masks with different designs and motifs, as well as T-shirts with messages of the funniest nature related to COVID-19.

Social distancing and millions of people in isolation have caused a drastic increase in watching online movies and TV series. American media provider *Netflix* has, during the COVID-19 pandemic, acquired 16 million of new subscribers on its streaming platform (Ryan et. al., 2020). At the same time, British company MUSO's data, which follows thousands of pirate platforms and contains a database on digital online content in 196 countries, speak of a drastic increase of Internet piracy, which is directly correlated with isolation measures. Since the last week of February and the first week of March, when mass isolation measures commenced, a drastic increase was recorded world-wide. According to this data, we can almost observe the level of isolation measures taken in certain countries. In Italy, the country which was, at one point, most harshly hit by the pandemic, the increase of movie piracy reached unbelievable 66%. Repressive isolation measures were especially strictly taken in India, where the said increase amounted to 62%; afterwards, Spain overtook the primacy from Italy, when speaking of the number of infected individuals, and illegal consumption of authorship has increased for 50%; in Britain, during the same period, the increase amounted to 43%, and in the United States, it amounted to a 41% (Chatterley, 2020).

**Figure 1.** Increase of movie piracy in February/March of 2020



Source: MUSO

The graph expresses the increase of movie piracy during the last week of February, in comparison to the first week of March. It is well noticeable that the highest peak occurred in

Italy, India and Spain, that is, in the countries that, exactly at that time, commenced implementation of strict isolation measures.

Parallel to exponential increase of number of visits to websites containing pirated content during the times of pandemic, the number of websites containing illegal streaming of sports events decreased, given that there are no sporting events. The loss of emitters of sports programs is enormous. They are directly dependent on their viewers, given that their massiveness brings them profit, not only from subscriptions, but from commercials as well. Without sporting transmissions, none of the previously mentioned exists. This vicious circle also includes professional athletes, whose high profits depend in many ways on TV rights, paid by cable and Internet providers.

Companies such as Disney, which have a high dispersion of authorship rights, are currently counting their losses. While Disney streaming platform acquired a record of 32 million subscribers, thanks to a great extent to isolation measures, great losses occurred due to closing of Disney parks in America, Japan, France and China, and the world premiere of “Mulan” movie was postponed due to the pandemic. Disney faced certain loss also due to reduced possibility for merchandising product placement.

The Dutch media and fashion company *RUMAG* (acronym made of the title *RUDE MAGAZINE*), famous for production of T-shirts, mugs, etc. with funny, vulgar or sexual quotes, was publicly accused of copyright infringement. The majority of quotes and slogans that they print on their products (in white lettering on a black background) were taken from social networks and other sources. During the pandemic, they have decided to introduce a special Corona collection to the market, and the entire revenue was intended for the Red Cross. Some of the quotes that sounded funny in the context of the pandemic were taken from the songs of authors popular in the Netherlands. Even though the authors of the said quotes were listed, and the funds were donated for charity, the pressure of the public on *RUMAG* was so strong that the CEO resigned.

Do producers, such as *RUMAG* company, commit infringement of authorship by such conduct? The laws on authorship of the majority of countries do not provide a legal authorship protection to small textual and artistic forms (short phrases and slogans, ornaments, etc.) (Bogdanović, 2017), and they are seen as the so-called “bits of authorship rights”. Certain slogans, ornaments and phrases are protected with a trademark, and in such a way, they enjoy legal protection.

No lawmaker can foresee all life situations. When there is not a legally prescribed provision for a normative solution of a certain problem, we resort to analogy through implementation of suitable rule from a different source. In praxis, commercial use of the title of an authorship work (movies, songs, etc.) without the approval of the carrier of authorship, is very common. Within the contemporary Comparative Law, not all national legislation provides the same protection to a title. If original, the title is regarded as an authorship and enjoys independent protection within the French law. On the contrary, in Great Britain, it is defined that, in the case of use of the same or similar title for the same type of work, the protection might be demanded on the basis of the provisions on fair competition (Spasić, 2011).

According to our Law on Authorship and Familiar Rights, if the title of a work is an original, it represents the subject of authorship legal protection, independently from the piece that is marked by the said title. In praxis, however, not many titles can enjoy such a status. If the title of a work is not an original to the extent that it represents an authorship itself, but is regarded

as an integral part of the authorship named by the said title, the use of the work without its title or with a changed title is regarded as an infringement of authorship of the said title.

### **3. MANAGING PATENTS DURING CORONAVIRUS PANDEMIC**

Nowadays, the Earth is inhabited by the highest number of habitants since its inception (currently numbering more than 7,5 billion), of which a significant percentage inhabits urban settings where they come to a close contact among themselves on a daily basis. Population fluctuation is higher than ever, and airlines have, during the course of 2019, transported more than 4,5 billion of travelers, which is more than double in comparison to the previous year. Transportation decreases distance, and thus, the world has become a “global village” in which, and all thanks to transportation, infections can reach, together with passengers, another side of the planet in just a day. Because of that, the possibility of spreading viruses will continue to grow in the years that shall follow, and the response of the humanity cannot remain in the scope of increasing physical distancing measures and other preventive measures; it is hidden in thousands of laboratories world-wide, where scientists must create new inventions for repressing their impact.

From the invention of the first wheel, to cuneiform, steam machine, penicillin and even a computer chip, innovation represented progress, but also survival (Lukinović, 2017). A patent is a law which protects inventions. It is an award in the form of monopoly rights, given by the state to the inventor for his innovative success, materialized through a unique position on the market (Lukinović et al. 2017). The industrial property protection system is not seen as a goal itself, but as means for encouraging creative work. In order for authors and inventors to be encouraged to create, state provides them with privileges in the form of legal protection, authorship rights or inventions. Through these instruments, individuals are actually being put in the function of the general thing representing progress, as a result of some authorship work or an invention.

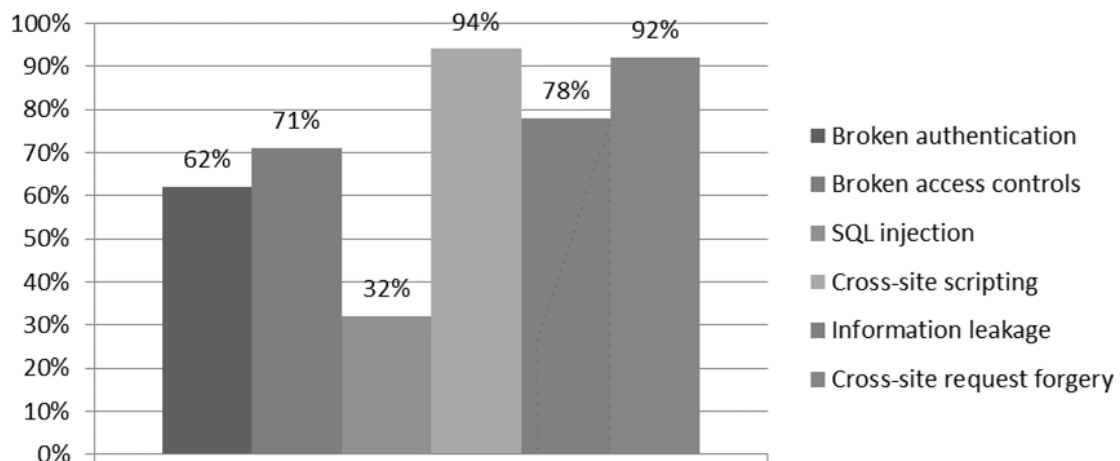
### **4. INTERNET ATTACK AND WEB APPLICATION VULNERABILITIES CAUSED BY COVID-19**

Whenever a new crisis emerges, different criminal actors are the first to jump on the occasion to exploit unsuspecting victims in times of fear, uncertainty and doubt. These exploits take multiple forms, from the physical to the digital world. History has taught us that the most efficient method to initially counter these threats is through prevention and awareness towards all levels of corporate and personal life.

There is a widespread awareness of web application security issues. Users are often called upon to verify certificates because they want to entrust their information to serious organizations that store their data behind advanced cryptographic protocols. Based on the examination of security vulnerabilities of web applications in the period from 2016 to 2019, we can single out the following categories of attacks:



**Figure 2.** Frequency of web application vulnerabilities in the period from 2016 to 2019



Source:

[https://www.academia.edu/35796648/Upravljanje bezbednoscu u Cyber prostoru i mehani zmi zastite web aplikacija](https://www.academia.edu/35796648/Upravljanje_bezbednoscu_u_Cyber_prostoru_i_mehani_zmi_zastite_web_aplikacija)

**Table 1.** Vulnerabilities and categories of attacks in the period 2016-2018.

<b>Disadvantages of authentication</b>	Include compromising and abusing various shortcomings of the system login mechanism. The method of random guessing of the user code is most often used here.
<b>Broken Access control</b>	Deficiencies are a case where an application is unable to protect access to data and resources. Here, the attacker is allowed to access sensitive user data on the server, or to perform privileged actions.
<b>SQL injection</b>	Allows an attacker to modify an SQL query intended for a database. In this way, the attacker may be able to access the data stored in the database.
<b>Cross-site scripting</b>	Allows an attacker to attack other users of the application, as well as gain access to their data or perform unauthorized actions on their behalf.
<b>Cross-site requests forgery</b>	Allows an attacker to perform unwanted actions on behalf of the user of the application. The attack is realized based on the visit of the malicious site by the victim, after which the user's browser performs certain actions that the user does not intend to do.
<b>Information leakage</b>	Includes cases where the application displays sensitive information that is useful to the attacker in developing mechanisms against the application itself, by printing error messages and other similar behavior.

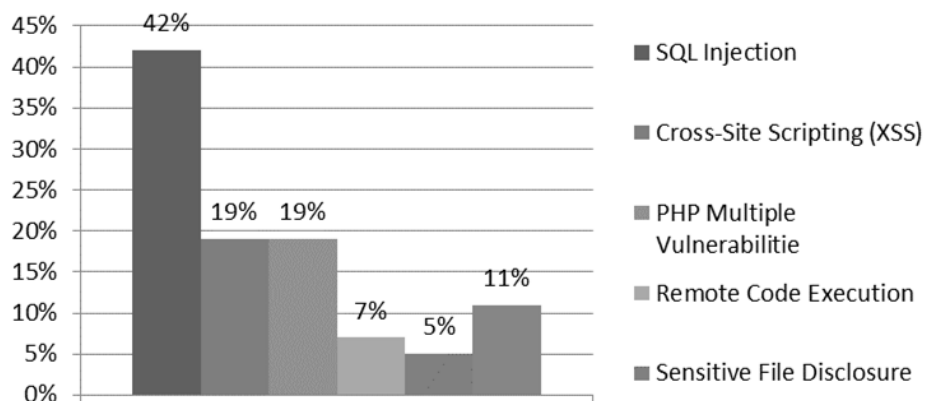
Website attack attempts per day grew by 59% from January 2018 to December 2018, ending at a peak of 80 attacks per day and averaging 62 attacks per day for the year. Rising attack volume suggests cybercriminals are automating their attacks to expand their reach and frequency. However, the sample of infected websites remained steady at about 60,000 throughout the year, indicating that website security tools are likely becoming more successful at combating the increasing number of attacks.

As 5G networks roll out, the use of connected IoT devices will accelerate dramatically. They will increase networks' vulnerability to large-scale, multi-vector Gen V cyber-attacks. IoT devices and their connections to networks and clouds, are a weak link in security. It's hard to get visibility of these devices that can have complex security requirements. What's needed is a more holistic approach to IoT security, combining traditional and new controls to protect these ever-growing networks across all industry and business sectors.

Many organizations have shifted workloads to the cloud. However, the level of understanding as to securing them remains dangerously low. Security is often an afterthought as traditional security can be perceived as inhibiting business agility. This is why security solutions need to evolve to a new paradigm of flexible, cloud-based, resilient architectures that deliver scalable security services at the speed of DevOps. Cloud computing is fastmoving and dynamic. As organizations adopt new and more efficient cloud-based services and technologies to meet their business needs, cloud attack vectors become more complex and diversified. An additional concern is that cloud has enabled the increase in the speed and agility of development teams to use new technologies, but security controls for these new technologies often lag behind new technology adoption.

Next figure shows most common critical vulnerabilities in 2020 (Internet facing):

**Figure 3.** Most Common Critical Vulnerabilities in 2020 (Internet facing)



Source:

[https://landing.edgescan.com/hubfs/BCC030%20Vulnerability%20Stats%20Report%20\(2020\)\\_WEB.pdf](https://landing.edgescan.com/hubfs/BCC030%20Vulnerability%20Stats%20Report%20(2020)_WEB.pdf)

**Table 2.** Vulnerabilities and categories of attacks 2020.

<b>SQL injection</b>	SQL injection attack consists of insertion or “injection” of a SQL query via the input data from the client to the application. A successful SQL injection exploit can read sensitive data from the database, modify database data (Insert/Update/Delete), execute administration operations on the database (such as shutdown the DBMS), recover the content of a given file present on the DBMS file system and in some cases issue commands to the operating system. SQL injection attacks are a type of injection attack, in which SQL commands are injected into data-plane input in order to affect the execution of predefined SQL commands.
<b>Cross-site scripting (XSS)</b>	Cross site Scripting (XSS) attacks are a type of injection problem, in which malicious scripts are injected into web sites. Cross site scripting flaws are the most prevalent flaw in web applications today. Cross site scripting attacks occur

	when an attacker uses a web application to send malicious code, generally in the form of a browser-side script, to a different end user. The ‘stored’ variant is considered a “Critical” vulnerability as it persists across all users who access an infected page and has the potential to infect a wide user base of the web application or site.
<b>Php multiple vulnerabilities</b>	Many PHP vulnerabilities were discovered with ratings including both high and critical risk. Many PHP deployments have multiple vulnerabilities concurrently. PHP is still a widely used programming language but loosing popularity. Millions of sites on the Internet use PHP and will for some time to come
<b>Remote code execution</b>	Remote code execution (RCE) is used to describe an attacker’s ability to execute arbitrary commands or code remotely across the Internet or network on a target machine. This is achieved by exploiting a vulnerability which generally, if known about, could be mitigated via a patch or configuration change
<b>Sensitive file disclosure</b>	This is the result of leaving unprotected files on a hosting environment, systems using inadequate authorization or poorly deployed systems which result in directory listing and sensitive data disclosure. A recent trend in such a vulnerability, are exposed AWS S3 buckets which are misconfigured, resulting in publicly exposed database back up files, internal files, configuration files and other private information being left available on the Internet

Vulnerabilities may result in complete compromise of a system or a user. They are generally highly likely to occur, high impact or both. SQL Injection was first discovered in 1998 and still lives on the Internet today together with XSS and RCE.

Since the beginning of the outbreak, a total of 90,284 new corona related domains have been registered globally. Many of them were found to be malicious and suspicious.

More online transactions mean more opportunities to hack credit card data, and people working remotely have opened up new ways for criminals to target both individuals and organizations.

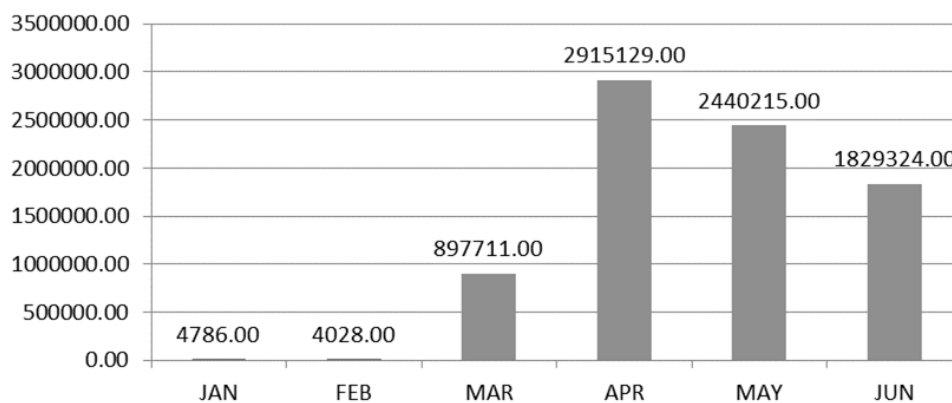
Key findings highlighted by the INTERPOL assessment of the cybercrime landscape in relation to the COVID-19 pandemic include:

- **Online Scams and Phishing** - Threat actors have revised their usual online scams and phishing schemes. By deploying COVID-19 themed phishing emails, often impersonating government and health authorities, cybercriminals entice victims into providing their personal data and downloading malicious content. Around two-thirds of member countries which responded to the global cybercrime survey reported a significant use of COVID-19 themes for phishing and online fraud since the outbreak.
- **Disruptive Malware (Ransomware and DDoS)** - Cybercriminals are increasingly using disruptive malware against critical infrastructure and healthcare institutions, due to the potential for high impact and financial benefit. In the first two weeks of April 2020, there was a spike in ransomware attacks by multiple threat groups which had been relatively dormant for the past few months. Law enforcement investigations show the majority of attackers estimated quite accurately the maximum amount of ransom they could demand from targeted organizations.
- **Data Harvesting Malware** - The deployment of data harvesting malware such as Remote Access Trojan, info stealers, spyware and banking Trojans by cybercriminals is on the rise. Using COVID-19 related information as a lure, threat actors infiltrate systems to compromise networks, steal data, divert money and build botnets.
- **Malicious Domains** - Taking advantage of the increased demand for medical supplies and information on COVID-19, there has been a significant increase of cybercriminals

registering domain names containing keywords, such as “coronavirus” or “COVID”. These fraudulent websites underpin a wide variety of malicious activities including C2 servers, malware deployment and phishing. From February to March 2020, a 569 per cent growth in malicious registrations, including malware and phishing and a 788 per cent growth in high-risk registrations were detected and reported to INTERPOL by a private sector partner.

- **Misinformation** - An increasing amount of misinformation and fake news is spreading rapidly among the public. Unverified information, inadequately understood threats, and conspiracy theories have contributed to anxiety in communities and in some cases facilitated the execution of cyberattacks. Other cases of misinformation involved scams via mobile text-messages containing 'too good to be true' offers such as free food, special benefits, or large discounts in supermarkets. The concepts of misinformation and disinformation are not new. Evidently, the current situation has made it easy to spread this across all social platforms. A very large portion of Internet users are confined in their homes and are using the Internet in a heightened capacity which enables misinformation to be posted, re-posted and added upon across any media. The techniques used are very complex and can take many forms. There are websites that are trying to investigate misinformation related to COVID-19. In a little over a month, more than 50 articles have been debunked and proven false. It has become exceedingly difficult to keep up with the amount of misinformation related to the current situation. Considering this, it has become more important than ever to ensure that the source of the information is verified, credible and corroborated before any action is undertaken in relation to the news.

**Figure 4.** The monthly count for Covid-19 related email threats - first half of 2020



**Source:** [https://www.trendmicro.com/en\\_us/research/20/i/1h-2020-cyber-security-defined-by-covid-19-pandemic.html](https://www.trendmicro.com/en_us/research/20/i/1h-2020-cyber-security-defined-by-covid-19-pandemic.html)

Email was the most used entry point, making up 91.5% of detections for Covid-19-related threats. The numbers started rising in March and peaked in April. Some of the emails we observed include those that pose as health advisories or donation requests. These usually have attachments that carry malware.

Taking advantage of the increased demand for medical supplies and information on COVID-19, there has been a significant increase of cybercriminals registering domain names that contain related keywords, such as “coronavirus” or “COVID”. These fraudulent websites underpin a wide variety of malicious activities including C2 servers, malware deployment and phishing. Taking advantage of the increased demand for medical supplies and information on

COVID-19, there has been a significant increase of cybercriminals registering domain names containing keywords, such as “coronavirus” or “COVID”. These fraudulent websites underpin a wide variety of malicious activities including C2 servers, malware deployment and phishing. From February to March 2020, a 569% growth in malicious registrations, including malware and phishing and a 788% growth in high-risk registrations were detected and reported to INTERPOL by a private sector partner.

We can conclude that the most vulnerable parts of the application are those where the application accepts input from the user and this is where the most attention should be paid. When a vulnerability is detected, appropriate updates for the application are found relatively quickly. Attacks using client-side vulnerabilities are the ones most used and developed in the last few years. Attacks on databases (SQL Injection) are slowly disappearing, as very strong protections are being made that are impossible to circumvent. By using the PDO prepare PHP command, the application is enabled to pre-implement the structure of the SQL query before accepting the user input parameters, so that later the attacker will not be allowed to modify and abuse the query.

The impact of the COVID-19 on life on our Planet is fearful. Social relations (quarantine measures, physical distancing) and economic decline, collapse of trade, financial and commodity channels, elimination of a huge number of jobs have a strong impact on social and societal movements (Lukinović, Jovanović, 2020). The economic impact of the pandemic is evident in many sectors, from service industries (transport, tourism, hospitality, education), to manufacturing (cars, textiles, construction, consumer electronics). Pandemic measures will result in a serious decline of GDP in 2020 (Radić et al., 2020)

The global pandemic COVID-19 has proved the importance of a global response in collaborative and coordinated manner (Radanov, 2020). It is especially important to establish international cooperation in the field of pharmacy and synthesis of new drugs and vaccines. COVID-19 treatment protocols are now being supplemented with new experimental and generic drugs from different countries. Avifavir and coronavir are successfully used in the Russian Federation. Good results in the treatment of COVID-19 disease are given by antibodies from the blood plasma of donors who have suffered from COVID-19 in severe form. However, the greatest hopes of the population in all countries of the world are placed on antiviral vaccines against COVID-19 disease. Vaccination with Russian and Chinese vaccines take place in South American and Asian countries (Jovanović, Ermakov, 2020).

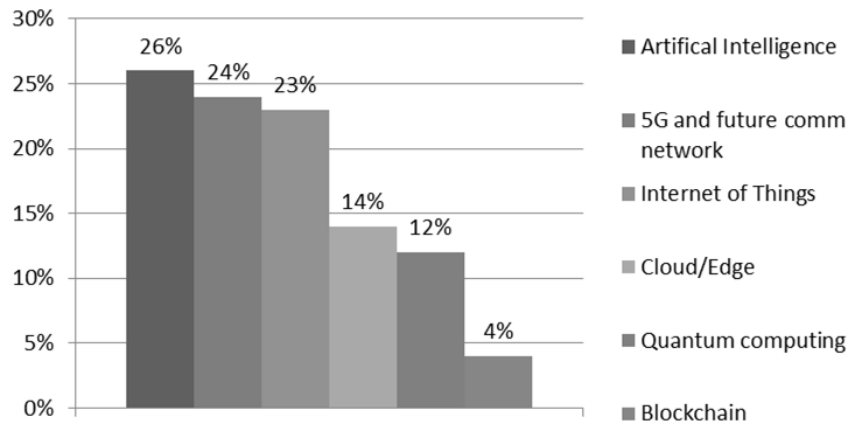
Digitalization of all branches of the economy, financial and cultural-educational sector, as well as administrative jobs in cities and suburbs, in addition to many positive aspects, opens opportunities for numerous cyber intrusions and cyber-attacks (Milošević et al., 2020, Munitlak Ivanović, 2020).

It is very important to ensure the safety of the traffic and the infrastructure of communal services in large smart cities (Kotur, Radović, 2020, Latinović, Jovanović, 2019).

Cybercriminals are developing and boosting their attacks at an alarming pace, exploiting the fear and uncertainty caused by the unstable social and economic situation around the world. At the same time, the higher dependency on connectivity and digital infrastructure due to the global lockdown increases the opportunities for cyber intrusions and cyber-attacks.

The most urgent priority to address these growing cyberthreats is to further enhance international police cooperation for operational activities and to improve cybercrime information exchange with diverse partners within the global ecosystem of cybersecurity (Zlatković, Denić, 2020).

**Figure 5.** Key technological areas with drastic impact on the future



**Source:** <https://www.ecs-org.eu/documents/uploads/report-on-the-ecso-members-and-the-community-survey.pdf>

The European Commission's Next Generation EU proposal is a step in the right direction as it looks to harness the full potential of the EU budget and allocate €8.2 billion toward the Digital Europe Programme (DEP), involving investments in supercomputing, artificial intelligence and cybersecurity. This includes:

- Investing in more and better connectivity, especially in the rapid deployment of 5G networks.
- A stronger industrial and technological presence in strategic sectors, including artificial intelligence, cybersecurity, supercomputing and cloud.
- Building a real data economy as a motor for innovation and job creation.
- Increased cyber resilience.

## 5. CONCLUSION

The impact of the pandemic on humanity is incredible, modern history remembers such changes only during the great wars. Whether these changes will be permanent or temporary, time has yet to show. When we look at intellectual property, similar changes have already taken place in the field of copyright under the influence of new technical changes. Invention of radio transmission, gramophone, tape recorder, CD, etc. hit hard in the field of the copyright industry. The postulates established more than a hundred years ago were shaken, but with the necessary changes in management and law, it continued. Other intellectual property rights, primarily patents, are now facing such a challenge. It is difficult to predict how things will go on, the length of the pandemic will depend on how much and what the consequences will be. The answer to the solution to the pandemic lies in innovations, new drugs, new vaccines and the depth of the changes will depend on the speed of the inventors.

## REFERENCES:

- Bogdanović, D., Autorsko pravo i biblioteke digitalnog doba, *Bosniaca: časopis Nacionalne i univerzitetske biblioteke Bosne i Hercegovine*, Vol. 22 No. 22, 2017, pp. 77- 83.
- Chatterley, A., The New Normal? What The Coronavirus Means For Digital Piracy, *Forbes*, available at: <https://www.forbes.com/sites/andychatterley/2020/04/23/the-new-normal-what-the-coronavirus-means-for-digital-piracy/#665e1c1443bc>
- Jovanović, L., Ermakov, V., Značaj selena i cinka u prevenciji i lečenju virusnih oboljenja, *Ecologica*, Vol. 27, No 99 (2020), 357-365.
- Kotur, M., Radović, V., Važnost autonomnih automobila i održivog transporta u razvoju „pametnog grada“, *Ecologica*, Vol. 27, No 98 (2020), 273-280.
- Latinović, L., Jovanović, Đ., Application of the "Smart City concept" through efficient recyclable waste collection, *Ecologica*, Vol. 26, No 95 (2019), 364-370.
- Lukinović, M., Intelektualna svojina, *Pravni fakultet Univerziteta Union/Službeni glasnik*, 2017, pp. 36.
- Lukinović, M., Plagiranje, naučni rad i autorsko delo, *Zbornik radova Pravnog fakulteta u Nišu*, LVI/2017, Issue No: 77, str. 121-132.
- Lukinović, M., Jovanović, L., Uticaj pandemije COVID-19 na životnu sredinu, *Ecologica*, Vol. 27, No 99 (2020), 376-382.
- Lukinović, M., Stamatović, M., Šarkić, N., Inovacije: pravno-ekonomski aspekti, *Pravni fakultet Univerziteta Union/ Službeni glasnik*, Beograd, 2017, pp. 45.
- Milošević, M., Milošević, D., Stanojević, A., Simjanović, D., IAHP kao podrška primeni tehnoloških inovacija u razvoju pametnih gradova, *Ecologica*, Vol. 27, No 99 (2020), 407-413.
- Munitlak Ivanović, O., Razvoj pametnih gradova - primer četvrte industrijske revolucije, *Ecologica*, Vol. 27, No 97 (2020), 15-21.
- Radić, V., Radić, N., Ravić, N., Uticaj pandemije korona virusa na ciljeve održivog razvoja i ekonomiju, *Ecologica*, Vol. 27, No 99 (2020), 366-375.
- Radanov, P., Informisanost stanovnika grada Pančeva o korona virusu – izazivaču teškog akutnog respiratornog sindroma i merama zdravstvene zaštite, *Ecologica*, Vol. 27, No 98 (2020), 288-299.
- Ryan, B., Coppola, D., Canyon, D., Brickhouse, M., Swienton, R., COVID-19 Community Stabilization and Sustainability Framework: An Integration of the Maslow Hierarchy of Needs and Social Determinants of Health, *Disaster Medicine and Public Health Preparedness*, 2020, pp. 1-16.
- Spasić, V., Autorska dela u digitalnom okruženju, *Pravni fakultet u Nišu, Univerzitet u Nišu*, 2011, pp. 51.
- Zlatković, D., Denić, N., Smart cities: from urban development to digital infrastructure and cybersecurity, *Ecologica*, Vol. 27, No 99 (2020), 443-450.
- [https://landing.edgescan.com/hubfs/BCC030%20Vulnerability%20Stats%20Report%20\(2020\)\\_WEB.pdf](https://landing.edgescan.com/hubfs/BCC030%20Vulnerability%20Stats%20Report%20(2020)_WEB.pdf)
- [https://www.academia.edu/35796648/Upravljanje\\_bezbednoscu\\_u\\_Cyber\\_prostoru\\_i\\_mehani\\_zmi\\_zastite\\_web\\_aplikacija](https://www.academia.edu/35796648/Upravljanje_bezbednoscu_u_Cyber_prostoru_i_mehani_zmi_zastite_web_aplikacija)
- <https://www.ecs-org.eu/documents/uploads/report-on-the-ecso-members-and-the-community-survey.pdf>
- [https://www.trendmicro.com/en\\_us/research/20/i/1h-2020-cyber-security-defined-by-covid-19-pandemic.html](https://www.trendmicro.com/en_us/research/20/i/1h-2020-cyber-security-defined-by-covid-19-pandemic.html)
- [https://www.unodc.org/documents/middleeastandnorthafrica/2020/COVID19/COVID19\\_MENA\\_Cyber\\_Report\\_EN.pdf](https://www.unodc.org/documents/middleeastandnorthafrica/2020/COVID19/COVID19_MENA_Cyber_Report_EN.pdf)





# KEYWORD ANALYSIS WITH USING STATISTICAL METHODS

Dominika Krasňanská<sup>81</sup> 

Mária Vojtková<sup>82</sup> 

DOI:

---

**Abstract:** *There are currently more than a billion websites worldwide. In so many websites, everyone wants to be visible to search engines through the keywords that people search for. The article deals with the process of creating keywords, through which we can identify the intention of the searcher. The process of creating keywords consists of several steps, namely the collection of keywords, subsequent cleaning of keywords, their categorization and the last step is the interpretation of keywords. The paper focuses mainly on the categorization of keywords, which we obtain through the use of statistical methods, which includes a method of visualizing relationships between keywords by determining the strength of the association between words called concept linking or term map.*

**Keywords:** *keywords, keyword categories, statistical methods.*

---

## INTRODUCTION

The Internet originated in the early 1960s. Initially it served as a communication medium for the military, later it was used by universities to share scientific knowledge, but its use was very difficult. The change came thanks to Tim Bernerser Lee, an employee of the European Organization for Nuclear Research (CERN), who simplified working with the Internet for the average user by creating the World Wide Web in 1990 (Jurčík, 2017).

The World Wide Web (WWW) is the official term for the part of the Internet where information is in the form of web pages called documents. Each document has its own specific address, literally a Uniform Resource Locator (URL), that allows it to be found and displayed in programs called a web browser (Berners Lee, et al., 1994).

At present, the Internet does not only serve to mediate communication and entertainment, but the possibilities of the web space have begun to be used mainly by entrepreneurs, whether to promote products or services, or directly on trading by the web, where they look for potential customers. This procedure can be implemented only in cooperation with the customers themselves (on the Internet, these are visitors to the selected website). It is the visitors who try to satisfy their needs via the Internet by searching for various products and services. Initially, the visitor was only oriented among dozens of websites, which did not present any complications. There are currently more than a billion websites in the world. In so many websites, everyone wants to be visible to search engines through the keywords that people search for. Keywords are terms that people enter into search engines. Based on the keyword, relevant web pages appearing that address the issue for the keyword you entered. Knowing the

---

<sup>81</sup> University of Economics in Bratislava, Faculty of Economic and Informatics, Dolnozemska cesta 1, Slovakia

<sup>82</sup> University of Economics in Bratislava, Faculty of Economic and Informatics, Dolnozemska cesta 1, Slovakia

keywords is especially important for the site owner, because it is through the keywords that visitors come to the site, who can then perform a conversion on the site<sup>83</sup>.

## **THE IMPORTANCE OF KEYWORD ANALYSIS**

Keyword analysis is a way to gain insight into market behavior. This is a detailed analysis of words and phrases that are relevant to the selected area based on the focus of the site. (Binka, 2019).

Keyword analysis makes it easier to get to know your customers. The purpose of keyword analysis is to identify the intent of the searcher through the keywords. This means identifying words or phrases that the visitor enters into the full-text search engine. Performing keyword analysis is important for every site owner. It is the first step in understanding user behavior. However, applying the results found in the keyword analysis is more important, because without incorporating the results, all the work is useless. Only when the keyword analysis findings are incorporated can the web come to the forefront of search results. Keywords need to be incorporated within the site, because it is through keywords that visitors come to the site.

## **PROCESS OF CREATING KEYWORDS**

In the world of the Internet, a keyword is a word or phrase that is entered into a search engine by an Internet visitor, such as Google, as a simplistic term for finding a comprehensive solution. Keywords are the deciding factor in displaying a website's bidding on a search engine. After entering a keyword into a search engine, the search engine will show us the search result, i.e. a list of websites that match the content of the keyword.

The position of each website in the list of search results is determined by the search engine's ranking, so the smaller the position number, the better the website is ranked for that keyword. It is natural that every website strives to achieve the best result in its area of interest. Ideally, it ranks first in search results after entering keywords that are relevant to the industry. However, there is only one first position, so we also consider the position in the top ten results to be a good result. The top ten means that the webpage appears right on the first page of search results in the search engine.

Why is position so important? Because more website traffic means more leads for the site owner, which in turn increases conversions. If a website ranks higher in search results, traffic will be higher. Search engine search analysis speaks for itself. The searcher usually clicks on the link (website) from the first page that the search engine offers him after entering the keyword. In general, therefore, a smaller number of website positions will ensure more traffic. For this reason, knowing the keywords for any website is the starting point for gaining potential visitors. Keyword collection is the first step in keyword analysis.

The second step is to clean up your keywords. In the keyword cleanup process, duplicate keywords need to be removed in the first phase, then zero-search keywords and irrelevant keywords need to be removed. The principle of the third step, keyword categorization, is to

---

<sup>83</sup> The conversion is the required action that the visitor will perform on the website, it can be the execution of the order, registration on the website, filling in the contact form, filling in the survey, registration in the newsletter, etc. What will be considered a conversion on a particular site is set by the site owner individually according to their own business goals. In the e-shop, the conversion in most cases is considered to be an online order, filling in a contact form, filling in a survey, registering for a newsletter, etc.

categorize keywords into the categories we create. In each keyword analysis, the categories differ, depending on the area analyzed. For products, it can be a division of keywords into categories such as price, color, quality, type of product. The individual categories in which we classify keywords should be as specific as possible and clearly distinguishable from the rest of the categories. Keyword categorization is one of the most important parts of the whole analysis process. The reason is precisely that the created categories serve as a basis for creating the information architecture of the entire website. It is the information architecture of the website that significantly influences the position of the website in search results.

The practical part of the paper is mainly focused on the categorization of keywords using statistical methods. The last step in keyword analysis is to interpret the results. That means an explanation of the procedures used and the conclusions we have reached.

### CONCEPT LINKING

Creating a link between concepts and data is one of the most important and difficult steps in the research process (Angot, Milano, 2001). To understand the relationships between words based on the common occurrence of words in a document, there is a graph called concept links or term map (Chakraborty, Pagolu, Garla, 2014). Concept linking or term map is a term for a graph that shows the specific strength of the association of words on the edge with a word in the middle. The association is shown on the graph by lines. The thicker line represents a stronger association. The strength of the association is calculated as follows:

$$strength = \log_e\left(\frac{1}{Prob_k}\right) \quad (1)$$

where,

$$Prob_k = \sum_{r=k}^{r=n} Prob(r) \quad (2)$$

whereas,

$$Prob(r) = \left[ \frac{n!}{[r!(n-r)!] p^r (1-p)^{(n-r)}} \right] \quad (3)$$

*A* – the word in the middle of the graph

*B* – the word on the edge of the graph

*n* = number of documents (nu. of phrases), in which we can find term *B*

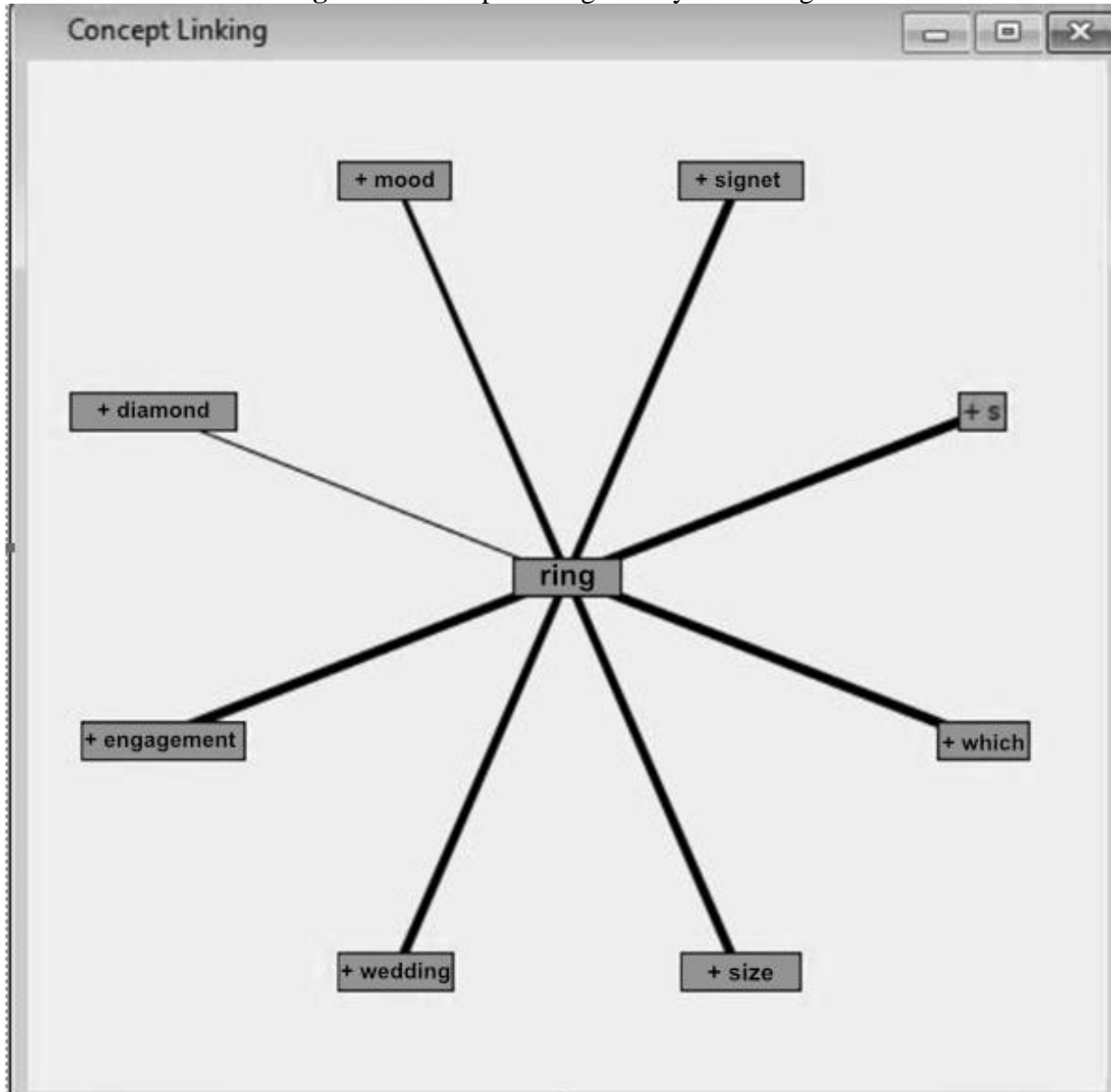
*k* = number of documents, in which we can find both of terms *A* and *B*

*p* = *k/n* = the probability that the expression *A* occurs in conjunction with the expression *B*, provided that they are independent of each other.

### FUTURE RESEARCH DIRECTIONS

The first step in keyword analysis is to gather keywords. The area of analysis depends on the focus of the sold assortment of the given customer. We decided to analyze the area of jewelry. When collecting keywords, we used various online marketing tools at our disposal, such as: the website of the customer for whom we processed the analysis, the websites of competitors, discussion forums, social networks and various other resources dedicated to the field of jewelry. In the keyword cleanup process, we removed duplicate keywords, deleted zero-search keywords, and irrelevant keywords. The goal of categorization is to categorize your keywords, with the most similar words within one category. We categorized keywords using the statistical software SAS Text Miner. By creating a concept linking graph or term map, which allows the display of word associations, we have reached the following results:

**Figure 1.** Concept linking for keyword "ring"



**Source:** own edit in the SAS Text Miner, 2020

Figure 1 shows the strength of the association of the word ring with other words. As we can see in the graph, the strongest association of the word ring is with the words engagement, marriage, seal, etc., because there is the thickest line between these words. However, what is not visible from the graph is the number of times the word is in all connections and how many times it is in connection with the word in the middle, i.e. with the word ring. For example, a "diamond ring" is found a total of 23 times. In connection with the word ring only 12 times, so a narrow line is shown on the graph because the association is weak. The term "seal" has a ratio of 10/10 because it is always associated with the word ring. However, the problem is that in the graph, a maximum of about 8 words can be assigned to the word in the middle (default setting), so it always displays only the words that occur most often with the selected word. In this part, we decided to point out one of the possibilities of using statistical methods. This is a clear, visual means of creating categories and subcategories, which we can effectively use, especially in the case of smaller files.

## CONCLUSION

Using a statistical method to visualize the association of keywords through the concept linking graph, we created several categories. It was through categorization of keywords that we created a proposal for an information structure for the website owner. One of the main categories was the Rings category, which contained subcategories such as engagement rings, diamond rings, etc. In the same way as we mentioned above, we also created categories such as Chains, Earrings, etc.

After incorporating the findings from the keyword analysis, the site for which we developed the keyword analysis moved to a better position in the search results, which is the result of each keyword analysis. Better positions in search results will ensure higher conversions for the website, which resulted in an increase in the number of orders and a consequent increase in turnover, respectively profit. Because each website aims to increase conversions, we can say that we've met the goal of keyword analysis for the selected website.

This paper highlights the growing importance of using less traditional statistical methods that focus on textual or unstructured data. The issue of representation and categorization of keywords is currently the subject of much research and its use is very current in various fields.

## ACKNOWLEDGMENT

*This research was supported by the project VEGA 1/0193/20 Impact of spatial spillover effects on innovation activities and development of EU regions.*

## REFERENCES

- Angot, J. & Milano, P. (2001). Linking concepts and data. In Thiétart, R. *Doing management research* (pp. 132-146). London, GB: SAGE Publications Ltd. doi: 10.4135/9781849208970
- Berners-Lee, T., Cailliau, R., Luotonen, A., Frystyk Nielsen, H. & Secret, A. (1994). The world-wide web. *Communications of the ACM*, 37.8: 76-82. ISBN: 0002-0782/94/0800.
- Binka, M. (2019). *Analýza klíčových slov: Návod krok za krokem*. první vydání, Brno, Česká republika.
- Feldman, R. & Sanger, J. (2007). *The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data*. Cambridge, GB: Cambridge University Press. 410 p. ISBN 978-0-521-83657-9.
- Chakraborty, G., Pagolu, M. & Garla, S. (2013). *Text mining and analysis: practical methods, examples, and case studies using SAS*. North Carolina, USA: SAS Institute Inc., Cary. ISBN 978-1-61290-551-8
- Jurčík, M. (2017). Berners-Lee – Tvorca World Wide Webu, *Goldman*, Vydavatel'stvo MEDIAGE.



# GREENHOUSE GAS EMISSIONS PRODUCED IN AGRICULTURE SECTOR IN EU

Mariana Dubravská<sup>84</sup>   
Elena Širá<sup>85</sup> 

DOI:

---

**Abstract:** *Each economy must adapt its activities to the protection of the environment. It is now an essential part of everyday life, in the face of various climate changes. The Europe 2020 strategy sets out a set of objectives in the EU, including those promoting environmental sustainability, called sustainable growth. The aim of the paper is to determine, if the performance of the country, in the area of greenhouse gas emissions reduction is adequate to the strategy Europe 2020. In the analysis of greenhouse gas emission reductions, we will also focus on the agriculture sector and compare the development over time with the development in other EU countries. The analyzed period is 10 years, from 2009 - 2018. The article investigated the performance of greenhouse gas emissions in the example of EU (including the Great Britain) countries.*

**Keywords:** *EU, Greenhouse gas emissions, agriculture, Europe 2020.*

---

## INTRODUCTION

In today's world, sustainability issues are becoming more emergent. A common attribute among the different approaches to defining this concept is the orientation towards the future. The sustainability economy is usually based on the idea of resource efficiency. Because a sustainable economy is about a long-term future that is largely unknown. It is therefore necessary to answer questions, that can ensure the long-term stability and growth of the country.

The concept of sustainable development is quite dynamic. This means that this issue can be explored from several perspectives (Sinakou et al. 2019). From the point of view of most theoretical approaches, there are three components to the issue of sustainable development: environmental, economic and social. Of these three aspects, the environmental dimension of sustainability has so far received the most attention. If people want to live in a prosperous country with a healthy environment, the main trends of today's world need to be addressed (such as changes in demography, changing consumer patterns, social change, changing the use of natural resources and increasing pressure on natural resources and ecosystems, etc.). which may worsen the situation.

---

<sup>84</sup> Department of Economics and Economy, Faculty of Management, University of Prešov, 080 01 Prešov, Slovakia

<sup>85</sup> Department of Economics and Economy, Faculty of Management, University of Prešov, 080 01 Prešov, Slovakia

## **THEORETICAL BACKGROUND**

### **Europe 2020 and Sustainable growth**

In 2010, the European Commission officially issued a Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth. It succeeds the Single European Market program (1986-1992) and the Lisbon Strategy (2000 - 2010), decided by the European Council on 26 March 2010, chaired by President Herman Van Rompuy. The Lisbon Strategy, from the substantive perspective, was not a new initiative, as before there had been attempts to introduce various processes in order to recover and reorganize the functioning of the EU (Stec, Grzebyk, 2018). The Lisbon Strategy aimed to transform Europe into the most competitive economy in the world (Silander 2019), but according to some problem areas and other problems that arose during implementation, it was not as successful as expected. The Europe 2020 strategy is the EU strategy for sustainable and inclusive growth, for fighting the structural weaknesses of the European economies, and for improving their competitiveness. (Radulescu et al., 2018)

The Europe 2020 strategy set out the main goals to be achieved in the EU countries by 2020. It is up to the Member States to take action at national and regional level to try to achieve these goals (Radulescu et al. 2018). In order to guide member states' efforts and manage progress, only a limited number of headline targets had to be set (Abad-Segura, González-Zamar, Belmonte-Ureña, 2020). These targets are representative, measurable, able to reflect the diversity of situations in the Member States and based on sufficiently reliable data for comparison purposes (Barroso 2010). In order to ensure that each Member State adapts the Europe 2020 strategy to its specific situation, the Commission proposes that EU objectives be reflected in national targets and trajectories. For each of these growths, targets have been set. Some targets are the same for all member states. Other targets are adapted to the conditions of individual member countries, respecting the specifics of the economy. And the last group consists of targets, where all EU countries participate, according to their possibilities, in fulfilling the targets and achieving the set value by aggregate.

This strategy focuses on three key areas. They are sustainable, inclusive and smart growth. (Širá 2017) Sustainable growth is explained as a set of measures aimed at promoting a greener and more competitive, resource-efficient economy (Witkowska-Dąbrowska, 2018). Sustainable growth means building a sustainable and competitive resource-efficient economy and strengthening competitiveness. This approach will help the EU prosper in a low-carbon, resource-constrained world, while preventing environmental degradation, biodiversity loss and unsustainable resource use (Barroso 2010).

Sustainable growth through the transition to a greener economy refers to building a European economy of resource efficiency and sustainability (Adamišin et al. 2016), and staying global competitive based on greener technologies. The main themes addressed by this strategy are climate, energy, mobility and competitiveness. This requires innovative European political enterprise to promote competitive entrepreneurship, new network businesses and a consumer culture that values resource efficiency and a greener, low-carbon economy. (Silander 2019).

The Commission stated the importance of continued open trade of exports and imports but also that Europe had to become more competitive and with higher productivity of partner states (Anastasiou, Marietta, 2020). Europe must also continue its early initiatives to become a global green economic actor by pushing for green technologies to safeguard resource efficiency. The push for green technologies would lead to fulfilled climate change goals, with significant



decreased emissions, but would also open up for a transition to a new environmentally friendly economy of new innovations, products and services that all together would create new jobs and a growing economy. A transition to a greener economy would also lead to lowered costs for import of expensive oil and gas and would be beneficial for European security because of lowered dependency on specific foreign governments. (Barroso 2010).

Sustainable growth would be approached based on three climate change and energy targets.

The so-called 20-20-20 targets (Stec, Grzebyk, 2018) set out by the EU include:

- reducing greenhouse gas emission by 20 percent,
- increasing renewable energy in gross final energy consumption by 20 percent,
- increasing energy efficiency by 20 percent. (Barroso 2010).

Such targets not only provide for important measures against ongoing climate change, but also provide new jobs in a transformed, greener economy with green products and services and makes the EU become a green, global competitive actor (Silander 2019). This sustainable growth will require the implementation of countries' emission reduction commitments in a way that maximizes benefits (Stăncioiu, Costea-Dunărișu, Păduraru, 2017) and minimizes costs, including through the dissemination of innovative technological solutions. In addition, EU countries should focus on decoupling growth from energy use and becoming more resource-efficient economies, which will not only give Europe a competitive advantage but also reduce its dependence on foreign sources of raw materials and commodities (Barroso 2010).

## **Agriculture**

Greenhouse gas emissions from agriculture, including crop and livestock production, forestry and associated land use changes, are responsible for a significant fraction of anthropogenic emissions, up to 30% according to the Intergovernmental Panel on Climate Change. (Tubiello et al. 2013) Among the important issues for agriculture's sustainability is greenhouse gas emissions, and their impact on climate. Whereas agriculture can benefit from a warmer climate in some parts of the world through longer growing seasons, agriculture could also be negatively affected in many regions by drought, flooding, pests and/or diseases. In addition, greenhouse gas emissions represent an indirect economic loss for the farmers (Verge, De Kimpe, Desjardins, 2007).

Globally, the emissions of carbon dioxide, methane and nitrous oxide from agriculture account for approximately one-fifth of the annual increase in radiative forcing, and for one-third when land use changes are included. The agricultural sector contributes with significantly % of the total anthropogenic emissions of CH<sub>4</sub> and N<sub>2</sub>O. Land use change, crops and cropping systems have various effects on the weathers (Verge, De Kimpe, Desjardins, 2007).

Three steps according to Franks & Hadingham (2012) are required to successfully and efficiently reduce greenhouse gas emissions from agriculture:

- identification of the most greenhouse gas polluting farms,
- determining appropriate mitigation options for these farms,
- selection between these options on the basis of their cost effectiveness.

Carbon footprints of a sample of farms together with an analysis of the Kyoto Protocol show the difficulties encountered at each step. These difficulties are caused by:

- failure to agree which functional unit to use to measure GHG emissions and pollution swapping;
- weaknesses in the Kyoto Protocol's territorial/production-based accounting methodology,
- lack of cost-effectiveness data (Franks, Hadingham, 2012).

## **METHODOLOGY**

The aim of the paper is to determine, if the performance of the country, in the area of greenhouse gas emissions reduction is adequate to the strategy Europe 2020. We assessed the fulfilment of the goal set out in the section of sustainable growth in the Europe 2020 strategy. The goal set the reducing greenhouse gas emission by 20 per cent compared to year 1990. Because the strategy Europe 2020 is the strategy obligatory for all EU member states, we analyzed the example of all EU countries (including the Great Britain). The analyzed period is 10 years, from 2009 - 2018.

In the analysis of greenhouse gas emission reductions, we will also focus on the agriculture sector and compare the development over time with the development in other EU countries. Based on the approaches of various authors, we have elaborated theoretical background. These characterize the researched area and define the goal of the work. When processing the next part of the paper, we worked with data from Eurostat.

## **RESULTS AND DISCUSSION**

In the previous section, we pointed out the importance of sustainability, especially in the long term and for maintaining the current state for the future, and its improvement in areas where this is possible. The environment and its protection are an area regulated by legislation. This area and the possible damage in it, have a far-reaching impact on many other areas of people's lives. Therefore, it is sustainable growth dedicated to the environment, which is an important area that has also come to the head of the Europa 2020 strategy. It is a commitment for all EU member states to support improvements in this area, as well as various innovations sparingly to the environment.

The inclusion of resource efficiency and a low-carbon society among European policy priorities is the result of the recognition, that the prevailing model of economic development based on the fluent growth of resource use and harmful emissions, is unsustainable in the long run. (Chovancová 2015)

Rising greenhouse gas emissions are causing increased concentrations of these gases in the atmosphere. This in turn causes the earth's surface to overheat, leading to climate change. This is the physical side of the problem of climate change. This problem can also be seen from a socio-economic point of view. In this case, it is the relationship between the economy and the emissions generated. The economy produces greenhouse gas emissions mainly through various combustion processes, which are necessary to obtain the energy needed in the production process. (Habrman 2012)

The Europa 2020 strategy has set as one of the goals of sustainable growth a reduction in greenhouse gas emissions of at least 20 % compared to the values achieved in 1990. These values for the EU countries in the period 2009 - 2018 are stated in Table 1. The aim is for all EU states to had the values for this indicator of 80 or lower in 2020. The years in which the individual countries met the set value are indicated in the table.

**Table 1.** Reduction of greenhouse gas emissions in % of terms compared to 1990

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Belgium	87,61	92,63	85,76	83,61	83,48	79,77	82,81	81,96	82,14	82,67
Bulgaria	57,18	59,74	64,88	59,93	54,78	57,74	60,93	58,52	60,88	57,16
Czechia	69,75	71,07	70,28	68,14	65,46	64,41	65,13	66,06	65,56	64,82
Denmark	90,58	90,89	83,78	77,52	79,88	74,35	70,66	73,74	70,67	70,69
Germany	74,05	76,64	74,73	75,25	76,68	73,49	73,8	74,17	73,22	70,44
Estonia	41,18	52,3	52,48	49,89	54,46	52,5	45,22	48,98	52,26	49,98
Ireland	113,15	112,47	104,76	105,23	105,41	105,34	109,56	113,34	113,29	113,6
Greece	120,39	114,48	111,82	108,44	99,42	96,53	92,98	89,74	93,62	90,84
Spain	130,96	126,21	126,38	123,77	114,87	115,77	119,83	116,51	121,49	119,74
France	93,64	94,78	89,76	89,78	89,96	84,41	85,28	85,44	86,35	83,1
Croatia	88,77	87,51	86,55	80,99	76,7	74,34	75,62	76,15	78,71	75,23
Italy	98,19	100,44	98,12	94,43	87,63	83,71	86,3	85,8	85,05	84,41
Cyprus	166,42	161,52	156,65	147,73	135,68	141,56	142,01	151	155,75	153,81
Latvia	43,38	47,6	44,62	43,97	43,76	43,26	43,41	43,55	43,94	45,95
Lithuania	41,68	43,44	44,67	44,59	42,09	42,02	42,64	42,77	43,24	42,64
Luxembourg	97,71	102,38	100,82	98,04	93,98	91,21	88,67	87,98	90,88	94,16
Hungary	69,04	69,43	67,72	63,62	60,64	61,33	64,95	65,48	68,25	67,82
Malta	114,59	118,84	119,43	126,67	115,91	118	94,18	83,84	93,45	96,14
Netherlands	93,84	99	92,95	91,04	90,96	87,73	91,63	91,57	90,78	88,58
Austria	103,39	109,19	106,41	102,82	103,25	98,68	101,6	103,05	106,17	102,66
Poland	83,13	87,1	86,9	85,35	84,64	82,02	82,73	84,56	87,7	87,42
Portugal	125,57	118,96	116,78	113,69	110,69	110,82	118,01	115,32	123,78	118,9
Romania	51,64	50,11	52,03	50,66	46,83	46,96	47,08	46,29	47,39	46,84
Slovenia	105,09	105,2	105,23	102,21	98,51	89,22	90,18	94,69	93,47	94,35
Slovakia	62,24	63,25	62,3	58,85	58,39	55,6	57,04	57,72	59,31	59,16
Finland	96,18	107,11	96,8	89,12	89,8	84,01	79,06	83,16	79,59	81,41
Sweden	83,56	91,82	86,07	82,01	79,79	77,4	77,11	76,99	76,52	75,28
UK	77,67	79,33	73,68	75,63	73,97	69,03	66,9	63,76	62,7	61,59

**Source:** own procession according to Eurostat

We can see, that some countries have the values of this indicator below the limit set in the Europe 2020 strategy throughout the observed period. These are the Baltic countries, then the V4 except Poland, Romania, Bulgaria and Germany. As the second group of countries, there are countries where during the analyzed 12 years, at least in some years, most often in recent years, values below the recommended limit were reached. These are Croatia, Belgium, Denmark, Finland, Sweden and the United Kingdom. The remaining countries have values higher than the recommended 80 %. On the positive side, however, we can see an effort in these countries to reduce these unfavorable values, such as in Malta, Slovenia, Italy and elsewhere. Cyprus (154 %) and Spain (126 %) have the highest average values over the period. On the contrary, the lowest average values were reached in Estonia (50 %) and Romania (51 %).

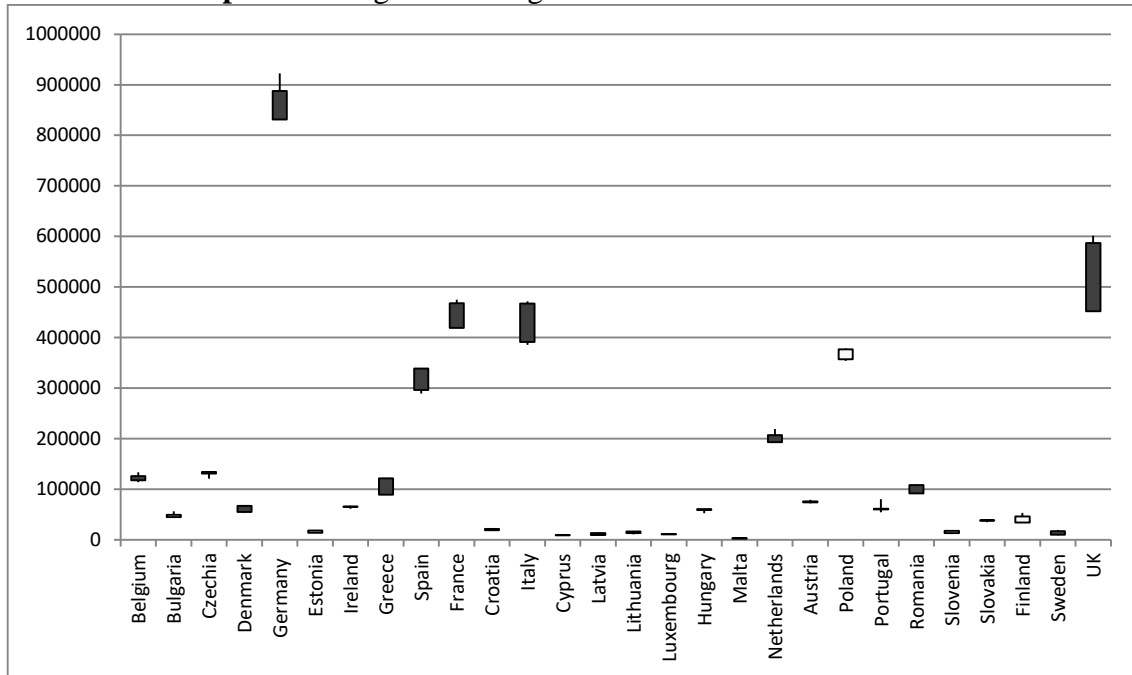
The next table compares the volume of greenhouse gas emissions in agriculture. For better comparability of EU countries, we converted the data to % of the total number. In this statement, we see big differences between countries.

**Table 2.** Greenhouse gas emissions in agriculture in %

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Belgium	8,15	7,65	8,20	8,22	8,27	8,87	8,56	8,52	8,64	8,48
Bulgaria	11,11	11,35	9,08	10,12	11,97	12,50	11,71	12,99	12,30	13,00
Czechia	5,79	5,56	6,12	6,28	6,49	6,65	7,00	7,02	6,90	6,43
Denmark	16,46	17,03	19,02	20,02	18,99	20,87	20,29	19,51	21,10	20,14
Germany	7,24	6,90	7,25	7,25	7,23	7,72	7,73	7,54	7,61	7,65
Estonia	9,13	7,40	7,63	8,42	7,55	7,42	9,10	8,15	7,56	7,99
Ireland	26,76	26,59	27,79	28,42	29,77	29,90	29,06	29,42	29,58	30,59
Greece	7,01	7,65	7,64	7,75	8,31	8,06	8,55	8,89	8,54	8,72
Spain	11,29	11,91	11,65	11,46	12,49	13,06	12,88	13,43	13,24	13,39
France	16,59	16,11	16,92	16,91	16,85	18,30	17,87	17,63	17,44	17,84
Croatia	13,96	14,48	14,15	14,51	14,80	15,05	14,33	14,03	13,65	14,55
Italy	6,60	6,39	6,56	6,82	7,49	7,82	7,65	7,79	7,47	7,72
Cyprus	5,40	5,83	5,96	6,06	6,19	5,70	5,78	5,50	5,78	5,94
Latvia	25,92	19,99	22,30	26,86	24,35	18,59	20,71	24,24	27,21	19,85
Lithuania	33,37	39,55	38,71	40,25	39,68	39,00	30,66	27,47	25,98	26,10
Luxembourg	5,83	5,48	5,51	5,57	6,04	6,40	6,82	7,21	7,10	6,68
Hungary	9,51	9,37	9,93	10,79	11,92	12,58	12,33	12,51	12,13	12,20
Malta	2,39	2,28	2,16	2,07	2,27	2,23	2,99	3,41	3,00	2,99
Netherlands	8,67	8,20	8,61	8,67	8,91	9,36	9,28	9,42	9,51	9,44
Austria	9,54	8,98	9,37	9,57	9,38	10,08	9,78	9,79	9,48	9,79
Poland	8,79	8,11	8,38	8,52	8,83	8,90	8,55	8,47	8,66	8,80
Portugal	11,03	11,26	11,44	11,43	11,62	12,24	11,17	10,84	8,40	11,12
Romania	18,79	17,48	16,76	17,34	19,85	20,10	20,34	21,03	20,21	21,66
Slovenia	12,94	12,63	12,40	12,75	14,99	10,20	10,35	9,89	10,01	9,70
Slovakia	6,26	5,96	6,37	7,13	7,65	8,03	7,69	7,80	7,19	7,29
Finland	19,32	12,53	14,35	17,46	14,96	17,68	18,15	16,17	17,36	14,22
Sweden	40,22	35,29	41,89	52,59	52,13	53,68	58,73	80,83	72,87	69,39
UK	6,89	6,75	7,35	7,07	7,21	8,03	8,20	8,65	8,94	9,04

**Source:** own calculations according to Eurostat

While in some countries the values of greenhouse gas emissions in agriculture are below 10 % (Belgium, the Czech Republic, Germany, the Netherlands, Malta, Slovakia, the UK and others), in other countries the values are significantly higher. For example, Sweden has the highest values, around 70 %, then Ireland has values of about 30 %. Denmark, Lithuania and Romania still have values of 20 %. At the same time, these countries (highlighted in color) did not achieve exceptionally high values at all in terms of overall greenhouse gas emissions in tones among other countries.

**Graph 1.** Total greenhouse gas emissions in thousands of tones

Statistical overview of achieved values of greenhouse gas emissions in thousands of tones in EU countries in the period 2009 - 2018 is in graph 1. From the graph, we can see that the countries with the largest volume of greenhouse gas emissions are Germany, UK, Italy and France. The countries with the lowest volume of greenhouse gas emissions were Malta, Cyprus and Latvia. Between the EU countries are quite a great difference. It is caused by the size of the country, the amount of industry in the country and by other factors.

## CONCLUSION

The Europe 2020 strategy is a strategy for smart, inclusive and sustainable growth. The greener economy is, according to climate changes and environmental protection, nowadays a priority for the most countries. EU countries, too. This strategy includes the elements of environmental protection, too. The sustainable growth is focus on the reduction of greenhouse gas emissions, too. This is the one of the three priorities of sustainable growth.

One of the three goals set the reducing greenhouse gas emission by 20 per cent compared to year 1990. In the year 2018, approximately the half of the EU member states, fulfill this goal. Some countries fulfill this goal for a whole analyzed period, some countries fulfill it in the last years.

Agriculture is one of the oldest industries. It has a permanent position in each country. But in recent years, its share of the country's GDP has been steadily declining. But this trend has not spread to the field of greenhouse gas emissions. There are countries where the share of greenhouse gas emissions in agriculture is significant (e.g. in Sweden), but overall, the country does not have a large volume of greenhouse gas emissions.

We have tried to point out these peculiarities in the article, but there is still a need for further analysis of this phenomenon. What may be the subject of further studies and research?

## ACKNOWLEDGMENT

*This research was supported by the Scientific Grant Agency of the Ministry of Education: VEGA No. 1/0082/19*

## REFERENCES

- Abad-Segura, E., González-Zamar, M. D., & Belmonte-Ureña, L. J. (2020). Effects of Circular Economy Policies on the Environment and Sustainable Growth: Worldwide Research. *Sustainability*, 12(14), 5792.
- Adamisin, P., Pukala, R., Chovancova, J., Novakova, M., & Bak, T. (2016). Fulfillment of environmental goal of the strategy Europe 2020. Is it realistic; In *3rd International Multidisciplinary Scientific Conference on Social Sciences and Arts, SGEM* (pp.181-190).
- Anastasiou, A., & Marietta, P. (2020). Sustainable Development at the Frames of the Strategy "Europe 2020". *Theoretical Economics Letters*, 10(03), 443.
- Barroso, J. M. (2010). Communication from the Commission EUROPE 2020 - A strategy for smart, sustainable and inclusive growth. European Commission, Brussels
- Franks, J. R., & Hadingham, B. (2012). Reducing greenhouse gas emissions from agriculture: avoiding trivial solutions to a global problem. *Land Use Policy*, 29(4), 727-736.
- Habrman, M. (2012). Štruktúrna dekompozícia emisií CO<sub>2</sub> v slovenskej ekonomike. In Economic analysis & policy group: working paper series, č. 6, 11 s. Bratislava: o.z. SOLIM
- Chovancová, J. (2015). Hodnotenie vzťahu medzi ekonomickým rastom a produkciou emisií skleníkových plynov v krajinách V4 pomocou metódy decoupling. In Correspondence conference EAEP 2015 (p. 134).
- Radulescu, M., Fedajev, A., Sinisi, C. I., Popescu, C., Iacob, S. E. (2018). Europe 2020 implementation as driver of economic performance and competitiveness. Panel analysis of CEE countries. *Sustainability*, 10(2), 566.
- Silander, D. (2019). The European Commission and Europe 2020: smart, sustainable and inclusive growth. In *Smart, Sustainable and Inclusive Growth*. Edward Elgar Publishing.
- Sinakou, E., Boeve-de Pauw, J., Van Petegem, P. (2019) Exploring the concept of sustainable development within education for sustainable development: implications for ESD research and practice. *Environ. Dev. Sustain.*, 2019, 21(1), 1-10. DOI: 10.1007/S10668-017-0032-8
- Stăncioiu, A. F., Costea-Dunărințu, A., & Păduraru, D. (2017). The European union strategy for sustainable development in the energy sector. *Calitatea*, 18(S2), 431-434.
- Stec, M., & Grzebyk, M. (2018). The implementation of the Strategy Europe 2020 objectives in European Union countries: the concept analysis and statistical evaluation. *Quality & quantity*, 52(1), 119-133.
- Širá, E. (2017). The Europe 2020-sustainable growth in V4 countries. *SGEM International Multidisciplinary Scientific GeoConference*, Vol 17, No.53, 893-899
- Tubiello, F. N., Salvatore, M., Rossi, S., Ferrara, A., Fitton, N., & Smith, P. (2013). The FAOSTAT database of greenhouse gas emissions from agriculture. *Environmental Research Letters*, 8(1), 015009.
- Verge, X. P. C., De Kimpe, C., & Desjardins, R. L. (2007). Agricultural production, greenhouse gas emissions and mitigation potential. *Agricultural and forest meteorology*, 142(2-4), 255-269.

Witkowska-Dąbrowska, M. (2018). Evaluation of The Attainment of Environmental Goals in Sustainable Growth Regarding Gas Emission and Energy Consumption, as Defined for Poland in the Europe 2020 Strategy. *Olsztyn Economic Journal*, 13(4), 397-409.





# HOUSEHOLD/INDIVIDUALS IN THE PROCESS OF PRODUCTION AND DELIVERY OF ELECTRICITY FROM RENEWABLE ENERGY SOURCES – PHOTOVOLTAIC SYSTEMS

Serjoza Markov<sup>86</sup>

---

**Abstract:** *First and foremost, the main inspiration for the specific problematics in this paper is solar energy as clean and profitable energy for businesses in the Republic of North Macedonia.*

*The question that arises as the basis is finding the reason why the progress in the sector of renewable energy sources in this country is still slow and insufficient.*

*The results and conclusions of the research shall be achieved via comprehensive analysis, and by finding the answer to the posed question through the: theoretical analysis, the inductive and deductive methods, as well as description shall be used, whereas the techniques utilized shall be questionnaires, interviews, observations.*

*By summarizing in one place all the theoretical and empirical aspects, we are finding the answer to the main question asked: One of the possible reasons for this actual situation is the fact that so far there is no possibility in this country for individuals to be involved in the process of production and transmission of electricity in the energy system.*

*The goal is achieved in this paper through providing specific guidelines and suggestions regarding the improvement of the legal framework in the Republic of North Macedonia, emphasizing on benefits if the households are allowed to deliver their produced solar energy and considering the possible ways to remove the determined obstacles for implementing this idea.,*

**Keywords:** *electricity, solar energy, Republic of North Macedonia,*

---

## INTRODUCTION

Solar energy is clean and profitable for businesses in R.N. Macedonia. Our country has more than 280 sunny days a year and the production of one photovoltaic can reach 1500 kWh per year, which is far above the European average.

This is followed by the capacities that Macedonia has, hence according to the Low carbon energy calculator<sup>87</sup> for 2050, Macedonia, in 2050, can be supplied with electricity from fully decarbonized sources, almost 60% of solar energy.

South East Europe Sustainable Energy Policy (SEE SEP) is a multi-annual program funded by the European Commission that provides a technical analysis explaining the critical pathways described in the 2050 Low Carbon Energy Calculator for South East Europe, a decision-making tool developing technical and economic scenarios for the future of the decarbonization of the energy sector in this region.

The technical analysis of the SEE SEP – ‘Southeast Europe: The Road to the EU or the Road to Nowhere? Energy Plan for 2050’, using the Calculator and expert opinions, predicts two

---

<sup>86</sup> Law Company Cukic & Markov, 33A-01 Aminta Treti str., 1000 Skopje, Republic of North Macedonia

<sup>87</sup> For complete calculator and web tool, please visit: <http://www.see2050carboncalculator.net>

scenarios and includes ‘sliders’ for the development of changes in various economic sectors to obtain results by 2050<sup>88</sup>.

The roadmaps follow the first scenario focused on future planned coal developments and the second scenario ‘Road to the EU’ where the countries of Southeast Europe (including R.N. Macedonia) successfully operate in accordance with the EU regulations on environment and climate change.

In R.N. Macedonia, although there is evident progress in the sector of renewable energy sources, it is still slow and insufficient, and one of the possible reasons for that is the fact that so far there is no possibility for individuals to be involved in the process of production and transmission of electricity in the energy system.

Although so far in our country there were several initiatives from different social actors, institutions, and similar, still this idea for active involvement in the production from photovoltaic systems and delivery/sale of such electricity by individuals, has not been realized in practice, nor were made changes in such direction in the last Law on energy. Unlike the individuals, the legal entities have different treatment and the same according to the applicable law<sup>89</sup> in the practice can be actively included, besides in the production at the same time also in the delivery/sale of the produced solar energy through a premiums model and preferential tariffs model.

#### **1. POSSIBLE WAYS AND METHODS OF TREATMENT AND BENEFITS FOR USING THE ‘SURPLUS’ ELECTRICITY PRODUCED BY HOUSEHOLDS FROM PHOTOVOLTAIC SYSTEMS IN ACCORDANCE WITH THE PERFORMED ANALYSIS<sup>90</sup>**

Namely, as a possible way to stimulate such development is the very idea that individuals without starting a company to be able to produce electricity from renewable energy sources and deliver it directly to the system with the possibility of ‘settlement’ with the electricity distributor.

Encouraging and activating the households to use the renewable energy sources could be expected, if they are allowed in case they install, for example, photovoltaic panels, the electricity, in addition to being able to use it for their own needs, to be able to hand it over to a previously concluded contract to the operator/distributor or to sell it directly on the electricity market.

Hence, it is necessary to find an appropriate applicable mechanism by which the surplus, which was especially incurred by the producer, is regulated in a way that everyone would have benefit, both distributors and suppliers, as well as the households themselves that are in the role of producers.

---

<sup>88</sup> Dominković, D. F., Bačeković, I., Čosić, B., Krajačić, G., Pukšec, T., Duić, N., & Markovska, N. (2016). Zero carbon energy system of South East Europe in 2050. *Applied Energy*

<sup>89</sup> Law on energy ‘Official Gazette of the Republic of Macedonia’ No.96/2018, 96/2019

<sup>90</sup> ‘Grid measurement in the Republic of Macedonia, possibilities, perspectives, examples-how to cleaner energy?’ by Sonja Risteska, Analytica Think Tank, February, 2017. Before passing the last Law on energy, ‘Analytica’ participated with initiative the individuals to be allowed without starting a company to be authorized producers and sellers of renewable sources electricity. ([http://www.analyticamk.org/images/2017/mrežno\\_merenje\\_a40ba.pdf](http://www.analyticamk.org/images/2017/mrežno_merenje_a40ba.pdf))

### **1.1. Comparative analysis of applicable ways and methods for stimulating the production and delivery of solar energy from households and feeding (preferential) tariffs**

There are several ways and methods used in Europe and America through which the production and transmission of solar energy from households to the energy system are allowed, encouraged, and stimulated.

These good and functional examples could find appropriate application in our country if the same make sufficient efforts to overcome some already located obstacles, which the institutions in the energy field refer to and use them as an excuse for the current situation.

Available options are the introduction of monthly, seasonal, annual, or kWh-credits indefinitely from the unspent solar energy produced by households.

It is necessary to enable the users-individuals who produce their solar energy to be able to use it at any time, and not only when it is generated (alternating/ depending on the weather conditions). In such a way, on a monthly basis, the users are enabled to use at night the solar energy produced during the day.

On an annual basis, the net kilowatt credit is shifting, allowing households to use solar energy, which, for example, was produced in July and delivered to the system, in December.

A similar practice would exist with the periodic grid measurement (for example, every 6 months/one year).

What is also proposed and necessary, and which is already functioning in other European countries, is the possibility for the household as a producer and consumer of solar energy to hand over in the system the excess electricity that it cannot use and, at the same time, to get a credit on the bill that will be applied in terms of future electricity consumption.

Vice versa, if the household-consumer spent more than what was delivered to the system, then, it would pay the same price as any other consumer (retail price / price of electricity for households).

While, if the household manages to save the consumption, another option is in the case on the date of the anniversary when the offset of spent/handed over there are excess production credits left on the bill, the distribution company to be able to repay that credit at market (current price per MWh on the open market) or at retail price, which depends on how this issue would be regulated by law.

The idea is based on purely economic motives, but also on environmental benefits, and the point is to first satisfy its own consumption, and only then to 'bring back' to the system.

This method can be defined as a collection mechanism that rewards individuals / owners of the photovoltaic panels for the electricity they supply to the grid.

For example, if a household has a photovoltaic panel on the roof and is able to generate more electricity than the household can use during the day and has built-in so-called smart two-way meter that will turn backwards, would provide credits when the household consumes electricity overnight or other periods when the electricity consumption exceeds the one which comes out from the system.

In that case, the households would be billed only for their 'grid' use of the energy.

Another possible similar option is at the end of the billing period, if the electricity produced by the photovoltaic system exceeds the consumption at the place of production based on the agreement with the distributor, for the difference in the produced energy the household to get credit, by which the electricity bill will be reduced, with the equivalent amount the next time.

Of course, in such options, the household must use a two-way electricity meter that measures changes in the electricity flow, which means that it measures the consumption of electricity (taken from the grid) and the amount of electricity delivered to the grid (produced by the household).

A very specific example, which has been operating for a long time in California<sup>91</sup>, is the use of energy by the user, which is determined by dynamics prices according to the function of the purchase price of electricity. In this case the users' meters are programmed remotely to calculate and read the value.

So, there can be a variable calculation of the prices of the excess energy produced by the system according to this example for calculation at market price.

This way allows small systems to have zero annual net cost, if the consumer can switch to a low-cost tariff while the electricity generation is at its peak then back to the grid, and not used locally.

When electricity generation exceeds customer demand, excess power generation automatically goes through the smart meter back into the grid by measuring "backwards" in order to be able to credit the household bill.

At other times of the day, when household demand may be higher than what it produced, it relies on additional quantities it takes from the grid.

The producers who have produced a net surplus of energy at the end of the twelve months can receive payment for this energy under special utility tariffs.

When it comes to net payment in European countries, within the payments two models are used for the payment of subsidies.

One of them is for the produced electricity, which is consumed at the place of production, and the other for part of the produced electricity that is delivered to the grid.

The first model pays a premium for real-time electricity consumption, such as the Italian model<sup>92</sup>, while the other is an integrated model applied in Germany. In Italy the received credits for the difference between the supplied/spent have no limit on use regardless of the electricity market fluctuations.

---

<sup>91</sup> Grid measurement in California ([http://www.gosolarcalifornia.ca.gov/solar\\_basics/net\\_metering.php](http://www.gosolarcalifornia.ca.gov/solar_basics/net_metering.php))

<sup>92</sup> Ameli, N., Kammen, D.M. 2014. Innovations in financing that drive cost parity for long-term electricity sustainability: An assessment of Italy, Europe's fastest growing solar PVmarket. *Energy for Sustainable Development*, 19, 130-137.

In this case, the households have an incentive to use their own produced energy because they would not benefit from the type of profit made, but only in the form of savings in electricity bills, which of course are significant.

## 1.2. Feeding (preferential) tariffs

Feeding (preferential) tariffs is a policy that encourages the production of electricity from renewable energy sources in a country, on a commercial level and promotes certain ‘green’ technologies.

The feeding tariff is also an energy-supply policy, which is focused on supporting the development of new renewable energy projects, offering producers long-term purchase agreements (guaranteed, always by the country) of the sold electricity<sup>93</sup>.

In the feeding tariff, which is an older applicable model in contrast to the previously considered options, it is specific that two electric meters are always needed.

## 2. RENEWABLE ENERGY SOURCES EMPHASIZING THE PHOTOVOLTAIC SYSTEMS AND PARTICIPATION OF THE HOUSEHOLDS ACCORDING TO THE R.N. MACEDONIA’S REGULATION

The applicable Law on energy<sup>94</sup> in the R.N. Macedonia, among others, incorporates also the Directive 2009/28/EC for promoting the use of renewable sources of energy.

According to this law, a producer of electricity from renewable sources can acquire the status of a preferential producer of electricity from renewable sources, which gives him the right to use a premium or preferential tariff.

The law gives the preferential producer the right to use a premium or preferential tariff, in a manner and in a procedure prescribed by law, regulations and rules adopted based on this law and state aid regulations, according to which the Energy and Water Services Regulatory Commission<sup>95</sup> is responsible for conducting and regulating the entire procedure.

The right to use a premium or preferential tariff is acquired through the application of procedures based on the principles of objectivity, transparency and non-discrimination.

A producer of electricity from renewable sources that are connected to the electricity distribution grid (meaning legal entities) can be represented on the electricity market by a virtual electricity producer.

The preferential producer that uses premium is selected by conducting a tender procedure with an auction for granting the right to use premiums for preferential producers.

An authorized producer who has acquired the right to use a premium for a certain power plant cannot use a preferential tariff and has not guaranteed the purchase of the produced energy for the same power plant by the electricity market operator.

<sup>93</sup> NREL (National Renewable Energy Laboratory), A Policymaker’s guide to feed-in tariff policy design, Technical report, July 2010, page 6 <http://www.nrel.gov/docs/fy10osti/44849.pdf>

<sup>94</sup> Law on energy ‘Official Gazette of the Republic of Macedonia’ No.96/2018, 96/2019

<sup>95</sup> <https://www.erc.org.mk>

The law defines the ‘premium’ as a form of financial support granted to a preferential producer of electricity from renewable sources as an additional amount to the price achieved by selling the produced energy on the electricity market.

‘Preferred electricity producer’ is defined as a producer of electricity from renewable sources that uses one of the support measures established by this law.

Although these two legal definitions do not clearly and decisively exclude individuals as possible preferential producers, still the bylaw and the manner of conceptualizing the use of the state measures allude to the impossibility of involving households in the transfer/sale of the energy produced from renewable sources.

This is evident from the definition of the term ‘household’, which according to the law represents a consumer connected to an energy distribution system, who supplies or produces energy for its own consumption in the household, but not for commercial or professional purposes.

In R.N. Macedonia are currently used these measures as an incentive to generate electricity from renewable energy sources and they are quite successful, although the quantities produced in these ways are far from the potential of the country.

### **3. BENEFITS IF THE HOUSEHOLDS ARE ALLOWED TO DELIVER THEIR PRODUCED SOLAR ENERGY TO THE R. N. MACEDONIA’S ENERGY SYSTEM**

The benefits of allowing households to transmit their electricity to the system are huge, and the first and most important benefit is increased use of solar energy.

If R.N. Macedonia has the potential to produce 4.4. TWh in 2050, then the situation is clear, the citizens and the individual households must be more actively involved in using the solar potential that the state has.

Also, the second benefit is reduced pollution and participation in lower greenhouse gas emissions through the use of photovoltaic systems as renewable energy sources, and the third benefit is job creation and encouraging private investment.

‘The next benefit is the increase in demand for solar energy systems, which in turn creates jobs for installers, electricians and manufacturers working in the solar supply chain’, the analysis of ‘Analytica Think-Tank’ indicated<sup>96</sup>.

‘The distributed solar systems can help avoiding significant investments in the infrastructure, reduce the pressure on state-owned fossil fuel-based electricity generation when demand is at its peak and at lower prices’, the analysis said.

The idea of these models is to encourage self-sufficiency of energy needs as an independent entrepreneurial activity. The offset prescribed for independent generation and transmission of solar energy has the added advantage, by the fact that the investments in the distribution grid

---

<sup>96</sup> Grid measurement in the Republic of Macedonia, possibilities, perspectives, examples-how to cleaner energy? by Sonja Risteska, Analytica Think Tank, February, 2017

are more cost-effective than in the system with preferential tariffs. In this way, the awareness of fulfilling the obligations to increase the share of renewable energy sources in the total energy consumption for all, not only for the ‘big’ investors, would be further encouraged. The increased awareness for rational use of electricity is also a benefit, as well as a lower load on the grid.

Another possible advantage of such system, emphasized in the same analysis, is that when the electricity market is fully open also for households, the electricity will be given to the buyer, to be offset at the end of the year; how much he spent from the grid, how much his own, and how much he gave in the system – and if he saved, such savings should be paid to him at a market price.

#### **4. OBSTACLES FOR INTRODUCING THE MODEL ALLOWING INDIVIDUALS TO GENERATE ELECTRICITY FROM PHOTOVOLTAIC SYSTEMS AND THE SURPLUS OF SOLAR ENERGY TO BE DIRECTLY DELIVERED IN THE ENERGY SYSTEM**

Although drastic changes may have been expected with the adoption of the latest Law on energy in the R.N. Macedonia, the role of households as potential producers and sellers of the produced solar energy remained unchanged. As potential obstacles for such condition, which are previously located by several energy institutions and companies in R.N. Macedonia according to the analysis<sup>97</sup>, the following can be pointed out.

##### **4.1. Costs for the consumers**

Expected is diversion of costs from consumers who use and sell solar energy to those who do not. In R.N. Macedonia the price for the feeding tariffs that are paid, is paid by the final consumers because it is included in their bills.

If they do not receive bills, in that case they would not pay grid fees, etc., so, the price for their use of the grid will have to fall to other users, which increases the price of electricity for end users. Hence, in adopting this measure, it is important to be introduced a payment of a grid fee and of the ‘privileged’ users-producers.

This would mean that the bills would be made in such way that the distributor would charge for the connection of the household to the grid, but not for the electricity delivered when the household uses its own generated electricity.

##### **4.2. Unprepared grid**

The lack of grid readiness remains a common critical point for integrating the solar energy in the grid.

However, if there are significant investments in the electricity sector in the future as a result of the necessary upgrades, the proper investment and measures should ensure the integration of renewable energy sources and solve the problems with the alternation. The voltage failures of the grid and the return power in opposite direction could be a problem due to distributed solar

<sup>97</sup> \* Grid measurement in the Republic of Macedonia, possibilities, perspectives, examples-how to cleaner energy?“ by Sonja Risteska, Analytica Think Tank, February, 2017, pp.23,24

panels. However, in some cases the studies have shown benefits from delayed investments in capacitor banks and resistive switches<sup>98</sup>. The distributed solar energy could even delay some upgrades of voltage regulator, gearbox load, and capacitor devices by providing voltage support and some kind of frequency regulation in combination with energy storage<sup>99</sup>.

### 4.3. Technical shortcomings

Technically, care must be taken on how will be performed the including of the households and the introduction of the model of 'settlement' of produced-delivered electricity, so that the electricity grid does not suffer from load. If the photovoltaic systems are in a location that is not yet well connected to the distribution grid, grid failures are possible and expected<sup>100</sup>.

### 4.4. Calculation and including the Value Added Tax (VAT)

A possible problem is the calculation of VAT, i.e. how it will be charged, if the price at which household buys electricity has VAT included, and the electricity that is delivered to the system; if it is calculated as purchase price, and not as retail, is not subject to VAT.

Hence, the problem is how to settle the delivered/spent, if VAT must be included when invoicing a bill.

## CONCLUSION

With the drastic reduction of the price of solar and wind energy and the aging of the existing energy infrastructure in the region, R.N. Macedonia, as well as the whole of Southeast Europe faces the dilemma of whether to follow the path that relies exclusively on new coal development, without any significant progress in solar or wind energy, or to accept the challenge and advance towards EU accession using clean energy technologies and energy efficiency measures.

The price of solar panels is expected to decrease from around 6,6€/W in 2002 to 0.9€/W in 2027.<sup>101</sup>

Renewable sources in the electricity sector, inspiring new and innovative approaches, fundamentally change the policy and financial environment in terms of capacity expansion, shifting to lower marginal costs.

Generally, the investments in new electricity supplies will be crucial to meeting the EU Roadmap to reduce greenhouse gas emissions by 80% to the levels from 1990 until 2050.<sup>102</sup>

Increasing the number of solar panels installed in the distribution system can also solve the issues with the supply system and the lack of electricity.

With the increasing presence of distributed solar energy, further grid upgrades can be expected to adapt to new technologies, as it is obvious that the grid needs upgrades for each new capacity.

---

<sup>98</sup> Gil, H. A., & Joos, G. (2006). For quantification of the value of the delayed capacity to the grid of the distributed production. *Power Systems, IEEE Transactions on*, 21(4), 1592-1599

<sup>99</sup> Southeast Europe: The Road to EU or the Road to nowhere? Energy plan for 2050: Technical analysis, 52

<sup>100</sup> Sustavi poticanja za integrirane fotonaponske sustave, Andrea Brajko, Hrvatski operator tržišta energije d.o.o.

<sup>101</sup> Cost overview for 2015 EUR. Zheng, C., & Kammen, D. M. (2014). Innovative focused roadmap for a sustainable global photovoltaic industry. *Energy Policy*, 67, 159-169

<sup>102</sup> SEE SEP, Southeast Europe: The Road to EU or the Road to nowhere? Energy plan for 2050: Technical analysis, 2016, 26



Second, the distribution company can improve its revenues, as well as monitor electricity, in parallel with the mentioned necessary investments in the grid and in the system.

This will enable future programs to satisfy the consumption or other forms of energy efficiency interventions to be able to effectively reshape both the electricity supply and consumption throughout the region<sup>103</sup>.

The roadmaps presented in the region can be contextualized within the global and European trends, emphasizing the reduction of the price of renewable energy sources, the ability for energy efficiency and renewable measures to create new jobs at a fast pace, and the possibility of integration by using the new grid architectures that can make Southeast Europe a leader, rather than lagging behind energy production and the deployment of technological infrastructure.<sup>104</sup>

Following up on this, the study<sup>105</sup> demonstrated and established the hypothesis that although obstacles and problems such as reduced revenues for the country and distribution grid operators are expected, the risk of price increase for end users, and the need to upgrade the grid over time in order to receive such electricity; however, the practice shows that all these issues have answers, that citizens should be given the right to be responsible for the supply of electricity and to ‘help’ the system by supplying it with electricity at the peak.

The measure has been successfully implemented in the United States for decades, and is spreading across Europe, so with the inevitable liberalization of the electricity market, which should have happened until now, such measure will only be an added plus for households that have opportunities and would like to produce the electricity they use.

All this would mean that such investments are possible and desirable for the households and in accordance with the guidelines of the European Union, but of course, if proper development policies are created within the country itself.

---

<sup>103</sup> SEE SEP, Southeast Europe: The Road to EU or the Road to nowhere? Energy plan for 2050: Technical analysis, 33

<sup>104</sup> SEE SEP, Southeast Europe: The Road to EU or the Road to nowhere? Energy plan for 2050: Technical analysis, 52

<sup>105</sup> “Grid measurement in the Republic of Macedonia, possibilities, perspectives, examples-how to cleaner energy?” by Sonja Risteska, Analytica Think Tank, February, 2017, 33,34



# LEVELS OF SOME PRIORITY SUBSTANCES ON ADRIATIC SEA, ALBANIA

Aurel Nuro<sup>106</sup>  
Bledar Murtaj<sup>107</sup>

DOI:

---

**Abstract:** *This study evaluated levels for organochlorine pesticides (DDTs, HCHs, Heptachlors, Aldrins and Endosulfanes), their residues, polychlorinated biphenyls (PCB) and poly aromatic hydrocarbons (PAH) in water samples of Adriatic Sea, Albanian part. Water stations were chosen near the main river estuaries of Albania (Vjosa, Semani, Shkumbini, Erzeni, Mati and Buna rivers). These rivers have catchment areas that cover almost all Albania. First, agricultural, industrial and urban waste is transported in these rivers and after that they finished in Adriatic Sea.*

*Water samples were analyzed for a five-year period from February 2015 to December 2019. Liquid-liquid extraction was used to isolate chlorinated pollutants and a florasil column was used for clean-up procedure. Analysis of organochlorine pesticides (according to Method EPA 8081B) and 7 PCB markers was realized using GC/ECD and RTX-5 capillary column. The PAHs were isolated by liquid-liquid extraction technique and after sample concentration qualitative and quantitative analyses were performed by the GC/FID technique.*

*Organochlorine pollutants were detected for all stations of Adriatic Sea because of new arrivals by agricultural and industrial activity in river basins. The highest levels were found near Shkumbini and Semani estuaries due to impact Myzeqeja agricultural area. New arrivals from water irrigation and rainfall influence in found levels. Degradation products of pesticides and volatile PCBs were found at higher levels for all samples analyzed. The levels of some individual organochlorine pesticides were higher than EU and Albanian norms for Semani and Shkumbini rivers. Also, PAHs were found at higher levels for Semani River because of extracting-processing industry in Patos-Marinza area. Monitoring of organic pollutants in water of Adriatic Sea should be continuous because of its importance in fishing, tourism, recreation and Albania economy overall.*

**Keywords:** *Organochlorine pesticides; PCBs; PAH; Water analyzes; GC/ECD.*

---

## INTRODUCTION

Albania is a country located in the Balkan Peninsula in Southeast Europe. It is rich in marine and surface waters. It faces the Adriatic Sea and the Ionian Sea that are part of the Mediterranean Sea. The total length of the coastline is approximately 274 km, 178 km of which are covered by sandy beaches and the remaining by different landforms. The main lagoons (Narta, Karavasta and Patoku lagoons) are formed in estuaries of rivers that flow in Adriatic Sea. These water ecosystems are rich in flora and fauna. Fishing, tourism and ship transport activity in marine waters have an important role in Albanian economy. The major

---

<sup>106</sup> Department of Chemistry, Faculty of Natural Sciences, Tirana University, Blv. "Zog I", Nr. 25, Tirana, Albania

<sup>107</sup> Department of Chemistry, Faculty of Natural Sciences, Tirana University, Blv. "Zog I", Nr. 25, Tirana, Albania

surface water resources are many lakes and rivers. Three main lakes of Albania are Shkodra Lake, Ohrid Lake and Prespa Lake. The most important rivers are Drini, Mati, Ishmi, Erzeni, Shkumbini, Semani, Osumi, Vjosa, Bistrica and Buna (Cullaj et al, 2005). Waters of these rivers are in use mainly for producing electricity by hydropower plants and for water irrigation in agricultural. Note that occasionally waters of rivers are polluted by urban and industrial waste and by remains of agricultural pesticides and veterinary drugs. These pollutants end up in the seawater. The main rivers of Albania flow in Adriatic Sea. Based on this fact, monitoring pollution levels in marine and surface water samples must be continuous, especially recently after rapid growth of tourism in Albania. Marine and surface water resources have a direct impact on people health and present an important contributor to the country's economy too. This is the reason that river waters must have additional attention in assessing their chemical and microbiological parameters by responsible institutions. In this context, this study presents concentrations of organochlorine pesticides, their residues, PCB markers and PAHs in water samples of Adriatic Sea for a five-year period. Sampling stations were selected near the main river estuaries (Vjosa, Semani, Shkumbini, Erzeni, Mati and Buna rivers) that discharge to the sea. These rivers have catchment areas that cover almost all Albania so the arrival of new pollutants is not excluded.

For more than 50 years (after the Second World War to 90') organochlorine pesticides were used widely in Albania against malaria vector and for agricultural purposes. The main agricultural areas are located in the western of the country near Adriatic Sea. These fields are covered mainly by the Vjosa, Semani, Shkumbini, Erzeni, Mati and Buna rivers and their branches. The use of pesticides in Albania after 1990 decreased rapidly due to migration and immigration of population. PCBs were not in use in Albania until 90'. They can be found only in some electrical transformers that were used in the early 1990s, but they were reported in many water ecosystems of our country because of atmospheric depositions. PAHs are pollutants generated by automobiles transport, extracting/processing of oil industry, coal mine and other industries. Forest burning and their natural background make them very often in environment. Organochlorine pollutants (OCP and PCB) and PAHs have high stability, high bioaccumulation capacity and the ability to spread out far away from the application site. Generally, these compounds are difficult to degrade and can persist for many years in particular in water ecosystems (Corsi et al, 2010; Nuro et al, 2012).

## **MATERIALS AND METHODS**

### **Study areas**

The study areas were river estuaries of Vjosa, Semani, Shkumbini, Erzeni, Mati and Buna (Adriatic Sea, Albania). Water samples were taken two times per year in a five-year period from February 2015 to December 2019. The sampling stations are presented in Figure 1. 2,5 liters of water were taken from each station in Teflon bottles. The sampling method was based on UNEP/MED Wg. 128/2, 1997. Water samples were transported and conserved at +4°C before their analysis.

**Figure 1.** Sampling stations in Adriatic Sea and the main rivers catchments in Albania

### Treatment of water samples for pesticide and PCB analyzes

Liquid-liquid extraction was used for extraction of organochlorine pesticide and polychlorinated biphenyls from marine water samples of Adriatic Sea. One liter of water and 30 ml n-hexane as extracting solvent were added in a separatory funnel. After extraction, the organic phase was dried with 5 g of anhydrous  $\text{Na}_2\text{SO}_4$  for water removing. A florisil column was used for the sample clean-up. 20 ml n-hexane/dichloromethane (4/1) was used for elution. After concentration to 1 ml, the samples were injected in GC/ECD (Lekkas et al, 2004; Vryzas et al, 2009; Nuro et al, 2012).

### Gas chromatography analysis of pesticides and PCBs

Organochlorine pesticides and PCBs were analyzed simultaneously using capillary column model Rtx-5 (30 m long x 0.25 mm i.d. x 0.25  $\mu\text{m}$  film thicknesses) on a gas chromatograph HP 6890 Series Plus with  $\mu\text{ECD}$  detector. Helium was used as carrier gas (1 ml/min) while nitrogen as make-up gas (24 ml/min). The manual injection was done in split mode (1:50) at 280°C. The organochlorine pesticides detected were DDT-related chemicals (o,p-DDE, p,p-DDE, p,p-DDD, p,p-DDT), HCHs ( $\alpha$ -,  $\beta$ -,  $\gamma$ - and  $\delta$ -isomers), Heptachlor's (Heptachlor and Heptachlorepoxyde); Aldrin's (Aldrine, Dieldrine and Endrin) and Endosulfanes (Endosulfan alfa, Endosulfan beta and Endosulfan sulfat). Analysis of PCBs was based on the determination of the seven PCB markers (IUPAC Nr. 28, 52, 101, 118, 138, 153 and 180). Quantification of OCPs and PCBs were based on external standard method (Vryzas et al, 2009; Lekkas et al, 2004; Nuro et al, 2014).

## Treatment of water samples for PAH analyzes

Liquid-liquid extraction was used for extracting PAHs from marine water samples. One liter of water and 30 ml dichloromethane as extracting solvent were added in a separator funnel. After extraction, the organic phase was dried with 5 g of anhydrous  $\text{Na}_2\text{SO}_4$  for water removing. Extracts were concentrated to 1 ml using Kuderna-Danish and then were injected in GC/FID for PAHs their quantification (Nuro et al, 2014; Gustafson and Dickhut, 1997).

## Determination of PAH in water samples

Gas chromatographic analyses of PAH in water samples were realized with a Varian 450 GC instrument equipped with a flame ionization detector and PTV detector. VF-1 ms capillary column (30 m x 0.33 mm x 0.25  $\mu\text{m}$ ) was used to isolate and determine 13 most toxic PAHs according to Albanian and EU norms. Helium was used as carrier gas with 1 ml/min. FID temperature was held at 280°C. Nitrogen was used as the make-up gas (25 ml/min). Hydrogen and air were flame detector gases with 30 ml/min and 300 ml/min, respectively. EPA 525 Mixture was used for qualitative and quantitative of PAH analyze. Acenaphthylene, Fluorene, Phenanthrene, Anthracene, Pyrene, Benzo [a] anthracene, Chrysene, Perilene, Benzo [b] fluoranthene, Benzo [k] fluoranthene, Indeo [1,2,3-cd] pyrene, Dibenzo [a, b] anthracene and Benzo [g, h, i] perylene were determined in seawater samples. Quantification of PAH was based on external standard method (Nuro et al, 2014; Gustafson and Dickhut, 1997).

## RESULTS AND DISCUSSION

Marine water samples from Adriatic Sea (Albanian part) were selected near the six main river estuaries that flow on it (from South to North: Vjosa, Semani, Shkumbini, Erzeni, Mati and Buna rivers). The average data of a five-year period (2015–2019) are shown in this study to understand their pollution impact on seawater. These rivers cover a large catchment area including the main agricultural areas and the main cities as well as industrial areas of Albania. Organochlorine pesticides, their degradation products and PCB markers were analyzed using GC/ECD and GC/FID techniques.

**Figure 2.** DDTs in water samples of Adriatic Sea

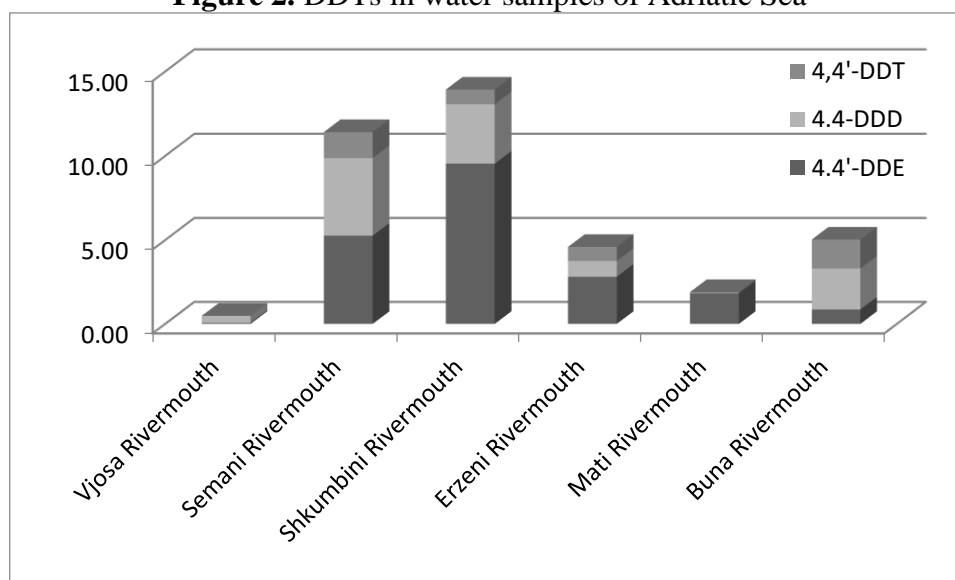
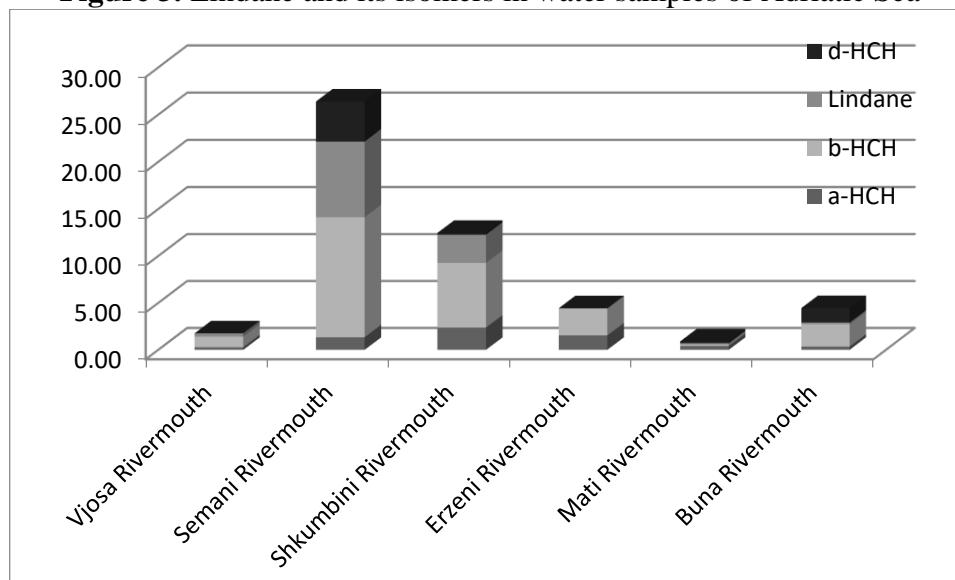


Figure 2 shows DDTs (4,4'-DDT, 4,4'-DDD and 4,4'-DDE) in marine water samples of Adriatic Sea located near river estuaries for Vjosa, Semani, Shkumbini, Erzeni, Mati and Buna rivers. The higher DDT levels were found in Shkumbini river mouth water samples (13.7 ng/l) and after that in Semani River (10.9 ng/l) because of new arrivals by Myzeqeja field that lie near these rivers. Total of DDTs near Vjosa river mouth was lower (0.5 ng/l) compared with other stations on Adriatic Sea. DDT pesticide was found partially on samples of Semani, Shkumbini, Erzeni and Buna rivers. DDT was not detected in water samples of Vjosa and Mati rivers. DDT degradation products (DDE and DDD) were found in high concentration for all samples because of DDT previous use for malaria vector and agricultural purposes. DDT levels were lower than 1 ng/l for all stations except for two samples in Semani rivermouth station (2017) and three samples in Buna rivermouth station (2016, 2017 and 2018). For other stations 4,4'-DDT was lower than permitted level (0.01 ug/L) based on Albanian and EU norms.

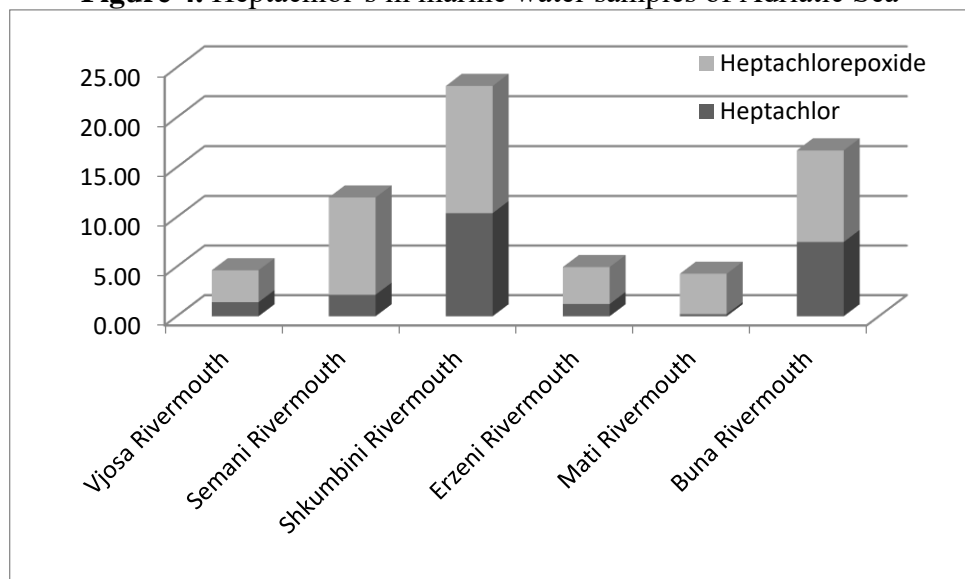
Concentrations of Lindane and its isomers (alpha-, beta-, and delta-hexachlorocyclohexanes-HCHs) are shown in Figure 3. Also, HCHs were found in higher concentrations in water samples near Semani and Shkumbini river mouths (25.4 and 12.5 ng/l) while samples near Mati and Vjosa estuaries were at lower concentrations (0.8 and 1.1 ng/l). Note that Lindane was found only in 25% of all analyzed samples. beta-HCH was found to be the primary isomer for all seawater samples. Its origin could be because of beta-HCH presence as an impurity in Lindane formulations or because it's physical – chemistry properties. HCH isomers could be found because of Lindane previous use in agricultural or due to degradation of other pesticides. HCH's arrival by urban waste it's not excluded. For all stations, total of HCHs was lower than permitted level of 0.04 ug/l conform to EU Directive 2013/39 and Albanian norms for surface waters.

**Figure 3.** Lindane and its isomers in water samples of Adriatic Sea



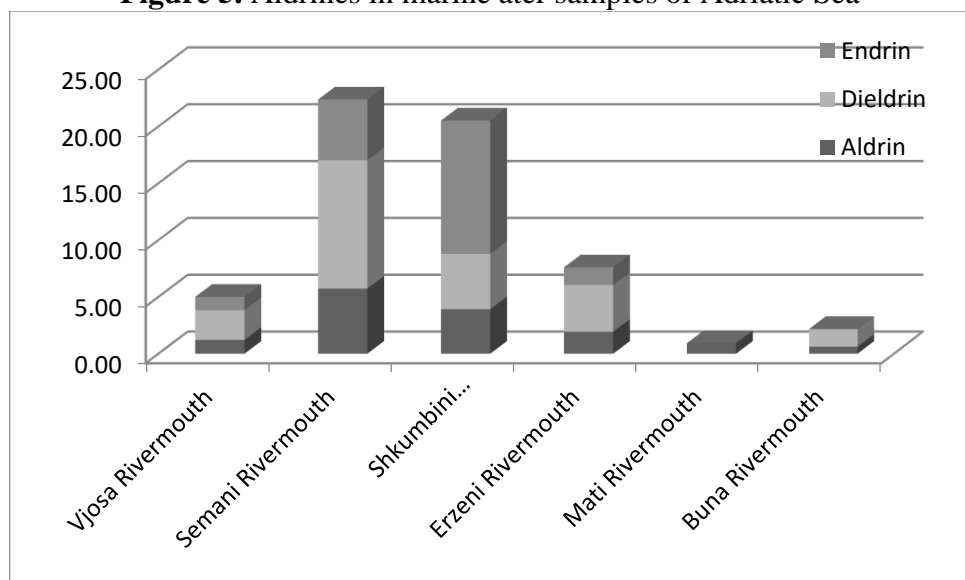
Average concentrations of Heptachlors in seawater were shown in Figure 4. Heptachlors were found in higher concentrations in water samples of Adriatic Sea near Shkumbini estuary (23.2 ng/l) and after that near Buna (12.0 ng/l) and Semani samples (4.6 ng/l). In the higher levels in all analyzed samples were found Heptachlorepoide, its degradation products. This fact is connected with the previous use of Heptachlor. Levels of Heptachlors in some samples taken near Shkumbini and Semani rivers were higher than EU Directive 2013/39 or Albanian norms.

**Figure 4.** Heptachlor's in marine water samples of Adriatic Sea



Concentrations and profiles of Aldrines were shown in Figure 5. The higher levels of Aldrines were for Semani River with 22.2 ng/l and for Shkumbini River with 19.9 ng/l. In fact, the higher level of Aldrine in Semani River was connected with higher concentration of Dieldrin, while in Shkumbini River in higher concentration was Endrin. This is connected with the time of use for Aldrine in the agricultural areas near these rivers. Aldrins were found in lower levels in water samples of Mati, Buna and Vjosa river mouths. Aldrines were found 2 times higher than EU directive 2013/39 and Albanian norms for 44% of seawater samples near Semani and Shkumbini rivers.

**Figure 5.** Aldrines in marine water samples of Adriatic Sea

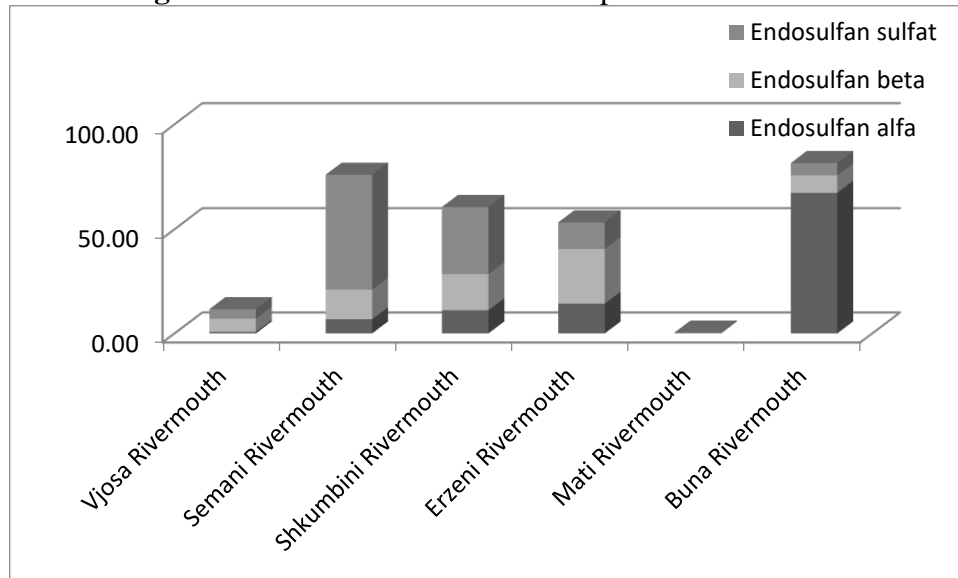


Averages of concentrations for Endosulfan in estuaries of rivers (Adriatic Sea) are presented in Figure 6. Total of Endosulfan alpha, Endosulfan beta and Endosulfan sulfate were higher in Buna (79.8 ng/l), Semani (75.6 ng/l), Shkumbini (59.6 ng/l) and Erzeni (51.3 ng/l) river mouths. Note that Endosulfans were found at higher levels for some individual samples near Buna (2015, 2017, 2018), Semani (2017 and 2018) and in Shkumbini river mouths (2018). These data could be the result of Endosulfan's punctual source in agricultural areas near these



ecosystems. It's not excluded the recent use of Endosulfan in water basins of Buna, Semani, Shkumbini and Erzeni rivers. Endosulfan could be in use in these areas under false trade name. Endosulfan concentrations for water samples of Buna, Semani, Shkumbini and Erzeni rivers were 5 to 10 times higher than permitted level based on EU Directive 2013/39. The presence of Endosulfane in surface water samples must be lower than 0.005 ug/l.

**Figure 6.** Endosulfanes in water samples of Adriatic Sea



**Figure 7.** PCB markers in marine water samples of Adriatic Sea

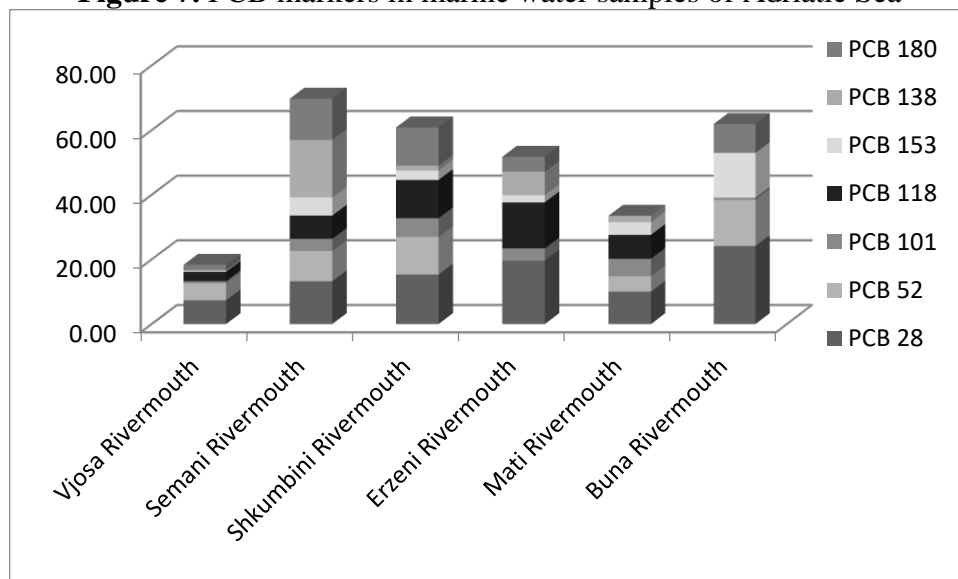
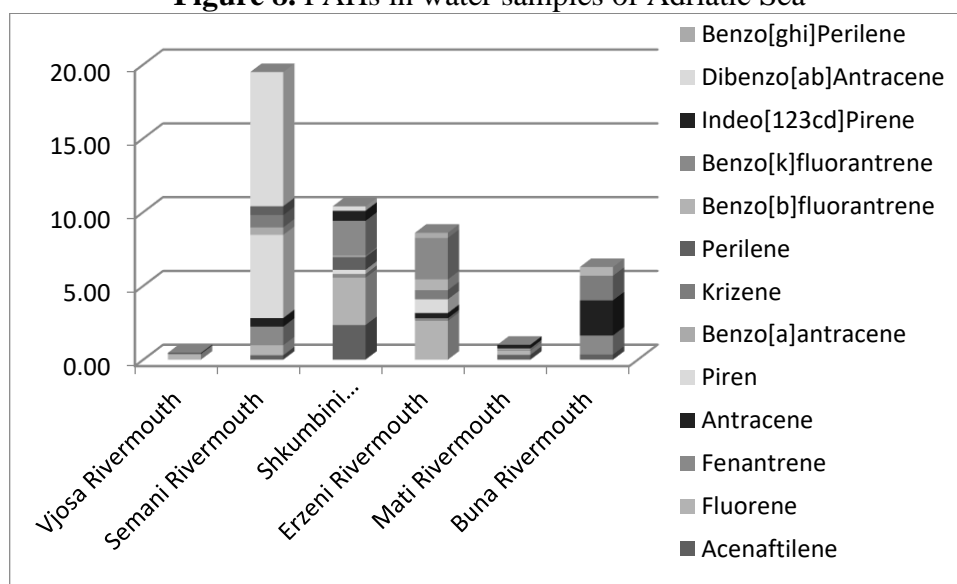


Figure 7 shows the total PCB markers in water samples of Adriatic Sea near six river estuaries for 2015–2019 periods. PCBs were found in all analyzed samples. They were found in this rate: Semani (69.4 ng/l) > Buna (60.7 ng/l) > Shkumbini (60.2 ng/l) > Erzeni (50.5 ng/l) > Mati (31.1 ng/l) > Vjosa (16.7 ng/l). The higher concentrations of PCBs in Semani, Shkumbini dhe Buna rivers can be related to the elevated industrial activity in their water basins. For all water samples, volatile congeners (PCB 28 and PCB 52) were found at higher level. This fact is connected with the atmospheric deposition. For Semani, Shkumbini, Buna, and Erzeni rivers were detected relatively high level of heavy PCB congeners (PCB 180) that is connected with punctual sources of these pollutants. Some industries that can influence PCB levels are

extraction and processing of oil industry (Semani Rivers) and metallurgical complex near Elbasani (Shkumbini River). PCB concentrations for water samples of Vjosa, Semani and Shkumbini rivers were comparable levels than the reported data on previous studies on the same stations (Murtaç et al. 2014; Como et al. 2013, Nuro et al. 2017).

Figure 8 shows totals of 13 PAHs according to EPA 525 Method in water samples of Adriatic Sea measured by the GC/FID technique. PAHs were detected for all samples under study. They were found in higher concentration for station near Semani River with 19.2 ug/l. Their presence could be because of extracting-processing oil industry in Patos-Marinza area that is part of its basin. Ship transport could be another source of PAH pollution in marine water samples of Adriatic Sea. Dibenzo [ab] anthracene and Chrysene were the most abundant peaks for water samples near Semani River. Average levels of PAHs were relatively high near Shkumbini (10.1 ug/l), Erzeni (8.4 ug/l) and Buna (6.0 ug/l) while in Mati and Vjosa their levels were in LOD (limit of detection) for the GC/FID technique. The presence of some individual PAHs in higher level was noted. Also, this could be a momentum value of PAHs depended on sampling periods. PAH levels in seawater samples near Semani were higher than the reported levels for other ecosystems of Albania (Nuro et al., 2014). The presence of some individual PAHs was higher than permitted level according to Albanian and EU norms.

**Figure 8.** PAHs in water samples of Adriatic Sea



## CONCLUSION

Organochlorine pesticides, their residues, PCBs and PAHs were found in all water samples of Adriatic Sea. The higher level was found near Semani and Shkumbini river mouths because of new arrivals from waters from channels of Myzeqeja field (the main field on Albania). It was noted presence of degradation products of pesticides in higher levels. This fact is connected with the previous use of pesticides in Albania and their degradation process. Endosulfan was shown to be in high level in all samples. This pesticide could be in use in agricultural areas near these rivers under false trade name. PCBs volatile were found at high levels for all seawater samples. Their presence could be because of their atmospheric deposition. In marine water samples near Shkumbini, Buna and Semani river mouths were found heavy PCB. This could be connected with punctual sources of PCBs in these stations or a momentum value. Also, PAHs were found at higher levels for Semani River because of extracting-processing

industry in Patos-Marinza area. Concentrations of some individual organochlorine pesticides and PAHs were found in higher concentrations than permitted levels for surface waters according to EU Directive 2013/39 and Albanian norms. Monitoring of organic pollutants in water of Adriatic Sea should be continuous because of its importance in fishing, tourism, recreation and Albania economy overall.

## REFERENCES

- Borshi Xh. Nuro A., Macchiarelli G., Palmerini G.M., “Analyzes of Some Chlorinated Pesticides in Adriatic Sea. Case study: Porto-Romano, Durres, Albania” *Journal of International Environmental Application and Sciences (JIEAS)*, Vol. 9(4): 521-424 (2016).
- Como E., Nuro A., Murtajn B., Marku E., Emiri A. (2013): Study of Some Organic Pollutants in Water Samples of Shkumbini River”, *International Journal of Ecosystems and Ecology Sciences (IJEES)*, Vol 8, Issue 4; 573-579
- Corsi I., Tabaku A., Nuro A., Beqiraj S., Marku E., Perra G., Tafaj L., Baroni D., Bocari D., Guerranti C., Cullaj A., Mariottini M., Shundi L., Volpi V., Zucchi S., Pastore A.M., Iacocca A., Trisciani A., Graziosi M., Piccinetti M., Benincasa T., Focardi S. (2010): “Ecotoxicological assessment of Vlora Bay (Albany) by a biomonitoring study using an integrated approach of sub-lethal toxicological effects and contaminants levels in bioindicator species”. *Journal of Coastal Research, Special Issue 58 - Coastal Research in Albania: Vlora Gulf [Tursi & Corselli]*: pp. 116 – 120. DOI:10.2112/SI\_58\_1
- Directive 2008/105/Ec Of The European Parliament And Of The Council on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council
- Gustafson E., Dickhut M., (1997): Distribution of polycyclic aromatic hydrocarbons in southern Chesapeake Bay surface water: evaluation of three methods for determining freely dissolved water concentrations. *Environment Toxicology Chemistry* 16, 452–461
- Konstantinou I.K., Hela D. G., Albanis T. A. (2006): The status of pesticide pollution in surface waters (rivers and lakes) of Greece. Part I. Review on occurrence and levels, *Environmental Pollution*, Volume 141, Issue 3, Pp. 555–570
- Lekkas Th., Kolokythas G., Nikolaou A., Kostopoulou M., Kotrikla A., Gatidou G., Thomaidis N.S., Golfinopoulos S., Makri C. (2004) Evaluation of the pollution of the surface waters of Greece from the priority compounds of List II, 76/464/EEC Directive, and other toxic compounds, *Environment International*, Volume 30, Issue 8, Pp. 995–1007
- Murtaj B., Çomo E., Nuro A., Marku E., Emiri A., (2013): “Evaluation of Organochlorine Pesticides Residues and PCBs in Sediments of Karavasta Lagoon, Albania”, *Journal of International Environmental Application and Sciences (JIEAS)*, Vol 8, Issue 4, Fq. 573-579
- Nuro A., Marku E., Shehu M., (2012): “Organochlorine pesticide residues in marine water in the South of Albania”. *International Journal of Ecosystems and Ecology Sciences (IJEES)*, Vol 2, Issue 1, Fq. 27-34
- Nuro A., Marku E., Murtaj B. Levels of organic pollutants in water samples of Vjosa River, Albania” *Zastita Materijala/ Materials Protection*, Vol. 58 (3) (2017), pp. 385-384
- Vryzas, Z., Vassiliou, G., Alexoudis C., Papadopoulou-Mourkidou E. (2009): Spatial and temporal distribution of pesticide residues in surface waters in northeastern Greece, *Water Research*, Volume 43, Issue 1, Pp. 1–10

Wells DE., Hess P. (2000): Determination and evaluation of chlorinated biphenyls. In: Barceló E (2007) *Sample handling and trace analysis of pollutants, techniques, applications and quality assurance*. Elsevier, Amsterdam; 239–285

# HEAVY METAL ACCUMULATION AND CHEMICAL COMPOSITION OF ESSENTIAL OILS OF LEMON BALM (*MELISSA OFFICINALIS* L.) CULTIVATED ON HEAVY METAL CONTAMINATED SOILS

Violina Angelova<sup>108</sup>

DOI:

---

**Abstract:** *Comparative research has been conducted to allow us to determine the content of heavy metals and chemical composition of lemon balm oils, as well as to identify the possibility of lemon balm growth on soils contaminated by heavy metals. The experimental plots were situated at different distances of 0.5 km, and 15 km, respectively, from the source of pollution the Non-Ferrous-Metal Works (MFMW) near Plovdiv, Bulgaria. On reaching the flowering stage the lemon balm plants were gathered. The content of heavy metals in leaves of lemon balm was determined by ICP. The essential oils of the lemon balm were obtained by steam distillation in laboratory conditions which were analyzed for heavy metals and chemical composition was determined. Lemon balm is a plant that is tolerant to heavy metals and can be grown on contaminated soils. Heavy metals do not affect the development of lemon balm and the quality and quantity of oil obtained from it. Forty components were identified in the oils. The quantity of identified compounds corresponds to 98.82-98.83% of the total oil content. Among the detected compounds, beta-citral (neral) (19.31-20.78%), alfa-citral (geranial) (18.65-19.12%),  $\beta$ -caryophyllene (14.76-16.28%),  $\alpha$ -cadinol (3.88-4.74%), geranyl acetate (3.49-3.59%), trans-geraniol (3.40-3.51%), germacrene (3.18-3.28%), citronellal (2.94-3.03%), nerol (2.63-2.71%), neryl acetate (2.42 -2.49%) were the major compounds. The essential oil of *Melissa officinalis* L. can be a valuable product for farmers from polluted regions.*

**Keywords:** *Contaminated soils, Essential oil composition, Heavy metals, Lemon balm.*

---

## 1. INTRODUCTION

Lemon balm (*Melissa officinalis*) is a perennial herbaceous plant of the family Lamiaceae. The plant is grown mainly in Germany, France, Italy, Romania, Bulgaria and North America [1-2]. It reaches a height of 70-150 cm. The leaves have a mild lemon scent. At the end of summer, small flowers full of nectar appear, they attract bees, hence the name Melissa (Greek for “honey bee”). The citrus aroma of lemon balm is due to the terpenes citral and geraniol, citronellal, citronellol and geranyl acetate [3]. The above-ground part of the lemon balm is used as a spice and herbal tea, in medicine, in the perfume and cosmetics industry, in folk medicine. Traditionally in Bulgaria it is used for making tea, as well as for making bowles and liqueurs. Lemon balm tea is used in nervous sleep disorders and gastrointestinal disorders [4], lowering the temperature and relieving headaches caused by stress.

The oil contains terpenes (monoterpenes, sesquiterpenes and triterpenes), phenolic compounds (phenolic acids, flavonoids and tannins) [5-6]. The main active ingredients of *M. officinalis* are volatile compounds (geranial, neral, citronellal and geraniol), triterpenes (ursolic acid and

---

<sup>108</sup> Department of Chemistry, Agricultural University – Plovdiv, Bulgaria

oleanolic acid) [7], flavonoids and phenolic acids [8-9] such as rosemary acid [10] and caffeic acids [11], phenylpropanoid heteroside [12]. *M. officinalis* essential oil is used because of its antimicrobial activity [13], antiviral [14], antibacterial, antioxidant and insect repellent properties [15]. There is evidence that lemon balm has a positive effect on patients with Alzheimer's disease [6].

The chemical composition of balm mint oil has been the subject of many studies around the world. In most studies, in the essential oils from *M. officinalis* has been found to be characterized mainly by oxygenated monoterpenes and sesquiterpenes. The analysis of essential oils indicated some major constituents, like geranial, neral and citronellal [6, 10, 16-20], (E)-caryophyllene and caryophyllene oxide [10,21], linalool [16], geraniol [22], thymol [23],  $\alpha$ -pinene [21],  $\beta$ -pinene [21,24], carvacrol and iso-menthone [20], decadienal [25] and trans-carveol [26]. The composition of the oil depends on various factors, such as genetic origin, habitat, environmental conditions, physiological stage (time of harvest, plant parts of the plant used to extract the essential oil, soil composition, etc.).

It has been found that the medicinal plants can accumulate larger amounts of heavy metals such as Cd, As, Pb and Hg compared to other plants [27].

Some medical plants such as mint, St. John's wort, lavender, marigold, marshmallow, cumin, garlic, garden sorrel, hemp and others can accumulate large amounts of toxic heavy metals in their tissues. However, Zheljazkov [28] demonstrated that aromatic crops may not have significant phytoremediation potential, but growth of these crops in metal contaminated agricultural soils is a feasible alternative. Aromatic crops can provide economic return and metal-free final product, the essential oil. The essential oil of aromatic plants does not contain heavy metals, although there is an accumulation in the plant biomass [28-29].

The plants of the Lamiaceae family are also widespread in world and have a large biomass production capacity. However, there are no studies on the possibilities of heavy metals accumulation in *Melissa officinalis* L. when grown on contaminated soils. There are no comprehensive studies on the relationship among the total content of heavy metals in the soil, their uptake by the leaves of balm mint and quality of oil.

The purpose of this work is to conduct a comparative study, which allows us to determine the heavy metal accumulation in balm mint, the quality of balm mint oil, as well as the possibilities to grown on heavy metal contaminated soils.

## 2. MATERIAL AND METHODS

The experiment was performed on agricultural fields contaminated by Zn, Pb and Cd, situated at different distances (0.5, and 15.0 km) from the source of pollution, the NFMW near Plovdiv (Non-Ferrous Metal Works), Bulgaria.

Characteristics of soils are shown in Table I. The soils were slightly neutral to alkalic with moderate content of organic matter and essential nutrients (N, P and K) (Table I). The pseudo-total content of Zn, Pb and Cd is high and exceeds the maximum permissible concentrations (MPC) in soil 1 (S1) (Table 1).

**Table 1.** Characterization of the soils

Parameter	pH	EC, dS/m	Organic C. %	N Kjeldal, %	P, mg/kg	K, mg/kg	Pb, mg/kg	Zn, mg/kg	Cd, mg/kg
Soil 1 (S1) 0,5 km	7,4	0,15	2,2	0,34	625,6	6960	2509,1	2423,9	64,3
Soil 2 (S2) 15 km	7,5	0,15	1,54	0,12	387,3	6780	49,4	172,7	1,0

MPC (pH 6.0-7.4) – Pb-100 mg/kg, Cd-2.0 mg/kg, Zn-320 mg/kg

MPC (pH >7.4) – Pb-100 mg/kg, Cd-3.0 mg/kg, Zn-400 mg/kg

The test plant was *Melissa officinalis L.* Balm mint is grown according to conventional technology. Five plants of each of the areas were used for the analysis. Upon reaching the stage just prior to blooming, balm mint was harvested and the content of Pb, Zn and Cd in leaves was determined. The essential oil of the balm mint was obtained by steam distillation in laboratory conditions which was analyzed for heavy metals content and its chemical composition was determined.

Pseudo-total content of metals in soils was determined in accordance with ISO 11466 [30]. The available (mobile) heavy metals contents were extracted in accordance with ISO 14870[31] by a solution of DTPA. The contents of heavy metals (Pb, Zn and Cd) in the plant material (leaves) and in the essential oils of sage were determined by the method of the dry mineralization. The quantitative measures were carried out by ICP method (Jobin Yvon Emission - JY 38 S, France). Digestion and analytical efficiency of ICP was validated using a standard reference material of apple leaves (SRM 1515, National Institute of Standards and Technology, NIST). The chemical composition of the oil was determined on a gas chromatograph PYE UNICAM series 204, equipped with a flame ionization detector and a capillary column CARBOWAX 20 M with hydrogen carrier gas.

### 3. RESULTS AND DISCUSSION

#### Soils

The results presented in Tables I and II show that in the soil samples S1 (taken from the area situated at the distance of 0.5 km from NFMW), the reported values for Pb were exceeding MPC approved for Bulgaria and reached to 2509.1 mg/kg. In the area located at a distance of 15 km, the contents of Pb significantly reduce to 49.4 mg/kg. Similar results were obtained for Cd and Zn. The results for the mobile forms of the metals extracted by DTPA show that the mobile forms of Cd in the contaminated soils are the most significant portion of its total content and reached to 57,2%, followed by Pb with 33,8 % and Zn with 9,8%.

In the soil located at a distance of 15 km from NFMW the mobile forms of Cd are the most significant part of it.

**Table 2.** DTPA-extractable Pb, Zn and Cd (mg/kg) in soils sampled from NFMW

Soils	Pb		Cd		Zn	
	mg/kg	%*	mg/kg	%	mg/kg	%
S1 (0.5 km)	849.1	33.8	36.8	57.2	236.8	9.8
S2 (15.0 km)	21.5	43.5	0.7	70	38.9	22.5

\*DTPA -extractable / total content

### Content of Heavy Metals in balm mint

A significant accumulation of Pb is found in the leaves of the balm mint. The content of this element reaches up to 143.5 mg/kg in leaves of the balm mint grown at a distance of 0.5 km from NFMW (S1) (Table 3) and was very high beyond the proposed guide value for medicinal plants. Kabata Pendias [27] quote that normally there are 5 - 10 mg/kg Pb in a plant material. Schilcher and Peters [32] proposed to set the limits for Pb in medicinal plants at 10 mg/kg, due to their little portion in the human diet and incomplete extraction of Pb during tea preparation. The World Health Organization (WHO) recommends limits for various medicinal plants of not more than 10 mg/kg Pb and 0.3 mg/kg Cd in the final dosage form of the plant material. The relatively high amount of Pb may be caused by the morphological characteristics of the plant. The leaves of balm mint were covered with pappus, which contributed to the fixing of the aerosol pollutants and for their accumulation there. The content of Cd in the leaves of balm mint grown at a distance of 0.5 km from NFMW reaches up to 2.25 mg/kg, values considered to be nontoxic to plants. According to Kabata-Pendias [27] 5.0 mg/kg Cd is considered to be a toxic value for the plants. The content of Zn in the leaves of balm mint grown at a distance of 0.5 km from NFMW reaches up to 184.7 mg/kg, as these values are also less the critical values for plants - 100-400 mg/kg. With increasing the distance from NFMW a clear trend is seen towards reducing the content of heavy metals in the leaves of the studied crop. The content of heavy metals in the leaves of the balm mint grown at 15 km from NFMW reaches up to 1.6 mg/kg Pb, 0.08 mg/kg Cd and 17.7 mg/kg Zn (S2).

The heavy metal content in the essential oil from balm mint was also determined. The results obtained show that the majority of the heavy metals contained in the leaves of the balm mint do not pass into the oil during the distillation, therefore their content in the oil are much lower. In the process of oil extraction by distillation, heavy metals remain in the extracted plant residues, limiting the quantities of heavy metals in the commercial oil product. Pb content in the essential oil of balm mint reaches up to 0.2 mg/kg, Zn up to 4.5 mg/kg, while the content of Cd is below the limits of the quantitative measurement of the method used. Significantly lower are the figures in the essential oil of balm mint grown at a distance of 15 km from NFMW – 0.03 mg/kg Pb and 1.6 mg/kg Zn (S2).

These results strongly suggest that the main part of Pb, Cd and Zn, contained in the leaves of balm mint, cultivated 0.5 km from the NFMW, does not pass into the oil obtained, its content in the oil are lower according the Directive 76/768/EEC for plant extracts (20 mg/kg Pb and 2 mg/kg Cd) and it can be used for cosmetics. This result is very important, given the commercial value of the essential oil extracts of the aromatic and medicinal plants. The accumulation of heavy metals in the end products, obtained after the processing of the aboveground parts of the plant, was within the limits of the permissible values to the normative requirements for ecologically clean product.

**Table 3.** Content of Pb, Cd and Zn (mg/kg) in leaves and essential oil of balm mint

Soils	Pb		Cd		Zn	
	Leaves	Oil	Leaves	oil	Leaves	oil
S1 (0.5 km)	143.5	0,2	2.25	n.d.	184.7	4.5
S2 (15.0 km)	1.6	0.03	0.08	n.d.	17.7	1.6

n.d.-non detectable



*Effect of heavy metals on the quality of the oil*

The results of the chromatographic analysis of essential oils obtained by processing of leaves balm mint grown at a different distance from NFMW are presented in Table 4. The values of the main components of the essential oil of balm mint are compared with the data obtained from all cited references.

No significant differences were observed in the composition between the oils obtained from the areas of different distance from NFMW. The yield for balm mint oils ranged between 0.245% (S1) and 0.25% (S2). Ozturk [33] found that the content of essential oil in lemon balm varies between 0.02 and 0.30%, which is much lower than other plants in the family Lamiaceae. According to Turhan [34] the content of essential oil and its composition depend on the cutting height of the lemon balm. It was found that the content of essential oil in the upper part (young leaves) is 0.39%, while in the whole leaf mass it is 0.14%. For this reason, the production costs and the price of the essential oil are very high on the market. Souihi [35] found that the essential oil content in Tunisia is very low (0.032%), the content in the oil from Turkey varies from 0.01 to 0.25%. [36], 0.03 - 0.067% [37] to 0.27-0.36%, [38], from 0.06-0.16% in Iran oil [39], from 0.08 to 0.25% in the oil from Poland [16], 0.25% in the oil from Germany [40], and from 0.5 to 0.8% [40] in the oil from Spain.

Forty compounds representing 98.82 – 98.83% of the oil were identified, 21 of which were above 1 %. The obtained results show that oxygen-containing monoterpenes (neral and geranial) and sesquiterpenes hydrocarbon ( $\beta$ -caryophyllene) predominate in the essential oils.

It is noteworthy that the content of oxygen-containing monoterpenes neral and geranial, and the sesquiterpene alcohol  $\alpha$ -cadinol is higher in the balm mint oil obtained from the contaminated area, while the content of  $\beta$ -caryophyllene is lower. No significant difference was found for the other components.

The monoterpene aldehyde citronellal determines the sweet floral aroma of rose. The content of citronellal in the studied oils varies from 2.94% (S1) to 3.03% (S2), whereas significantly higher values were found by Popova [41] for the Bulgarian commercial oil (18.5%). According to literature data, the content of citronellal varies widely - from 0.2% in the oil from Cuba [42] to 40% in the oil from France (40%) [43]. Some essential oils, such as those of Brazilian origin, do not contain citronellal [17]. Shamsi [44] found that the amount the amount of citronellal is lower in the leaves of the upper third part (2.82%) compared to the total leaf mass (6.44%).

The monoterpene aldehyde (*Z*)-citral (neral) causes the sweet citrus aroma of lemon. The content of beta-citral (neral) in the studied oils varies from 19.31% (S2) to 20.78% (S1). According to literature data, the content of neral varies widely in lemon balm oil - from 4.3 to 43.8%. The highest content of neral was established in the oils from Cuba (29.9%) [42], Brazil (39.3%) [17] and Iran (43.8%) [39]. The content of neral is significantly lower in the oil from Scotland (4.3%) [45], and Bulgaria (5.9%) [41], while neral is not found in the oil from Greece. The monoterpene aldehyde (*E*)-citral (geranial) determines the citrus aroma of lemon. The content of alpha-citral in the oils varies from 18.65% (S2) to 19.12% (S1). According to literature data, the content of geranial varies widely - from 6.6 to 47.3%. The highest values were found in the oils from Cuba (41.0%) [42] and Brazil (47.3%) [17], while in the oils from Greece and Scotland [45] no geranial is contained. According to Hefendelth [46], the young leaves have higher citral content, while the older leaves have higher citronellal content. Similar results were reported by Mrlanova [47], who found that the amount of citral isomers (neral

and geranial) was higher in the leaves of the upper third part of the lemon balm (59.74%) than in the leaves of the whole aboveground mass (56.87%).

Sesquiterpene, bicyclic  $\beta$ -caryophyllene causes spicy woody citrus aroma. The content of  $\beta$ -Caryophyllene in the studied oils varies from 16.280 (S2) and 14.762% (S1). Similar results were obtained by Allahverdiyev [5] for Turkish oils, which are characterized by a high content of  $\beta$ -caryophyllene (14.2%). Slightly lower results were obtained for the content of  $\beta$ -caryophyllene in the oils from Slovakia (4.2 %) [48], Serbia (4.6%) [49], Iran (4.9%) [39], and Egypt (4.9%,) [50]. Significantly lower values were reported for the oil from Algeria (1.3%) and France (2.4%) [43]. Mrlianova [47] b) found that the amount of beta-caryophyllene was higher in the leaves of the upper third of the lemon balm (6.97%) than in the total leaf mass (5.13%),

The content of geraniol varies from 1.358 (S2) to 1.317% (S1). According to literature data, the geraniol content varies from 0.2% to 15.2%, with higher values found in oils from Serbia (3.4%) [49], Egypt (4.2%) [50], Scotland (5.73%) [45], Bulgarian commercial oil (15.72%) [41], and significantly lower in oil from Algeria (0.6%)[43].

**Table 4.** Composition of oil (%) obtained by processing fresh leaves of balm mint

№	Compound	RI	S1 (0.5 km)	S2(15.0 km)	Reference
			% of TIC		
1	$\alpha$ -Pinene	939	0,367	0,356	
2	$\beta$ -Pinene	979	0,934	0,906	
3	1-Octen-3-ol	982	0,119	0,075	
4	beta-Myrcene	990	0,25	0,243	
5	Limonene	1029	1,879	1,822	trace - 57.5
6	cis-beta-Ocimene	1040	1,176	1,141	
7	trans-beta-Ocimene	1050	0,577	0,56	
8	beta-Linalool	1097	0,988	0,958	trace - 1.3
9	cis- Rose oxide	1110	0,339	0,329	
10	trans-Rose oxide	1128	0,466	0,452	
11	Verbenol	1134	0,339	0,329	
12	Citronellal	1151	3,03	2,939	0.2 – 43.8
13	trans-Carveol	1195	0,149	0,144	
14	Myrtenol	1198	1,359	1,318	
15	Menthol	1173	0,936	0,908	
16	Isomenthol	1180	0,384	0,373	
17	$\alpha$ -Terpineol	1187	0,164	0,159	
18	Nerol	1228	2,709	2,628	
19	Geraniol	1230	1,358	1,317	0.2-15.2
20	beta-Citral (Neral)	1240	19,308	20,783	4.3-39.3
21	trans-Geraniol	1255	3,505	3,4	
22	(S)-(-)-Citronellic acid, methyl ester	1261	1,253	1,215	
23	alfa-Citral (Geranial)	1270	18,649	19,116	6.6 - 47.3
24	Citronellyl acetate	1354	0,426	0,413	0.6 - 7.24
25	Neryl acetate	1364	2,493	2,418	
26	Geranyl acetate	1383	3,593	3,485	
27	$\beta$ -Caryophyllene	1419,1	16,28	14,762	1.3 - 15.3

28	(E)- $\beta$ -Farnesene	1460	0,604	0,586	
29	Germacrene D	1480	3,277	3,179	trace - 2.14
30	Caryophyllene Oxide	1581	1,166	1,131	1.2 - 12.6
31	n-Pentacosane	1500	1,192	1,156	
32	n-Hexacosane	1600	1,041	1,009	
33	tau.-Cadinol	1629	1,166	1,131	
34	tau.-Muurolol	1631	1,366	1,325	
35	$\alpha$ -Cadinol	1653	3,884	4,737	
36	n-Heptacosane	1700	0,83	0,806	
37	n-Octacosane	1800	0,115	0,088	
38	n-Nonacosane	1900	0,237	0,229	
39	n-Eicosane	2000	0,565	0,548	
40	n-Heneicosane	2100	0,353	0,342	
	Total		98,826	98,816	
	Yoeld, %		0.24	0.25	

RI - Relative Index; TIC - Total Ion Current

The content of monoterpene geranyl acetate varies from 3.49 (S1) to 3.59% (S2). Slightly higher values of geranyl acetate were found in the oil from Slovakia (5.9%) [48], Iran (7.1%) [39] and Bulgarian commercial oil (7.24%) [41].

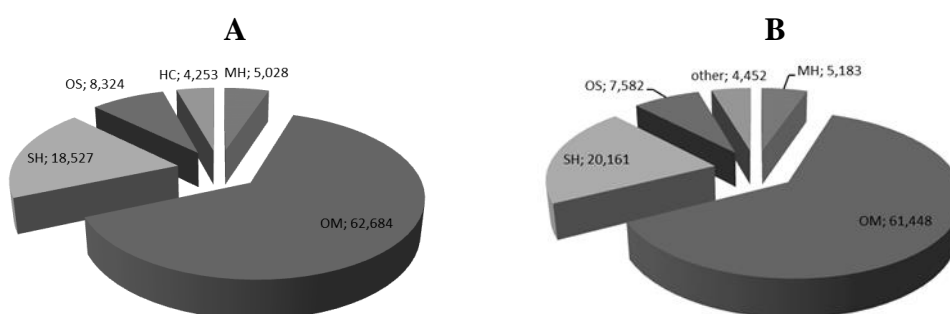
Sesquiterpene oxide  $\beta$ -caryophyllene oxide causes the woody spicy aroma. The content of caryophyllene oxide varies from 1.166 (S2) to 1.131 (S1). Similar results were obtained for the oils from Algeria (1.3%) and Serbia (1.7%) [49]. Significantly higher results were obtained for the oils from Iran (2.7%) [39], Cuba (5.3%) [42], Slovakia (8.35%) [48], Egypt (10.0%,) [50]. The highest values were reported in the oil from Jordan, in which caryophyllene oxide is the dominant ingredient (43.6%) [51].

Most studies have shown that oxygen monoterpenes, such as the isomers of citral (geranial and neral), citronellal and geraniol, predominate in the oil from *M. officinalis* [49,52]. For example, lemon balm oils from Serbia [49], Slovakia [48], Egypt [50], France [43] and Iran [39] are characterized by a high content of geranial, neral and citronellal. Citral, citronellal and caryophyllene oxide [44] dominate in the oils obtained in Algeria. Meftahizade [52], report that the main constituents of the essential oil are citral (geranium and neral), citronellal, geraniol, beta-pinene, alpha-pinene, and beta-caryophyllene. According to Bagdad and Coşge [36] the main components of the oil obtained in Turkey are citronellal (39%), citral (33%), citronellol, linalool and geraniol, while according to Allahverdiyev [5] the oil is dominated mainly by sesquiterpene hydrocarbons  $\beta$ -cubebene (15.41%) and  $\beta$ -caryophyllene (14.24%). The sesquiterpene hydrocarbons  $\beta$ -cubeben (39%) and terpinolene (9.6%) also predominate in the oil obtained in New Zealand [3]. Van den Berg [53] reported that the main components in the oil were germacrene D (34.79–51.50%), sabinene (0.91–14.68%),  $\beta$ -caryophyllene (7.27–12.66%) and  $\beta$ -pinene (0.53– 8.03%), whereas limonene is a major component in the oil obtained in Scotland (57.5%) [45].

The results of this study show that balm mint oil belongs to the citral/ $\beta$ -caryophyllene chemotype - neral (19,308-20,783%)> and geranial (18,649-19,116%)>  $\beta$ -caryophyllene (14,762-16.28%). Oils from Tajikistan [54], Turkey [24], Romania [19], Serbia [18], Poland [16], and Brazil [17], belong to geranial/neral chemotype, oils from Iran - to geranol/caryophyllene oxide chemotype [25], while from Egypt [55], Turkey [23], and Italy

[20] – to citronellal chemotype, oils from Iran - to  $\alpha$ -pinene and caryophyllene oxide chemotype [56], oils from Greece - to caryophyllene-oxide/ $\beta$ -caryophyllene/ $\beta$ -pinene chemotype [21]. The studied oils are a new chemotype of balm mint oil. So far, in the scientific literature there is no information about such a type of citral/ $\beta$ -caryophyllene chemotype of oils. The results from the present study confirm that balm mint have a unique chemical composition and individual oil chemotype.

**Figure 1.** Classification of the identified compounds based on functional groups in oils from contaminated soils (A) and non-contaminated soils (B) (OM - oxygen-containing monoterpenes; MH - monoterpene hydrocarbons; SH - sesquiterpene hydrocarbons; OS – oxygen-containing sesquiterpenes)



The chromatographic profile shows a complex mixture of components contained in balm mint oil. Figure 1 shows the classification of the identified compounds on the basis of functional groups. The highest is the content of oxygen-containing monoterpenes (61.448-62.684%), followed by sesquiterpene hydrocarbons (18.527-20.161%), oxygen-containing sesquiterpenes (7,582-8.324%), monoterpene hydrocarbons (5.028-5.183 %), and others (4.253- 4.452%). There are no significant differences in the profile of essential oils extracted from balm mint when grown on contaminated and uncontaminated soils. Probably the contamination of the soil with heavy metals does not affect the composition and quality of the oil.

This study shows that balm mint can be grown on heavy metal contaminated soils. The oil yield, essential oil content and essential oil compositions are similar to the oil from the uncontaminated area and to the oils currently available on the market from other countries. Therefore, essential oils extracted from balm mint grown in contaminated areas could be marketed in the same way as essential oils produced in other regions of the world.

## CONCLUSION

Based on the obtained results, the following conclusions can be made:

1. *Melissa officinalis L.* is a plant which is tolerant to heavy metals and can be grown on contaminated soils.
2. In the leaves from *Melissa Officinalis L.*, cultivated in the region of the NFMW, the contents of Pb, Zn and Cd exceeded the Maximum permissible concentration, and could be a potential danger for men, when used as herbal tea.
3. The amounts of Pb, Zn and Cd in the oil of balm mint grown on contaminated soil (Pb -2509.1 mg/kg, Zn -2423.9 mg.kg, Cd - 64.3 mg/kg) are lower than the accepted maximum values and meet the requirements of an environmentally friendly product.
4. The contamination of the soils with heavy metals does not affect the composition and quality of the oil. The content of the oxygen-containing monoterpenes neral and geranial,

and the sesquiterpene alcohol  $\alpha$ -cadinol is higher in the balm mint oil obtained from the contaminated area, the content of  $\beta$ -caryophyllene is lower, and no significant difference was found for the other components.

5. The highest is the content of oxygen-containing monoterpenes (61.448-62.684%), followed by sesquiterpene hydrocarbons (18.527-20.161%), oxygen-containing sesquiterpenes (7.582-8.324%), monoterpene hydrocarbons (5.028-5.183 %), and others (4.253- 4.452%).
6. Balm mint oil from contaminated and uncontaminated area belongs to the new type of oils- citral/ $\beta$ -caryophyllene chemotype - neral (19,308-20,783%)> geranial (18,649-19,116%)>  $\beta$ -caryophyllene (14,762-16.28%).
7. *Melissa officinalis* L. could be cultivated in industrially polluted regions, as it is mainly used for obtaining essential oil. The essential oil of balm mint can be a valuable product for the farmers from the polluted areas.

**Acknowledgements:** The financial support by the Bulgarian National Science Fund Project DFNI H04/9 is greatly appreciated.

## REFERENCES

- [1] Anonymous (2003) Microsoft Encarta Encyclopedia, 1993- 2000
- [2] De Sousa, A. C., Gattass, C. R., Alviano, D. S., Alviano, C. S., Blank, A. F., Alves, P. B. (2004) *Melissa officinalis* L. essential oil: antitumoral and antioxidant activities, *Journal of pharmacy and pharmacology*, vol. 56(5), pp.677-681.
- [3] Bernard, S.W., Dawson, Franich, R., Meder, R., (1988) Essential oil of *Melissa officinalis* L. subsp. *altissima* (Sibth. et Smith) Arcang, *Flavour and Fragrance Journal*, vol. 3(4), pp.167-170.
- [4] Beloued, A. 2009. *Plantes médicinales d'Algérie*. Alger: Office des Publications Universitaires p 134.
- [5] Allahverdiyev, A., Duran, N., Ozguven, M., Koltas, S., (2004) Antiviral activity of the volatile oils of *Melissa officinalis* Against Herpes simplex virus type-2, *Phytomedicine*, vol. 11, pp. 657-661.
- [6] Moradkhani, H., Sargsyan, E., Bibaky, H., Naseri, B., Sadat-Hosseini, M., Fayazi-Barjin, A., Meftahizade, H. (2010) *Melissa officinalis* L., a valuable medicine plant: A review, *J. Med. Plants Res.*, vol.4, pp.2753-2759.
- [7] Mencherini, T., Picerno, P., Scesa, C., Aquino, R., (2007) Triterpene, Antioxidant, and Antimicrobial Compounds from *Melissa officinalis*, *J. Nat. Prod.*, vol.70(12), pp.1889–1894.
- [8] Constantine, D.S., (2007) Extraction, separation and detection methods for phenolic acids and flavonoids, *J Sep Sci.*, vol. 30, pp.3268-3295.
- [9] Ziakova, A., Brandsteterova, E. (2003) Validation of HPLC determination of phenolic acids present in some Lamiaceae family plants, *J Liquid Chromatogr.*, vol.26, pp. 443-453.
- [10] Toth, J., Mrlianova, M., Tekelova, D., Karenova, M., (2003) Rosmarinic acid – an important phenolic active compound of Lemon balm (*Melissa officinalis* L.), *Acta Facult. Pharm. Univ. Comenianae*, vol.50, pp. 139-146.
- [11] Tagashira, M., Ohtake, Y., (1998) A New antioxidative 1, 3- benzodioxole from *Melissa officinalis*, *Planta Med*, vol. 64, pp.555-558.
- [12] Mulkenst, A., Kapetanidis, I., (1988) Eugenylglucoside, a new natural phenylpropanoid heteroside from *Melissa officinalis*, *J Nat Prod.*, vol. 51, pp.496-498.

- [13] Vitullo, M., Ripabelli, I., Fanelli, I., Tamburro, M., Delfine, S., Sammarco, L, (2011) Microbiological and toxicological quality of dried herbs, *Lett Appl Microbiol.*, vol. 52, pp. 573-580.
- [14] Adjorjan, B., Buchbauer, G., (2010) Biological properties of essential oils: an updated review, *Flav Fragr J.*, vol. 25, pp.407-426.
- [15] Spiridon, L, Colceru, S., Anghel, N., Teaca, C.A., Bodirlau, R., Armatu, A., (2011) Antioxidant capacity and total phenolic contents of oregano (*Origanum vulgare*), lavender (*Lavandula angustifolia*) and lemon balm (*Melissa officinalis*) from Romania, *Nat Prod Res.*, vol. 25, pp.1657-1661.
- [16] Patora, J., Majda, T., Gora, J., Klimek, B., (2003). Variability in the content and composition of essential oil from lemon balm (*Melissa officinalis* L.) cultivated in Poland. *J. Endocrinol. Invest.*, vol.26(10), pp. 950-955.
- [17] da Silva, S., Sato, A., Lage, C. L. S., da Silva, San Gil, R. A., de Almeida Azevedo, D., Esquibel, M. A., (2005). Essential oil composition of *Melissa officinalis* L. in vitro produced under the influence of growth regulators. *J. Braz. Chem. Soc.*, vol.16, pp. 1387-1390.
- [18] Anicic, N. V., Dimitrijevic, S., Ristic, M. S. Petrovic, S. S., Petrovic, S. D., (2005) Antimicrobial activity of essential oil of *Melissa officinalis* L. Lamiaceae, *Hem. Ind.*, vol. 59, pp. 234-247.
- [19] Hancianu, M., Aprotosoiaie, A. C., Gille, E., Poiata, A., Tuchilus, C., Spac, A., Stanescu, U., (2008) Chemical composition and in vitro antimicrobial activity of essential oil of *Melissa officinalis* L. from Romania, *Rev. Med. Chir. Soc. Med. Nat. Iasi.*, vol.112, pp. 843-847.
- [20] Martino, L. D., Feo, V. D., Nazzaro, F., (2009) Chemical composition and in vitro antimicrobial and mutagenic activities of seven Lamiaceae essential oils, *Molecules*, vol.14, pp.4213-4230.
- [21] Basta, A., Tzakou, O., Couladi, M., (2005) Composition of the leaves essential oil of *Melissa officinalis* from Greece, *Flav Fragr J.*, vol.20, pp.642-644.
- [22] Hussain, A. I., Anwar, F., Iqbal, T., Bhatti, I. A., (2011) Antioxidant attributes of four Lamiaceae essential oils, *Pak. J. Bot.*, vol. 43, pp. 1315-1321.
- [23] Cosge, B., Ipek, A., Gurbuz, B., (2009) GC/MS analysis of herbage essential oil from Lemon balms (*Melissa officinalis* L.) grown in Turkey, *J. Appl. Biol. Sci.*, vol.3, pp. 149-152.
- [24] Sari, A. O., Ceylan, A., (2002) Yield characteristics and essential oil composition of Lemon balm (*Melissa officinalis* L.) grown in the Aegean region of Turkey, *Turk. J. Agric. For.*, vol. 26, pp. 217-224.
- [25] Saeb, K., Gholamrezaee, S., (2012) Variation of essential oil composition of *Melissa officinalis* L. leaves during different stages of plant growth, *Asian Pac. J. Trop. Biomed.*, vol. 2, pp. S547-S549.
- [26] Adinee, J., Piri, K., Karami, O., (2008) Essential oil component in flower of Lemon balm (*Melissa officinalis* L.), *Am. J. Biochem. Biotechnol.*, vol. 4, pp. 277-278.
- [27] Kabata-Pendias, A., (2010) Trace Elements in Soils and Plants. 4th edition., Boca Raton, FL, USA: CRC Press/Taylor & Francis Group, pp. 548.
- [28] Zheljzakov, V., Craker, L. E., Xing, B., Nielsen, N. E., Wilcox, A., (2008) Aromatic plant production on metal contaminated soils, *Sci. Total. Environ.*, vol. 395, pp. 51-62.
- [29] Angelova, V.R., Grekov, D. F., Kisyov, V. K., Ivanov, K. I., (2015) Potential of Lavender (*Lavandula vera* L.) for Phytoremediation of Soils Contaminated with Heavy Metals, *World Academy of Science, Engineering and Technology International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering*, vol.9 (5), pp.514-521.

- [30] ISO 11466, (1995) Soil quality - Extraction of trace elements soluble in aqua regia.
- [31] ISO 14780, (2001) Anonymous, Soil quality - Extraction of trace elements by buffered DTPA solution.
- [32] Schilcher, H., Peters. H., (1990). Empfehlungen von Richtlinien und Grenzwerten für den maximalen Blei und Cadmiumgehalt von Arzneidroge und daraus hergestellter pharmazeutischer Zubereitungen, *Pharm. Ind.*, vol. 52, pp.916-921.
- [33] Ozturk, A., Unlukara, A., Ipek, A., Gurbuz, B., (2004) Effects of salt stress and water deficit on plant growth and essential oil content of Lemon Balm (*Melissa officinalis* L.). *Pak. J. Bot.*, vol.36(4), pp. 787-792.
- [34] Turhan, M., (2006) Hand book of herbal plants, chapter 4. *Melissa officinalis*, vol.3, pp. 184-245
- [35] Souihi, M., Amri, I., Souissi, A., Hosni, K., Brahim, N. B., Annabi, M., (2020) Essential oil and fatty acid composition of *Melissa officinalis* L., *Progress in Nutrition*, vol. 22 (n. 1), pp. 253-258.
- [36] Bagdad, B.R., Cosge, B., (2006) The essential oil of lemon balm (*Melissa officinalis* L.), its components and using fields, *J Fac Agri Onodokuz Mayis Univ.*, vol.21(1), pp.116–121.
- [37] Sari, A.O., Ceylan, A., (2002) Yield characteristics and essential oil composition of Lemon balm (*Melissa officinalis* L.) grown in the Aegean region of Turkey, *Turk J Agric For.*, vol. 26, pp.217-224.
- [38] Avci, A.B., Giachino, R.R.A., (2016) Harvest stage effects on some yield and quality characteristics of lemon balm (*Melissa officinalis* L.), *Industrial Crops and Products*, vol.88, pp. 23-27.
- [39] Sadraei, H., Ghannadi, A., Malekshahi, K., (2003) Relaxant effect of essential oil of *Melissa officinalis* and citral on rat ileum contractions, *Fitoterapia*, vol. 74, pp.445-452.
- [40] Bomme, U., Feicht, E., Rinder, R., (2002) Ergebnisse aus mehrja'hrigen Leistungsprüfungen mit ausgewählten Herkünften von Zitronenmelisse (*Melissa officinalis* L.) (in German), *Z Arznei- Gewurzpfla*, vol.7, pp.422–432.
- [41] Popova, A., Dalemska, Z., Mihaylova, D., Hristova, I., Alexieva, I., (2016) *Melissa officinalis* L.—GC profile and antioxidant activity, *Int. J. Pharmacogn. Phytochem. Res.* vol. 8, pp. 634–638.
- [42] Pino, J.A., Rosado. A., Fuentes. V., (1999) Composition of the essential oil of *Melissa officinalis* L. from Cuba, *J Essent Oil Res.*, vol. 11, pp.363-364.
- [43] Carnat, A.P., Carnat, A., Fraisse, D., Lamaison, J., (1998) The aromatic and polyphenolic composition of lemon balm (*Melissa officinalis* L. Su, bsp. *officinalis*) tea, *Pharma Acta Helv.*, vol. 72, pp. 301-305.
- [44] Shamsi, A.M., Amnzade, Y., Jahanshir, F., Jamshidi, A., (2005) Production of suspension cell culture in *Melissa officinalis* and comparison of produced secondary metabolites in callus versus whole plant, *J. Med. plant*, vol.13, pp. 68-71.
- [45] Damien, D.H.J., Surai, P., Deans, S.G., (2000) In vitro antioxidant activity of plant essential oils and phytoconstituents, *J Essent Oil Res.*, vol.12, pp.241-248.
- [46] Hefendehl, F.W., (1970) Composition of etheric oil of *Melissa officinalis* L. and secondary changes of oil composition, *Archiv Pharm.*, vol.303, pp.345–357
- [47] Mrlanova, M., Tekelova, D., Felklova, M., Toth, J., Musil, P., Grancai, D., (2001) Comparison of the quality of *Melissa officinalis* L. cultivar Citra with *Melissas* of European origin, *Pharmacopsychiatry Jul.*, vol.34 , Suppl 1, S20-21.
- [48] Holla, M., Svajdlenka, E., Tekel, J., Vaverkova, S., Havranek, E., (1997) Composition of the essential oil from *Melissa officinalis* L. cultivated in Slovak Republic, *J Essent Oil Res.*, vol.9, pp.481-484.

- [49] Dukic, N.M., Bozin, B., Sokovic, M., Simin, N., (2004) Antimicrobial and antioxidant activities of (Lamiaceae) essential oil, J Agric Food Chem., vol.52, pp. 2485-2489.
- [50] Shalaby El-Gengaihi, A.S., Khattab, M J., (1995) Oil of *Melissa officinalis* L. as affected by storage and herb drying, J Essent Oil Res., vol.7, pp.667-669.
- [51] Barakat, S.A., Hudaib, M., El-Asad, N., Burns, D.T., (2016) Composition of volatile oil and methanolic extracts of Jordanian *Melissa officinalis* L. and actions against human cancer cell lines, Orient. J. Chem., vol.32, pp.2355–2362.
- [52] Meftahizade, H., Sargsyan, E., Moradkhani, H., (2010) Investigation of antioxidant capacity of *Melissa officinalis* L. essential oils, J. Med. Plant Res., vol. 4(14), pp. 1391-1395.
- [53] Van den Berg, T., Freundl, E., Czygan, F.C., (1997) *Melissa officinalis* subsp. *altissima*: characteristics of possible adulteration of lemon balm, Pharm., vol.52, pp. 803–808.
- [54] Sharopov, F.S., Wink, M., Khalifaev, D. R., Zhang, H., Dosoky, N. S., Setzer, W.N., (2013) Composition and Bioactivity of the Essential Oil of *Melissa officinalis* L. Growing Wild in Tajikistan, International Journal of Traditional and Natural Medicines, vol. 2(2), pp. 86-96.
- [55] Aziz, E. E., El-Ashry, S. M., (2009) Efficiency of show release urea fertilizer on herb yield and essential oil production of Lemon balm (*Melissa officinalis* L.) plants, Am.-Eurasian J. Agric. Environ. Sci., vol.5, pp. 141-147.
- [56] Norouzi, M., Soleimani, T., Pasha Zanousi, M., (2012) Essential oil component in leaf and flower of Lemon balm (*Melissa officinalis* L.), Res. Pharmaceut. Sci., vol.7, p.749



