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- Management, Economics, Leadership and Entrepreneurship;
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TIEM'22 Program

December 2nd - OPENING SESSION – 10:00h.	
	Prof. MIGLENA TEMELKOVA, PhD Rector of University of Telecommunications and Post, Sofia, Bulgaria <i>Opening speech</i>
KEYNOTE SPEECH 1	
	Prof. ACE MILENKOVSKI, PhD Rector of University of Tourism and Management in Skopje The need for a new paradigm in education in the age of technological disruption
KEYNOTE SPEECH 2	
	ARMAND LEBLOIS CISCO Systems - Manager for East Europa - Education programs
KEYNOTE SPEECH 3	
	TAL PAVEL, PhD Founder & Director, The Institute for Cyber Policy The Energy Sector under Cyber Attacks

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SLOBODAN IVANOVIĆ Faculty of Tourism and Hospitality Management Opatija, University of Rijeka ZAGORKA IVANKOVIĆ Hotel - Tourism School, Opatija ANGELA MILENKOVSKA KLIMOSKA University of Tourism & Management, University in Skopje	<i>Aspects of seasonality in the hotel business</i>
ANTOANETA PETROVA IVANOVA-BARES ANI DIMITROVA DIMITROVA National Company Industrial Zones	<i>Increasing the innovation potential of enterprises through the introduction of high-tech digital solutions.</i>
PETYA GEORGIEVA University of Telecommunications and Post, Sofia, Bulgaria	<i>Some Aspects in Expert Foresight in the Business Model Innovation Activities</i>
PLAMEN PAVLOV University of Telecommunications and Post, Sofia, Bulgaria	<i>Application of Business Process Analysis in the Digitalization of Public Administration</i>
KATERINA BLAZHEVSKA MIT University – Skopje, North Macedonia ORCE SIMOV International Slavic University in North Macedonia	<i>Promoting the concept of critical thinking as a major challenge of the global higher education</i>
KIRIL ILIEV University of Telecommunications and Post, Sofia, Bulgaria	<i>The Covid-19 Crisis as a Force Majeure Circumstance in Case of non-Performance of Trade Contracts</i>
DIMITAR KOLEV University of Telecommunications and Post, Sofia, Bulgaria IVAN PETKOV University of Transport “Todor Kableshev” Sofia, Bulgaria	<i>Courier Services in the Conditions of a Pandemic (case study of "Speedy" JSC)</i>
VICTOR GLADCHENKO University of Telecommunications and Post, Sofia, Bulgaria	<i>Viral Business Process Modelling</i>

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VICTOR GLADCHENKO University of Telecommunications and Post, Sofia, Bulgaria	<i>Analysis of ERP Integration Failure Factors</i>
RADI DIMITROV University of Telecommunications and Post, Sofia, Bulgaria	<i>Technological Model for Factor Analysis of Production Costs from the Cyber-Physical Systems</i>
BORIS STANIMIROV University of Telecommunications and Post, Sofia, Bulgaria	<i>Postal Services and Communications in Gabrovo till the Beginning of the 20th Century with Biographical Notes on Some Significant Contributors</i>
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Section 1.

MANAGEMENT, ECONOMIC, LEADERSHIP AND ENTREPRENEURSHIP

Aspects of Seasonality in the Hotel Business

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Abstract—In the aspects of seasonality in the hotel business, the importance of improvement is highlighted tourist offers at the destination level, increasing tourist satisfaction, increasing tourist consumption, the competitiveness of the Croatian tourist product, more substantial inclusion in tourist flows and, ultimately, the extension of the tourist season of a particular tourist destination in the hotel industry of Europe and Croatia. The set goals of the work refer to the concept and characteristics of seasonality in the hotel industry, the dimension of seasonality in the hotel business, and the effects of seasonal movements on the hotel business: costs and profits. The strategy of managing seasonality in the hotel business and the trends of seasonality in the hotel industry in Europe. Achieving the set goals will enable the provision of guidelines for applying new and/or innovative strategies to reduce seasonality to satisfy existing and attract new market segments successfully.

Keywords—hotel industry, seasonality, seasonality reduction strategy

I. INTRODUCTION

Hotels are the basic receptive facilities that enable tourists to stay in the destination, but they are also the most recognizable element of the accommodation sector. The hotel industry has a clear vision for the growth of the travel and tourism sector. Its activities have a positive effect on tourist trends and tourism development in general. In many countries, the hotel industry participates with a significant share in the total employment of the population and is an essential factor in economic, social, cultural and other development. Many factors affect the hotel industry. One of these factors is seasonality.

Hotel companies face seasonality as one of the most apparent characteristics of tourist activities. Annual business cycles with interrupted seasons have a significant impact on the revenues of hotel companies. Understanding the phenomenon of seasonality and its aspects is necessary so hoteliers do not remain passive but define a long-term strategy for mitigating the consequences of seasonality in their business with the necessary knowledge. Seasonality points to several issues that require special attention and the application of appropriate strategies. In particular, seasonality affects tourist movements in the destination and can threaten the sustainability of the destination's business. For example, seasonality can cause significant pressure on the business of a hotel company in destinations with seasonal business, related to available and professional staff,

significantly more than in destinations with year-round business. In addition, hotel companies with seasonal operations find it difficult to obtain the necessary financial resources on the capital market for current and investment operations; there is a low return on investment and a low level of resource utilization in the hotel industry.

When discussing seasonality and tourism, there is no doubt about their connection. Namely, tourism originated as a seasonal phenomenon and remains a phenomenon characterized by seasonality with a greater or lesser concentration of tourist movements in a greater or lesser period. **The question that arises, however, is: how to influence the reduction of seasonality?** Seasonal business characterizes every destination to a lesser or greater extent. To increase the satisfaction of tourists staying in the destination, increase tourist consumption, increase competitiveness at the destination level, and extend the tourist season and the importance that hotel companies have in the development of the tourist destination, the need to intensify small entrepreneurship in the hotel industry at the destination level is emphasized.

II. THE TERM AND CHARACTERISTICS OF SEASONALITY IN THE HOTEL BUSINESS

The concept of seasonality includes "cyclical variations in the movement of some phenomenon, that is repetition of an identical or similar pattern every calendar year at approximately the same time". These cycles occur under the influence of various changes, which may be conditioned by the climate, economic activity, institutional factors, people's behaviour and social phenomena. It is common to change meteorological conditions following the seasons, which are determined by air temperature, precipitation, winds and other natural phenomena. Economic activities also have their cyclical movements, manifested through oscillations of production and employment during the year, which significantly determines the seasonality of many other economic variables closely related to production and employment.

The presence of institutional factors, such as religious, state and school holidays, vacations, etc., also results in cyclical phenomena, as well as people's behaviour conditioned by fashion, culture, local customs, etc., which largely determines the dynamics of society as a whole.

Seasonality is displayed through changes in production,

service or purchasing structures that inevitably occur at specific periods during the year, that is, in certain cycles. Tourist activities are an integral part of people's leisure time, resulting in the different elasticity of the dynamics of tourism development to various natural, social, economic and institutional factors. Despite this fact and the consensus of the professional and scientific public about seasonality more as a problem (rather than a positive aspect of tourism) that affects all stakeholders in tourism, there is no generally accepted definition of seasonality in the literature. Different definitions of the concept of seasonality stem from different aspects of looking at this phenomenon. However, the authors agree that seasonality is an unavoidable tourism component because "tourist flows are determined by transience" and is traditionally the most significant problem "which has negative implications, and accordingly requires special attention".

From the aspect of fluctuating tourist demand, seasonality in tourism is seen as a "temporal imbalance in the phenomenon of tourism, (which) can be expressed in the dimensions of individual elements, such as the number of visitors, their consumption, traffic on highways and other forms of transport, employment and the number of tickets sold on tourist attractions", i.e. "concentration of tourist traffic during a relatively short period within the year". In this context, tourist destinations are busier in one part of the year than in another. Although destinations usually have one primary tourist season and one season with very low or almost no visitor levels, research has shown several different forms of seasonality.

Kastenholz and Almeida identify three seasons, i.e. three categories of the seasonality of tourist demand: high, medium and low. However, based on variations in seasonal fluctuations, Butler and Mao indicate at least five categories of the seasonality of tourist visits. It is generally known that tourism in urban destinations shows less seasonal fluctuations in tourist demand compared to rural and more remote areas. Despite the peak activity during the year, tourist destinations that support large urban centres show more continuous activity throughout the year because they offer services to different segments of tourist demand.

In addition to the time component of seasonality, the literature also points to the spatial aspect seasonality. Tourists with school-age children, for example, have to adapt to their children's school obligations and use their holidays in the peak season. Urban tourists, on the other hand, differ from tourists in holiday destinations. Urban tourists support the continuity of tourism operations with their activities compared to other types of locations. However, it can also be noted that different urban areas within the same country can show a significant time difference, manifesting in different problems for the local and regional economies. In some areas where mass tourism has developed based on time-defined vacation markets, such as Mediterranean coastal resorts, "temporal polarization has the effect of reinforcing spatial polarization."

Spatial and temporal dimensions can be observed in peripheral areas, for example, in the North Atlantic, where they encounter temporal polarization within that region due to spatial distances, limited year-round access and different

climate patterns. Including the above, seasonality in tourism is defined as an "innate" characteristic of tourism that consists of temporal and spatial variations in demand during the year that can be observed in many destinations worldwide.

Most definitions and general concepts of seasonality describe this phenomenon only in general terms or are related to its causes. However, definitions that state how tourist seasons can differ and how seasonality can be compared between different regions or years are lacking. The annual repetition and limited duration of swings (e.g. tourist rush) clearly distinguish seasonal variations from other changes in time series, such as trends and cyclical and random movements. An example of a quantitative definition of the appearance of tourist seasons is given by Lim and McAleer, who investigated seasonality from the aspect of statistical analysis and described tourism seasonality as "months for which the corresponding average indices exceed 1.0, which means that seasonal factors increase the number of tourists above the trend and the cyclical component".

Koenig-Lewis and Bischoff point to various measures of seasonality in the academic literature but without a widely accepted method.

Each season is associated with different expectations of guests. In destinations where the main reason for guests' stay is available only during a limited time of the year, hotels usually operate only during a particular season, the so-called seasonal hotels. They include hotels near ski resorts, beaches, theme parks, etc. Due to seasonality, hotels are forced to generate income in a few weeks or months, compensating them for the time when attendance is absent or when the hotel's occupancy level is shallow. Understanding the seasonal trends in the destination where they operate allows them to adopt business policies and strategies to overcome the problems arising from this phenomenon.

III. DIMENSIONS OF SEASONALITY IN THE HOTEL BUSINESS

Fluctuations in the level of tourist activity during the year affect the hotel business, the development of the hotel business as an activity, the stability of the business and the growth of economic profit. Starting from the fact that seasonality is one of the biggest challenges of most hotels, especially those located in destinations with a high level of fluctuating tourist demand, such as Mediterranean destinations, it seems necessary to point out the dimensions of seasonality in the hotel business. Some of the dimensions of seasonality are stable over a more extended period, for example, Christmas and New Year's time; some are variable. In discrete intervals, such as annual holidays, some are variable but predictable, such as Easter, while some are unpredictable, such as weather opportunities and climate in the destination. In the literature, one comes across attempts to recognize and classify different causes of seasonality in tourism, including causes that affect the hotel business in the context of the phenomenon of seasonality. Butler defines five main reasons for seasonality:

- regular temporal variations in natural phenomena, especially those associated with climate and seasons;

- factors of human decisions - institutionalized seasonality;
- social pressure and fashion;
- sports seasons;
- inertia and tradition.

IV. DIMENSIONS OF SEASONALITY IN THE HOTEL BUSINESS

Research points to the dependence of seasonality on the tourist destination and the location of the tourist company within the tourist destination, which partly reflects the diversity of physical conditions and the nature of the attractions. Thus, for example, tourist destinations with a high level of specialization will also have the highest seasonality. While tourist destinations, as already pointed out, which support urban centres, will have a significantly lower level of seasonality due to the diversification of demand. Aiming at hotel specialization, for example, holiday hotels or business hotels, cannot affect a more favourable degree of seasonality. Seasonality, however, is also greatly influenced by fluctuations in tourist demand, which can be seen in large city centres, such as London, which reach their peak of visits during the summer.

In contrast, they reach their minimum in the winter period due to a large number of international visitors during the summer. Such trends are also reflected in the hotel business. Seasonality will significantly impact the hotel business in specialized destinations compared to destinations that diversify their offer —the greater the degree of seasonality, the greater the hotel's business efficiency.

However, seasonality does not necessarily have to be harmful to the tourist destination and the holders of the tourist offer. While on the one hand, represents a social and personal cost due to a lower standard of quality and service in the "peak" season. On the other hand, seasonality can have advantages if ecological and socio-cultural perspectives are taken into account because months of low attendance levels may be the period used for recovery. Surveys of small family hotel businesses point to the benefits of running a business on a seasonal basis. In the season of low occupancy, the owners mostly close their hotel facilities and devote themselves to other interests, family and personal. Economic effects are most often represented in discussions about seasonality, and many authors consider seasonal fluctuations to be a key factor affecting business sustainability. Economic effects include: "inefficiency in the use of resources, volatility of income, volatility of the level of employment, difficulties in attracting investments, etc."

In the hotel industry, it implies the differentiation of occupancy of accommodation capacities, with negative consequences in both periods, both during peak periods and periods of minimal attendance, which implies the coexistence of periods of high activity with periods of underutilization. This leads to variability in the income of hotel companies during the year. In addition, the hotel product cannot be stored, so the value of the unsold hotel service is zero. Getz and Nilsson point out that seasonality clearly and drastically limits the tourism business's creation, profitability and growth.

In order to justify keeping the hotel open during the low occupancy season, it would have to cover at least the variable costs associated with the business (for example, heating, salaries and insurance). The exception is family hotels, where the family provides all the necessary labour so payroll costs can be avoided. When a family stays in their hotel, at least part of the hotel costs can be considered family living expenses. A summary of the effects and implications of seasonality identified in the literature is shown in “Fig. I”.

TABLE I. EFFECTS AND IMPLICATIONS OF SEASONALITY

	Tourist demand side	Type of effect
Expenses		
Commons and Page, 2001.	Rising prices during the main season (pressure on goods and transport in the area and rising supply costs for the company).	Expense
Commons and Page, 2001.	Budget management/ cash flow	Expense
Commons and Page, 2001.; Goulding, Baum and Morrison, 2004; Young, 2004.	Income volatility/return on investment (O-M) leading to high risk for O-M, the investor and the region.	Expense
Goulding, Baum and Morrison, 2004.	The income generated in the high season must cover the annual fixed costs.	Expense
Espinet, J.-M. et al., 2012.	Seasonality of hotel service prices.	Expense
Krakow, 2000.	Seasonal employment costs.	Expense
Getz and Nilsson, 2004.	Possible increase in risk for family hotel businesses; business failure can mean the loss of family assets.	Expense
Getz and Nilsson, 2004.	Seasonality clearly and dramatically limits the creation, profitability and growth of the tourism business.	Expense
Vrkljan, Barišić and Vrenc, 2019.	Hotel specialization does not lead to a reduction in seasonality.	Expense
Contents		
Commons and Page, 2001; Young, 2004.	Under- or over-utilization of resources	Expense
Commons and Page, 2001.	Perishability of the product, the product cannot be stored	Expense
Commons and Page, 2001.	Pressure on the transport system and other infrastructure during the high season	Expense
Employment		
Commons and Page, 2001.	The lack of seasonal workers in the destination leads to a demand for workers from outside the local community.	Expense
Common and Page, 2001; Goulding, Baum and Morrison, 2004; Jang, 2004; Krakow, 2000.	Sporadic demand for labor affects the retention and development of employees in: • loss of skills and experience • lack of opportunities for training and career • inconsistencies in service quality and a reduced number of satisfied consumers • lack of worker engagement • unhealthy fluctuation	Expense
Tourist demand		
Duro, 2016.	Seasonality creates difficulties in recruiting and retaining labor, can disincentivize investment in human capital, and result in low-skilled and/or over-skilled labor.	Expense
Commons and Page, 2001.	Seasonal operations ensure O-M post-seasonal recovery, especially suitable for "lifestyle" companies and family businesses	Benefit

	Tourist demand side	Type of effect
Kozić, Krešić and Boranić-Živoder, 2013.	Seasonal work enables the employment of students, housewives, and other workers who are suitable for temporary employment in a hotel.	Benefit
Environmental protection and safety		
Twining-Ward and Twining-Ward, 1996.	The season of low demand means the reduction of pressure on the environment, the recovery of damaged natural resources, and the continuation of traditional social and cultural activities.	Benefit
Butler, 2001.	The concentration of visitors in peak seasons causes environmental pollution and increases the risk of terrorism.	Expense
Giannoni and Maupertuis, 2007.	Tourism is an unstable source of income, because it is very often sensitive to real or perceived environmental and socio-cultural conditions of the tourist destination.	Expense
	Tourist offer	
Jang, 2004.	High prices in the main tourist season motivate tourists to undertake tourist activities in the low season.	Expense
Espinet, J.-M. et al., 2012.	Low prices in a season of low demand can damage the hotel's image and result in the loss of the hotel's preferred target market.	Expense
Jang, 2004.	Concentration of visitors (it is difficult to get quality and satisfaction)	Expense
Jang, 2004.	Peak tourist visits may increase the risk of security and threats (e.g. terrorism)	Expense
Krakow, 2000.	Reduction in the availability of accommodation capacities	Expense
Commons and Page, 2001.	Pressures on the transport system and infrastructure	Expense

Fig. I. Compiled by the author according to: Lee, C. et al.: Seasonality in Tourism Industry, Impact and Strategies, CRC for Sustainable Tourism, Australia, 2018, p. 5. ([https://coastaltourismacademy.co.uk/uploads/CRC_Queensland_2008_Seasonality_in_the_tourism_industry_\(2\).pdf](https://coastaltourismacademy.co.uk/uploads/CRC_Queensland_2008_Seasonality_in_the_tourism_industry_(2).pdf) (18.01.2020))

V. SEASONAL MANAGEMENT STRATEGIES IN THE HOTEL BUSINESS

The numerous problems accompanying seasonality in the hotel business indicate the complexity of the problems and challenges that hoteliers and other stakeholders in tourism face in suppressing or at least managing the seasonality of the business. Hotel industry stakeholders strive to reduce seasonality's adverse effects by applying various strategies and policies aimed at extending the tourist season and developing selective forms of tourism that will result in an additional season. A large number of strategies are used to reduce the effects of seasonality, both at the level of a tourist destination and at the level of a business entity in the hotel industry.

A. Seasonal Trends In The Europe Hotel Industry

Seasonality trends in the European hotel industry can be observed through quantitative indicators, i.e. the distribution of realized tourist arrivals, overnight stays and income by month, and through qualitative trends observed on the supply side, i.e. through the behaviour of tourists and other trends that affect the seasonality of tourism. Understanding seasonality trends enables hoteliers to apply an appropriate strategy that will respond to the challenges of seasonality and reduce its effects and implications.

Observed at the global level, Europe is the tourist region that achieves the most significant number of international tourist arrivals worldwide. In 2019, European tourist arrivals accounted for 50.8% of the total international tourist arrivals worldwide. However, this share is decreasing yearly due to an increasing number of new tourist destinations and increasing competition in the global tourist market “Chart I”;

TREND IN THE NUMBER OF INTERNATIONAL TOURIST ARRIVALS IN EUROPE AND THE WORLD IN MILLIONS.

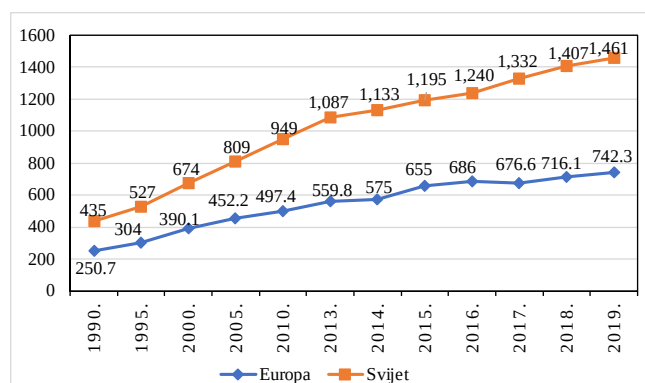


Chart I. Tourism Highlights 2015, UNWTO, Madrid, 2015., p. 13., Tourism Highlights 2018, UNWTO, Madrid, 2018., p. 5. i UNWTO, World Tourism Barometer, vol. 18, br. 1, 2020., p. 5.

According to the data in graph 2, 742.3 million international tourist arrivals in Europe were realized in 2019, an increase of 196.1% compared to 1990. The average annual growth from 1990 to 2019 was 6.76%. However, the number of international tourist arrivals grew at a lower rate compared to the global level, which also affected the reduction of Europe's share in international tourist arrivals, from 57.6% in 1990 to 51.1% in 2019. In the absence of data on the hotel industry in all European countries, the analysis of the European hotel industry is limited to the member states of the European Union.

According to the data in “Fig. 2”; the European hotel industry's accommodation capacities in all EU-27 member countries show an increase in the period from 2010 to 2019, except Latvia, Luxembourg and Romania. The number of beds in the hotel industry of Latvia and Luxembourg remained almost at the same level, while the number of hotel beds in Romania decreased by 12.6%. The trend of reducing the number of hotel beds in Romania was present until 2016, and in 2017 there was an increase in the number of hotel capacities by 2.9% compared to 2016, and the growth continued in 2018 and 2019. The highest growth rate of hotel capacities in the period from 2010 to 2019 is visible in the member countries that joined the European Union in 2004, such as Lithuania (63.4%), Poland (53.1%), Slovakia (46.0 %), Slovenia (42.8%), the Czech Republic (28.4%). However, a high growth rate is also visible in other member countries, such as Denmark (28.4%). Analyzing the trends in EU-27 hotel capacity in 2019 compared to 2018, growth is visible in all countries except for Austria and Finland, which experienced a slight decrease. The most significant growth was in Lithuania (28.4 %), and the smallest in France (0.2 %), and in Italy and Luxembourg, the number of hotel beds remained at the same level.

TABLE II. FEATURES OF SMALL FAMILY HOTELS

Products	Markets
• usually up to 40 rooms • restaurant and bar • the possibility of offering other contents: smaller rooms for meetings, wellness, fitness	• specialized • mostly individual guests • personalized relationship with the guest
Ownership and financing	Organization and employment
• individual or family owner • legal form: d.o.o. or trade • own capital • subsidized credit financing • cash and non-cash benefits for owners	• owner and manager in one person • the owner defines the concept and arrangement of the building • simple and flexible organization • rational employment • care about the overall profitability of the hotel

Fig. II. Čižmar, S.: Structure of the hotel industry, teaching material, Faculty of Economics, University of Zagreb, Zagreb, 2009, according to: Aflić, S., Priskić, E., Bačić, L.: Entrepreneurship in Small Family-run Hotels - Croatian Tourism Case Study, Learning for Entrepreneurship, vol. 2, no. 2, 2012, p. 330. (329-335)

B. Tourism Policies of European Countries for the Purpose of Reducing Seasonality

The importance and role of tourism in the European Union emphasized the need to include tourism in the policies of the European Union. However, it should be noted that tourism became a subject of European Union policies relatively late. The reason for this can be found in the reluctance of member states to transfer their competencies to others, even to supranational bodies at the level of the European Union. Nevertheless, due to the economic, cultural-social, political and other impacts of tourism, the awareness of the need to coordinate tourism-related activities at the level of the European Union gradually grew. The close connection of tourism with different sectors, especially transport, ecology and culture, in which the European Union influences national and regional integration, contributed to this.

The legal basis of the tourism policy of the European Union is based on Article 6 point (d) and Chapter XXII. Article 195 of the Treaty on the Functioning of the European Union, according to which the action of the European Union in the tourism sector aims to: encourage the creation of an environment that favours the development of entrepreneurs in that sector and promote cooperation between countries, primarily through the exchange of good practices. The European Union has been given the function of supplementing the actions of the member states in the tourism sector, especially promoting the competitiveness of European Union companies in the tourism sector. However, no coherent tourism policy of the member states has been adopted at the level of the European Union.

However, various communications have been adopted that support the European Union's tourism development and have the role of a kind of tourism policy. Certain bodies of the European Union have been given powers in the field of tourism and travel (the European Commission, the European Parliament within which the Committee for Transport and Tourism operates, the General Directorate for Entrepreneurship and Industry within which the Tourism Sector operates, etc.). That laid the foundation for the implementation and integration of communications in individual activities, as well as other policies of the member

states. The European Union's policy aims to maintain its position as a leading destination for international tourist trips, maximizing the contribution of tourism to economic growth and employment and promoting cooperation between the countries of the European Union. Without going deeper into the discussion of tourism policy at the level of the European Union, “Fig. 3”; gives an overview of its development.

TABLE III. FEATURES OF SMALL FAMILY HOTELS

Historical overview of development	Overview of development for the period 2000-2010.	Overview of development for the period from 2012
1. The first guidelines of tourism policy (1982)	1. Working together for the future of European tourism (2001)	1. Communication (COM(2012)0649) "Implementation and improvement of the common visa policy as an incentive for the growth of the European Union" (2012) - establishment of a common visa policy for the purpose of increasing tourist traffic
2. Tourism sector - horizon 1992 (1987)	2. Basic guidelines for the sustainable development of tourism in Europe (2003)	2. Two public consultations for the tourism sector "European tourism of the future" and "Regulatory and administrative framework for EU tourism" (2013-2014)
3. European Year of Tourism and Legal Framework for Travel (1990)	3. Renewed tourism policy: towards strengthening cooperation in European tourism (2006)	3. Communication (COM(2014)086) "European strategy for greater growth and jobs in coastal and maritime tourism" (2014)
4. Plan of joint actions in favor of tourism (1992); Maastricht Treaty (1992)	4. Communication (COM(2007)0621 "A program for sustainable and competitive European tourism" (2007)	4. European Union Strategy for the Adriatic-Ionian Region (EUSAIR) (2014) and Action Plan, which is based on four pillars, one of which is "Sustainable tourism".
5. The role of the European Union in tourism (Green Book, 1994)	5. Treaty of Lisbon, Art. 195 (2009)	5. European Parliament Resolution on New Challenges and Concepts for Stimulating Tourism in Europe (2015)
6. Instructions for the collection and processing of statistical data (1995)	6. Communication (COM(2010)0352 "Europe, the world's No. 1 tourist destination - a new policy framework for tourism in Europe" (2010)	6. Communication (COM(2020)550 "Tourism and transport from 2020 onwards" (2020)
7. Tourism and employment (1997)		

Fig. III. Hendija, Z.: Tourism policy of the European Union, Zagreb School of Management, Zagreb, 2008, p. 18. and European Commission, Overview of EU European Commission, Overview of EU Tourism Policy, https://ec.europa.eu/growth/sectors/tourism/policy-overview_hr (June 28, 2020); European Parliament, Tourism, (<https://www.europarl.europa.eu/factsheets/hr/sheet/126/tourism> (2/12/2020))

The main priorities of action in the European Union in the tourism sector emphasize the promotion of sustainable, responsible and high-quality tourism as a response to the effects of seasonality in the tourist destination and the sustainability of the business of entrepreneurs in tourism. The concept of sustainability is contained in all policies of the European Union that are directly or indirectly related to

tourism. The Communication "Europe, world tourist destination no. 1 – a new political framework for tourism in Europe" defined four action priorities:

- increase in tourist demand, both within the European Union and beyond;
- improving the offer of tourist products and services;
- improving the quality of tourism, sustainability, accessibility, skills and the use of information and communication technology;
- strengthening the socioeconomic knowledge base in the tourism sector; promoting Europe as a unique destination;
- inclusion of tourism in other policies of the European Union.

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable. Tourist destinations faced with the problem of seasonality use different policies and strategies to reduce this problem. Research, however, shows that efforts to differentiate tourist products and better distribution of arrivals in time and space as the primary strategy used by all destinations have limited success.

For example, in destinations where "sun and sea" is the primary motive for the arrival of tourists, the idea of deseasonalizing flows by attracting tourists outside the primary tourist season requires the development of new tourist products, as well as the appropriate infrastructure for the reception of tourists in areas that are not valued for tourism, which would be used as an alternative to the main tourist hotspots. The main measures to solve the problem of excessive tourism are:

- marketing efforts focused on the seasonal distribution of tourists;
- season extension;
- diversification of products for the distribution of tourists.

From this brief presentation of the tourism policies of European countries, it can be seen that the policymakers emphasized the development of tourism in the context of new market trends and the reduction of seasonality and overloading of tourist destinations with visitors in the primary season, both in spatial and temporal dimensions.

VI. CONCLUSION

Tourism seasonality is a crucial determinant of hotel business in coastal holiday destinations. The problem of seasonal concentration of tourist demand has and will continue to present hoteliers with a significant challenge. Large differences in the utilization of accommodation

capacities between summer and winter cause business inefficiency and impose a fight against the unprofitability and unprofitability of the hotel business. The seasonality of business is a fundamental characteristic of the hotel industry. Still, surprisingly, although it is common knowledge that seasons differ in business intensity and are divided into individual types, there is a lack of empirical knowledge about the duration of a particular season and the power of utilization of accommodation capacities for a specific season.

New trends in the hotel industry highlight the importance of personalized services in the hotel industry to attract guests. Modern guests want a unique service intended for their needs and requirements. It was the Covid-19 disease pandemic that showed how necessary the provision of personalized service in the hotel industry is for business success. Changes in the tourist market are dynamic in all spheres, both in tourist supply and demand. Digitalization of business and digital transformation, which accelerates changes, even more, contribute to this. These changes require changes in the hotel business.

Seasonality is identified as one of the main challenges in European tourism. Therefore, to increase competitiveness and reduce seasonality, encouraging small business initiatives related to the hotel business is vital. Policymakers emphasized the development of tourism in the context of new market trends and the reduction of seasonality and overloading of tourist destinations with visitors in the primary season, both in spatial and temporal dimensions.

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Increasing the Innovation Potential of Enterprises Through the Introduction of High-Tech Digital Solutions

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I. INTRODUCTION

Innovative solutions in technology are extremely important for the development of the economy, because through them the public and private sectors have the opportunity to develop their potential, generate more services, improve their activities and products offered. Nowadays, it is important to change the economy structure by applying innovative approaches (among them also digital ones) to improve activities of industrial enterprises.

Today, competitive advantages are almost entirely due to digitalization in production, management, production organization and service delivery technologies. The need to ensure the innovative digital development of industrial enterprises and the economy as a whole is becoming an important problem in modern economic conditions

II. ANALYSIS OF THE CONDITIONS FOR THE IMPLEMENTATION OF THE PROJECT

Digital transformation of business processes and business models is a necessary and relevant stage in the development of the high-tech industry; in fact, it is the transformation of high-tech industry into digital industry based on the development and application of digital platforms; development and application of digital duplicates; implementation of the transition to cyber-physical systems (Balakrishnan, R.; Das, S. 2020, 29, 531–541)

The idea is to create conditions for the rapid development of innovative processes and systems/products aimed both at more fundamental research (oriented towards academics) and at helping enterprises to model, design and visualize their future projects.

The market niche in which will implement its products and services is the creation of a complete digital factory and includes:

- Digitization and optimization with digital "doubles" - creation of virtual products and processes described by mathematical models in computer systems allows a significant shortening of time to market and lower product cost, at the expense of the possibility of non-destructive optimization of product characteristics and the processes for their production;

- Interoperability: the ability of cyber-physical systems (delivery of parts, assembly stations and products), people and "smart" factories to connect and communicate with each other through the "Internet of Things" and "Internet of Services".
- Virtualization: virtual copies of the smart factory created by connecting sensor data from physical production process monitoring with the virtual factory model and production simulation models.
- Decentralization: the ability of cyber-physical systems in the smart factory to make decisions on their own.
- Real-time capability: real-time data collection and analysis capabilities for immediate decision-making.
- Service orientation: offering services (of cyber-physical systems, people or smart factories) through the "Internet of Services".
- Modularity: flexible adaptation of smart factories to changing requirements by replacing or expanding individual modules.

The scientific research carried out and the realization of new products and services that the Center will offer will generally contribute to increasing the competitiveness of the industry through integrated development and production of products in the so-called "smart factories":

On a global scale, analysts report significant dynamics regarding the development of the digital services and virtual reality market, noting that in the period 2016-2021 this market will increase by an average of 58% per year, and the expected revenue from the sale of products and the supply of services within this market will reach 99.4 million at the end of 2021. In short, in 5 years this market will grow 10 times, and even the most pessimistic expectations are for the entry of many new products and services and the growth of revenues in the sector.

While the consumer segment is expected to remain the largest within this market, the enterprise solutions market is also expected to grow rapidly. According to the forecast, the growth of the segment for corporate customers will be 80% compared

to 50% growth of the segment for individual users. In this case, the analyzes show that equipment and services in the field of digitization and virtual reality contribute significantly to increasing productivity, and also save companies time and money. Analysts see the best prospects for the implementation of such technologies in the following sectors: production, design, healthcare, transport and retail trade.

We define digitalization as the “use of digital technologies to innovate a business model and provide new revenue streams and value-producing opportunities in industrial ecosystems” (Parida, Sjödin, & Reim, 2019 p. 6) . The overall effect of digitalization is increased effectiveness of the work of industrial enterprises and other economic sectors, which is directly related to environmental sustainability by reducing the cost of energy, materials, transport, time and labour. Further cost-effective energy savings can be achieved by means of improved process control and connection of smart sensors and data measurement and analysis devices, forecasting damages of the equipment and other innovative applications.

The dynamics with which the market segment of digital services and virtual reality is growing also opens up wide opportunities for the entry of new products. According to data for 2016, although currently the main players offering products and services for digitalization and virtual reality are the big technology companies according to data from Goldman Sachs and Venture Beat, in 2016 alone, more than 250 start-ups were founded in the world, whose activity is focused in the field of virtual reality.

The following can be identified as possible risks for the successful construction and the market realization of the products/services offered by it:

Companies operating in the virtual reality sector fall into three categories: hardware (production of helmets and devices specific to the technology), software (production of software to interact with the hardware) and content (production of content, whether interactive or passive, for consumption with the hardware). The question is whether the leading factor in development will be the hardware or the range of available applications. For now, like smart phones, there is a rapid decrease in the prices of glasses and other accessories and continuous improvement of the devices. For this reason, sales are growing rapidly, but at the same time, a special emphasis is placed on software and content, and that is where the efforts of project will be directed.

Lack of sufficient trained staff to create content. According to the predictions of some futurologists, one of the professions of the future will be called “virtual reality designer”. This means that we will not only have to use virtual reality in the educational process, but also train specialists in this field. Cooperation with the HIGH SCHOOL OF TELECOMMUNICATIONS AND POSTS, Technical University, the Departments of Informatics and Mathematics of the SU, the Mathematical High Schools is seen as an important tool for attracting young and ambitious personnel to work in this field;

Lack of sufficient funding for the development of activities in the future. It is planned that after the construction

of the project part of the revenues will be reinvested in new equipment and activities, especially software and content development. For this purpose, new experts will be recruited. An application for funding under new grant programs will be organized and prepared.

During the initial period after the commissioning of the equipment and new developments, disruptions in the work of the experts who work with it can be expected. To avoid this risk, special attention should be paid to the testing, quality control, user training and initial support of the activities of working with the specialized equipment;

Insufficient degree of publicity and popularization of the possibilities of the project to the potential users of the services. In order to avoid this risk, it is necessary to plan and conduct an active explanatory campaign, both in the initial stage of system implementation and during its active operation.

At this time, no potential competitors can be identified. The reasons for this are determined by the type and nature of the equipment, which is unique to Bulgaria and far exceeds the possibilities provided by the equipment of other technological parks and companies. The virtual reality laboratory built by Sofia Tech Park has an immersive system (power-wall) for passive stereoscopic visualization with a breakable wing, which has good characteristics, but incomparable to the interactive four-sided and two-sided CAVE systems of the last generation, which will be acquired by the project. The rest of the companies offering VR services focus on the entertainment side of the business and to some extent on conducting presentations.

Product innovation has largely been regarded as one of the foremost organizational capabilities and it was conceptualized in the literature as a firm’s ability to offer a new or improved product that can meet the needs of market target (Damanpour, 1991; Hanaysha, 2020).

Competition can be expected outside Bulgaria, especially from the technologically developed countries USA, Western Europe, China, Taiwan, Korea, as well as from the software “factories” India and Pakistan.

It is planned to establish close contacts with all companies and the academic community working in this field with a view to creating prerequisites for the implementation of joint activities and exchange of experience.

On the other hand, the extremely wide range of services that will be able to be provided to interested customers from various fields of security, public life, industry, education and science, guarantee sustainable demand for a long period of time.

Currently, the regulations and policies in the area are well settled and do not pose any challenges to the successful implementation of the project. The Innovation Strategy for Smart Specialization (ISIS) is a mandatory prerequisite according to Regulation 1303/2013 for the new programming period 2014-2020, relative to the financial means from the European Structural and Investment Funds in the field of thematic objective 1 “Strengthening the scientific research activity, the technological development and innovation” of the

General Strategic Framework. Through ISIS, Bulgaria already meets thematic precondition 1, item 1.1 "Research and innovation: Existence of a national or regional strategy for smart specialization in line with the national reform program, aiming to raise private funds for R&D and innovation and which is consistent with the characteristics of well-functioning national or regional research and innovation systems";

III. POTENTIAL CUSTOMERS AND POSITIONING ON THE BULGARIAN AND INTERNATIONAL MARKETS

Potential customers who are interested in the services and products of project:

The armed forces - New technologies and industrial solutions can find application in all three types of armed forces, for the development of the military education system, scientific research and innovations related to the country's security and defense capability. The project activity is suitable for the purposes of training military personnel related to the performance of routine activities, as well as for recognizing and overcoming dangerous situations that may arise. A particularly great advantage of this technology is that the fighters will receive the necessary knowledge and skills without exposing themselves to unnecessary risk to their health and life and with complete safety for military equipment. Applications will be developed for training drivers of military vehicles and combat vehicles, for shooting training, for reconnaissance missions, etc.

Education - through interactive approaches and products, the productivity of learning in the education system as a whole can be increased. The goal is to increase the effectiveness of teaching and learning through the use of modern, high-tech educational technologies. Talks were held with the Department of Architecture at UASG and great interest was shown in conducting practical classes for students of architecture and PGS for training in the application of virtual reality technologies in design.

Healthcare - virtual reality can be a generator for new ideas, optimization of processes and creation of collaboration between specialists in the industry. VR can be used to treat a wide range of problems, it can also be used to simulate surgery, create nanotechnology and teach skills. Leading surgeons from the Academy of Medicine are interested in applying methods and techniques for distance learning and operations using virtual reality technologies.

The entertainment industry is one of the areas where VR is widely used (cinema, games, various shows). VR is already part of activities of any entertainment nature. Project can be useful for this industry by providing a place with special equipment where different activities can be presented or different products from the virtual world can be tested. In this field, on the one hand, there is a lot of competition, but on the other hand, there is a huge unmet demand.

The business and the opportunities it can take advantage of - BP is increasingly becoming an innovative method for managing various production processes. It has many applications in the corporate world:

Virtual prototyping for design validation

User simulations for testing products and services

Product presentation in an immersive and interactive environment

Virtual tours of a business environment

Training of new employees

360-degree view of a product

Another use is virtual worlds, which are used as a means of holding meetings with people who are based in different locations.

The virtual environment is also used for educational training courses and role-playing scenarios.

Engineering and reengineering - VR engineering involves the use of 3D modeling tools and visualization techniques as part of the design process.

Sports - VR is used as a training aid in many sports such as golf, track and field athletics, skiing, cycling, etc., as a means of measuring athletic performance as well as technique analysis and is designed to help with both.

Construction - VR can be extremely useful in the construction industry, which is often known for very high inefficiencies and low profit margins. Using a virtual environment, the organization can not only transform the resulting structure into 3D, but also present it as it would be in the real world.

Simultaneously with the opportunities provided by the CAVE system for virtual reality, the Center will offer a number of other opportunities to close the scientific-production cycle, namely:

- Direct transfer of the results of the users' activity on a paper or digital medium;
- 3D laser scanning of small or large objects and digitization of the source data;
- 3D printing using carbon, fiberglass or other polymer materials;
- Conducting trainings and experiments of a different nature.

Also, the practice of "business angels" is confirmed as the most effective approach in the development of new technologies. In this approach, small start-ups are provided with a resource - technological or financial - with which to develop and realize their innovative ideas or products. The resource that the National Research Institute of the National Institute of Health and Welfare can provide in the period of its approval is ultra-modern equipment, which plays an essential role in the development of innovative projects.

In the market realization of the products from the activities of project, the revenues are distributed between the company and the business angels. For example, the Bulgarian virtual reality company ZenArt develops different plots involving real and legendary places. The company mainly works with foreign clients and partners. Business angels have invested 300,000 euros and plan new investments to expand the activity by attracting new specialists. Another small Bulgarian IT company, QuarkVR, specialized in the application of 5G communications in the field of virtual

reality, with the help of a large technology company, in 5 years has gone from a home computer to a partner of giants such as HTC, Orange and Deutsche Telekom.

In order to be able to provide a suitable environment for the development of new products/services, the National Research Center for National Research and Development of the National Institute of Health and Welfare will offer a completely new product in terms of its technical and functional characteristics, not only for Bulgaria, but also globally, through which services will be provided, which are currently not available in our country:

- interactive applications;
- visualization of architectural solutions;
- visual prototyping of projects;
- product design;
- development of platforms of different types;
- opportunity for training and others.

The scientific units from the branch of UNIVERSITY OF TELECOMMUNICATIONS AND POST, as well as all other researchers, will have the opportunity to test their scientific developments and new applications using the RCDRI. The center will provide constant methodological and material support for the successful completion of scientific research and the development of new applications within the field of application of the equipment.

The transition to digital design and subsequent application in product manufacturing will lead to the following direct benefits for increasing the competitiveness of export-oriented manufacturing companies:

- up to 30% shorter order fulfillment cycle
- 10 - 15% lower production cost
- 100% avoidance of errors, marriage and revisions.

The market implementation plan is tailored to the field of application of the implemented technologies. As a basis for the successful development of the project, PESTEL and SWOT analyzes will be made, in order to systematize information and evaluate the possibilities for positioning and market realization.

Based on these analyses, the market related to BP, 3D printing, construction and design documentation, etc., will be segmented, after which the target groups will be identified.

3D printing was found to be most popular in Germany, where it is used by 9% of enterprises, and least popular in Ireland, Greece, Spain, Latvia, and Romania (only 2% of enterprises use this technology). When it comes to the use of industrial and/or service robots, this technology was found to be used to the greatest extent by enterprises in Denmark (13%) and to the least extent in Ireland (only 2%). (Brodny J. and Tutak M; 2022)

Efforts to popularize the Center's activities will be directed at these groups. These are mainly:

- Defense and security structures;
- Universities and profiled schools;
- Architectural and design firms;
- Sports clubs and individual athletes;
- Schools for the training of motor vehicle drivers, drivers, seafarers, etc.;
- Companies and corporations interested in training employees or presenting their products;

Steps will be taken to position project, both on the Bulgarian and international markets. When positioning the Center, the quality and high-tech capabilities it offers, the functionality and quality of the equipment available to the laboratory, as well as the technological capabilities of 3D printers and the quality of the materials used in 3D printing, will be highlighted.

The specific events that will be implemented to present the activities of the National Research Council of the NCIC will include:

- business/work events/round table/seminar with representatives of the media, academia, business and state enterprises from various sectors with the aim of increasing awareness of the services that will be offered;
- independent presentations of the goals and opportunities provided by;
- Open days where the capabilities of specialized equipment will be demonstrated to the public.
- events together with investors who have implemented successful projects with the help of the specialized equipment.

In order to establish and promote cooperation with partners in the field and exchange of experience and good practices related to the development of innovative technological potential, eight international and local events/forums/exhibitions in the field of technology and the digital world will be selected, whose representatives of the National Center for National Research and Development of National Institutes of Health will participate in order to present the Center to a wide and properly targeted audience. The most important high-tech conferences and forums (in Bulgaria and abroad) will be selected, which are mainly focused on the digitalization of business and the public sector from the point of view of accelerating the digital transformation of the economy.

Participation in the mentioned events can serve as an effective mechanism for creating useful partnerships and a good opportunity to popularize the National Research Institute of the National Institute of Health and Welfare in front of potential foreign and local partners. This, in turn, will create sustainable contacts and an excellent opportunity for future development, both nationally and in foreign markets. The participation of the members of project and its representatives will provide an opportunity to reach new potential customers and partners.

IV. CONCLUSION

With the market realization of the scientific innovation products and services offered by the RCDRI, the implementation of highly efficient industrial technologies, processes and solutions supporting the digitization and automation of export-oriented manufacturing companies seeking competitive advantages internationally will be accelerated.

The adoption and integration of advanced digital technologies (fifth-generation (5G) mobile networks, the Internet of things (IoT), cloud computing, artificial intelligence, big data analysis, robotics, etc.) means that we are moving from a hyperconnected world to one of digitalized economies and societies. It is a world in which the traditional economy, with its organizational, productive and governance systems, overlaps or merges with the digital economy, with its innovative features in terms of business models, production, business organization and governance. This results in a new, digitally interwoven system in which models from both spheres interact, giving rise to more complex ecosystems that are currently undergoing organizational, institutional and regulatory transformation (ECLAC, 2018).

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Some Aspects in Expert Foresight in the Business Model Innovation Activities

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Abstract—This paper presents some aspects in expert foresight in activities concerning business model innovations. Author groups some of applicable foresight methods. Paths, expert visions, estimation, and criteria are explored and recommended to take into account in business model innovation activities.

Keywords—*foresight, forecast, innovations, business model*

I. INTRODUCTION

Foresight methods seek to collect data and make sense of it so that people can think in different and new ways about the future. This data can be collected from humans or from the analysis of documents and artifacts, or both. Data can be analyzed using qualitative or quantitative techniques, or both. In the present study, foresight methods will be considered. In strategic processes, this data must be analyzed, interpreted, and used in ways that make sense for the organization. The information resulting from this analysis allows the organization to better understand its past and present, which allows the use of foresight methods and to explore its potential future.

II. THEORETICAL FINDINGS

A. Business model innovation

In times of economic change, executives, managers, and entrepreneurs are looking for new sources of competitive advantage that are different from the already well-studied areas of product and process innovation. With these findings, business model innovation is becoming a recognized way for companies to renew their competitive advantage. Business model innovation involves finding a new option or opportunity that will renew the existing system of activity in some way. [5]

The business model is widely described in the literature. But it is widely defined as a system with three building blocks: value creation, value delivery and value appropriation. Value creation refers to the resources and processes that underlie the development and production of products and services. Delivering value focuses on those products and services and the environment in which they are sold. Value assignment refers to costs and revenues.

Business model innovation is defined as a major change in the elements of value creation, value appropriation, or value delivery for the firm. [1]

These are the areas of foresight methods application.

B. Foresighting

Foresight is “the human ability that enables people to think about the future and to model, create and respond to future possibilities” [6,3]. Foresight, however, is usually an unconscious thought process. Everyone thinks about the future, but often they do not realize that they are making predictions. In the context of business model innovation, it is not necessarily recognized or universal, and is usually about putting in place well-defined processes, supported by specific methodologies, to develop a company's foresight capacity. [2,4].

C. Forecast

The forecast is the result of the process of predicting a judgment expressed in a verbal, a mathematical, a graphic etc. It can cover a possible state of the firm and its environment in a future period, trends, future events, expectations and changes in people's attitudes and mindsets, etc.

Human thinking in foresight according to Popper (2008) concerns these capabilities: [7]:

- Creativity - refers to the mixture of original and imaginative thinking and is often provided by artists or technology gurus', for example. These methods rely heavily on the inventiveness and ingenuity of very skilled individuals.
- Expertise - refers to the skills and knowledge of individuals in a particular area or subject and is frequently used to support top-down decisions, provide advice, and make recommendations. These methods rely on the tacit knowledge of people with privileged access to relevant information or with accumulated knowledge from several years of working experience in a particular area.
- Interaction - recognizes that expertise often gains considerably from being brought together and challenged to articulate with other expertise (and indeed with the views of non-expert stakeholders). Therefore, given that foresight studies often take place in teams where democratic ideals are widespread, and legitimacy is normally gained through “bottom-up” and participatory processes, it is important that they are not just reliant on evidence and expertise.
- Evidence - recognizes that it is important to attempt to explain and/or forecast a particular phenomenon with

the support of reliable documentation and means of analysis of, for example, statistics and various types of measurement indicators. These activities are particularly helpful for understanding the actual state of development of the research issue.

III. FORESIGHT ASPECTS RECCOMENDATIONS

After practical workshops within a large company (1000 employees), author of the research presents some main points important in organizing the forecasting of innovations in the business model. He groups expert forecasting methods, which are useful and appropriate. A framework for shaping the visions of the experts is given, as well as a way of processing their opinions is recommended.

A. Foresight methods groups

Methods are based on people's ability to process and make sense of diverse but fragmented information and to formulate inferences from uncertain data. They can be group in five areas:

- Methods of following emerging signs:

Scanning - a method that considers the widest network of events and trends of any kind, with the aim of sifting them from the ch.t of their impact.

Monitoring - a method involving observing trends and series of events to determine whether they are strengthening or fading.

Tracking - monitoring trends in a specific area.

Simulations - an attempt to formalize most of the forces shaping the future by determining their probabilities.

- Extrapolators:

Technology trend analysis - a method based on the belief that technological advantages follow the exponential of the improvement process.

Fisher - Pry Analysis - a mathematical method predicting the replacement of older with newer technologies.

Gompertz Analysis - a mathematical method for predicting the path along which mature technologies will reach a limit in their development.

Learning Curve Techniques - a method predicting the economic effect of the learning curve.

- Pattern Analysis (Cycle Analysis):

Analysis of analogies - a method that tries to apply several analogous past patterns /schemas/ to obtain several alternatives of the possible future.

Analysis of previous changes - a method by which previous changes, such as the implementation of time-related user improvements, are predicted.

Morphological matrices - a method of discovering new products and processes by combining features /characteristics/ of already existing ones.

Feedback models - predict the relationship between different factors in a mathematical model where they

influence each other through a closed feedback loop.

- Analysis of objectives- these group of methods includes a broad collection of methods by which future results are interpreted because of the actions of various actors. While these actors (whether individuals or entire organizations) influence the future, we will be able to describe it by studying their goals, especially those of them who directly create or sustain the trends.

Content analyst

Impact analyst

Patent analyst

Stakeholders' analyst

- Expert intuitive methods- according to this group of methods, "the future cannot be designed by deliberate or directed methods." It emerges from the ever-moving, complex convergence of powerful tendencies, individual actions, and circumstances. Therefore, the best way to capture the future is through extensive information gathering, followed by unconscious and intuitive processing to extract insight. Each of these methods has its own specific ways of gathering information and working intuitively with different groups of individuals.

Delphi Survey

Nominal Group Conferencing

Structured & Unstructured Interviews

B. Expert visons formation

Trends tend to follow a predictable cycle (see Fig.1). An issue emerges on the fringe of society and is of interest to an eclectic group of people. Part of mainstream society considers these issues as odd. This is the stage where unchallenged worldviews result in the dismissing of the issue as irrelevant. During the time ahead, numerous companies/competitors with good practices and outstanding ideas emerge and often a public event is the trigger for transforming the issue into a trend. The related data is gathered and could be published on different kinds of media. Eventually, the newly emerged trend gains widespread popularity being adopted and legalized by institutions and governmental bodies. [8]

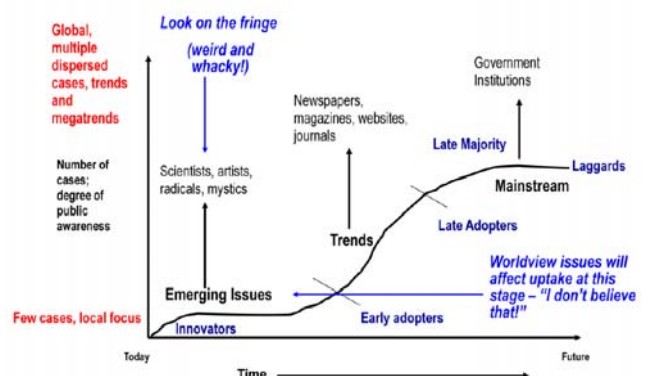


Fig. 1. Trend Cycle [8]

C. Foresight innovation domains according to the business model elements

TABLE I. FORESIGHT INNOVATION DOMAINS ACCORDING TO THE BUSINESS MODEL ELEMENTS

Business model elements	Domain 1: Doing things in a better way	Domain 2: Ddoing things in a new way
Creating value	Offering more of the same	Offering something different (different for the company at least)
Target customers	Existing market	A new market
Customer relations	Continuous improvements to existing channels	New relationship channels (eg physical/virtual, personal/peer/mass awareness)
Value chain architecture	Operation (eg internal, direct, continuous improvements)	Exploration (e.g. open, flexible, diversified)
Key competencies	Known competencies (e.g. improving existing technology)	Disruptive new, unfamiliar competencies (eg new emerging technology)
Affiliate network	Known (fixed) network	New (dynamic) networks (eg merger, joint venture)
Profit formula	Existing revenue generation processes followed by/or incremental processes of (cost) cuts	New revenue generating processes followed by/or disruptive processes of (cost) cuts

According to Taran's research business model elements can be referred to incremental and radical innovation activities [9]. The author of the current paper adapts and develops the idea and puts innovation activities into domains. Each domain activity is applicable to be a frame for foresight.

For example, it may be predicted Customer relations with the application of different methods for Objectives analysis.

D. Expert estimation

In the simplest version of predictive expertise of specialists-experts (with number m) in the area, several pre-formulated statements (with number n) affecting different directions of innovation development are presented. The experts are expected to rank them according to the probability of realization in a certain period of time, assigning to each statement a rank (number in order) r_{ij} , $i = 1..n$, $j = 1..m$ according to their subjective views.

The overall ranking of the statements according to the possibility of realization (prediction) will be obtained by summing the respective ranks and comparing them.

To be sure of the result, it is necessary to check the consistency of the expert assessments by calculating the concordance coefficient CW and checking its statistical significance. This coefficient is calculated using the formula:

$$CW = \frac{12S}{m^2 \cdot (n^3 - n)} \quad (1)$$

The S is a sum of the squares of the differences of the ranks from the mean value, which is determined by the formula:

$$S = \sum_{i=1}^n \left[\sum_{j=1}^m r_{ij} - \frac{m \cdot (n+1)}{2} \right]^2 \quad (2)$$

The CW significance test is performed based on the Pearson Chi square distribution by calculating the criterion:

$$\chi^2 = m \cdot (n-1) \cdot CW \quad (3)$$

Criteria for selecting forecasts must be:

- Reality- they must have clarity and relevance to the object of the study, as well as be relevant and transparent.
- Link to content - forecasts must be based on valid assumptions, be plausible, complete, consistent, describe developments, contain detailed information.
- Applicability - to be a function of decisions, to be applicable to different forecasting processes.
- Proportionality of the forecasts among them- to differ among themselves and to include all expected variants of the future.

E. Foresight teams

Before starting workshops there is need to clear and define details as follows:

- Internal and external participants.
- Work environment- space, time, and duration, teambuilding.
- Objectives of the workshops and letting all participants with them.
- Some human barriers to avoid resistance to taking part in a team.

F. Barriers to foresight

After a lot of workshops in company X author of the research report some barriers for human willing to make insight:

a) Cultural barrier

- Conformity of ideas (old and new)
- Too much stress for no reason
- Prejudice
- Cultural differences
- Disintegration, despair, aggressiveness, frustration

b) Personal nature

- Negative thinking: "I'm not creative!"
- Difficulty distinguishing between facts and problems
- Premature presentation of pseudo-solutions to the problem
- Difficulty perceiving unusual relationships between ideas and objects

c) *Professional environment*

- Misunderstanding
- Education, training
- Tension, lack of rules
- Lack of funds
- Communications
- Decision making process
- Authoritarian management style
- Strict hierarchy in the brainstorming group

d) *Self-imposed barriers*

- Fear of making mistakes, lack of self-confidence and knowledge
- Weakness, lack of ability to relax, fatigue
- Excessive dependence on the opinions of the other party
- Lack of interest and motivation
- Expectations

IV. CONCLUSION

Foresight is based on using the thought processes of personnel and participants in an organization's business ecosystem. The methods help develop a long-term framework for action that transcends the limitations of business as usual in the present. In this way, a sense of the uncertain and complex future environment is provided to support future decision-making. The result is survival and development through innovation. An organization's capabilities are

expanded so that it finds new and sustainable options.

Foresight in organizations is about broadening people's attitudes by questioning long-held assumptions and beliefs. Careful selection of methods is necessary so that people understand the process they are going through, what results are expected and how those results will be used. Difficulties in applying the results arising from the use of different forecasting methods are no different from any traditional strategic process. The more people involved in it, the greater the chance that it will be implemented successfully.

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Application of Business Process Analysis in the Digitalization of Public Administration

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Abstract—Bulgaria embarked on the path of digitization of its public administration sector more than a decade ago. The process of digitization is bringing far-reaching changes to the functioning of public administration, changing the entire system. This article examines the application of business process analysis in public administration against the background of the trend towards its digitalization.

Keywords—Public administration, business process analysis, digitalization

I. THE CURRENT SITUATION

According to the E-Government Development Index (EGDI) [1] of the state agency "E-Government", currently:

"... in the 2020 report, our country ranks 44th among 193 countries in terms of the e-Government Development Index and for the first time enters the category of very high level of e-Government development together with the countries from the European regional group Czech Republic, Slovakia, Latvia, Croatia, Hungary and Romania. The results show that our country, together with the others in this category, demonstrates consistency and progress in the development of strategic documents in the field of e-government and in the coordination and provision of electronic services".

The Estonian model chosen by Bulgaria implies full digitization of all aspects of public administration¹. In the country, online services are currently digitized in several separate administrations (NAS, NII, the Commercial Register and individual municipalities), but one cannot speak of a single and flexible electronic system (in the general sense of this term) - i.e. work is done piecemeal in individual administrations and municipalities.

II. THE CHALLENGE

According to "Architecture of electronic government in the Republic of Bulgaria" [2], which is one of the strategic documents of the State Agency "Electronic Government", the architecture of electronic government in the Republic of Bulgaria is aimed at the realization of:

- digital transformation of the administration;

- mandatory use by administrative bodies of horizontal systems and shared resources of e-government;
- mechanisms for coordination and control of the execution of the architecture;
- application of uniform standards and operative compatibility when designing, building, upgrading and implementing information solutions;
- defining the participants in electronic management, their functions, the principles of Electronic Government and the requirements for the system and technological architecture;
- sustainable, high general level of network and information security;
- transforming data into information and knowledge;
- achieving trust from citizens and businesses.

Thus defined, the architecture that relies on certain information solutions (separately for each administration/municipality) with a requirement for mutual compatibility between them, especially within a country, is a global challenge to which a global approach must accordingly be applied.

III. POSSIBLE APPROACHES

The challenge of architecture of information solutions within a country can be approached in several different (so-called classical) ways:

- Each information unit (administration/municipality) develops/looks for a solution separately for itself.
- The same information solution is used with a different combination of modules, which is adapted for each individual unit.
- The hybrid method is also applied – the units are classified through cluster analysis according to their needs (previously identified by an integration team), and the needs of each cluster are satisfied through a unified selection of information solutions (which, of course, are mutually compatible).

The first approach is the so-called asynchronous approach. Its advantages are not to be underestimated and are the following:

- It requires the least preliminary preparation - technical

¹ Георгиева, П., „Въздействието на технологиите върху бизнес моделите на услугите за предоставяне на персонал”, Сборник научни трудове от Единадесета международна научно - приложна конференция „Дигитрова икономика и блокчейн технологии”, ISBN- 978-954-635-008-4, Варна 2018, стр.172

and bureaucratic.

- Each unit bears the responsibility for its own solution and its integration.
- Each unit (administration/municipality) can choose the most appropriate combination of information solutions.
- Requires less concurrent resource consumption.

The disadvantages of the asynchronous approach are:

- Of a technical nature - mostly regarding the technical compatibility between the different information solutions between the different units.
- Each unit bears the responsibility for its own solution and its integration.

IV. DIFFICULTIES BEFORE DIGITALIZATION

The responsibility of the administration/municipality for the selection and integration of the information solution is both a serious advantage and a serious disadvantage of the asynchronous method. Combined with the high risk of the integration of information solutions, the result is a delay in digitization in many of the administrations/municipalities, especially in the smaller ones.

The high risk of the integration of information solutions is the result of many factors, some of which are discussed by Viktor Gladchenko in his article "Consequences of failed ERP integration and criteria for their evaluation". The factors are as follows:

- lack of the necessary business process specialists to collect the business requirements of the client organization;
- lack of the necessary business process specialists to describe and analyze the business processes of the client organization;
- lack of the necessary business process specialists to develop an adequate and accurate business assignment for the necessary parameters of the ERP system;
- lack of the necessary IT specialists to transfer/import the organization's database into the ERP system;
- lack of the necessary testing specialists for the testing of the integrated ERP system – interface, database, business processes, references;
- underestimation of the scale of the ERP system integration task [3].¹

These factors are valid for the integration of any information solution. The following factors are added to them:

- the particularly strong resistance (the so-called resistance) in the administrations/municipalities against the changes;
- communication problems between users and integrators

of information solutions;

- the lack of experience and skills of the employees in the administration/municipality in the selection and integration of information solutions.

The reasons for the lack of the necessary BPA2 specialists will be discussed further in the article.

The lack of the necessary IT specialists to transfer/import the organization's database into the ERP system and testers to test the integrated ERP system is no longer as relevant a problem as in 2018, but they are still lacking particularly in smaller administrations/municipalities.

Underestimating the magnitude of the task of integrating information solutions is (perhaps) the only factor which is no longer valid for administrations/municipalities, because they tend to overestimate the magnitude of such tasks.

Users' resistance to innovation is a typical problem for all information solution integration. In administrations/municipalities, this problem is particularly pronounced because:

- in the public administration, the average tenure of expert employees is very high (thanks to the Civil Servant Act) at medium and low hierarchical levels, especially in small administrations/municipalities and/or in non-elected positions;
- the relatively high average age of the employees;
- there is the typical fear of responsibility for the public administration in Bulgaria, especially at the higher hierarchical levels;
- the projects on the integration of information solutions are very complex and are developed over a long period of time.

Users resistance to innovations should not be seen solely through a "mechanical" approach that could only reflect on its results. For the results to be true, it is also necessary to consider the psychological components - in this case the reaction are the reason and need:

- the stress of changing business processes
- the stress when bottlenecks occur in the working environment of the human element.

Reactions to the specified types of stress could be absolutely different for different users, both as a direction (positive, neutral, negative, etc.), as well as duration. The factors on which the human element's reaction depends on are:

- surrounding work environment;
- attachment to work;
- resistance to stress;
- physical condition;
- mental state;
- working capacity;

¹ Consequences of failed ERP integration and criteria for their evaluation. Viktor Gladchenko, VFU, 2018.

² BPA – business process analysis.

- age;
- others. [4]

As a result of these factors presented above, the ways in which users resistance to innovations could be grouped into several groups:

- fear of any type of changes/innovations;
- fear of new technologies;
- unwillingness to learn new skills/knowledge;
- lack of work motivation (laziness);
- fear of being fired - particularly strong among public administration employees

Standard solutions/measures have been developed to overcome the resistance of each of these groups - they are also grouped into several groups:

- standard management methods for increasing employee motivation, which are not the subject of this article;
- standard management methods to lower employee anxiety, which are not the subject of this article;
- promises by the management that there will be no reduction of the employees
- conducting in-house trainings to acquire the necessary new skills/knowledge;
- conducting presentations of the advantages of new technologies with an emphasis on their advantages:
 - easing the work process;
 - reducing the work routine;
 - reducing the possibility of making mistakes during the execution of business processes;
 - reducing the consequences of mistakes made during the execution of business processes;
 - facilitates the execution of standard periodic reports;

It should be noted that workflow tracking for the purpose of individual employee accountability may be perceived by some public administration employees as a disadvantage.

V. THE SOLUTION – BPA APPLICATION

As often happens, the solution to these problems is rooted precisely in their cause - the lack of a sufficient number of business process analysis specialists.

These specialists are very necessary for the following reasons:

- They monitor, describe, analyze and optimize business processes.
- They are mediators between users and integrators of information solutions.
- They are trained to overcome the resistance of users of

information solutions against innovations.

- They are trained to integrate information solutions (in this case, their mediating role is expressed in mediation between users and the integration team of BP Analytics).

In other words, they are the solution to a large number of the obstacles to the digitization of the public administration in Bulgaria.

Statistics show that projects for the integration of information solutions (especially ERP systems) in the period 2009-2014 ended unsuccessfully in more than 60% of cases. With the increase in the quantity and quality of BPA specialists in Bulgaria, the number of failed integrations in the period 2014-2019 dropped to about 50%. In the following years, the tendency to reduce the risk of failed integrations is maintained, but no longer at such a pace.

The required BPA specialists in Bulgaria are few, because they need specialized training, which is almost unavailable in Bulgaria, except for:

- self-training;
- in-house training;
- certified online training.

In other words, there is almost no opportunity for methodical professional training.

It is also necessary for the relevant specialist to possess a rare combination of specialized knowledge simultaneously in:

- applied mathematics;
- business analysis;
- system analysis;
- computer software and databases;
- economics and accounting;
- management and governance;
- logistics;
- presentation skills;
- organizational psychology.

It is exactly this combination of:

- lack of access to methodological training;
- the complexity of the preparation;
- the multidisciplinary of the preparation,

That is the main reason for the lack of the required quantity of BPA specialists (and in some cases of the required quality).

VI. CONCLUSIONS

The lack of the necessary number of BPA specialists is one of the main obstacles to the digitalization of public administration.

The solution to this problem is rooted in providing the

opportunity for methodical professional training to the necessary specialists:

- it is necessary to develop curricula for the training of business process analysts;
- it is necessary within the framework of the training that the future business process analysts be trained in all the above-mentioned knowledge/skills
- textbooks and teaching aids for business process analysis need to be developed;
- it is necessary for developers to have
 - serious practical experience in business process analysis;

- both academic and analytical approach;
- pedagogical skills.

The simultaneous implementation of the above measures will lead to solving the problem of the lack of such specialists in the next decade.

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Promoting the Concept of Critical Thinking as a Major Challenge of the Global Higher Education

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Abstract—The challenges of global higher education act in several directions. Initially, of particular importance is the accepted higher educational framework in the society, that is, how adapted it is to the needs of students, in the direction of developing of their potential. In addition, to the greatest extent the educational frameworks are reduced to the methods and techniques that have been adopted individually by the teachers/educators, so that it does not provide an opportunity to set the measurability of the achieved results, as well as a real insight into their effectiveness.

Within the framework of this paper, the importance of the role of interests, motivation and critical thinking is highlighted as the main processes, instigators of effective higher education in a global framework. This ratio, in addition to the theoretical aspect, is also shown through a quantitative empirical framework, to a target group of respondents from the Macedonian society: university professors, educational analysts and experts.

Keywords—critical, thinking, concept, global, education

I. INTRODUCTION

The indicated analysis highlights the role of interests, motivation and critical thinking as main processes, drivers of effective education in global frameworks. What needs to be emphasized in this domain does not allude that students should, on the basis of their own affinities, choose their subjects. At the same time, the same does not underline the responsibility that certain subjects are not studied at all in the curriculum. However, it is important to highlight the need to study the teaching material at levels, based on the demonstrated inclination, affinity, easier understanding and above all, interest, to study at an advanced level. In that direction, the goal of the global education system is to enable: curiosity, imagination, innovation, self-initiative and entrepreneurial spirit in the students; to prepare future generations for professional life, for contribution to the common good as well as for active citizenship. [1]

The purpose of this scientific paper is to promote the concept of critical thinking as a major challenge of the global higher education. Furthermore, the narrower goal of this paper is to give a clear insight into the role of creating an educational framework within the higher education institutions, in the direction of encouraging interest, motivation from the teaching material, so that later it

encourages applicability when choosing a suitable profession.

The scientific paper implements a quantitative research framework, on the basis of which the general hypothesis is confirmed, i.e.: "If within the higher education framework, the curriculum is based on the application of the concept of critical thinking, in that case conditions are created for the direct applicability of the educational program with an appropriate choice of profession in the future".

In order to ensure high quality of the Proceedings of Instructions for the authors.

II. THEORETICAL FRAMEWORK

A. Stimulating interest

The study of the specifics of the educational program, in order to encourage interest and will for it, represents a particularly current and significant problem that deserves a closer theoretical and scientific insight. [2]

Taking into account that the teaching consists of a different selection of subjects and interests that also come from different natures, it is necessary for the students to, firstly master the laws regarding the possibilities offered by a certain subject, and furthermore to be able to create a greater or lesser inclination towards it. Starting from the fact that we live in a time of global connection, the use of a multidisciplinary approach represents one of the basic global educational codes that needs to be accurately and precisely mastered by all involved parties within the educational structure. [3]

If it is a matter of formal, higher education, it is essential that the educator can promptly study the capacity of the students in relation to the adoption of different subject units. More specifically, it is necessary to inspect the appropriateness of the adopted program in the respective subject, as well as in relation to the capacity for acceptance of the program by the students.

The application of a functional approach in order to stimulate interest, aims to achieve compatibility between the student's abilities and needs, in relation to the teaching unit he/she is mastering. Consequently, educational institutions in a global framework should focus on modern technical aids and approaches that will contribute for development of creative abilities among students, as well as critical thinking.

Providing a positive atmosphere of cooperation and offering acceptable models by the teaching staff encourages activities that precede the mastery of the teaching subject. This is the only way to ensure a focus on the basic idea of the educational process, and not on the interpretive errors that may occur on a regular basis. [4]

One of the most important conditions for encouraging student interest in a particular subject is first of all enabling and encouraging them to independently assess their own possibilities, which through individual analysis will contribute to active self-expression, and thus encouraging their own abilities and inclinations towards critically analyzing the teaching material and creating one's own attitude. In this context, above all, it is a matter of respecting certain principles of learning that are specific in terms of certain differences and barriers that may arise during this process.

B. Motivational process

Nowadays, as a consequence of the predominance of the communication method and the intercultural approach in teaching, the process of adopting the teaching subject is largely subordinated to the process of motivation. In terms of motivation, it is important to point out that it is necessary to find appropriate strategies for motivating students, as well as conditional opportunities for studying a certain subject. What is most important and universal, regardless of social opportunities on a global level, is actually the timely creation of awareness among students, regarding the necessity of studying the subject. [5]

Advancing the idea of a higher quality educational framework that will be globally unified always depends on the current developments in a society. New approaches and methods in teaching are almost always a consequence of major social changes and the need for communication between different target groups. Communicative competence represents a set of knowledge and skills not only for the structure of the teaching material, but also for its use in accordance with the communication situation and the socio-cultural norms of the community within which the education takes place, but also more broadly at the global level. [6]

In order to encourage motivation to effectively master the educational process, it is necessary to harmonize the purpose and the situation of using the acquired knowledge. The modern approach that derives from the mentioned directions is an approach that perceives all units of the process as participants in the communication process, in which the exchange of information, interaction, interpersonal activity is highlighted. The global educational values need to offer a learning process in which the skills of the educator stand out, so that he/she can correctly apply the gained knowledge and experience.

C. Professional orientation

There is evidence of current changes in the world when choosing a professional orientation. That means more external changes within the business activities. The changes refer to the "concept of profession" itself, which for generations has been the basis of professional activities, and thus the basis of the educational system in Europe. In practice, the changes in the world of various professions affect precisely the

educational systems that need to change their concept in the direction of satisfying future professional demands. In fact, nowadays we live in a world that is in constant dynamics and it represents a preparation for something that will appear again in a modified form, as a future profession. [7]

The very term "professional orientation" denotes a state or process, in the capacity of orientation of the individual towards a certain activity or influence, regardless of the way it does it. In this domain, it can be talked about a wide range of steps within the orientation process. This domain includes the understanding of professional orientation in teaching, which actually represents, in one way, a view into one's own personality, as well as an external understanding, which represents a view into the real world of professions, up to sending the person to a choice and a decision on a particular profession. [8]

Choosing a profession as a developmental process is particularly important because it is not considered an isolated process of working life, but rather chapters throughout the entire life cycle in professional development. This approach is based on dependence on the decisions that a young person makes. Choosing a profession is part of a continuous development process of one's own identity.

Hence, the concept of critical thinking is actually an interdisciplinary process, which refers to the application of a concept, applicability, analysis, synthesis as well as the appropriate evaluation of the received information. Critical thinking is constantly upgraded based on new experiences gained, as well as skills for observation, experiential practice, reasoning and communication with different subjects. As such, the concept of critical thinking needs to be part of the new challenges of global higher education. [9]

III. METHODOLOGICAL FRAMEWORK

Regarding the methodological framework, for the needs of the empirical research, a quantitative research strategy was applied. The main instrument used is a closed-type survey questionnaire, with claims/attitudes placed on a Likert scale, in order to see the gradation of the attitude of the respondents, from negative to positive. For the purpose of reliable analysis and interpretation of the set hypothesis, those questions that are most closely correlated with the hypothesis have been selected for display. The answers to the questions do not include testing of variables, but the distribution is considered in relation to the total number of respondents. The questionnaire was administered individually to each respondent, taking into account the ethical dimension of the questions, as well as the protection of personal data in relation to public presentation of the same, without damaging the credibility of both the respondents themselves and the organization/ institution they represent.

IV. RESULTS

The general hypothesis that is analyzed and interpreted is: *"If in the higher education framework, the curriculum is based on the application of the concept of critical thinking, in that case conditions are created for the direct applicability of the educational program with an appropriate choice of profession in a future perspective".* The hypothesis was

analyzed on a target group of 50 respondents, university professors, educational analysts, experts on the educational and strategic framework, who operate within the framework of the Macedonian society. The target group was selected as particularly relevant in relation to the analyzed problem. The empirical research was carried out on-line, in the time period from 15/10/2022 - 30/10/2022.

This hypothesis is analyzed and interpreted through the answers to the statement (question):

- Number 5 of the survey questionnaire, "The educational framework needs to be based on methods that encourage interest, motivation and visualization of the teaching material in order for the student to see the application when choosing a future profession"
- Number 8 of the survey questionnaire, "In the Macedonian higher education system, the concept of critical thinking is not included in a comprehensive framework, but individually by the skills and competencies of the teaching staff".

The following results were obtained:

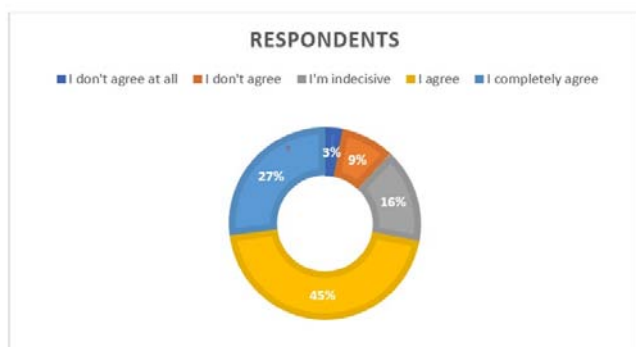


Fig. 1. The educational framework needs to be based on methods that encourage interest, motivation and visualization of the teaching material in order for the student to see the application when choosing a future profession

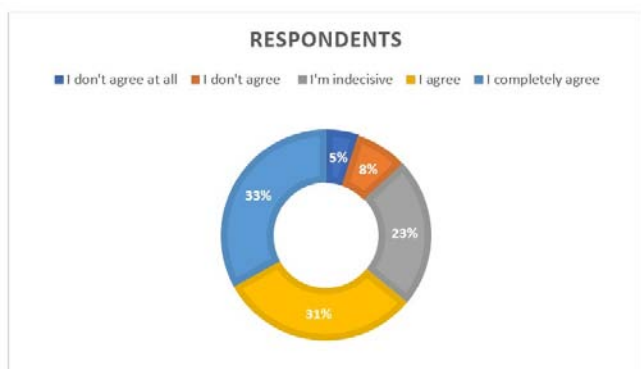


Fig. 2. In the Macedonian higher education system, the concept of critical thinking is not included in a comprehensive framework, but individually by the skills and competencies of the teaching staff

V. DISCUSSION

A comprehensive aspect of global education is elaborated within the Maastricht Global Education Declaration European Strategy Framework for Improving and Increasing Global

Education in Europe. [10] In addition, the concept of global education has been analyzed and interpreted through a series of development projects within the Macedonian society. It is about the offer of different educational platforms and interpretations of the "National Qualifications Framework", as well as directions of setting up a more efficient way of developing qualifications, including the institutional aspects, the evaluation of competencies, as well as the awarding of qualifications. [11]

According to the obtained results, shown in the frames of Figure 1 and Figure 2, according to the analyzed and interpreted data, statistically processed, the attitude and perception of the respondents can be seen based on the stated claims. According to the obtained results in Figure 1, the following distribution of answers is shown: 12% of the respondents do not agree with the statement (categories: "I do not agree at all" and "do not agree"), 16% of the respondents are undecided in their attitude and 72 % of respondents agree with the statement (categories: "I agree" and "I completely agree").

According to the obtained data within the framework of Figure 2, the following distribution of answers was obtained: 13% of respondents do not agree with the statement (categories: "I do not agree at all" and "do not agree"), 23% are undecided in their attitude and 64% of the respondents agree with the statement (categories: "I agree" and "I completely agree").

Based on the obtained data, the overall perception of the respondents is seen, which directly refers to the need to introduce the concept of critical thinking as permanent within the educational framework of the Macedonian higher education system (64%) of the respondents agree with this position). In addition, the respondents in a high percentage (72%) believe that the educational framework of the Macedonian system needs to integrate a methodology for the development of interest, motivation and other practices that will ensure better applicability in professional life.

The importance of developing interest, motivation and critical thinking in the process of global education as a future endeavor is in direct correlation with the theory of choosing a profession as a learning process. Through this theory of learning, the choice of a profession is explained by affirming the "personal concept", with the totality of influence from the area of residence (family, school, etc.), but also the scientific methods of solving problems. It is a learning experience that builds on each other and leads to a conscious choice of profession.

The concept of critical thinking in the higher education framework is in direct correlation with the concept of long-term learning. The purpose of this system is not to profile a measure of success in terms of academic expression of students, but to assure certain standards during the educational process which in the future will not allow profiling of students without interest in any career field. In this way, not only the students but also the teaching staff benefit because they participate in the creation of an effective educational process, with greater applicability during the implementation. Namely, the teachers have the opportunity to adjust the curriculum of the subject based on the affinities of

the students, and at the same time they are faced with a group of students who really express a desire to be in that place. Thus, encouraging critical thinking, demonstrated interest in the subject matter and high motivation throughout the educational process, allow students to fully express their potential, which is the main priority of the global education.

If one takes into account the continuous changes in education and the labor market, worldwide, as well as the overall strengthening and improvement of abilities, attitudes and knowledge, then as a model of professional orientation one takes into account the preliminary decisions for a certain profession that are still being created in primary education, until the final decision-making. In that way, the classification process is finally a learning process that enables the unification and comparison of the personality profile with the requirements in education, and further, the requirements in the profession itself.

VI. CONCLUSION

Choosing a profession is not an independent process, it is also considered as a process of interaction. It is about interaction between the person who chooses a profession and the environment. Various interests and values of the individual positioning into that interaction. It is in this way that a high degree of rationality is developed in connection with the choice of a profession, which is in direct correlation with the applied methodology of the completed educational process.

As concluding observations, it is necessary to adapt the model of transmission of certain information in the educational process, in order for the users themselves (students) to consider that it is useful and, above all, applicable for them. It is necessary to implement a model of education in which each individual will have the opportunity to express his/her attitude, to establish a close relationship

with the educator, to have an understanding of the teaching process and program in order to see the benefit of it. Consequently, setting up a higher education framework by applying the concept of critical thinking, encouraging interest and motivation among students, is a priority of the global education.

ACKNOWLEDGEMENT

Addressing gratitude to each participant in the empirical framework of the research, in order to get a clear picture of the real situation within the Macedonian society, when it comes to problems from this domain. It is the beginning of awareness regarding this issue to be implemented in the long-term strategy of the higher education framework in North Macedonia.

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The Covid-19 Crisis as a Force Majeure Circumstance in Case of non-Performance of Trade Contracts

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Abstract—Over the past 2 years, our society and economy have faced a challenge of unprecedented magnitude and scope that has affected absolutely every aspect of modern life - the pandemic caused by SARS-CoV-2a or briefly called Covid – 19 virus. In this article, an attempt will be made to consider in principle the issues related to the application of the norms of the Bulgarian Trade Law and more specifically the norms regarding the non-performance of contractual obligations due to the presence of force majeure caused by Covid – 19 virus, and its use as means of evidence when proving force majeure in court proceedings.

Keywords—Covid-19, non-performance of trade contracts, force majeure

I. INTRODUCTION

In just a few months, the world was conquered by an unprecedented global pandemic, which turned out to be the epidemic caused by the Covid-19 virus. Already with the first manifestations of the virus and the effect it had on human health, its high mortality rate and the subsequent post-covid complications, made our society change the priorities of its agenda, get out of its normal rhythm and look for ways to reduce the harmful effect from the virus in every sphere of life. The sector of the economy reacted in the same way, which, driven by pragmatic caution and fear of the unknown, and due to the many uncertainties surrounding what the impact of the virus could be on the economy, decided to slow down, revise its business strategies and adapt them with the new realities and, of course, to adopt adequate plans and strategies to overcome easily the negative consequences caused by the spread of the virus.

In Bulgaria, as well as in all Eastern European countries, already with the appearance of the first virus cases in March 2020, it became clear for both people and the economy that what lies ahead in the coming months or years will teste, like no other so far, the entire system and, in addition to the unknown number of physical victims that will be given, entire sectors of the national economy may cease to exist after the pandemic, and recovery and overcoming the consequences may take decades.

II. NATURE OF THE PROBLEM AND IMPACT ON THE ECONOMY

The too rapid spread of the virus, and the scope of the consequences for the economy that were formed from it, could not be predicted even by the best economic specialists, because the lack of experience in reacting to the manifestation of a phenomenon of a similar scale and the lack of preliminary anti-crisis plans, tested every single enterprise in our country. The delay in the execution of orders, the refusal to conclude and perform already concluded contracts, due to the impossibility of securing both raw materials and labor together with transport delays of a logistical nature, led to a breakdown in a larger part of production, supplies which understandably caused market deficits in the globally connected economy. All these economic complications of pandemic origin, led to the systematic application of a specific legal institution, which until the moment before the pandemic was not often implemented, and whose purpose is to fairly regulate relations related to the non-fulfillment of commercial contracts, due to the occurrence of a circumstance of an insurmountable nature – „force majeure“. It is for this reason that the purpose of this article, as a series of articles related to the failure of commercial contracts caused by the spread of a viral epidemiological disease, aims to examine the process of applying the institution of force majeure, often called "force majeure" (French), and the treatment of the Covid-19 virus as a circumstance of an unforeseeable and insurmountable nature that can be used to manifest and apply the special norms of the Bulgarian Trade Law [1] (TL) regulating the relations between the economic entities that have fallen into a situation of non-fulfillment of a commercial contract concluded between them. The existence of this institution is a thousand years old, but until now its use has always been related to overcoming the legal consequences of often accidental and temporary circumstances and often for single and isolated cases from each other. Now globalism in the economy sets a new revision of the institute precisely because of the enormous scope and spread of the Covid-19 virus, as our national law was challenged to regulate both domestic and international commercial relations regarding the non-fulfillment of already assumed obligations, the fulfillment of which must be carried out during a pandemic phenomenon, the consequences of which cannot be predicted, nor can its strength, duration and extent of impact. All the uncertainty, unpredictability and

ambiguities surrounding emerging commercial disputes led to the fact that the solution to the accumulating questions about overcoming the consequences and minimizing the damage was sought precisely through law as a social phenomenon created to regulate relations between subjects, to provide additional security in relations between them, ensuring basic fairness and creating stability and predictability in the environment, or at least as much as possible in the state of all general uncertainty. Thus, the use of force majeure turned out to be the only legal means to regulate the unusual economic relations that arose when commercial contracts were terminated as a result of the impact of the Covid-19 virus, and it turned out to be the only tool through which severe consequences for business can be avoided.

The term "force majeure" and the understanding we have today of the facts and circumstances that can lead to the failure of commercial relations due to a phenomenon of a random and unforeseeable nature, were developed by French jurists of the past and more last century, and are based on the institution of Roman law, and the application of the principle "vis major" with which the ancient Roman philosopher-jurists explained their understanding that no one can perform something that does not depend on him and cannot be performed a given obligation if it does not meet the capabilities of the contractor. Moreover, the Roman jurists accepted that when a thing - the subject of performance in a commercial dispute has perished due to an event that did not depend on the will or behavior of the party and this thing cannot be delivered or made, a principle is applied which is determined with the term "ad impossibilia nemo tenetur" which translates to "no one can be expected to do the impossible" [2]. And so, this institute remained forgotten or, more precisely, unused for decades, until the need for its application came to the fore again as a result of the growth of the intercontinental exchange of goods and services that flourished in the 19th and 20th centuries. It is at this time in commerce and economics in general that many cases appear in which the decision of who is responsible was made after examining the decision about the guilt and due conduct of the parties to the transaction and how it should proceed when the event that has arisen does not depend on human will, and the consequences of its manifestation cannot be overcome and their occurrence prevented with the capabilities of the person responsible for the execution of the transaction, and how should the issue concerning the guilt of the persons who encountered be treated with similar phenomena and have suffered damages or have fallen into a state of impossibility to fulfill an assumed obligation due to the occurrence of such an accidental event. It is the problem of attribution of blame and the assumption of responsibility by individuals and the need to have a fair resolution of the disputes that have arisen and that led to the development of the principle of "vis major" to its current form of "force majeure". Moreover, the introduction of the legal institute also achieves the desired degree of certainty in commercial relations so that the economy will continue to develop even after this event and the circumstances surrounding it are overcome.

In our time and today's national reality, the legal regulation of force majeure is implemented in the current Bulgarian Trade Law (TC) [1] and more precisely in Section

IV of the same, in which the institution of force majeure is established imperatively. Indeed, in our Trade law, it appeared only 5 years after the adoption of the law itself in 1991, as until then the relations were regulated by civil law and more precisely by the Law on Obligations and Contracts [3], and lawyers presumptively assumed that since commercial law is part of civil law, its norms can be transposed interpretatively for commercial relations, and only to avoid the extremely undesirable lack of justice in law.

Precisely the institution of force majeure is described in the provision of Art. 306 of the Trade Law, which reads:

(1) The debtor under a commercial transaction is not liable for non-performance caused by force majeure. If the debtor was in delay, he cannot invoke force majeure.

(2) Force majeure is an unforeseen or unpreventable event of an extraordinary nature that occurred after the conclusion of the contract.

(3) The obligor, who cannot fulfill his obligation due to force majeure, shall notify the other party in writing within an appropriate period of what the force majeure consists of and its possible consequences for the performance of the contract. In case of non-notification, compensation is due for the resulting damages.

(4) As long as the force majeure lasts, the performance of the obligations and related counter-obligations shall be suspended.

(5) If the force majeure lasts so long that the creditor no longer has an interest in performance, he has the right to terminate the contract. The debtor also has this right.

The deeper analysis of Art. 306 of the Trade Law leads us to make the justified conclusion that already in the first paragraph of the norm, the rulemaker with his inherent categoricalness made a specific statement that the person who was obliged to perform a given commercial transaction will not be liable in case of failure to perform the same, if the non-performance was a consequence of force majeure. With this paragraph, the legislator unequivocally resolves the issue related to both the responsibility and the fault of the person obliged to perform the commercial transaction. The burden of proof for the occurrence of the circumstance is attributed specifically to the obligated person, and although this is not specifically stated in the norm, it is presumptively allowed, because one of the most widespread misunderstandings in the matter is related to the fact that force majeure should not simply be declared, but must be proved. For the proof, the greatest burden of proof rests with the trade organizations of the traders, but this will be discussed below in the article. Another feature of the will of the legislator implemented in the norm is related to the fact that the failure to fulfill the obligation must already be a fact, i.e. to have arisen and to be subsisting and the only thing to be decided by the legislator is the question of liability, its occurrence and its application. That is why the norm will be applied only after the non-fulfillment and the impossibility of fulfillment have been proven with the instruments of the law.

In continuation of this line of thought, the norm-maker in the second part of the first paragraph, as a separate norm,

added the addition through an independent and separate text, how to solve the issue related to the terms of implementation.

"If the debtor was in delay, he cannot invoke force majeure."

With this second norm of this article, it is additionally shown and indicated that the institution is only applicable if the force majeure occurred during the performance of the obligation, or in other words, if the person is already in delay [4] and the deadlines for the performance have expired and this event occurs, he cannot refer to the norm and he should not be exonerated and will assume full responsibility for the obligation. Therefore, the obligated party will not be able to refer to the institution of force majeure and must immediately proceed with the execution of the transaction or bear the responsibility provided for non-fulfillment of the same. Precisely through such a construction of his will, the lawmaker protected the state interest and the principle of justice, that contracts must be performed qualitatively and on time, because if the deadline is not met, the performance of the contract may be meaningless, and the party expecting the performance may refuse to receive it due to loss of legal or commercial interest in it.

In the second paragraph of Article 306 of the Trade Law, the definition of what constitutes force majeure is derived and the selection of each of the terms used is not random, but contains the idea that the law carries, namely that no one can bear guilt innocently, and that the consequences arise only for the one who can and should bear the blame. An important condition for the use of this provision is that the contract between the parties has been concluded, entered into force and the deadline for its implementation is in effect, and of course the event referred to by the parties is an event of a random nature.

The terms describing the event that occurred are "unforeseen" and "unavoidable", and one of the disputes in the matter is whether the two, descriptive features must have occurred cumulatively i.e. to have occurred and cause legal action only if they occurred simultaneously, or their legal effect will occur and cause legal consequences and only if one of the signs of force majeure is manifested.

The most widespread of these two controversial theses is also defended by Prof. Gerdzhikov [5], according to which, in order to be able to achieve the security necessary for legal peace in commercial relations, the term "or" in the norm must be replaced by the connecting term "and", and the norm will manifest its legal effect only and only if both signs occur, though not at the same time. According to the same author, it is not legally justified when one feature can replace the action of the other feature and obtain the same legal effect, because if an event can be prevented, but the persons did not exercise the care of a good steward, or due to some negligence have taken the necessary measures to prevent its occurrence, but at the same time it can be accepted and characterized as an event which cannot be predicted to occur but does occur, then the institute will again be applicable, which is deprived of legal logic and does not sufficiently protect public relations. Therefore, the cumulative application of the two features is better suited to public needs and to a greater extent can create a fair solution to overcome the consequences of the accidental

event that has occurred, which prevents the fulfillment of the obligations under the given commercial transaction

On the other side of this perception, I stand apart from the jurisprudence of a number of courts, but also the analysis of some researchers who advocate the thesis that the will of the legislator is justified, and by providing an alternative premise implemented in two separate descriptive features of the given event, are covered more practical cases and greater concreteness is achieved in the legal protection of relations arising between commercial subjects. Perhaps this thesis is best defended in the works of Vanya Jeferlieva [6] according to which, by the description and characterization so used, public attitudes are most adequately answered, because if an event of a fortuitous nature occurs, and it was foreseeable or permissible that it might occur, and the parties did their best to foresee it, but could not in any way take action to prevent its harmful effect, and they occur, then they should not be held responsible for the consequences of the event, and it should qualify as force majeure.

Therefore, both in court and in arbitration practice, it is accepted that in addition to the event, but also the consequences arising from it must be unavoidable, because on the one hand, if the event can be prevented, it will not cause legal consequences, but after since it cannot be prevented and it occurs, then the consequences cannot be avoided or prevented from occurring. And since both the phenomenon and the consequences have occurred against the will of the party obliged to perform, then guilt cannot and should not be imputed. Precisely because of this, the legislator gave the possibility for the obliged person to be released from responsibility, but only after the clear and categorical provision of evidence that he did everything possible to prevent the occurrence of the event and its consequences, or at least exercised care of a good trader, which should also be examined and proven.

But let's return to the analysis of descriptive signs of force majeure, because it is precisely in their interpretation that the details that provide the most argued justification for the application of the institution of force majeure to the occurrence of non-fulfillment of commercial obligations in the event of a viral pandemic, as it was the pandemic caused by the Covid-19 virus.

First of all, we will interpret what is the meaning attached to the term "unforeseen event" and of course what event can be accepted as such? The practice abounds with different interpretations and interpretations of the term, as most often, it is confused or conveniently replaced with the term "unpredictable event", i.e. an event which cannot be predicted to exist, but nevertheless occurs in the legal peace and is assumed to be treated and applied as force majeure. There are different disputes and arguments in this direction, but the term "unforeseen" is more clear and descriptive, because it contains a word combination that shows that the event can and does exist, but no one in the past period could allow when and where, it may occur and what is the magnitude of the consequences that may occur if this event occurs. With this term, in fact, the legislator assumes that if something cannot be proven not to exist, it is assumed that it exists and it should be predicted that it can occur. This practically covers the

entire spectrum of phenomena that exist physically. Another is the perception and understanding of the term "unforeseeable", it is rather used for an event whose existence cannot be admitted, but nevertheless occurred and caused given legal consequences.

The second term used to describe the sign of the event of an extraordinary nature, used by the legislator is "unavoidable", with it we associate the description of the behavior of the obliged person and the hypothetical assumption of the range of actions that he should have taken to oppose the occurrence of an event or its consequences. Whenever analyzes are made of the behavior of the obliged person, an answer to the question must be sought: whether the obliged person could, in one form or another, do what is necessary to prevent the occurrence of the event of a random nature and, accordingly, to prevent the occurrence of the harmful consequences of it, and of course whether this was possible to be carried out with the available forces and capabilities of the person or of third parties whose competences are specifically related to overcoming harmful phenomena of a similar nature, if and when such occur or occur.

The term "inevitably" used by the legislator gives a wide range of interpretative considerations and all of them are refracted through the prism of the concept touched upon above in the article, concerning the competence of the trader - a professional, who treat him as a subject of the law with special competences, which follows, in addition to being able to anticipate the various categories of risks in his profession, but also to take actions to prevent their occurrence. The judgment in the process must be made through the prism of the care that should be exercised by the "good merchant" in the trade law regulations and his efforts to prevent every harmful consequences that may appear and its personal obligations in this trade realtions. This feature is also described in great detail by Vanya Jeferlieva [8] according to which the good merchant may and should be made a claim that corresponds to his capabilities and the counter party's claim cannot exceed due diligence in performance. Or, in other words, the good trader cannot be required to do anything more or anything extra beyond his normal and currently existing capabilities. Of course, purely hypothetically there is also the possibility to compare these possibilities with the possibilities of other traders and to assess their reaction if they are put in a situation identical to the one that took place and treated as a force majeure, but the subjectivity and the different forms of reaction are strictly specific and strictly applicable even to the specific event itself. In this line of thought, the unpreventability of the event often does not mean the unpreventability of the harmful effect and resulting consequences.

In the third paragraph of Art. 306 of the Trade law, the legislator fixed the procedure by which the notification of the other party should be carried out that due to the occurrence of force majeure, the performance of the obligation will not be carried out.

What is interesting for analysis and relevant to the topic related to the pandemic as force majeure is related to the interpretation of the legislator's understanding of the concept of "adequate notice period" to the counterparty of the occurrence of the event or phenomenon that can be accepted

as force majeure and which prevents the performance of a given commercial obligation. With the adoption of the special Law on measures and actions during the state of emergency, announced by a decision of the National Assembly of March 13, 2020 and to overcome the consequences [7], the state actually fixes and postpones a large part of the deadlines for the fulfillment of obligations, but in view of the provisions of the commercial law and commercial law, the terms for notification were not fixed and the applicable regime regarding the notification of the counterparty of the event or phenomenon of an extraordinary nature remained the same as for the other events falling under the norm of Art. 306 of the Trade Law.

In commercial law, an appropriate period for the provision of the notification is accepted as any period suitable and sufficient for the submission of information through which the other party can react adequately to a newly formed reality, and this period should not be too short and too delayed in time, and the judgment as to how far it may be considered reasonable is again left to the court, which must decide in the circumstances whether it is acceptable or not. Thus, this important detail is subject to proof and carries an independent burden of proof regarding the establishment of the good faith of the merchant. As any notification actions taken after the expiration of a period that may be considered appropriate or acceptable will not be considered by the law enforcement authority. Since the accepted form for concluding contracts between traders is strictly formalized and in writing, the legislator has also taken the view that the notification of the occurrence of force majeure must also be in writing, having deliberately not specified explicitly the content of this notification, and so it is gave the parties the opportunity to determine for themselves how their will should be implemented in this statement. Another required element of the notification is the obligation for the notifying party to make a description of the nature and nature of the force majeure that has occurred, which prevents the performance of the contract and the possible consequences, and conditions that have arisen for the performance of the obligation or those arising from the non-performance, etc. The practice so far shows that the notification, in view of its mandatory written form, follows and can be made through the use of a courier service, which must necessarily be able to be used as a means of proof. In practice, it is accepted that even on the envelope it should be mentioned what the contents of the shipment are, and that the delivery of the document was made on the specified date, as well as it should be described on a separate document, on which it should also be noted indisputably which one postmark date. If the provision of Art. 306 par. 3 and the procedure contained therein are not complied with, the obliged party will bear full responsibility for the damages caused and will not be able to take advantage of the provided opportunities described in the previous paragraphs of Article 306 par. 1 and 2. Moreover, in case of non-notification, additional liability may be sought for the damages incurred, and not only from the non-fulfillment of the main obligation, but also from the non-notification. This is because the purpose of the notice is not simply to state to the other party that the obligation to him will not be able to be fulfilled, but also to inform him that he should look for other ways to realize his interest.

The following provision of Art. 306 of the Trade Law, paragraph four, concerns the circumstance that the legislator accepts force majeure as a phenomenon of a temporary nature, which follows and can pass over time, and in practice the execution is suspended only and only while this accidental phenomenon lasts. However, there is no express regulation as to whether the parties' interest in performing the obligations still exists or not and whether they can choose between continuing the transaction or not. According to the situation thus fixed in the law, they have no choice and their relationship should be continued.

However, in the norm, the issue of suspension of performance and the possible subsequent termination of the contract between the parties does not indicate the order in which the issue should be resolved, in which performance will be resumed after the expiration of the period during which the force majeure lasts. This is a known omission of the legislator, because in the next paragraph of Art. 306 contains a regulation if the force majeure lasts so long that the counterparty loses interest in the performance of the contract, but nowhere is the question of how and under what conditions the performance of obligations should be restored. Of course, the general practice says that the obligation is postponed and is accepted as active, in force, and real, but here the limit and the collision that may possibly arise is related to the application of another legal institution such as the one described in Art. 307 of the Trade Law that of economic intolerance or activation of the next paragraph of Art. 306 – para. 5. Therefore, the postponement of obligations in the case of economic intolerance is considered to be real only while it lasts and immediately after overcoming it, the fulfillment of obligations must be started.

Precisely following the legal logical sequence in Art. 306 par. 5, the hypothesis of what should be the behavior of the parties if they end up in a situation where both or only one of them wishes to terminate the contractual relationship between them. The form of expression chosen by the legislator is actually quite evasive and ill-chosen, because in the conclusion of any commercial contract, it is assumed that the parties are equal and it is concluded in a state of mutual benefit, in which each contracting party has achieved what it needs to satisfaction of the legal interest, and has negotiated favorable conditions for her. In the provision of Art. 306 paragraph 5, however, a certain advantage is given to the creditor, who is first given the opportunity to refer to the permanent continuation of the force majeure and, if he has lost interest in the performance, to be able to refer to the law and terminate the contractual relationship. Only in a subsequent separate sentence, i.e. through an independent separate norm, such a right is also granted to the trader who owes performance under the transaction. This was not done by chance and reflects first the rights of the creditor, and only then of the debtor, although in practice there are plenty of examples where, especially for the so-called futures transactions, if the subject of the transaction is seasonal production that has perished due to force majeure, the debtor company, upon the occurrence of force majeure, refuses the transaction, and does not suspend it, due to the fact that in the next season the terms of execution may be different for it as well it is fairer to invoke the provision and thereby terminate

the contractual relationship rather than postpone it until the next season when the force majeure will have passed but the market relationship will also be different.

A significant omission is the absence of a norm that determines the form and procedure that should be done in order to manifest the necessary legal action, presumptively assuming that this is done in accordance with para. 3 of Art. 306 of the Civil Code - in writing and within a reasonable time. Another omission is that nowhere is it described exactly from which moment the contract will be considered terminated and under what conditions the termination will be realized and what will be the possible additional consequences of the termination. All this gives rise to legal disputes and trials, an important part of the evidentiary process in each of which is that in order to invoke the rule the facts must be admitted that the three facts necessary to terminate the transaction must have operated together or with others words, for the provision of the norm to come into force, we must have force majeure, it must last permanently, and the parties (or one of them) have lost interest in the transaction, to declare their will by explicitly referring to it.

With the adoption of the special law, which was the Law on measures and actions during the state of emergency, announced by a decision of the National Assembly of March 13, 2020 and to overcome the consequences, precisely this legal basis was created to ensure evidential implementation of the clauses of the Terms and Conditions concerning the failure to fulfill commercial obligations caused by the occurrence of a force majeure circumstance. Only exactly two years after the restrictive obligations were introduced, on 01.04.2022 all anti-epidemic measures were lifted and practically the reference to force majeure for the non-fulfillment of concluded contracts of this nature was dropped, and the economy began to slowly recover and look for ways to build again the interrupted processes. Regardless of the spread of the virus and the phases that the economy and society went through during those two years, as soon as the pandemic risk subsided, businesses began to look for ways to settle disputes that arose between them, and when disputes could not be resolved extrajudicially to solved through the means of commercial law. Precisely because of this, from a purely practical point of view, it is necessary to examine in detail the various arguments and means of evidence that can be used and accepted by the court as legally relevant and proving the real reasons for non-fulfillment of commercial obligations. It is extremely difficult, and impractical, to unify the individual cases, and that is why it is necessary to acent on several elements important to the process, which should be examined and accepted without question, before proceeding to the more detailed examination of the specific cases. The first and main thing that must be fixed are the terms in the contracts - the period of conclusion of the transaction, the period of performance, the date of occurrence of the force majeure circumstance, the dates of the notification, the dates of the suspension and the dates of the restoration of the performance or the date from which considers that the contract will not be performed due to the loss of interest in its performance. As of the date of entry into force of the decision of the National Assembly of 13.03.2020 on the creation of a state of emergency, all actions and activities related to the

performance of a given contract can be accepted as conditional for performance because they exist during a specific state of emergency and passing under the status of an unforeseen and irreversible event. All contracts concluded before this date and subject to execution after the date of the declaration of the state of emergency can use the force majeure as a circumstance for non-performance, but all contracts concluded after the date 13.03.2020 are subject to execution in the relevant order, because they were concluded during the declared and statutory time stage. There are several categories of evidence, as regards the non-fulfillment of commercial transactions, an extremely important document with primary evidentiary value is the certificate of force majeure issued by the Bulgarian Chamber of Commerce and Industry [8]. By its essence, it represents an expert analysis of force majeure phenomena or circumstances that prevented or delayed the fulfillment of the given obligation, fixes the place and time of their occurrence, as well as the period of their effect, as well as comprehensive additional information establishing the cause-and-effect relationship between the phenomena and the complete or partial non-performance of the contract between the parties. For every single intention and realized action, it is good to create formalized and suitable evidence, so that in the event of a possible dispute, such evidence can be presented and they have a suitable evidentiary weight. The judgment of the parties in these relations and the timely and reasoned reaction are extremely important, because the very invocation of the state of emergency, which is not disputed, is itself a force majeure circumstance due to the fact that the affected parties cannot in any way stop the spread of the virus, cannot resolve disputes that have arisen, but must be backed up with additional argumentation and evidence.

III. CONCLUSION

As a conclusion from the analysis made on the failure to fulfill contractual obligations in the occurrence of an extraordinary, accidental, unforeseen and unpreventable event during a state of emergency caused by the spread of the

Covid-19 virus, it will undoubtedly be developed by the legal matter in the years to come. The unabated spread of the virus and the multitude of new strains emerging means that countries' economies will be constantly exposed to stress tests and businesses will have to continue to function in an environment of unnatural uncertainty. The law, as a real reflection of our reality and guaranteeing the security and justice of relations, will be constantly challenged to give an adequate assessment of the relations of the subjects and be a measure in them. Business, for its part, must also change and adapt to the new features of reality, namely that it must create such an environment of action in which even if events occur again that cannot be prevented, it must create alternative forms of functioning and techniques and technologies can provide adequate solutions for this.

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Courier Services in the Conditions of a Pandemic (case study of "Speedy" JSC)

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Abstract—The current study examines the impact of the COVID-19 pandemic on courier services in Bulgaria. The market of nonuniversal postal services in the country for the past 3 years is analyzed. The current financial and market state of SPEEDY JSC is discussed and conclusions are drawn for the future courier services market trends.

Keywords—courier services, COVID-19, digitalization, deliveries

I. INTRODUCTION

In modern society, an increasing part of the population is taking advantage of the possibilities of e-commerce, which often relies on various courier/postal operators.

At the same time, in the conditions of the COVID-19 pandemic, people were forced to stay in closed spaces, and the main alternative for acquiring various products became through courier deliveries. It can be argued that while a number of other industries are greatly affected by the crisis caused by the pandemic, things are just the opposite for these services. Thanks to e-commerce, which is enjoying significant growth and thus leads to the growth of related industries - online payments, courier services and cyber security.

In Bulgaria, the courier/postal services market is not very defragmented and consists of several main companies - "Econt Express" with a market share of 37.1%, "Speedy" JSC with 30.8%, "DHL Bulgaria" with 7.4% and "Bulgarian Post" with 6.2% [1]. COVID-19 has played a significant role for these organizations to strengthen their positions in the market and even have the opportunity to increase the price of the service provided, because many consumers are willing to pay more for so-called "contactless" deliveries [2].

Inevitably, this will lead to the generation of higher turnover and income for postal operators.

The **main objective** of the present study is to determine the impact of the COVID-19 pandemic on the activity of courier service organizations.

The following **tasks** have been selected:

- ✓ Analyzing the state of the postal services market before (2019) and during the COVID-19 pandemic (2020 - 2021);
- ✓ Examination of the income from the main activity of one of the leading companies providing this type of service in last 3 years;

- ✓ Analyzing the consequences of COVID-19 on the activity of the selected organization;
- ✓ Revealing prospects and problems for other transportation services.

II. METHODOLOGY AND ANALYSIS

The current study uses official data from the Communications Regulatory Commission (CRC) and annual financial statements (AFS) of one of the leading companies in the country - "Speedy" JSC. The focus is on the so-called non-universal postal service (NPU), which covers courier services, but it should be considered that most operators in the country also provide the universal postal service.

The national statistics institute [3] describes the non-universal postal services as a service that cover the orders, carriages and deliveries of national and international post parcels, which are not part from the universal postal services. These services include transport, delivery, distribution, storage and processing of clients goods or correspondence and it consists the courier service.

The courier service is presented as: "The courier services include postal parcels like correspondence parcels (letters and/or post cards), printed issues (newspapers, periodicals, books, catalogues and other printed publications), small parcels up to 2 kg and courier services, direct mail (direct post advertising) up to 1 kg and parcels up to 10 kg.

Parcels include national and international parcels from 10 to 20 kg of goods of commercial and non-commercial value. A parcel is a package post with defined dimensions and weight and contains different objects, materials and goods" [3].

Telegrams include receiving and delivery of electronic or physical messages [3].

Observed are national and international courier services, parcels over 10 up to 20 kg and telegrams.

National services - the sender and the addressee are on national territory [3].

International services - the sender and the addressee are in different countries [3].

According to CRC data for 2021, compared to the previous year, the following trends are observed:

- ✓ Growth in the number of courier shipments, in absolute terms by 26.4%;
- ✓ Growth in the number of postal money transfers of 14.4%;
- ✓ Insignificant growth of 0.7% in the number of hybrid mail shipments;
- ✓ Decrease in the number of postal items for the country and abroad by 27.8%;
- ✓ Decrease in the number of postal parcels for the country and abroad by 22.6% [1].

Regarding the dimension in natural meters for parcel shipments, it is from 94 million for the year 2019, to 102.4 million pieces in the year 2020 and 129.3 for the year 2021. The gross increase in the volume of shipments was 35.3 million shipments over a period of three years, or an average increase of 5.16 shipments per capita in the country.

As mentioned earlier, there are several main organizations in the country's courier services market, and the changes in their market shares can be seen in Table I:

TABLE I. MARKET SHARE OF COURIER OPERATORS IN BULGARIA

Courier operator	Market share (by income)		
	2019	2020	2021
Econt Express	32.5%	36.3%	37.1%
Speedy JSC	24.1%	28.5%	30.8%
DHL Bulgaria	7.5%	7.9%	7.4%
Bulgarian Post	10%	8%	6.2%
All Others	25.9%	19.3%	18.4%

Data by: CRC, Annual report – Analysis of postal services market for 2021 [1].

The table shows that the market leader is Econt Express, which in 2021 holds 37.1% of the market. At the same time, "Speedy" JSC has the largest growth in its market share from 24.1% to 30.8%, which is about 7%. For the same period, the market leader has registered a growth of 4.6%. On the other hand, the national postal operator - "Bulgarian Post" continues to lose positions, from 10% in 2019 to 6.2% in 2021.

It can be concluded that "Speedy" JSC is developing best in the conditions of COVID-19 in the Bulgarian market and has the prerequisites to be case study for this research paper.

For the considered period, the volume of sales of courier services grew by BGN 165.2 million or almost 37%, which is a significant increase (see Table II).

TABLE II. NON-UNIVERSAL POSTAL SERVICES INCOME IN BULGARIA

NPS	Income (mln. BGN)		
	2019	2020	2021
Courier services	446.5	524.6	611.7
domestic	325.1	389.9	453.7
international	121.4	134.7	158
Hybrid mail	16	17.6	16.8
Postal commercials	0.8	0.7	0.7
Money transfers	14.1	15.5	17.6
Total	477.4	558.4	646.9

Data by: CRC, Annual report – Analysis of postal services market for 2021 [1].

Courier services in the country grew for the same period by 39.56%, and international by about 30%. This is the main proof that this type of service is extremely profitable in the conditions of a pandemic.

The table shows that the remaining postal services that fall into this category have an insignificant share of the market.

One of the main catalysts for this growth is e-commerce, which is estimated to be around 2.5% of the Bulgaria's GDP [4]. According to CRC data - 33% of all consumers shopped online, of which 96.1% shopped from Bulgarian online merchants, 29.7% from online merchants in the EU and 16.5% from merchants outside the EU [1].

At the same time, according to a report by the European Commission for Electronic Commerce – „The Covid pandemic accelerated the digital transformation of businesses in Bulgaria and accelerated the merger of physical and online trade“[5]. Completely offline business such as workshop for coloring ceramics in Sofia completely transforms the online business model, in about 10 days during the state of emergency they transformed the model, processes, launched an online store and had orders. Another completely offline business created a landing page with the ability to purchase, send a link with bank payment, contactless payment and contactless delivery; Taxis have become couriers for the delivery of online orders and so on [5].

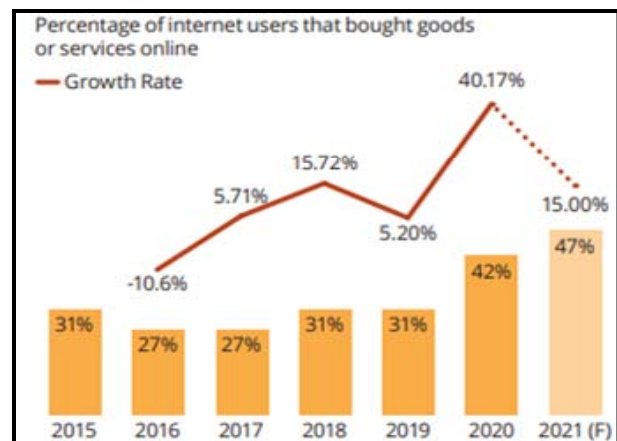


Fig. 1. E-commerce growth in Bulgaria (data by: Ecommerce Europe – 2021 EUROPEAN E-COMMERCE REPORT [5])

According to the same report (see Fig. 1), the share of Bulgarian consumers who bought goods online has increased during the first period of the pandemic (2020) by 10%, compared to the previous year, and later on in 2021 it reached 47% [5]. It is evident that the state of e-commerce in the previous years was almost at the same rate and it can be argued that COVID-19 had a serious impact on it and hence on the work of courier organizations.

The pandemic forced not only business to rely more on courier services, but also brought the development of electronic government and the increased usage of postal services by the state administration. In the field of digitization, various rules and norms for the work and assessment of civil servants are being developed [6, 7].

As mentioned earlier, Speedy JSC had the best performance in the conditions of COVID-19, which makes the company suitable for case study. It is traded on the Bulgarian Stock Exchange - Sofia and has a significant amount of business information and periodic financial reports that are publicly available. In addition, the dynamics of real financial indicators can be compared to the dynamics of stock trading on the stock exchange.

The company made significant investments in 2019, in the first half of the year their intensity was lower, with investments on a non-consolidated basis amounting to BGN 7.37 million, almost entirely in cars (BGN 5.1 million) and in smaller amount in computer equipment and software (BGN 0.8 million) [8].

On a consolidated basis, investments reach BGN 12.7 million, with investments made in subsidiaries in software provisioning and logistics capacity - newly hired assets added BGN 1.4 million. in assets right of use, and in business inventory, improvement of leased assets and other equipment, an additional investment of BGN 3.5 million was made [8].

At the same time in 2021, Speedy reports that the pandemic has had a beneficial effect on their activity and the demand for courier services has increased. According to the company's consolidated quarterly report at the end of 2021 - “Online commerce continues to be the main driver of growth, with the segment maintaining growth rates at the previous year's levels during the periods of restrictive measures. After the epidemiological situation calmed down, growth rates in Q2 and Q3 slowed, also due to the higher base after the strong Q2 2020 results. Until the end of September, results remained tied to the spread of the virus, with in the periods of opening, the growth rates of the B2C segment slow down, and the growth rate of the B2B segment increases, and vice versa. The new wave of virus spread at the end of the year led to a further shift in consumption to online commerce and boosted growth at the end of the period” [9].

According to the latest report on the activity of Speedy JSC, from the beginning of 2022, the company continues to grow dynamically and report intensive growth, driven mainly by the active expansion of online trade, but also by increased business activity. The significant changes in the economic and political situation, as well as the restrictive measures, had a multidirectional impact on the company's activities. Restrictions aimed at limiting the spread of the virus were eased in a large number of countries in Europe in the first quarter of 2022, which also led to a slowdown in the growth of online consumption and, consequently, the demand for courier services. After the slowdown in growth at the beginning of the year, business activity and consumption in Bulgaria has significantly increased in recent months, which has significantly increased the demand for our services in the country. Domestic revenue growth increased to over 30.4% in the 2nd quarter over the previous year, a significant increase from the 13.7% achieved in the 1st quarter. The B2B segment also contributed, which in the last three months achieved a record growth for recent years” [10].

From the published data it can be seen (see table 3) that Speedy JSC has an increase in sales revenue in the country of about BGN 50 million between 2019 and 2021. The growth in

the volume of sales for the first pandemic year (2020) is of 17%, and between the first and second year it is 20.6%. In natural metrics, this means an increase in transported shipments from 39.5 million parcels to 60.1 million parcels, which is a significant increase in the company's performance.

TABLE III. REVENUE STRUCTURE OF SPEEDY JSC

In thousand BGN	2019	2020	2021	Change 20/19 %	Change 21/20 %
Domestic marker	120510	141542	170648	17.5%	20.6%
International	98468	131643	161623	33.7%	22.8%
Others	9081	7995	7144	-12%	-10.6%
Total number of courier parcels	39586	52173	60115	31.8%	15.2%
Total revenues	228059	281180	339415	23.3%	20.7%

Data by: Speedy JSC management report Q4, 2021 [8].

It is evident that the change is significant for the first period of the COVID-19 pandemic, where the increase in the volume of transported parcels was 31.8%. The total revenue increase reported for the same year is 23.3%.

On the other hand, the shares of the company on the stock exchange market are not so high (see fig. 2).



Fig. 2. SPEEDY JSC on Bulgarian Stock exchange (Data by: BSE – SPEEDY [11]).

The data from the Bulgarian Stock Exchange - Sofia show a moderate growth in the company's shares. As in percentage terms, the price increase is 16.745%, and in value terms, the growth is BGN 15.35 [11]. This shows a significant lag behind the growth of sales revenue of 20.6%. Therefore, the company has significant potential for growth. The investments made in logistics bases in Bulgaria and abroad, as well as in the renewal of the car fleet, will have a positive impact on the price of the company's shares.

TABLE IV. IMPORTANT FINANCIAL RATIOS FOR SPEEDY JSC

ROA	0.20	ROA cons	0.15
ROE	0.47	ROE cons	0.42
ROA/EBIT	0.22	ROA/EBIT cons	0.18
ROE/EBIT	0.52	ROE/EBIT cons	0.52
Asset turnover	1.41	Asset turnover cons	1.59
Current ratio	0.97	Current ratio cons	0.89
D/A	0.52	D/A cons	0.67

Data by: BSE – SPEEDY [11].

Speedy JSC shows very good profitability with return of assets (ROA) 20% and 15% for consolidated. The results for the shareholders are even better return on equity (ROE) 47% and 42% respectively for consolidated. The company has paid dividend regularly, this year its amount was 4 BGN per share according to Bulgarian stock exchange data. Asset turnover is

very good for the sector. For the Bulgarian speedy JSC shows very good financial results and possibility for future growth.

III. CONCLUSION

In conclusion, it can be argued that the Covid-19 pandemic has a positive impact on e-commerce and an indirect effect on the activity of courier companies. Both in kind and value meters. For its part, Speedy AD is also generating significant growth, with the full growth potential not yet exhausted. Covid-19 is catalyzing fundamental changes in postal services, such as:

- ✓ Digitization of processes;
- ✓ Contactless deliveries;
- ✓ Money transfers;
- ✓ Home office service and others.

From a macroeconomic point of view, courier services are a counter-cyclical indicator compared to other industries.

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Viral Business Process Modelling

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Abstract—Until recently, viral business processes were not considered as a separate component (or at least a variety of standard business processes) in the system of business processes despite their serious potential to affect it- usually in a negative aspect but also not seldom in a positive one.

Keywords—viral business process, business process analysis, stages of business process analysis, monitoring, description

I. ESSENCE AND CURRENT STATUS OF THE PROBLEM

Viral business processes were first defined by the author in 2020 as “business processes that conquer the resources of other business processes in the system”[1] in the article „Viral Business Processes“. The final conclusion of this article remains relevant even today (two years later): “Viral business processes are understudied, objectively existing phenomenon that needs to be described, examined and analyzed because experience shows that they can significantly change the manner and effectiveness of the functioning of any system of business processes, even with a fatal outcome for the system” [2].

The author’s research in this area confirmed this conclusion, showing a curious aspect of viral business processes, which should be paid special attention to- viral business processes could optimize the system in the direction of more efficient distribution of its resources. This new aspect raises even more strongly the question of modelling viral business processes and their impact on the system.

II. IDENTIFICATION THROUGH PRELIMINARY MODELLING

The most difficult part of modelling viral business processes is determining their location. There are four options determining them:

- by accident;
- by psychological techniques from the array of organizational psychology and social engineering;
- by the exclusion method;
- by the preliminary modelling method.

An interesting fact from the author’s practice is that non-specialists in business process analysis most often come across viral business processes by accident (as a result of a combination of coincidences).

A curious novelty (for the author as well) is the application of psychological techniques from the organizational psychology array (the social engineering and

forensic science arrays included) when determining the location of the viral business processes- by asking and answering the following questions:

- Who (which employee) would like to ease their work without taking into consideration anybody, other employees included?
- Who (which employee) would resist existing business processes because they have great experience/ knowledge/lore in the given process (or group of processes) and could optimize it (in their opinion)?
- Who (which employee) would resist existing business processes because they are lazy/sloppy/irresponsible?
- Who (which employee) exercise resistance upon the existing business processes because they do not find their source reliable/ authoritative.
- the management imposing them;
- the business process analyst who monitors, describes, analyses and optimizes them?
- Who (which employee) exercise resistance upon the currently existing business processes and wish to use an older version of them (in the case of companies with recently optimized business processes)?

The exclusion method in this case is extremely unreliable when used on its own but it can be very useful as a complementary analytical tool in conjunction with psychological techniques from the organizational psychology array.

Their combined use can lead to finding the relevant employees would make it many times easier to locate the viral business processes indirectly- calculating the potential sources/authors of business processes and checking their business processes first.

It is necessary to note that for the effective application of psychological techniques from the array of organizational psychology, it can be extremely valuable to involve the company employee responsible for human resources as well as the company psychologist.

The most effective method (according to the author) for identifying viral business processes is the method of preliminary modelling. It consists of knowing the main characteristics of viral business processes and using them for the construction of the preliminary model of the business process sought for the purpose of locating it as efficiently as possible.

The key characteristics of viral business processes are the process reactions they cause in a chain.

- Viral business processes do not appear on their own- they are almost always the output of the actions/inactions of an employee of the organization who decided that by creating a viral business process they would ease his work.
- Viral business processes redistribute the resources of existing business processes and process groups- viral business processes redistribute the resources of the business processes directly affected by them in a huge number of cases (it should be noted that the organization is not always at a loss due to that activity).
- Viral business processes change the functioning of the affected business processes by triggering chain business process reactions- here the consequences are more often negative for the organization, because “the authors” of viral business processes (i.e. the employees who created them) rarely think about the consequences of their actions outside their entrusted process or group of processes (for them these are indirect/side effects).
- Process chain reactions have the property of weakening when distanced from their source (i.e. the business process whose change initiated the process chain reaction).

By knowing these key characteristics, it is possible to determine the location of the available viral process by building a preliminary model of it, which consists in answering the following questions:

- Which are the affected business processes?
- In what chronological order are they affected- all at once, in parts/portions, one after the other?
- What is the strength of the chain process reactions and in what direction does it increase/decrease?

The intersection of the answers to these questions allows extremely accurate location of the viral business processes. Naturally, things get significantly more complicated when there are more viral business processes close to each other.

III. BUSINESS PROCESS MODELLING

Following the successful viral business process location, it needs to be modelled in several directions.

- What is the reason (i.e. what prompted) the emergence of the viral business process?
- Is it more optimal (or not) than the original business process?
- Does it create process chain reactions that lead to changes in other business processes?
- If the answer is yes, how does it affect the related business processes- in a positive or in a negative way (from the point of view of optimization)?
- What is the final outcome for the organization’s entire system of business processes?

Modelling the viral business process provides answers to these questions. It consists of five stages:

- monitoring;
- description of the algorithm and calculation of the characteristics of the viral business process;
- analysis of its impact on related business processes;
- analysis of its impact on the entire system of business processes of the organization;
- Comparison between the original and the viral business process.

First stage- observation

At this stage, the only specificity is in the business process data collection through monitoring. The difficulty lies in the fact that the creator/author of the viral business process may be aware of the wrongness of his actions (in creating and using a viral business process) and may create (deliberately or not) difficulties in monitoring the viral business process.

These difficulties are usually overcome in one of the two ways:

- direct monitoring through the application of technical means;
- direct monitoring without application of technical means;
- social methods.

Direct monitoring through the application of technical means includes:

- direct remote monitoring in real time;
- video recordings;
- audio recordings;

The most effective (according to the author) methods of direct observation through technical means are video recordings, because they allow more optimal data collection.

The social methods of collecting information that are most often used in this case are:

- interview with the viral business process author ;
- cross-examination.

Interviews as a tool for obtaining information can only be effective in the following cases:

- voluntary participation and good will from the interviewee (when the author of the viral process is driven by altruistic and/or optimization motives);
- cooperates and/or does not try to mislead the interviewer because he realizes that he has made an uncoordinated change to prescribed business processes;
- at the beginning of the interview, evidence is provided to the interviewee about the viral business process he created.

Interviews as a tool for obtaining information can’t be effective in the following cases:

- the interviewee changed the prescribed business processes with selfish motives (irresponsibility, laziness, lack of work motivation, etc.);
- the interviewee doesn't cooperate and/or try to mislead the interviewer because he realizes that he has made an uncoordinated change to prescribed business processes;
- the author of the viral business process is unaware of the viral business process he created and its consequences (process chain reactions, etc.)
- there is no evidence of the viral business process created.

The problem with applying the interview as the primary data collection method for the viral business process is the need for assistance from the creator/author of the viral business process.

In the absence of cooperation, the method cross-examination can be used, but it is important to consider whether the use of this method will not lead to conflict between the employees of the organization.

Cross-examination (interview with several interviewers) is a highly undesirable method because it can lead to extremely strong feedback from staff leading to serious reputational damage for management and/or the business process analyst. A possible solution from the author's practice, which is both effective and without (or at least with significantly reduced) reputational damage, is conducting a cross-examination in an indirect form - for example, a meeting that includes a dialogue between the interviewee and several interviewers.

An essential factor for the effectiveness of the interview and cross-examination are the "soft skills" of the interviewers - an often underestimated fact when conducting them.

It is also helpful to have both internal and external participants available among the interviewers - all with a combination of analytical and soft skills.

Second stage-description of the algorithm and calculation of the characteristics of the viral business process

There are no specifics at this stage, so it will be described very briefly.

The methods for describing the process algorithm are standard:

- textual methods;
- text-table methods
- complex methods - for example system analysis or MUSKA
- graphic methods- UML, BPMN, ARIS.

The methods for calculating the characteristics of the viral business process are as follows:

- the mathematical means of system analysis;
- the mathematical means of MUSKA;
- other mathematical means.

Third stage - analysis of the impact of the viral business process on the related business processes

A feature of this stage is the need to identify all affected business processes. There are two ways to identify them:

- by the exclusion method;
- by the preliminary modelling method.

When using the preliminary modelling methodology, it is recommended to carry out the study of the affected business processes in several sub-stages.

The first sub-stage- the processes that are directly related to the viral process:

- through logical connections/conditions;
- through chronology (i.e. previous and subsequent)
- through communication links;
- through information links.

In the author's practice, cases were registered (9% of all cases) in which the viral business process did not affect the processes surrounding it.

Second sub-stage- the processes that are directly connected (through the listed types of connections) to the affected processes by the virus process.

Third sub-stage- the processes that are directly connected (through the listed types of connections) with the processes of the second stage.

The second and the third sub-stages are repeated until related processes that are not affected are achieved (i.e. the process chain reaction that was initiated by the viral business process has ended).

It should be noted that the identification of the affected business processes is extremely important, because wrong/incomplete identification of the affected business processes is a prerequisite for serious errors in the subsequent stage of analysis of the impact of the viral business process on the entire system of business processes of the organization. This is perhaps the most time-consuming stage of viral business process modeling.

As in the previous stage of modelling the virus business process, the methods for calculating the impact of the viral business process on the related business processes are as follows:

- the mathematical means of system analysis;
- the mathematical means of MUSKA;
- other mathematical means.

Fourth stage-analysis of the impact of the viral business process on the entire system of business processes of the organization.

This stage is practically a cumulative result of the outputs in the second and third stages.

The only feature in this stage is the possibility of passing the accumulated quantitative changes (which were identified

and analyzed in the previous two stages) into qualitative ones (in a positive or negative direction)- i.e. it is important to answer the question:

“Do the local changes that are caused by the viral business process lead to global (within the system) systemic changes?”.

As in the previous stage of modelling the viral business process, the methods for calculating the impact of the viral business process on the related business processes are as follows:

- the mathematical means of system analysis;
- the mathematical means of MUSKA;
- other mathematical means.

The importance of this stage (including the answer to the above question) is often seriously underestimated – this may lead to disastrous consequences for the organization.

Fifth stage-comparison between the original and the viral business process

As a fellow business process analyst put it, this stage is the “truth stage”. It is necessary to answer the following questions here:

- Is the viral business process beneficial to the system (i.e. does it optimize it?)
- If yes, should the viral business process replace the original one?

- If not, what measures must be taken to restore the original business process?

An extremely effective complementary analytical tool in process comparison can be the SWOT analysis - to assist in assessing the advantages, disadvantages, opportunities and threats of replacing the original business process with the viral one.

IV. CONCLUSION

Viral business processes are understudied but objectively existing phenomenon with a serious impact on individual business processes and on the entire systems of business processes of organizations. This impact can be both negative (in the majority of cases) and positive (less often), but in all cases it must be objectively studied and analyzed correctly with combination of soft skills and different analytical tools - psychological techniques from the array of organizational psychology and social engineering, exclusion method, preliminary modelling method, SWOT analysis.

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Intermodal Transport Terminal Build up (a case study for the city of Ruse)

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Abstract—The current study examines the possibility of building up an intermodal transport terminal in the city of Ruse, Bulgaria. The intermodality of transport and its variables has been analyzed. The option of building second bridge over the Danube River in the same city is discussed. The current measures connected with logistics infrastructure for the region of Ruse depicted in the national plan for development are analyzed.

Keywords—intermodal transport, logistics, analysis

I. INTRODUCTION

Border closures during the pandemic have disrupted supply chains for many businesses, requiring a shift in transport management models and significant changes to logistics operations. Bulgaria is also affected by these problems and in a number of publications it has been examined and analyzed [1, 2]. In addition, there are numerous queues at the borders and delayed crossing of checkpoints [3, 4, 5]. Despite the efforts and some researchers' suggestions to digitalize a range of administrative processes [6, 7, 8], it hasn't been improved so the national and local authorities are looking for other solutions. With one of the most seriously affected regions near Ruse, two possibilities are being discussed:

- Construction of a second bridge over the Danube River;
- Construction of a new intermodal terminal.

The **purpose** of this research is to analyze the two possibilities and to compare them with the measures laid down in the national plan for recovery and sustainability of Republic of Bulgaria.

The main tasks connected with the research are:

- Examining the possibilities of building a second bridge over the Danube River;
- Examining the possibilities of building a new intermodal terminal in the city of Ruse;
- Analysis and comparison of the two options with the planned measures in the national development plan;
- Analysis of the benefits and advantages of the intermodal terminal.

II. METHODOLOGY AND ANALYSIS

For many years, one of the main axes of transport and logistics in Bulgaria has been with our northern neighbor Romania. The Danube bridge near the city of Ruse was the main point of departure for heavy-duty road transport because of the faster land connection compared to the possibility of crossing by ferry.

In 2013, Danube Bridge 2 near the city of Vidin was put into operation and was expected to seriously affect the traffic between the two countries. According to some studies [6], in just 3 years, 1780336 vehicles passed through there, which brought 43 million euros of revenue to the national budget.

However, the measures imposed due to the COVID-19 pandemic and the border restrictions have made difficulties for movement and traffic delays are creating a number of problems in the border settlements. Additional alternatives are being sought to ease traffic, and for the city of Ruse, two main options have emerged - a new bridge over the Danube or the construction of an intermodal terminal.

Data indicates [9] that the construction of Danube Bridge 2 cost the Bulgarian state about 287 million euros and about 83.5 million euros for Romania. Compared to the current value, it can be assumed that the construction of a second bridge near the city of Ruse will cost twice as much if the inflation index of construction prices is taken with a 192 factor. The indicative value would be of around 600 million euros. which is quite a serious investment.

The intended benefits are as follows:

- ✓ traffic relief;
- ✓ additional jobs for employees from the "customs" agency for the new checkpoints;
- ✓ additional rail connectivity to transport larger volumes of cargo.

One of the main disadvantages of such a large infrastructure is the lead time, which will most likely take several years before it is fully operational.

On the other hand, the construction of an intermodal terminal will take much less time, money and will start bringing revenue in a shorter time. This is clearly the main

reason why it was included as a main measure in the national development plan of the country [10] - "Ensuring a fast and competitive transport connection with the business markets in Northern Bulgaria by building an intermodal terminal for freight transport in the area of Ruse". The plan envisages investments in the field of transport for a total of BGN 2996.8 million, of which BGN 1303.3 million is due to the Recovery and Sustainability Mechanism and BGN 846.7 million as a national and private co-financing [10].

An intermodal hub or intermodal terminal is a logistics platform specialized in the transfer of unitized cargo, namely freight loaded onto intermodal transport units, shifting from one mode of transport to another. Generally, with the term “intermodal hub” we refer to a terminal dedicated to combined transport, which involves the transfer of loading units from road to rail and vice versa. [11].

There are three main types of terminals [12]:

- **Port terminals.** In terms of traffic, port terminals take the lead. They are the largest and the most goods pass through them. They operate as a center for intermediation of sea cargo, which is transported and prepared for land transport.
- **Railway terminals.** Connected to the ports, the railway terminals are the beginning of the intermodal network of land transport. The containers are transferred from the ships to the wagons and set off to their destination.
- **Distribution terminals.** Also known as distribution centers, these terminals are the hub of the intermodal transportation industry. These include loading facilities, intermediate dockings and storage facilities.

Usually, when shipping cargoes via such terminals they are transported in the so called “TEU” containers. TEU container is the abbreviation for a Twenty-foot Equivalent Unit. A TEU has a capacity of 20ft (6.1 meters) and weighs around 8,000 pounds (3,629 kilograms) [13]. It usually takes place via sea freight. In simple words, TEU containers are commonly used to ship consumer goods, electronics, clothing, and other merchandise through the water. But if you’re still wondering how popular these containers are, here’s something that might help. TEU’s play a key role in global trade and commerce. In 2019, over 17 million TEU containers were shipped around the world – signifying the surging demand in the market [13]. 20ft Pallet wide container. Pallet-wide containers are built specifically to carry wooden Euro pallets and can fit up to 11 Euro pallets in a 20ft size.

The other option is the FEU The 40-foot container’s dimensions are usually measured using the imperial system (feet) and specifies both the exterior dimensions and the interior (usable) dimensions. The primary difference between a 40ft Standard height container and a 40ft High Cube Container is the difference in height of exactly one foot. The 40ft Standard container is 8ft 6 in high on the exterior, which corresponds to a 7ft 10in height on the interior. A 40ft Standard container has 2,350 cu ft of storage space on the interior, whereas the 40ft High Cube container has 2,694 cu ft of storage space. This additional height gives the 40ft High

Cube container an extra 344 cu ft of storage capacity[14].

The other main types of cargo containers are [12]:

- **Standard container:** These are used for all kinds of cargo. Commonly called dry containers, they transport dry goods in bulk. These containers have double doors at the rear where cargo is loaded and unloaded.
- **Open Top container:** These are without a roof and are used for oversized cargo that cannot fit in standard containers. The load is covered with a tarpaulin to protect it from weather conditions.
- **Tank:** If you ship liquids, you use a tank. Tanks can contain anything from food to chemicals.
- **Refrigerated container:** It is used to transport cargo at a controlled temperature, usually near or below the freezing point. This container has insulation and a refrigeration unit to maintain this temperature.
- **Container - platform:** They have no walls and no roof. This kind of containers are durable enough to accommodate heavy, oversized cargo that can withstand harsh outdoor conditions during travel.

In particular, an intermodal terminal in the city of Ruse would require the construction of one loading-unloading track, three receiving-departure tracks, electrification of the tracks, signaling and telecommunications, electricity supply, water supply, administrative-service building, domestic building for staff, checkpoint, road connection, storage areas for storing containers (TEU) of different types, parking lots for trucks and cars, customs control point, site for maintenance and repair of mobile equipment, including gas station and car wash, a container repair station, a truck scale, a scanning frame for trains and trucks, a fence and other elements inherent in a container handling terminal [10].

The total planned resource is BGN 51.95 million, of which BGN 44.16 million is due to the Recovery and Sustainability Mechanism, and the remaining BGN 7.79 million is for National Co-financing, with an implementation period of 2022-2026 [10].

From the point of view of macroeconomic theory, investments in infrastructure has a multiplier effect, as during a crisis they have a positive effect on employment and there would be significant benefits for the regional economy of Ruse. A 2013 study [15] indicates that during recessions the multiplier for investment in basic infrastructure is around 3 times – in other words, every euro invested in infrastructure generates an additional 3.5 euro of income. The reason is that better infrastructure fuels other sectors of productive activity such as transport, tourism, real estate and trade. Although the research was done in the US almost ten years ago, the conclusions are still relevant.

Ruse's strategic location makes the development of transport infrastructure imperative, the use of opportunities for river navigation and railway infrastructure can positively affect almost all of Northern Bulgaria, which will have a significant positive economic development, multiplying the effect of infrastructure investments on the entire region (see

table 1). Such projects will help Bulgaria to better realize the opportunities for river transport along the Danube.

According to the GDP indicator, the city of Ruse remains second in the region for 2020 after Razgrad, but it should be noted that in the second city there are serious investments in the field of sports and pharmacy, which distort the data.

TABLE I. GDP FOR THE NORTH CENTRAL REGION OF BULGARIA, 2020

North central Region	GDP, mln. BGN.	GDP per capita, BGN.
Veliko Tarnovo	2 656	11 492
Gabrovo	1 556	14 651
Razgrad	2 786	12 838
Ruse	2 696	12 592
Silistra	892	8 307

Data by: NSI, GDP regional data, 2020 [16].

The same applies to the indicator of GDP per capita, where Ruse again lags behind Gabrovo and Razgrad. In this case, Gabrovo is one of the smallest cities in the region in terms of population, and that is what makes the indicator so high.

On the other hand, in the last 5 years, the Ruse region has seen a small growth in its indicators, as can be seen from table 2.

TABLE II. GAV AND GDP FOR THE REGION OF RUSE

Region/year	GAV for economy sectors			GDP, mln. BGN.	GDP per capita, BGN.
	Agricultural	Industry	Services		
Ruse/2017	155	779	1218	2 505	11262
Ruse/2018	134	813	1303	2 595	11798
Ruse/2019	142	844	1422	2 786	12838
Ruse/2020	144	770	1422	2 696	12592

Data by: NSI, GDP regional data, 2020 [16].

On the table are presented data on Gross Value Added at base prices for the branches of the economy and GDP for the Ruse region. Value added is best for the service sector followed by industries and agriculture. The GDP is also increasing and from 2017 to 2019 it has a growth of about 200000 and in 2020 it decreases, but this is normal considering the COVID-19 pandemic.

Taking into account that the rest of the cities in the north central region have almost the same performance as they did in 2020, it can be concluded that Ruse really has a key role for the region and its economy.

Regarding the predictions of the national development plan, the fully operational intermodal terminal is expected to have the following capacity - annual traffic for the first year is about 20,000 TEU, and the weekly number of trains is 3-4 pairs. As of 2037, the situation regarding regular scheduled services on the main routes to/from Turkey, Central Europe and Sofia is expected to remain unchanged, but train usability will increase. There will be an economic opportunity to increase the number of trains to Western Europe and Greece from 1 pair per week to 2 pairs and to start a new service to Eastern Europe. The estimated traffic is about 10 pairs of trains/week, and the annual freight turnover of Intermodal

terminal Ruse - about 43 thousand TEU. The maximum possible capacity of the terminal is 115,200 TEU [10].

Intermodal terminal Ruse will significantly improve the transport supply for Industrial Park - Shumen, which is 120 km from Ruse for access to the common European market. By 2022, 28 companies are expected to work in this industrial park [10].

Bulgaria has been significantly delayed in start of the national development plan and has gone through five different updates, this entails risks for all corresponding projects, as the economic situation is unstable and with high inflation. Every month of delay makes the projects more expensive and reduces the undeniable economic effect.

Implementation of the EU guidelines for the development of ecological transport and balancing of different types of transport, in favor of rail, by attracting cargo from road to rail transport.

Improvement of intermodality in the south-eastern region of the EU and in particular - the North-Central region of Bulgaria, the attraction of more users and operators, which will lead to an increase in international intermodal transport with the countries of the TRACECA corridor region, Central Asia and the countries of Eastern and Central Europe.

On the figure (fig. 1) is shown the transport connection of Ruse, Bulgaria – with dark green areas within 150 km and light-green areas within 200 km. This is clear evidence of how big would be the region which benefits from the intermodal terminal.

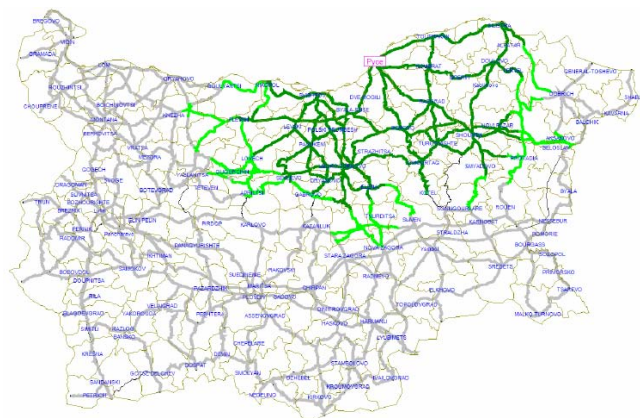


Fig. 1. Transport connection of Ruse (Source: National plan for development [10])

Other main benefits for the region are:

- ✓ Creation of conditions for building a trade-logistics complex and development of services related to it;
- ✓ Increase in revenues in the local budget;
- ✓ Improvement of the environmental situation - reduction of noise and pollution, by redirecting loads from road to rail transport;
- ✓ Raising the standard of living;
- ✓ Reduction of road traffic and road accidents by redirecting the movement of goods;

- ✓ Creation of new jobs;
- ✓ Increasing the attractiveness of the lands for sale.

The city of Ruse itself has a very good location, it has a connection with another large port - the one in the city of Varna and is located about 100 km from the capital of Romania, Bucharest. This is a basic prerequisite for the growth of logistics services in the region, from which there can be many profitable companies. One should not overlook the fact that the company with the largest market share in the field of postal and courier services was founded precisely in Ruse - Econt Express. Another one great beneficent could be the biggest online merchant for Bulgaria – EMAG, which is Romanian, based company and it could transport via more options their goods.

III. CONCLUSION

The **first** conclusion is that investments in an intermodal terminal will have a positive impact on transport connectivity throughout the region and will multiply the economic effect.

Second, the usage of TEU and other containers increases the volume of transport significantly and so the need of intermodal terminals to fulfill it. The city of Ruse already had some infrastructure for river transport and the building of intermodal terminal would allow it to be considered as a hub between Asia and Europe.

Third, any delay in the construction of such infrastructure facilities in an inflationary environment reduces the economic benefits for society and increases the risks.

Fourth, compared to the construction of a second bridge over the Danube near Ruse, the intermodal terminal will cost much less and will be ready for operation earlier.

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Analysis of ERP Integration Failure Factors

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Abstract—Although the risk of ERP system integration failure is continuously decreasing, it is still too high (from 67% in 2010 to about 40% in 2022 according to various studies).

Keywords—ERP, ERP integration, ERP integration failures, business process, business analysis, information management

I. ESSENCE AND CURRENT STATUS OF THE PROBLEM

ERP systems are a key factor in the ability of companies/organizations to adapt and respond to changes in an increasingly fierce competition. They provide an opportunity for advanced analyses and inquiries, improved management of business processes, management of information flows, better distribution of tasks and responsibilities between roles in the company/organization.

The coin, as always, has a flip side - the high complexity, duration and value of the integration are serious prerequisites for the high risk of failure, the consequences of which can even lead to the bankruptcy/closure of the company/organization.

These consequences are too serious to be ignored in an analysis of the risk of integration and its outcomes.

The purpose of this article is to address the failure factors in ERP systems integration based on:

- a survey conducted by the author among fellow business process analysts from Central and Eastern Europe, who wished to remain anonymous;
- the personal professional experience of the author for the last 10 years in the field of ERP technologies and their integration.

II. METHODOLOGY OF THE STUDY CONDUCTED

The conducted research is the result of interviews of business process analysts conducted in the period 2020-2022, selected according to the following criteria:

- high level of specialization;
- at least five years of professional experience in the integration of ERP systems;
- willingness to actively cooperate with other business process analysts;
- agreed upon consent to prevent the leakage of confidential information.

The interviews conducted are:

- standardized - i.e. the same questions (except control and clarifying questions) for all participants;
- individual - all participants answer independently without contacting each other;
- hybrid in terms of the types of questions involved in the interview;
- personal all are conducted by the author of the article;
- remote communication software (Viber, Skype, Zoom) was used for some of the interviews.

The types of questions used in interviews are:

- open questions that do not require expert assessments;
- open questions that require expert assessments;
- control questions;
- clarifying questions.

Open questions that do not require expert assessments refer to:

- number of years of professional experience;
- the total number of ERP systems integration projects in which they participated;
- The number of successful ERP systems integration projects in which they participated.

The open questions that require expert evaluations are about:

- the reasons for the failure of the integration of ERP systems;
- the degree of influence of the various causes of ERP systems integration failure;
- the assessment of the scale of the project (small, medium, large, extra large);
- the methodology used for the development and integration of the ERP system (Waterfall, Agile, Scrum, Canvas, etc);
- the relationships and interactions between the factors;
- the stage in which the interviewee started their participation in a given project;

- the possible measures to prevent the failure of the integration of ERP systems.

Control questions were asked at the end of each interview in order to clarify the “big picture” of the projects in which the interviewee had participated.

Clarifying questions were used in order to clarify individual details both during and after the interviews.

III. IDENTIFIED FACTORS

As a result of the collected information, the following ten factors for the failure of ERP system integrations were established (while it is necessary to note that they can be combined, and in some cases even interact, which significantly increases the negative consequences for the company/organization):

- First factor- inaccurate and/or incomplete information in the business requirements documentation or lack of such documentation;
- Second factor- inaccurate and/or incomplete information in the documentation about the business processes of the company/organization in which the ERP system is integrated;
- Third factor- problems when transferring/importing the data base of the company/organization into the ERP system;
- Fourth factor- skipping or neglecting the test stages in the integration of the ERP system;
- Fifth factor- ineffective coordination and communication between the business and the ERP system developers/integrators.
- Sixth factor- forcing integration as a result of underestimating the time required for successful implementation;
- Seventh factor- underfunding of the ERP system integration project;
- Eighth factor-integration of an inappropriate and/or unadapted ERP system for the given industry/firm/organization;
- Ninth factor- resistance on the part of the staff to innovations and changes;
- Tenth factor- integration of the ERP system without the participation of a competent business process analyst during the entire procedure.

First factor- inaccurate and/or incomplete information in the business requirements documentation or lack of such documentation.

This factor is still seriously underestimated, although it is one of the most dangerous. Its impact directly depends on the methodology used for the ERP system development/integration:

- In the Waterfall methodology, this factor influences as strongly as possible.

- With the Agile methodology the impact is seriously reduced.

- With the Scrum methodology, its influence is as small as possible.

Its most significant interactions are with:

- The fourth factor- skipping or neglecting the test stages in the integration of the ERP system;
- The fifth factor- ineffective coordination between the business and the ERP system developers/integrators;
- The sixth factor-forcing integration as a result of underestimating the time required for successful implementation.

This factor is extremely strong even without its interaction with other factors- it can independently put a cross on the entire ERP system integration project.

Second factor - inaccurate and/or incomplete information in the documentation about the business processes of the company/organization in which the ERP system is integrated

In order for an ERP system to be integrated in a company/organization, it needs to be adapted to its business processes, which in turn leads to the need for the latter to be studied and described in detail. An accurate and/or incomplete description of them may lead to one or more of the following extremely undesirable situations:

- The ERP system does not meet the business processes of the company/organization.
- The ERP system changes the business processes of the company/organization in an undesirable way.
- The ERP system hinders, instead of assisting, the execution of the organization’s business processes.
- The ERP system imposes its own business processes, instead of responding and following the business processes of the company/organization

Even just one of these consequences can be a serious obstacle to the normal functioning of the company/ organization, and their combination could also lead to bankruptcy/closure.

Third factor-problems in transferring/importing the database of the company/organization into the ERP system

In order for the ERP system to be useful for a company/organization, it is necessary to transfer/enter/import the company’s database, including its nomenclatures. An inaccurate and/or incomplete company/organization database may lead to one or more of the following extremely undesirable situations:

- complicated (or downright impossible) obtaining of reports/analyses;
- wrong or incomplete references/analyses;
- the ERP system hinders, instead of assisting, the implementation of the organization’s business processes.

- strong difficulty (or impossibility) of making quick and adequate decisions based on these inquiries and analyses;
- strong difficulty or impossibility of developing a company strategy.

In this case, the greatest advantages of the ERP system for the successful survival and development of the company are reduced (or even eliminated).

This factor has an extremely strong and negative interaction with the second factor “inaccurate and/or incomplete information in the documentation about the business processes of the company/organization in which the ERP system is integrated”, almost always with an extremely negative result for the company/organization. This combination of factors is one of the riskiest and with the most severe consequences for the company/organization.

Fourth factor- skipping or neglecting the test stages in the integration of the ERP system

This factor is one of the most underestimated and that is why it occurs most often. The reasons for this are:

- It relies on the subsequent finding and elimination of errors during its use.
- skipping the test stages is considered to save time and money.
- If problems/errors/bugs are found, the developers/integrators of the system can be blamed
- The importance of test stages for the correct functioning of the integration is greatly underestimated.
- It relies on a small number of errors with minor consequences.

It is extremely difficult to explain to business representatives (especially if they are not familiar with the software development and integration) how neglecting test stages can (and usually does) lead to unpredictable consequences and unpredictable (but in more than 90% of cases significantly greater than the savings) in terms of costs (financial and time) for their removal.

This factor on its own usually leads to unpleasant consequences, but it interacts with each of the other factors (it is one of the most combinative, with the most connections).

Fifth factor- ineffective coordination and communication between the business and the developers and/or integrators of the ERP system

This factor is also one of the most underestimated and therefore one of the most common. One of the business process analysts who were interviewed for the study called this situation “a dialogue between the blind and the deaf”, which quite accurately reflects its essence, because usually the business and representatives of the IT industry “do not speak the same language”, which leads to serious communication and coordination problems:

- The business cannot explain what it wants and how it wants it.

- Representatives of the IT industry cannot explain and demonstrate what have done.
- The results are usually as follows:
 - delay in the integration of the ERP system;
 - increasing the cost of the ERP integration;
 - lack of necessary functionalities;
- The available functionalities do not fully correspond (and in some cases have nothing in common) with the wishes of the businesses.

The interrelationships of this factor are many, but its most significant are with:

- The first factor- inaccurate and/or incomplete information in the business requirements documentation or lack of such documentation;
- The fourth factor- skipping or neglecting the test stages in the integration of the ERP system.

Sixth factor- forcing integration as a result of underestimating the time required for successful implementation.

This factor is also one of the most underestimated and for this reason, particularly common. Almost all business representatives (especially if they are not familiar with the software development and integration) consider standard deadlines to be unnecessarily inflated and unnecessary waste of time.

A quote from the author’s personal experience: “They installed Windows for me in less than an hour and you want that much time for some program.”

Usually an attempt is made to save time at the expense of one of the following stages:

- development of business requirements;
- description of the business processes of the company/organization;
- analysis and optimization (in some cases also reengineering) of the business processes of the company/organization;
- product testing.

This factor is one of the most combinative because it can:

- lead to the appearance of one or more of the other factors (each of them);
- enter into interaction with all other factors.

It is especially dangerous when it interacts with the seventh factor “Underfunding of the ERP system integration project”- their combination means almost inevitable failure of the ERP system integration and even if it is carried out, there will certainly be a huge adaptation period for the additional adjustments, updates and bug fixes.

Seventh factor- underfunding of the ERP system integration project

This factor is now less common, especially compared to the period before 2010. Businesses got used to the idea of serious financial costs for ERP system integration and are no longer so aggressive in cutting money for it.

Despite the improvement, this factor remains serious. Attempts to save money are usually at the expense of:

- hiring/paying QA specialists for testing the ERP system;
- the hiring/paying of a business process analyst usually due to a sincere misunderstanding of the functions and its importance to the success of integration.

It is especially dangerous in interaction with the sixth factor “Forcing the integration due to underestimation of the necessary time for successful implementation”- their combination means almost an inevitable failure in the integration of the ERP system, and even if it is carried out, there will certainly be a huge adaptation period for additional settings, updates and fixing errors and bugs.

The combination of these two factors is very common due the business understanding of the financial value of time (“time is money”).

Eighth factor- integration of an inappropriate and/or unadapted ERP system for the certain industry/firm/organization

This factor is significantly less common, especially compared to the period before 2015. Businesses have become accustomed to the idea of specialized ERP systems both in the industry and in the company.

The change in this factor is caused by the change in the market of ERP systems:

- The market is much wider, especially compared to 10-15 years ago.
- There are already both universal and industry specific systems- for example logistics, pharmaceuticals, etc.
- Special consulting teams have also been created for the integration of ERP systems, which are not tied to a given system.

Despite the significant reduction of the given factor, the following reasons for its existence are taken into account.

- The IT illiteracy of a large part of middle and senior management.
- purely financial reasons- i.e. the price;
- incompetent and /or purposefully misleading consultation;
- Too much choice on the market for ERP systems can confuse potential users.

The consequences of this factor can be extremely devastating for the company/organization in which an inappropriate/non-adapted ERP system is implemented- the results can be comparable to the combined consequences of all the preceding factors.

Ninth factor- staff resistance to innovation and change

This factor is practically eternal- people have always been afraid of change, and this is unlikely to change¹.

The ninth factor is still highly underestimated by managers at all levels- very often they even ignore staff resistance to innovation.

This resistance leads to:

- increasing the cost and delay of the integration of the ERP system with additional functional requirements;
- increasing the cost with additional non-functional requirements, often meaningless;
- in rarer cases, to significant personnel changes in the company/organization (dismissal of the most rebellious employees of the staff);
- in very rare cases it can lead to rejection of the ERP system.

The considered factor is subject to serious improvement because of:

- techniques developed by management to overcome staff resistance to innovation²;
- techniques developed by business process analysts to overcome staff resistance to innovation;
- techniques developed by organizational psychology to overcome staff resistance to innovation;
- the trust built over the years among users towards ERP systems.

Tenth factor-integration of the ERP system without the participation of a competent business process analyst during the entire procedure

This factor has also undergone a significant reduction in the last decade. It is extremely negative because of the combination of:

- too frequent underestimation;
- extremely negative result

The causes of this factor are usually two other factors:

- forcing the integration as a result of underestimating the time required for successful implementation;
- underfunding the ERP system integration project.

As a result, this factor is the only one that is equal to the eighth factor “Integrating an inappropriate and/or unadapted ERP system for the given industry/firm/organization”.

¹ Georgieva, P. An ER diagram concept of an entrepreneurial new product planning system. II International Scientific and Practical Conference Economics and Management, 2014”. - In: Sustainable development of business and regions. ISSN 13-14-197X, September 12-13, 2014, Varna.

² Georgiev, K. ,P.Georgieva. Challenges to the Innovation Paradigm for Ensuring Smart, Sustainable and Inclusive Growth, International Scientific and Practical Conference “Sustainable Development- Summer 2015”. -In: International journal “Sustainable Development”. ISSN 1314-4138, no.5 (26), September/October 2015, p.11.

IV. CONCLUSION

Many factors were considered and discussed during the research, but these 10 factors were singled out for the following reasons:

- They have the greatest influence (as a force) on ERP system integration projects.
- They most often have an impact on ERP system integration projects.
- They interact with other factors that significantly increase their impact.

Studying the frequency and strength of the negative impact of these factors is the most effective method (according to the author) to prevent failures (or at least to reduce their consequences) when integrating ERP systems.

It is also necessary to continue this research in the future

to examine trends in changes in the strength and frequency of negative impact of these factors, as well as their interaction.

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Technological Model for Factor Analysis of Production Costs from the Cyber-Physical Systems

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Abstract—The object of the present development is the activity of the cyber-physical production systems of the industrial economic entities. The main goal is to design a technological model for factor analysis of production costs from the cyber-physical systems of industrial enterprises. The present development presents a technological model for factor analysis of production costs from cyber-physical systems, which is designed by according to a certain algorithm applying a deductive approach. The toolkit of the technological model for factor analysis presented in the following lines is based on a deterministic combined approach for the analysis of the performance and factor indicators of production costs directly related to the production process carried out through cyber-physical systems.

Keywords—factor analysis, production, cyber-physical production systems, production costs

I. INTRODUCTION

Modern economic development is faced with a number of challenges related to digitalization on a global scale, one of the main ones being the intelligent digital transformation of technological processes in industrial enterprises. This is the basis for the fourth industrial revolution - Industry 4.0, through which they follow the development of economic, technological and production activities that will lead to evolution in the next stage of industrial, economic and social development.

At the core of Industry 4.0 are cyber-physical production systems, through which production processes in industrial entities are automated. In this way, intelligent systems are implemented for the manufacture of products, which monitor the process from its entry point to the final result - the actual manufactured product, and even to its realization. In connection with the implementation of the production programs and activities of the individual business entities, it is necessary to design an adequate technological model for the analysis of costs related to the production of products through cyber-physical production systems. For this purpose, the main factors and their constituent elements should be defined, the level and dynamics of which should be examined collectively and individually when participating in the production process.

The object of the present development is the activity of the cyber-physical production systems of the industrial entities.

The main goal is to design a technological model for factor analysis of production costs from the cyber-physical systems of industrial enterprises.

The exposition of the present development is limited to an examination of the main costs associated with the production of cyber-physical systems, as well as their results, factors and their constituent elements. The research is in accordance with the legal regulations of the national and European legislation as of July 31, 2022.

II. EXPOSITION

Cyber-physical systems represent a relatively new category of production systems that are familiar with the reformation and implementation of all intelligent technologies in the production processes of industrial enterprises. M. Temelkova represents the importance of the cyber-physical production system for modern manufacture from a theoretical-methodological point, as this "...finds expression in the purposeful and overall added impact on the main elements of the production ecosystem - its input products, its transformation processes, transforming the resources in, and its output.". The cited author also suggests that this system "...provides the networking of resources, information, objects and people. It merges into a complete physical world with a digital one, based on and integrating within itself the elements of the "machine-human" ecosystem, as well as based on blockchain technologies, where it interacts with physical reality through Big data sets stored by it and their assessment." [7].

B. Bagheri, for his part, defines that cyber-physical production systems "...generally refer to systems of collaborative computing elements that control physical objects, usually using feedback from sensors they observe. A cyber-physical system features a physical asset, such as a machine, and its digital twin; an underlying software model that mimics the behavior of the physical asset" [3]. The author also clarifies that cyber-physical production systems "...have a 5-tier architecture, which is why the literature assumes that its structure is based on the "5C" model - connection, conversion, cyber, cognition and configuration." [2].

Based on the above, it can be concluded that cyber-physical production systems are intelligent systems whose mechanism combines manufacture, mechanical and electronic parts, together with large arrays of information databases, as

well as software components that are controlled by computer based algorithms. Through these systems, the digitalization of the production process is implemented, with the main part of it being automated, i.e. the role of the human factor in manufacture is minimized and is mainly related to monitoring of technological processes.

Despite the digital transformation of the production process with the introduction of cyber-physical systems, the main costs related to the manufacture are preserved in a structural sense, changing the ratio of individual elements to their total value. For the introduction, operation and monitoring of the costs related to the manufacture by means of cyber-physical systems, an analysis of the factors ensuring the production process should be carried out regularly. For this purpose, however, a technological model must be built, the toolkit of which corresponds to the specifics of the production process itself, carried out by cyber-physical systems.

The toolkit of the technological model for factor analysis presented in the following lines is based on a deterministic combined approach for the analysis of the performance and factor indicators of production costs directly related to the production process carried out through cyber-physical systems. Taking into account the specificity of the latter and due to the fact that for the purposes of the analysis, the same or comparable measures of the resulting and factor indicators should be used, the author applies the value (monetary) measures of reporting data as a basis for the metrification of the production process.

The factor analysis of production costs from cyber-physical systems is modeled according to a certain algorithm applying a deductive approach, which includes the following several stages of analytical procedures:

- First, the level and dynamics of the total cost of production from cyber-physical systems are established, measuring the effect of the input (invested) costs for the implementation of the production process for the current relative to the base period;
- Second, the technological model examines the cause-and-effect relationships for the established dynamics and trends in the change at the level of direct costs for production by the cyber-physical system, by structural elements of the factor indicators;
- Third, the technological model examines the cause-and-effect relationships for the established dynamics and trends in the change at the level of indirect costs for production from the cyber-physical system, by structural elements of the factor indicators.

The first stage of the analysis of production costs from cyber-physical production systems involves measuring the level and dynamics of the production cost structure that directly or indirectly affects the production process. The main point of this stage is the establishment of the level of structural elements as part of the total value of the production costs incurred by the cyber-physical production system, since they represent the active part of the production process of this

system and on them the industrial enterprise can have a direct effect influence through optimization, additional investment, restructuring, etc. The total value of the costs is established by applying the following mathematical formula:

$$C = C_1x_1 + C_2x_2 + C_3x_3 + \dots + C_nx_n = \sum_{j=1}^n C_jx_j, \quad (1)$$

where C_jx_j represent costs of type "j" for production by the cyber-physical production system.

Costs associated with production from the cyber-physical system can be classified into direct and indirect. Direct costs represent the costs of implementing the production process carried out by the cyber-physical system, and indirect costs are those that are part of the production process, but do not directly participate in it, but only indirectly. Based on the above classification, the mathematical formula (1) presented above acquires the following expression:

$$C = C_{dir}^n + C_{ind}^n, \quad (2)$$

where:

C_{dir}^n – total value of direct costs for the production of the cyber-physical system performed in the “n” period;

C_{ind}^n – total value of the belonging indirect costs in connection with the production from the cyber-physical system performed in the “n” period.

The level of manufacturing costs from cyber-physical systems is established by comparing the total value of these costs for the current versus the base period. The results represents the change in production costs, which can be measured both in absolute and relative value through the following mathematical formulas:

- To establish the level of expenditure in absolute value:

$$\Delta C = (C_{dir}^1 + C_{ind}^1) - (C_{dir}^0 + C_{ind}^0), \quad (3)$$

ΔC – the change in the total cost value;

C_{dir}^1 – total value of direct costs for the production from the cyber-physical system during the current period;

C_{dir}^0 – total value of direct costs for the production from the cyber-physical system during the base period;

C_{ind}^1 – total value of indirect costs for the production from the cyber-physical system during the current period;

C_{ind}^0 – total value of indirect costs of the production from the cyber-physical system during the base period.

- To establish the level of costs in relative value:

$$\Delta C\% = \frac{C_{dir}^1 + C_{ind}^1}{C_{dir}^0 + C_{ind}^0} \times 100, \quad (4)$$

Another main point of the factor analysis of production costs is the establishment of the dynamics in the change in their level, which can be measured by the rate of change of costs. Dynamics can also be established both in absolute and

relative value. In this case, the value of the change is compared to the total cost of the base period using the following formula:

$$\Delta C_t = \frac{\Delta C}{C^0} \quad (5)$$

where ΔC_t is the rate of change of costs.

The technological model for the factor analysis of production costs from cyber-physical systems is deepened by detailing the individual cost groups, and in the present study, the factor indicators for the analysis of direct production costs and those of indirect costs, by structural elements, are considered.

The second stage of the factor analysis technology model emphasizes direct manufacturing cost indicators. They can be classified based on their accounting belonging to the costs of the main (operating) activity, through which the actual cost of production is calculated, as follows:

- ✓ Costs of energy intensity (fuels and energy);
- ✓ Costs of material intensity (materials, production resources);
- ✓ Costs for external support of the production system (external services related to servicing the cyber-physical system during the execution of the production process);
- ✓ Costs for operation (depreciation) of production equipment (machines) and facilities, including operation of fixed material and non-material assets;
- ✓ Labor costs of personnel employed in the production process, including costs for remuneration and insurance at the expense of the employer;
- ✓ Other costs related to the implementation of the production process by the cyber-physical system;
- ✓ Technological marriage costs associated with the execution of the production process by the cyber-physical system.

Adapting the above to the mathematical formula for calculating production costs from the cyber-physical system, the total value of direct production costs can be calculated as follows:

$$\Delta C_{dir} = C_{en} + C_{mat} + C_{es} + C_{op} + C_{lc} + C_{oth} + C_{tm}, \quad (6)$$

where:

C_{en} – costs for energy intensity;

C_{mat} – costs for material capacity;

C_{es} – costs for external services of the production system;

C_{op} – operating costs (depreciation) of the equipment (machines);

C_{lc} – labor costs of the personnel employed in the production process;

C_{oth} – other costs related to the implementation of the production process;

C_{tm} – costs of technological marriage related to the implementation of the production process.

For the metrication of the dynamics in the change of direct costs, the reported values for the current versus those for the base period are compared. After that, an analysis of the individual structural elements (types of costs) is carried out in order to establish their influence on the measured dynamics. The change in direct production costs from the cyber-physical system is determined by applying the following formula:

$$\Delta C_{dir} = C_{dir}^1 - C_{dir}^0 \quad (7)$$

The detailing of the influence of each individual type of expenditure on the dynamics is established by the application of conditional indicators in the following sequence:

First, the change in energy-intensive costs is measured as a structural element of the total value of direct production costs. In this way, it is presented what impact the change in the value of realized costs for fuel and energy for the current compared to the base period has on the level of direct production costs. In the specific case, the influence of the costs of energy intensity is measured by the calculation of a first conditional indicator. For this purpose, the following mathematical formula is applied:

$$\Delta C_{dir}^I = C_{en}^1 + C_{mat}^0 + C_{es}^0 + C_{op}^0 + C_{lc}^0 + C_{oth}^0 + C_{tm}^0 \quad (8)$$

Second, the impact of material intensity costs as part of the direct manufacturing cost structure is metrified. Through the aforementioned, the influence of the value of realized costs for resources and materials for production for the current relative to the base period, on the level of direct production costs, is presented. The impact of these costs is measured by calculating a second conditional indicator with the following mathematical formula:

$$\Delta C_{dir}^{II} = C_{en}^1 + C_{mat}^1 + C_{es}^0 + C_{op}^0 + C_{lc}^0 + C_{oth}^0 + C_{tm}^0 \quad (9)$$

Third, the impact of production system maintenance costs as a structural element of direct production costs is measured. In this way, it is presented what impact the change in the value of the realized costs for external services, related to the service of the cyber-physical system in the execution of the production process for the current relative to the base period, has on the level of direct production costs. The impact of production system maintenance costs is metrified by calculating a third conditional indicator through the following mathematical formula:

$$\Delta C_{dir}^{III} = C_{en}^1 + C_{mat}^1 + C_{es}^1 + C_{op}^0 + C_{lc}^0 + C_{oth}^0 + C_{tm}^0 \quad (10)$$

Fourth, the influence on the costs of the operation of production facilities and equipment as part of the structure of direct production costs is metrified. The indicated influence is

represented in the value of realized for operation (depreciation) of long-term costs for material and non-material activities employed in the production process of the cyber-physical system for the current targeted base period, on the created on direct production costs. The influence of the specified type of costs is measured by calculating the fourth conditional indicator with the application of the following formula:

$$\Delta C_{dir}^{IV} = C_{en}^1 + C_{mat}^1 + C_{es}^1 + C_{op}^1 + C_{lc}^1 + C_{oth}^1 + C_{tm}^1 \quad (11)$$

Fifth, the impact of labor costs as part of the direct manufacturing cost structure is measured. In this way, it is presented what impact the realized costs for the remuneration of the personnel employed in the management and monitoring of the cyber-physical system, including for insurance payments at the expense of the employer for the current relative to the base period, have on the level of direct production expenses. The stated impact of labor costs is metrified by the calculation of a fifth conditional indicator, for which the following mathematical expression is applied:

$$\Delta C_{dir}^V = C_{en}^1 + C_{mat}^1 + C_{es}^1 + C_{op}^1 + C_{lc}^1 + C_{oth}^1 + C_{tm}^1 \quad (12)$$

Finally, the influence of other costs related to the execution of the production process by the cyber-physical system as part of the direct production cost structure is metrified. In this way, it is presented what influence the specified costs have for the current compared to the base period, on the level of direct production costs. The specified cost impact is measured by calculating a sixth conditional indicator using the following mathematical formula:

$$\Delta C_{dir}^{VI} = C_{en}^1 + C_{mat}^1 + C_{es}^1 + C_{op}^1 + C_{lc}^1 + C_{oth}^1 + C_{tm}^1 \quad (13)$$

The next point of this stage of analysis is the measurement of the influence of elements of direct production costs on the dynamics of these. The set is for measuring the value of performance costs by individual elements of the current versus base period, on the overall dynamics of direct production costs. The above is metrified by successive chronological comparison of conditional indicators by separate elements of costs by applying the following mathematical apparatus:

1. Measuring the impact of the dynamics of energy-intensive costs on the dynamics of direct production costs:

$$\Delta C_{dir}(C_{en}) = C_{dir}^I - C_{dir}^0 \quad (14)$$

2. Metrified of the impact on the dynamics of material intensity costs on the dynamics of direct production costs:

$$\Delta C_{dir}(C_{mat}) = C_{dir}^{II} - C_{dir}^I \quad (15)$$

3. Measuring the impact of the dynamics of costs for external support of the production system on the dynamics of direct production costs:

$$\Delta C_{dir}(C_{es}) = C_{dir}^{III} - C_{dir}^{II} \quad (16)$$

4. Metrified of the impact on the dynamics of operating costs (depreciation) of production equipment and facilities on the dynamics of direct production costs:

$$\Delta C_{dir}(C_{op}) = C_{dir}^{IV} - C_{dir}^{III} \quad (17)$$

5. Measuring the impact on the dynamics of labor-intensive costs on the dynamics of direct production costs:

$$\Delta C_{dir}(C_{lc}) = C_{dir}^V - C_{dir}^{IV} \quad (18)$$

6. Metrified of the impact on the dynamics of other production costs from the cyber-physical system on the dynamics of direct production costs:

$$\Delta C_{dir}(C_{oth}) = C_{dir}^{VI} - C_{dir}^V \quad (19)$$

7. Measuring the impact on the dynamics of the costs of repairable technological marriage on the dynamics of direct production costs:

$$\Delta C_{dir}(C_{tm}) = C_{dir}^I - C_{dir}^{VI} \quad (20)$$

After measuring the differences between the conditional indicators, an analytical synthesis of the results established above is carried out (a balance of deviations is drawn up), the value of which should be equal to the differences calculated in the mathematical formula (4). In the event that there is a discrepancy from the latter, the reasons for this should be investigated. The analytical synthesis of the created and the dynamics of direct production costs is established by applying the mathematical formula:

$$\Delta C_{dir} = \Delta C_{dir}(C_{en}) + \Delta C_{dir}(C_{mat}) + \Delta C_{dir}(C_{es}) + \Delta C_{dir}(C_{op}) + \Delta C_{dir}(C_{lc}) + \Delta C_{dir}(C_{oth}) + \Delta C_{dir}(C_{tm}) \quad (21)$$

The technological model continues with the third stage, the analysis of the indirect costs of carrying out the production process, which cover the fixed and variable costs of the industrial enterprise, which are carried out in the implementation of the production activity, but they are not directly involved in the process itself. On this basis, the realized value of the costs is distributed based on the quantity (volume) of the produced output or another basis accepted by the industrial enterprise. Indirect costs are part of the calculation of the actual cost of the produced products by the cyber-physical systems. For the purposes of the present development, they are distributed based on the amount of produced products by the cyber-physical system relative to the total amount of produced products by the industrial enterprise. In the implementation of the specified calculation, the coefficient of distribution of indirect costs should be established using the following formula:

$$C_{dis}^n = \frac{Q_{cphs}}{Q_{total}}, \quad (22)$$

where:

C_{dis}^n is the distribution coefficient in the "n" period;

Q_{cphs} is the amount of produced products by the cyber-physical system;

Q_{total} is the total amount of produced products by the industrial enterprise.

The resulting value of the coefficient is multiplied by the total value of fixed and variable indirect for the overall production and the created part of the indirect for the production of products from the cyber-physical system is obtained. For this purpose, the following mathematical calculation is applied:

$$C_{ind}^n = C_{dis}^n \times OC^n \quad (23)$$

where:

C_{ind}^n is the value of the indirect costs for the production of products from the specific cyber-physical system during "n" period;

C_{dis}^n is the distribution coefficient over "n" period;

OC^n is the value of total production costs for the entire production process of the enterprise in "n" period.

Next, it is necessary to study the dynamics of indirect costs associated with the production of products of the cyber-physical system, comparing the data for the current versus the base period through the mathematical calculation:

$$\Delta C_{ind} = C_{ind}^1 - C_{ind}^0, \quad (24)$$

where:

ΔC_{ind} – change in the value of indirect costs related to the production of products from the cyber-physical system;

C_{ind}^1 – value of indirect costs during the current period;

C_{ind}^0 – value of indirect costs during the base period.

Analytical procedures can be performed to analyze the reasons for the established change in the distribution of the factors determining the indirect costs of production by applying a conditional indicator that measures the change in the level of the coefficient of distributed relative to the structure of the indirect costs associated with the production process. For this purpose, the following mathematical calculation is applied:

$$\Delta C_{ind}^1 = C_{dis}^1 \times OC^0 \quad (25)$$

In order to metrified the dynamics of the change in the creation of the distribution coefficient in the value of the indirect ones, the formula should be applied:

$$\Delta C_{ind} (C_{dis}) = C_{ind}^1 - C_{ind}^0 \quad (26)$$

The next moment of this stage of the technological model for factor analysis is a measurement of the impact of the change in the created on the other factor - the value of the

total production costs for the entire production process of the enterprise (OC), which is carried out by the calculation:

$$\Delta C_{ind} (OC) = C_{ind}^1 - C_{ind}^0 \quad (27)$$

The following measurement of the differences by applying a conditional indicator, an analytical synthesis is carried out in the created and the dynamics of indirect costs (a balance of deviations is drawn up), the value of which should be equal to the differences calculated in the mathematical formula (24). In the event that there is a discrepancy from the latter, the reasons for this should be investigated. The analytical synthesis of the created and the dynamics of indirect production costs is established by applying the mathematical formula:

$$\Delta C_{ind} = \Delta C_{ind} (C_{dis}) + \Delta C_{ind} (OC) \quad (28)$$

With the presented technological model for factor analysis of costs for the production of products from cyber-physical systems in industrial enterprises, a sufficient level of detailing of the influence of the level and dynamics of individual factor indicators and their constituent elements on the overall production process is achieved. It can also be used to prepare the production program of the industrial entity during the relevant period. In this order, through the application of the current model, the degree of realization of the production program can be established by comparing the reported versus the planned indicators. Finally, the technological model can be approved in the calculation of the actual production cost of the cyber-physical system.

III. RESULTS

The present development presents a technological model for factor analysis of production costs from the cyber-physical systems, which is modeled according to a certain algorithm applying a deductive approach, which includes the following several stages of analytical procedures:

The first stage includes the establishment of the level and dynamics in the total cost of production of products from the cyber-physical systems. This stage measures, by means of a specific mathematical apparatus, the effect of the input (invested) costs for the implementation of the production process for the current relative to the base period.

The second stage examines the cause-and-effect relationships for the established dynamics and trends in the change in the level of direct costs for the production from the cyber-physical system, by structural elements of the factor indicators.

The third stage of the technological model examines the cause-and-effect relationships for the established dynamics and trends in the change in the level of falling indirect costs for the production from the cyber-physical system, by structural elements of the factor indicators.

IV. CONCLUSION

From the exposition of the present study, it can be summarized that with the design of an adequate technological model for the factor analysis of production costs of cyber-physical systems, the processes of management and

monitoring of the main production costs will be improved.

In a theoretical-methodical and in a practical-applied aspect, the present development achieves results related to establishing the level and dynamics in the total production cost of cyber-physical systems.

These costs are measured using a specific mathematical apparatus developed, which measures the effect of the input costs for the implementation of the production process for the current relative to the base period, including the cause-and-effect relationships for the established dynamics and trends in the change in the level of direct costs of production and the indirect costs of production from the cyber-physical system, by structural elements of the factor indicators.

The technological model for factor analysis can be improved by including value indicators with which to measure the financial results and the added value of the realized production process, which will achieve the improvement of financial management and control, as well as the optimization of the monitoring process of the activities performed.

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Postal Services and Communications in Gabrovo till the Beginning of the 20th Century with Biographical Notes on Some Significant Contributors

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Abstract—The research makes a contribution to the study of the early history of the Bulgarian communication services, particularly in the town of Gabrovo, situated in the Northern slope of central Balkan region of Bulgaria. It is part of a bigger research on the genealogy of prominent families from Gabrovo and their impact on the national history. The article summarizes the documented first steps of the postal, telegraph and communication services in Gabrovo in the late Ottoman rule from the mid XIX century to the Russian – Turkish war 1877 – 1878 and the subsequent first decades of Bulgaria's self governance as a Principality. Genealogical and biographical data about some of the main actors are also included to describe the social and political context of the described events.

Keywords—history, post, telegraph, Gabrovo, 19-th century

I. INTRODUCTION

The geographical position of Gabrovo and the immediate proximity to the Shipka Pass gives the city an important role in communications in all state formations where the Balkan Mountain is a border or a natural barrier on the road between Europe and Asia.

According to archaeological data, Gabrovo was founded as a settlement no later than the 12th century. During the entire period up to the 18th century, the local population performed a specific military function of guarding the surrounding mountain passes. Because of this activity, the residents of Gabrovo enjoy a special status, which includes tax benefits, obtaining and preserving hereditary land plots, the right to bear arms, local self-government, etc. The privileges of the population of Gabrovo remained almost unchanged, and they performed their duties without interruption under three different state formations: Byzantium, the Second Bulgarian Kingdom and the Ottoman Empire.

Guarding the passes is strongly related to the commercial and military communication through these territories. In this sense, Gabrovo became a natural center of posts and communications when telegraphs and mails were implemented in the Ottoman Empire, in the Russian army

during the war of 1877-1878, in the border communication between the Principality of Bulgaria and Eastern Rumelia until the Unification and in the modern civil communications of the Third Bulgarian Kingdom. The heirs of the Derventji families, who for centuries guarded the mountain passes, became successful merchants and manufacturers in the "Bulgarian Manchester" and had written correspondence with all destinations of the Ottoman Empire and abroad.

II. EARLY POSTAL SERVICES UNDER OTTOMAN RULE

In the second half of the 18th till the mid 19th century, Gabrovo's merchants who maintained active correspondence with their offices and partners in the capital, in other cities of the Empire, or in Europe, used the services of travelers or acquaintances to send their letters, when the carriers route passed near the addressee.

If the matter was urgent, special persons were hired - "letter carriers" or "sahiyas", who were paid according to a negotiated agreement. Petko Kutelot is named as such a letter carrier.

The first information on postal activity in Gabrovo date from the middle of the 19th century. The local historian Petar Tsonchev describes that the "menzil" post office, where letters were received and delivered, was located in the building of the merchant Stancho Arnaudov, next to the administrative center, and the telegraph - near today's "N. Vasiliadi" high school in the Padalo area.

Since both services did not guarantee that the correspondence would be kept secret and that it would be delivered on time, merchants continued to use the services of paid private letter carriers in parallel, until the Liberation and the creation of the Bulgarian postal service.

In 1848, Gabrovo was part of tract II of the Ottoman post service, which had a route Edirne - St. Zagora - Kazanlak - Gabrovo - Tarnovo - Lovech - Pleven - Vratsa - Lom - Vidin. Felix Kanitz reports from 1871 about the irregularity of the service and the lack of discipline of the clerk at the Gabrovo post office.

In the 70s of the 19th century, in the Gabrovo School (now Aprilivska Gymnasium), as part of the equipment in the physics lab, there was a functioning educational telegraph purposely delivered from Vienna. We learn about it from the fact that after the suppression of the April uprising, the teacher Guselev was investigated by a special commission from Constantinople, on the charge that he used the telegraph to communicate with the insurgents

III. RUSSO-TURKISH WAR 1877-1878

Soon after the start of the Russo-Turkish War, an ordinance was issued in July 1877 that said: “To proceed with the organization of vigorous local self-government using local people. To organize a local police force, post office and especially administrative and judicial councils”. On November 17, 1877, the first postal tracts were launched in Bulgaria. Gabrovo is part of the tract Svishtov – Byala – Tarnovo – Gabrovo. In April 1878, the Pleven - Gabrovo tract was opened. The civilian post office in Gabrovo replaced the military telegraph service on January 3-4, 1878. Then the first three post offices in Bulgaria were opened - in Svishtov, Veliko Tarnovo and Gabrovo.

From January 1878, the postmaster in Gabrovo was the college registrar Lavrentiy Sikovich, the stationary superintendent (supervising chief) was Vladimir Almazov, and a month later Egor Tverdinin was appointed postmaster. In the first months of the establishment of the Gabrovo post office, Vasilij Viktorov, Vasilij Turanski, Danail Burmov, Viktor Andreevski, Ivan Maskin, Alexander Vasiliev, Nikolay Kazanmashev, Dimitar Petrov, Georgi Draganov also worked there.

Among these first Gabrovo telegraph postmen, only Danail Burmov was from Gabrovo, and the rest were from other settlements, but as postal workers they accepted appointments in various cities in the Principality.

Danail Burmov is believed to be the first Bulgarian postal employee - sorter and receiver. He is not a random figure, but one of the representatives of the prominent Gabrovi family Burmovi. The family traces its origins to the Gabrovi huts Nova Mahala, where their ancestors were blacksmiths and cutlers. The Burmovi family gave rise to a number of prominent personalities in several successive generations, who can be counted among the "Builders of modern Bulgaria". Among them are the first Bulgarian prime minister Todor Burmov (1834-1906), Lieutenant-General Hristo Burmov (1869-1936), Stefan Burmov (1862-1924), military doctor, head of the sanitary service of the Bulgarian army. In addition to Gabrovo, the Burmovi family also has a branch in Pleven, whose representatives are also notable individuals with a bright social contribution as parliamentarians and lawyers.

Danail Stoyanov Burmov was born in 1839. He is the younger brother of Todor Burmov. He studied at the Odessa Theological Seminary and used to be a teacher for a while. During the April Uprising, he was one of the officers of Tsanko Dyuztabanov's Gabrovo company. During the Russian-Turkish war, he worked as a sorter in the post office in Ruse, for which he was awarded a bronze war medal. After the liberation, Danail Burmov was the first Bulgarian sorter and receiver in the Bulgarian postal department, with assignments in Gabrovo and Ruse.

Under the Provisional Russian administration, the Gabrovo post office functioned under the command of Russian postal officials. On May 14, 1879, Russian officials handed over all postal and telegraph stations with all their inventory and equipment to the Bulgarian government. 39 postal and 26 telegraph stations, 1,630 km of telegraph pole lines with 2,582 km. wires and 64 telegraph apparatus in operation were ceded. The post office building in Gabrovo was located on "Bryanska" street, under the old building of the today "Balkan" hotel. The postal department begins work with the inventory and materials left by the Russian military post office in Gabrovo during the war. According to the "Temporary rules for the postal department in Bulgaria" the management and organization was assigned to the Postal Administration, which was initially subordinated to the Ministry of Internal Affairs, and at the next stage - to the Ministry of Foreign Affairs of the Principality of Bulgaria.

IV. BULGARIA UNDER THE TREATY OF BERLIN 13.JUNE 1878

After the partition of Bulgaria with the Treaty of Berlin in 1878, Gabrovo became a key border station between the Principality and Eastern Rumelia. The Rumelian mail is exchanged with Northern Bulgaria and the countries of Western Europe through the Gabrov passes. A customs office was also opened in Gabrovo. By order No. 14 of June 1, 1879, the head of the Telegraph Department appointed the first Bulgarian telegraphers. Hristo Stoykov was appointed to Gabrovo telegraph station.

The first Director of Posts and Telegraphs of the united Principality after 1885, Ivan Stoyanovich, who held this position for the longest time, was the head of the Gabrovo telegraph and post office from August 17, 1879 to November 7, 1881. Thus, Gabrovo turns out to be an important step in his long career at the head of Bulgaria's communications.

Ivan Stoyanovich is a person with a rich biography and a significant historical contribution far beyond the postal business. He was born in Stara Zagora in 1862 in the family of Petar Stoyanovich and Maria Hadjibojkova. His genealogy can be traced back to the 18th century, and his family is related to a constellation of distinguished families with contribution to the national history. Stojanovic's service in Gabrovo was interrupted by political infighting after the declaration of the mandate regime and the suspension of the Tarnovo constitution. As an uncompromising liberal, Stojanovic was dismissed and expelled in Eastern Rumelia. This action will prove to be fateful for him and for Bulgaria, because in Plovdiv Ivan Stonovich ranks among the leaders of the Unionist movement and, given the nickname Ajeleto (boisterous, implacable), became one of the fathers of the Unification.

V. UNIFIED BULGARIA - 1885

After the Unification of the Principality of Bulgaria and Eastern Rumelia on September 6, 1885, Ivan Stoyanovich was appointed Director General of Posts, Telegraphs and Telephones of Bulgaria and held this position with some interruptions for 28 years. During this period, under his leadership, the construction of the entire postal, telegraph and telephone network in Bulgaria was carried out, as well as postal transport, communications to neighboring countries, and the laying of an underwater sea

communication cable. Stojanovich also led the long negotiations for concluding agreements with the Ottoman Empire in settling the independent status of the Bulgarian posts and communications. He made significant efforts to displace the offices of the great powers from the postal sovereignty of Bulgaria. The inclusion of the young Bulgarian state in the international postal and telegraph unions is also part of the work of Ivan Stoyanovich. He represented Bulgaria at international postal forums and thus contributed to the establishment of the state sovereignty in communications. Stojanovic also managed the military posts and communications in the three wars at the beginning of the 20th century.

In May 1883, Gancho Gavrilo from Gabrovo won a state tender and became the first postman in Bulgaria, serving the tracts with 206 cars and 412 horses. His offer was 1/3 lower than the price offered by the Russian colonists.

Gancho Gavrilo is a well-known and active citizen of Gabrovo. As a student at the Aprilov High School, he was one of the founders of the first student association in Bulgaria in 1870, and in the period 1872-73 he was one of the publishers of the satirical handwritten newspaper Rak (Crab). Later, in 1887, he was a school trustee.

Gavrilo was a wealthy merchant. He married his wife Maria, known as Gavrilitsa Gančovata, a prominent public figure, founder of the Gabrovo charitable women's society "Mother's Care" and its first chairperson. During the Russo-Turkish War, Gavrilo's wife took great care in maintaining a hospital for wounded Russian soldiers in Gabrovo. She died in 1878 in the typhus epidemic. Maria Gavrilo is sister of Ivan Popvelchev Grudov - a revolutionary, close to Rakovski, merchant in Belgrade and Bucharest and a great charity donor. His family produced many prominent public figures.

The postal services of the Principality were not Gancho Gavrilo's only big entrepreneurial project. In 1885, he co-founded the "Bulgarian construction company for the construction of the Tsaribrod-Sofia-Vakarel railway", together with 28 other wealthy entrepreneurs, and in 1895 - the "Anonymous joint-stock company for the construction of the Varna port"

Another Gabrovo figure who reached the heights of the telegraph and postal service is Kosta Hristov. Born in 1875, he entered the post office in 1893, rose through the ranks and in 1907 was sent to the Paris Higher School of Telegraph and Posts. After his return, he was the head of the administrative department of the General Directorate of Posts, Telegraphs and Telephones until 1920. The biography of Tsviatko Hristov, born in Gabrovo in 1882, is similar. He joined the post office at the end of the 19th century, in 1905 he was sent to the Paris Post school. After his return, he held various high positions in the central postal administration until 1934. He was head of the Metropolitan Telegraph Station during the First World War. He was fluent in French, Russian, German, English, Italian and Romanian, he was also editor of the "Telegrafopostensko delo" magazine.

VI. LATER DEVELOPMENTS

In 1902, the employees of Gabrovo post office founded the Telegraph and Postal Community. These were the first manifestations of trade union activity in the field of communications, that two years later grew into a national union.

Thus, at the beginning of the 20th century, Gabrovo had a fully developed telegraph and post infrastructure and trained personnel. In the following decades, technical progress brought telephone connections to the city. Since 1908, Sofia had direct telephone connection with Pleven, Plovdiv and Ruse, and via Pleven - with Gabrovo. There are reports that in 1910, Gabrovo had a private telephone line that served the needs of the local industrialists. Gabrovo was among the first cities with installed automatic telephone services. In 1936, a telephone exchange with 400 posts was launched.

A modern post office in Gabrovo was built in 1933 and functioned as such until the 1970s. The building is among the city's landmarks and today houses the regional library "Aprilov - Palauzov".

VII. CONCLUSION

Gabrovo is located on a pass that connects North and South Bulgaria and this location predetermines the strategic transport and communication function of the city throughout its history. The serious delay in the introduction of postal services in the Ottoman Empire was the reason for their late appearance in Gabrovo as well. But once modernity spread into the field of communications and was institutionalized in the mid 19th century, postal and telegraph services started their fast development in Gabrovo. The town's strategic location was far from the only driver of this development. Much more important was the fast economic development of Gabrovo as an industrial center. The emerging new factories needed communications for their trade and logistic operations. The lively spirit of the Gabrovo inhabitants and their passion for innovations, turned the city into industrial heart of the Bulgarian society during the second half of the XIX century and one of the drivers of economic growth of the new Bulgaria after the liberation, having in mind that it was a predominantly agricultural economy. This industrial and trade activity also affected the development of the post office and telegraph. A number of people from Gabrovo contributed to the local telegraph and post, as well as to the Central Department of Posts and Telegraphs in the Principality of Bulgaria. Some of them belonged to families with serious social background and continuous presence in public life. Such examples are Danail Burmov and Gancho Gavrilo. Others, like Tsviatko Hristov and Kosta Hristov were of humble background, but due to their professional path were among the chosen to receive scholarships for the Paris Higher School of Telegraph and Post.

Ivan Stoyanovich was the most illustrious personality in the foundation and early history of Bulgarian postal and telegraph services. He served as head of the Central Department of Posts and Telegraph for three decades and was a true pioneer in nearly every aspect of the postal and telegraph authorities and regulations. Even if he was not from Gabrovo, this town was one of his early administrative appointments which paved his outstanding further professional career, as well as his political contribution as one of the leaders of the Bulgarian Unification movement.

The early history of Gabrovo postal and telegraph services and the public administrators, that served in the Gabrovo postal office is a milestone of Bulgarian communications and of the modern Bulgarian history.

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Integrated Approaches to the Implementation of Local Circular Economy and Development Policies

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Abstract—Changing the model and moving from linear to circular economy and development is an opportunity to overcome environmental, resource and social challenges and problems, but it is also a huge challenge for local authorities to make the transition possible. The application of integrated approaches in the implementation of local policies is a prerequisite for a smooth transition and overcoming the many challenges of an economic, territorial, social and resource nature.

Keywords—integrated approach, local policies, circular economy and development

I. INTRODUCTION

Today, the motivations for embracing the ideas of strengthening economic and social unity and ensuring harmonious development are marked by geopolitical, social and economic dynamism, provoked by the imperative to preserve the environment, conserve resources, reduce disparities and ensure security. It is out of doubt that the natural boundaries of the 21st century are fundamentally different from those of the last century, when globalization was expected to solve the acute problems of the distribution of global public goods. As a result of global social relations, new inequalities arise, which, in addition to economic and social, also have an ecological, informational and food nature, as well as a problem with shortages. The specified peculiarities are related to rapid economic growth, difficult to control urbanization, rapid increase in the living status of the population, depletion of resources and dangerous pollution of the environment. It is obvious that the classic linear model of economy and management is already outdated and does not meet the modern challenges. Changing the model and moving from linear to circular economy is a huge challenge for both the economy and the applied public policies, both globally and locally. The need for the transition requires avoiding classic universal approaches and looking for opportunities to provide an appropriate framework for integrated solutions that take into account all directions, as well as the preferences of the residents of a certain territory.

II. PECULIARITIES OF THE INTEGRATED APPROACH IN THE FORMATION AND IMPLEMENTATION OF LOCAL POLICIES IN THE CONTEXT OF THE TRANSITION TO A CIRCULAR MODEL OF THE ECONOMY AND DEVELOPMENT

Recently, the debate about smooth transition from linear to circular model of the economy and development puts on the agenda many questions related to the various aspects of the transition. It is logical that the ideas are focused on such approaches and methods that enable the complex implementation of management impacts. In practice, this involves integrating the following actions [1]:

1. Strategic planning should be oriented towards the achievement of a limited number of key medium and long-term goals and priorities of the transition to a circular model of the economy and development.
2. Results-oriented interventions with clear logic and quality of the implementation of the set objectives by using a system of criteria and indicators for specific products, results and impacts.
3. Classification, typology and zoning of the territory, prioritizing the objectives of the circular economic model.
4. Identifying the interrelated problems and goals in the transition to a circular economy and formulating complex solutions and actions.

Essentially, an integrated approach to promoting development requires close integration of public policies. It is not appropriate to have dominant areas of impact, as the "closing the loop" model is characterized by complex interrelationships and interdependencies between individual industries, as well as the role of consumers.

It is necessary to note that the prosperity of a given region is closely dependent not so much on the available resources, but on the effective management of the interrelated factors of growth [3].

Proof of this is the traditional concept of a high standard of living, which is based on the understanding "take, use and throw away", i.e. the extraction of resources generates huge amounts of waste, the use of large volumes of water and energy also generates waste. In this model of growth, natural

resources are extracted, transformed into products within production processes, which requires the growth of heavy industry and infrastructure. Heavy industry and infrastructure are intensive users of resources and intensive polluters with discarded resources and waste products. On the one hand, this leads to a shortage of natural resources, and on the other, to environmental pollution [2].

It is necessary to realize that if the burning issues related to the preservation of the natural environment and non-renewable resources, climate change, pollution of the world's oceans and the depletion of natural capital remain unresolved, the manifestation of many negative effects is imminent. The looming challenges on economic development will be a prerequisite for the deterioration of the quality of life on the entire planet, as well as an increase in the potential risks of natural disasters. The transformation of the mentioned trends requires substantial funds and complex efforts from all stakeholders, and it is necessary to pay attention to the fact that the negative effects of inaction and the associated social consequences can be much more unfavorable [10].

Changes in the globalized world, of a technological, structural and demographic nature, are changing the nature of work and raising issues of solidarity, questioning the hope that each generation can inherit a better world than the previous generation [10]. At risk and instability are the core values of the EU, democracy, the rule of law and fundamental human rights.

A major economic and managerial problem is the lack of balance between people's needs and the means to satisfy them due to limited resources, popularly known as the scarcity problem. Today, trends related to resource consumption, climate change, biodiversity loss and soil damage reflect the inadequacy of applied public policies, management strategies and basic social values. The cumulative consequences of these trends require radical changes in the direction of progress and a change in the overall philosophy of both development and existence.

The integrated approach can be defined as particularly appropriate in the effort to overcome the challenges of the transition to a circular model of the economy and development, because [1]:

1. The global challenges related to climate change, migration, the need for innovation and the achievement of sustainable development, continue to define the development horizon until 2050, are expressed in issues that are actually identified and assessed at the local level. The indicated challenges are related to a specific territory, which means that the possibilities for their solution rest on the implementation of appropriate strategies and policies for integrated local development.

2. The constantly growing and complicating challenges of territorial development require a change in the approach to their research, analysis and diagnosis. Therefore, policy impacts need to be based on an integration between routine and universal knowledge combined with the specific characteristics and changes of the specific territory. Expert knowledge of local specificities is needed, grounded and used through an integrated approach.

3. Political decisions need to be adequate and adapted to the dynamic changes of the environment, therefore they cannot be static and have a permanent character. In local policies for the transition to a circular model of the economy and development, there cannot be precise "recipes", universal for all territorial units. It is well known that no matter how effective a policy is, if it does not take into account changes in the initial parameters of development, the appearance of new factors or a change in the way they interact, it soon becomes ineffective. The appropriate approach is site-specific, where policies that take account of these changes can be considered, decided and implemented on an integral basis.

4. The application of an integrated approach in the transition to a circular model of the economy and development ensures the connection of different areas of social development - housing construction, transport, economy, employment, quality of the environment, various social elements, etc. For administrative and management reasons, these components are divided into separate spheres. On the basis of the integrated approach, it is possible to determine how these institutionally separate elements interact in order to outline their intersections, goals and priorities, with the task of achieving better interventions and positive economic and social effects with fewer resources.

III. CHALLENGES FOR THE MUNICIPALITY OF VARNA IN THE TRANSITION TO CIRCULAR ECONOMY

As a result of research, four main groups of challenges have been identified – economic, territorial, social and managerial, related to capacity – to look for opportunities to mitigate the negative impacts of the transition to a circular economy. The basic areas of development of the municipality of Varna outlined in this way are characterized by close interconnection and interdependence due to the multidimensional and cross-sectoral nature of the applied local policies for the transition to climate neutrality and circular economy.

It is necessary to note that, according to the requirements of the Regulation establishing the Just Transition Fund, the efforts of local authorities should be aimed at achieving a smooth transition by mitigating the negative impacts of the transition to a circular model of the economy and development, rather than on itself decarbonization of the economy [9].

A. *Economic challenges related to the growth and diversification of the municipality of Varna economy in the direction of climate neutrality*

1. Facilitation and promotion of industrial decarbonization through scientific research, development and implementation of innovative technologies to reduce greenhouse gas emissions in the atmosphere and especially carbon dioxide (CO₂). The emphasis is on carbon-intensive sectors and sectors with potential for growth and diversification.

The development and implementation of innovative technologies with low CO₂ emissions in the municipality of Varna puts on the agenda the overcoming of the following issues:

- 1.1. Low level of research and development in the field of low CO₂ production technologies in enterprises, as well as in sectors with growth potential;

1.2. Insufficient level of cooperation in research and development between business and research institutes in sectors with potential for growth and diversification in the economy of the municipality;

1.3. Little introduction of low CO₂ emissions technologies in enterprises located in the municipality of Varna.

2. Increasing the energy and resource efficiency of enterprises - in addition to high carbon intensity, also puts a number of challenges before the sustainable economic growth and improve circular economic business models [8].

3. Support for economic diversification and promotion of entrepreneurship. The high level of dependence on carbon-intensive sectors creates risks in economic development related to jobs and people's well-being. The pressing issues are:

3.1. Little introduction of modern, energy- and resource-efficient production equipment in existing enterprises;

3.2. Limited access to funding for small and medium-sized enterprises, which limits their business expansion and growth;

3.3 Insufficiently developed entrepreneurial infrastructure, need to strengthen the ecosystem to support business;

3.4. Weak entrepreneurial culture, insufficient knowledge and skills, especially of start-up entrepreneurs.

B. Territorial challenges - related to achieving climate neutrality in non-industrial sectors - Energy, Building Fund, Public Transport, Waste and Abandoned Industrial Areas

1. Challenges related to technologies and infrastructures for affordable clean energy in the territory of the municipality of Varna:

1.1. The carbon intensity of electricity production in Bulgaria is significantly higher than the EU average, which necessitates restructuring and the use of less carbon-intensive technologies;

1.2. High technological losses in the existing networks and capacity to connect local decentralized energy sources to the transmission and distribution networks;

1.3. Improving the level of digitization for the development of smart networks with the integration of renewable energy sources and energy storage capacity for better network balancing [7].

1.4. Investments are needed to rehabilitate production capacity and switch to technologies based on renewable sources and additional investment to ensure safety;

1.5. High demand for electricity leads to increased costs of greenhouse gas emissions combined with an increase in the price of electricity.

2. Territorial challenges related to renewable energy and energy efficiency, focused on improving the energy performance of buildings and production and in energy transmission and distribution [6]. The following problem areas with a need for development to reduce final energy consumption can be identified:

2.1. Renovation of buildings to achieve energy efficiency;

2.2. Implementation of renewable energy sources through decentralized solutions;

2.3. implementation of building automation and energy management system to optimize energy consumption and integrate renewable energy sources.

2.4. The administrative burden, the technical limitations of connecting new decentralized sources to the existing electricity grid and the high initial investment cost are also prerequisites for limiting their application..

2.5. Low level of energy management in buildings and enterprises due to the use of old technologies and insufficient digital skills of the staff.

2.6. Outdated and inefficient street lighting infrastructure, although under renovation, but energy management systems are generally not implemented.

3. Territorial challenges related to waste management and the circular economy. It is necessary to improve:

3.1. The separate collection of waste such as biodegradable and green household waste, textile, construction, hazardous and bulky waste;

3.2. The waste treatment infrastructure needs additional installations for biodegradable waste;

3.3. Need of strategic planning to improve waste management and transition to a circular economy;

3.4. Raising the awareness of the population.

4. Territorial challenges related to the renewal of abandoned and disturbed territories. In order to restore and create appropriate new functions with economic and social value, both types of territories require different renovation, redevelopment and repurposing activities [6].

The variety of territorial issues needs:

4.1. Renovation and repurposing of abandoned urban areas;

4.2. Providing opportunities for land recovery, development of green infrastructure and repurposing of territories with disturbed landscape.

4.3. Infrastructure renovation, restructuring, and optimization of unused plots in industrial zones.

C. Social challenges related to labor and social consequences of the green transition

1. Retraining and upskilling of the existing workforce and stimulating the transition to a new job of the newly qualified.

1.1. The population of the municipality of Varna is relatively younger than the average for the country, the workforce has a higher educational status, and this is a result of the better education system and greater opportunities for realization;

1.2. In the transition to a circular model of economy and development, the structure of employment in the district will undergo changes, on the one hand due to expected decline in the development of some sectors, and due to the rise of others [4];

1.3. In sectors directly reduced by the transition, older workers those with non-specialized education show skill and qualification shortages;

1.4. Providing employment opportunities to workers with newly acquired skills is critical to mitigating the impact of the transition, which will be very important for limiting migration, especially among the young population.

2. Constant challenges before the education system regarding the provision of quality education and effective development of basic skills [4];

2.1. Very low basic skills of future generations of workers;

2.2. Inadequate choice of specialization in training that is not aligned with the demand and does not provide a competitive advantage in the local labor market, also the opportunities to acquire qualifications for green jobs are too limited.

3. Improving the capacity among relevant stakeholders to provide adequate training for new professions related to the green transition and in sectors with high potential for growth.

3.1. institutional stakeholders are insufficiently prepared to develop effective policy options, there is a lack of reliable data to diagnose and forecast skills demand and supply, and there is insufficient cooperation between different institutions.

4. Social inclusion and promotion of the energy transition among disadvantaged groups.

4.1. The increase in energy prices has a negative impact on the well-being of energy-poor households in particular;

4.2. The alarming finding is that over 10% of the population in the various town halls of Varna municipality use wood for heating and about 5% of homes are heated and are customers of the largest heating company, which is about to go through a transformation process;

4.3. The risk of worsening the direct negative impacts on local economic development, employment and the energy-poor is a result of the indirect effects of reducing public revenues and deteriorating social infrastructure.

D. Challenges related to the capacity to move to a circular model of economy and development

1. Raising the awareness of the population about the policies for the transition to circular economy and climate neutrality, strengthening cooperation with all stakeholders is associated with a number of ambiguities, a lack of resources and of appropriate activities in the process of a just territorial transition.

2. A number of challenges related to building the capacity of governance bodies, stakeholders, as well as sectoral and territorial actors responsible for making the transition.

3. Technical difficulties and deficits related to the management and effective implementation of territorial plans and programs for the transition to a circular model of the

economy and development. There is a lack of a clear mechanism for monitoring, analyzing and assessing progress for informed decision-making. It is necessary to coordinate the intersectoral program documents, which requires specific competence and expert knowledge.

IV. CONCLUSION

The transition to a circular model of the economy and development at a local level is a challenging task that requires coordination at all political and expert levels. It cannot be claimed that there is a universally applicable model for the formation and implementation of policies for a smooth transition to a circular economy. The application of a complex and integrated approach creates the necessary basis for coordination, partnership, continuity, adequacy and consensus decisions in the formation and implementation of appropriate local policies.

The Municipality of Varna should take advantage of the created integrated strategies and participate in networks that go beyond regional borders. This will enable the adoption of more adequate solutions to municipal problems based on proven practices and lessons learned.

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Information Systems as a Tool for Dealing with Economic and Social Challenges in the Fourth Industrial Revolution in Bulgaria

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Abstract—The competitiveness of any national economy is directly linked to the development of the next generation of digital technologies. This poses new challenges to the social and economic development of Bulgarian society in the conditions of globalization. The solution to the thus formed task lies in the active implementation of information systems in the business process of our economic organizations.

Keywords—revolution, information systems, economy, social, software

I. INTRODUCTION

The world economy has always followed well-known patterns. One such model is the development of new technologies that drastically change industrial production and public attitudes. The changes began with the invention of the steam engine, which triggered the First Industrial Revolution, the beginning of mass production of the bag and the introduction of computer technology in enterprises, to the advent of digital technologies and the possibility of high-speed information exchange, which represents a new data revolution. It is safe to say that the interconnectedness and communication between people, machines and resources is at the heart of the Fourth Industrial Revolution. Fueled by the possibilities of technologies such as the Internet, cloud solutions, artificial intelligence and the development of cyber-physical systems, Industry 4.0 creates an interconnected environment in which non-stop and multidirectional data exchange takes place. It is precisely this that has transformed the nature of manufacturing, enabling it to keep pace with the ever-evolving needs of modern consumers.

Not only globally, but also in Bulgaria, Industry 4.0 is changing the rules of the competitive race in production. The introduction of new technologies is not an end in itself, but a way to achieve a completely new production environment characterized by:

- Higher work efficiency;
- Greater flexibility of production;

The modern type of customers requires a high level of personalization of the goods and services consumed - a result that can be achieved with the help of modern technologies such as information systems of a new generation, which cover

the entire process of movement of resources in the enterprise and bring reliable information to real time.

II. NATURE OF INDUSTRY 4.0 AND CHALLENGES ARISING FROM IT

From a historical point of view, in 2011 Germany became the first country to introduce the term "Industry 4.0" as part of the country's high-tech development strategy. Subsequently, many European countries are also starting to use it in their national policies for the digitization of production processes. In the Western world, thanks to the Industrial Internet Consortium /ICC/, the following definition of the fourth industrial revolution also appears: "the integration of complex physical machines and embedded systems and devices with networked sensors and software that are used to improve the processes of predict, control and plan for better business and societal outcomes" (Industrial Internet Consortium, 2013).

In its essence, Industry 4.0 is the digitization of the economy, its related processes on a global scale, and is also a generator of innovation, competitiveness and growth, with an unparalleled potential for the development of entrepreneurship and business units participating in economic markets of goods and services. It is a reflection of the scientific and production practices in our country, enabling the transformation of the principles for the production of economic goods and their placement on local and foreign markets at the industrial and economic level. This economic revolution naturally follows the production automation processes that have been going on until now, but the analysis of large data sets, the use of artificial intelligence, cloud services and virtual reality appears as a new moment. Most authors determine the following characteristics of the fourth industrial revolution:

- Optimized achievement of solutions - an essential feature of an information system in the direction of processing large data sets of the /Big Data/ type and the main management goal of analyzing information in real time. A typical example from practice is ERP systems;
- Optimization of resources in the organization - maximum achievement of strategic goals and set production quantities, through efficient use of limited

resources. Main property of cybernetic-physical systems and (Enterprise Resource Planning Systems);

- Customer-oriented approach - taking into account individual needs and requirements, even achieving profitability even with a batch of only one product;
- Optimum flexibility of the processes - balance of material security, achievement of the set deadlines, management of supply chains;
- The development of new sectors/services – innovations based on new technologies. A typical example are services between small and medium-sized enterprises (Business to Business);

Among the main digital products developed for enterprises and organizations participating in market mechanisms for the exchange of economic goods are business software for control and information security of information flows in a given enterprise, such as Enterprise Resource Planning Systems. As the main tool for overcoming competition at the industry, national and international level, they are the preferred business software of most foreign and now many of the native businesses. In the structure of their development, modules are implemented to track each of the processes for a given organization, they are distinguished by high flexibility and adaptability, easy to use by users and provide a control mechanism of the management structure in real time.

That is impact of the fourth industrial revolution on the public sector in our country. Activities such as e-government, digital education and health care and other innovations belong to the novelties of the state update. Policy and adaptability at the state level for the transition to a digital economy is essential, as this will directly affect our national competitiveness and impact on public life.

As a part of the European Economic Community, Bulgaria must have an active participation and contribution to the construction of common technological standards and the direction of introducing digitization of the economy. Only in this way can it be guaranteed that European business organizations will remain at the forefront of the world economic map. Uniform standards are also a reliable measure to ensure interoperability of new technologies and a guarantor of their confidentiality, security and accessibility of the information contained.

III. INDUSTRY 4.0 PROBLEMS AND CHALLENGES FOR SMALL AND MEDIUM ENTERPRISES

The process of global digitization is no longer aimed only at the manufacturing industry directly under the control of technological equipment manufacturers, but also at the functioning of small and medium-sized enterprises and the so-called "Start up" businesses, where a sharp increase in innovation is reported. It is important to pay attention to the fact that each organization leads its own unique life and there is no ready-made "recipe" for the correct and optimal application of digitalization, and it should be remembered that the main function of a small business is to provide jobs and employment at local and national level. The following figure shows the share of information systems /in percentages/ used

in our native enterprises as of 2021.

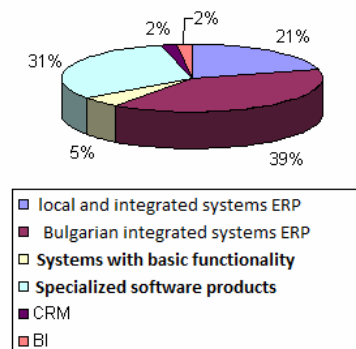


Fig. 1. Business software used in Bulgarian companies for 2021.

There are places around the world, the model of "collective search for solutions" is used. Practically, it is a periodic gathering of experts and employees in a given field, where they exchange fresh ideas, results of implementing different solutions or "Know How". This benefits the investment risk of small organizations because investors respond when an innovation can demonstrate real benefits in practice. According to the authors on the subject, this is how a reduction of the investment risk is achieved even before the decision is implemented in real conditions, or speaking from the point of view of the theory, the process is in the direction of "benefits - income - provision", as an alternative to the standard option "provision - benefits - income". Such an approach could ease the transition to a fourth industrial revolution for many of the small businesses and private initiatives, but for the backbone of an economic system, such as large-scale industry, which has the resources to afford huge investments in modernization, it should rather to look for another solution. Such is the implementation of information management systems. They allow timely tracking of information about processes and resources in the organization and continuous control at the management level. To this class of business software belong (Enterprise Resource Planning Systems), which have already proven themselves not only on the international stage, but also as a serious management tool for our native business. In practice, they are subject to individual synchronization with the needs and requirements of the client, retaining their basic structure of modules and full functionality. The above-mentioned model of "collective search for solutions" is very suitable for a country like Bulgaria, where a large part of the business is made up of small and medium-sized commercial organizations, as well as many self-employed craftsmen. It is here that various innovations obtained through "trial and error" are most often born, and this practical knowledge quickly turns into real skills.

IV. POSSIBILITIES FOR DIGITIZATION OF THE BULGARIAN ECONOMY, STATE POLICY AND CONCEPT

The development of Bulgaria in the direction of digitization of our national economy is closely related to the construction and development of a concept for the transformation through digitization of each of the economic spheres in the country, based on a generally developed strategy. Industry 4.0 on a global scale represents a "powerful

engine" for the development of innovations and optimization of the production process and the resources invested in it. They begin to position any enterprise or organization in the world and in our homeland, in terms of the process of digitization and implementation of new technologies, is of utmost importance for market survival in the coming decade.

At the state level, policies and models should be developed to support enterprises and organizations in the process of digitalization of the economy. It would not be possible to successfully go through this process and preserve our national competitiveness in the world economic markets without a close connection between technological development and active support at the state level. Among the policies that are expected to be undertaken by the European economic community are the development of common technological standards for the member countries, which will ensure the necessary level of interoperability of the implemented information systems and guarantee the necessary level of reliability and information security. Among the main priorities at the state level should be the creation of expert commissions to the ministries, as well as the development of the hidden potentials in our economy, in the direction of preserving the competitiveness of native business organizations and the smooth transition to a digital economy. For this purpose, it is essential to define nationwide principles for action. Based on a number of authors, we will derive the following principles, which are fundamental for a national concept, as:

- Support at the national level for the transition to Industry 4.0 – building specific policies, mechanisms and tools in service and assistance regarding the specific needs of our native enterprises;
- Synergy between existing policies and innovations;
- Close cooperation with educational and scientific institutions in order to develop the capacity of human capital;
- Development of test sites and pilot projects in the direction of innovation development;
- Providing financial resources/subsidizing projects/for supplying new technologies and implementing business software in our native enterprises.

After a number of analyzes by the European commissions, as the main weaknesses of the current economic situation in the country, those that represent a direct obstacle to an active transition to the fourth industrial revolution are indicated. Among the most important are weak competence for working with digital technologies of many of the workforce, lagging modernization of the infrastructure in the country, low use of Internet-based services by users, low level of education in the direction of information technology, lack of investments for scientifically developed - technological progress, delay of projects in the field of public e-procurement, which is a real prerequisite for slowing down the growth of small and medium-sized enterprises and reducing the possibility of exporting. As a result, it is concluded that active policies at the state level and development of conditions for attracting foreign investments are necessary.

V. INFORMATION SYSTEMS AS A TOOL FOR ACHIEVING OPERATIONAL EFFICIENCY BY BUSINESS ORGANIZATIONS

The provision of reliable information at the right time is of paramount importance for achieving precise planning of the production program and capacity utilization, as well as for optimal planning and management of material stocks. Having reliable and timely information about the occupied and free production resources, the availability or lack of raw materials, materials and tools and the status of current orders, the management of the enterprise can react with much greater flexibility to the arrival of extraordinary orders or take advantage of dynamically emerging market opportunities.

The overall digitization of production, which is the basis of Industry 4.0, is unthinkable without the solid foundation provided by business management systems. ERP systems are not new to the world of industrial production. Their history can be traced back decades, but the Fourth Industrial Revolution has given them the place of a key factor for success and competitiveness in changing market conditions. This has also led to the rapid evolution of ERP, leading among them include elements of artificial intelligence and successfully apply machine learning models, integrate easily with MES (manufacturing management systems) and IoT sensors, connect with customer relationship management (CRM) and business intelligence (BI) systems to form a single end-to-end system for managing every aspect of a manufacturing company's business. Figure 1 shows data on the use of ERP systems in Bulgaria by the native enterprises in the last few years.

Enterprises using resource management software						
	2013	2014	2015	2017	2019	2021 (%)
Total	19,7	27,2	24,9	23,3	23,4	21,8
By enterprise size						
10 - 49 hired employees	16,8	24,2	20,7	20,0	19,2	17,1
50 - 249 hired employees	29,7	38,5	41,4	35,5	40,1	40,1
250 or more hired employees	46,9	56,9	60,8	59,2	60,7	65,2

Fig. 2. Implementation of ERP systems in the Bulgarian economy.

Information systems are the link between the administrative management of the company and the real production side of the business. ERP systems cover in one environment basic processes of accounting and finance management, HR, sales and receivables, warehouse, deliveries and payables. At the same time, the information systems have a powerful production module that allows precise production planning against orders, deadlines and available resources. The business software type /ERP System/ is open for integration with software solutions involved in the physical management of production (MES/MOM), as well as with various sensors and IoT devices tracking the parameters and functioning of the machines on the production site. These integrations provide real-time information enabling a timely response to emerging opportunities or issues so that planned timelines and commitments are met. It makes them an essential digital tool for our native enterprises to deal with the economic challenges of Industry 4.0. The following figure shows a diagram of a typical home enterprise in the process of implementing an ERP system, from the point of view of changing the level of income and expenses.

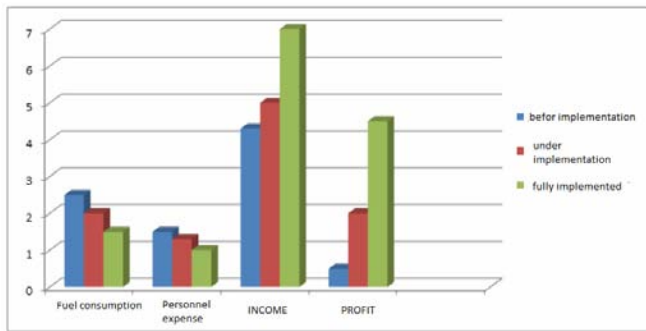


Fig. 3. Revenue, cost and profit levels in an ERP system implementation process

VI. CHALLENGES OF INDUSTRY 4.0 TO THE EDUCATIONAL MODEL AND E-LEADERSHIP

After the formation of the first forms of social society, the transition from a nomadic and unstructured way of existence of individual genera and individuals, followed by the first forms of settled existence and distribution of social roles, inevitably people /as a community/ set out on the path of socio-economic revolutions. As the main goal of satisfying needs with material and immaterial goods and the active development of labor, from the primitive making of knives to mechanization, the fruit of active engineering thought, man has imperceptibly carried out revolution after revolution in his way of being. In historical and economic terms, several major industrial revolutions were determined, which marked the beginning of completely new understandings for their time and developed in completely different directions the activity of supplying and exchanging economic and often spiritual goods. We are now in a new revolution, called by a number of authors Industry 4.0. It is distinguished by a different character of occurrence and development than we have known so far. It is defined as a new paradigm in the direction of digitization of all assets and economic agents that belong to common connectivity and integration in a single digital ecosystem. As a prerequisite for the occurrence, a number of reasons are indicated, among the most important of which, new possibilities for data storage and access to them, global communication system, increased power of macro-processors, networking of mobile devices and many others can be mentioned. We must take credit for technological innovations such as energy storage devices/batteries, nano-technologies, robotics developments and last but not least technological advances in artificial intelligence. In practice, the roots of the fourth industrial revolution are much deeper in time. For its successful implementation at the present time, a number of smaller but also significant events such as the restructuring of the production process, changes in logistics and forwarding, construction of modern business models, and also the global pandemic of 2020 are going through.

In order to be completely objective in our arguments, we must also consider the other face of Industry 4.0, each revolution brings its own reasons for concern, as well as challenges in social and economic terms. Let us define three main groups of directions resulting from the negative influence of the new economic reality, such as:

- Insufficient level of leadership and awareness to re-evaluate a number of accompanying changes in social, economic and political terms;

- Today's leaders have not yet developed a coherent and comprehensive understanding of the opportunities and challenges of this industrial revolution;
- The abrupt transition to such a technological-industrial-social process hides real risks and threats for the disintegration of the European Union /as a balancer between East and West/, and this may lead to solving the subsequent crisis through military action.

Let's also consider the downward directions of difficulty with the adaptation of most people to the new industrial revolution / here we will remind that such a problem stood before humanity in each of the previous industrial revolutions /, such as:

- ✓ Difficulties in understanding the new terminology / "digital literacy", "digital competence" and others/;
- ✓ New understandings and classifications of competencies;
- ✓ Creation of new systems for transition to a digital environment;
- ✓ Analysis of possible complications and resulting threats when working in a digital environment;

We want to be clear that the last of the above issues for threats in new platforms is particularly relevant. This exposes the user to new challenges and risks associated with working in a competitive environment and the ambiguities of the new digital reality, imposing ever higher requirements for training and retraining in order to meet the continuous changes in requirements. The situation thus created actually represents a sharp boundary between the requirements for technological skills and the preparation of public personnel in each of the spheres of economic activity, which brings to the fore social stability and the redistribution of the labor markets. In practice, the resolution of the problems defined in this way, which confront the society with new challenges in social and economic terms, happen with a delay. Any expert programs conducted both in the state and in the private sector really only have a catch-up character. The difficulties are increasing more and more, and this is a consequence of the increase in risk factors, as a consequence of the dynamics of the digitalization process and the new economic reality. In view of what has been said up to now, in summary we will indicate the opinion of leading authors on the topic, they believe that they have three important points to deal with the situation thus created:

- the first point is related to increasing the qualification and awareness of the labor force;
- the second moment – emphasizing the positive moments of the fourth industrial revolution;
- the third moment - going through the process of economic, social and industrial transformation.

The new socio-economic reality becomes a prerequisite for the appearance and search for a solution to completely unknown moral and ethical problems at the moment. Newly formed economic needs require research and development of adaptive specialties to meet the demand for personnel in the rapidly changing labor market. The requirements for the educational system are for the "production" of personnel who will be the

specialists of tomorrow. Their level of competence and comprehensiveness of knowledge will have to be directly related to the search for solutions to cases that did not exist until recently. These "future experts" must be deployed in the new socio-economic reality as a labor resource in the direction of digital leadership. The first fully digitally oriented majors already exist, which are a consequence of the active cooperation between the educational system and business structures in our country. Personnel with developed and implemented creativity, ambition and strong motivation to prove themselves in the field of the high-tech economic sphere. The sustainability of the system, a consequence of the fourth industrial revolution, is directly dependent on the leadership skills at the strategic and operational level and the overall policy of investing in education, scientific and technical progress and the implementation of new technologies. Our country is already in the process of transformation. The challenge is to find the optimal model for building a connection between technology, education and management skills, so that e-leaders of SMEs in Bulgaria succeed in the following:

- ✓ To find the right personnel for their business;
- ✓ To be actively involved in the development of new goods and services;
- ✓ To discover and satisfy the changing needs of their customers;
- ✓ To develop their supply chain.

According to many of the authors, future market-oriented personnel must possess the skills to operate in the global digital environment. They will be part of an economy that has shifted to the virtual environment, and this even more drastically requires their development as specialists able to impose themselves in a digital work environment. We believe that e-leadership is becoming a tool for accumulating knowledge and developing new products. The trend of tomorrow is to actively develop e-leadership training programs and ensure maximum access of SMEs to technological training.

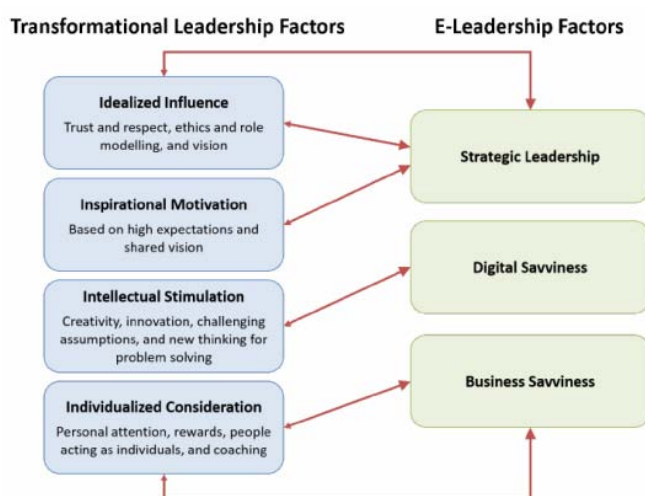


Fig. 4. Adopting E-leadership in SMEs.

Among the most distinguished are software products helping a smooth transition to information digitization of

processes affecting management structures in enterprises are software class (Enterprise Resource Planning Systems). ERP software has already distinguished itself as a part of modernizing business processes and increasing the competitiveness of any organization that has reached its implementation, and it can be assumed that it is among the main tools for the transition of the national economy to the fourth industrial revolution or better known as Industry 4.0.

The new reality resulting from the coming fourth industrial revolution builds and assigns a new meaning to the otherwise classic terminology and perception of the function of a leader. If we now connected our understanding with the activity of group management of a team of people, in the direction of achieving common goals, now the new meaning of a digital leader is taken to be innovative and atypically thinking individuals, looking for non-standard solutions to current cases, according to the terminology used - SMART leaders. Based on an expert study, the main characteristics of the qualities required for a digital leader have been identified, and this formulation applies in full force to the search for personnel in our native labor market. The basic characteristics are as follows:

- Competencies for working in a digital environment;
- Ability to transform the accumulated knowledge in the direction of the new digital requirements;
- Ability to be adequate to the process of leading and coordinating resources scattered in different locations in a unified whole to achieve an economic result;
- Out of the box thinking and innovative, successful in the process of adding added value in the conditions of a highly competitive environment.

Economically and socially, the changes and challenges of Industry 4.0 have a direct impact on the paradigm in our society, regarding the qualities and competences transmitted through the education system of the generations. Now, more prominently than ever, future personnel are required to develop non-traditional and highly flexible knowledge in order to fit into the understanding of the emerging economic reality.

VII. CONCLUSION

Industry 4.0 is not just a one-time event, but a complex and ongoing process that will continue to change and evolve with the emergence of each new digital technology. In the turbulent environment of the new industrial revolution, ERP systems are the stable foundation on which manufacturing enterprises can build their market success. In this direction, the application of the technologies that make up the Industrial Internet of Things (IIoT), which allow self-diagnostics of production equipment, optimal planning of preventive maintenance activities and minimizing losses related to unplanned emergency downtimes, will have an impact in this direction. The presence of isolated systems and lack of comprehensive information about the state of the business are unacceptable in the conditions of Industry 4.0. That regard, ERP solutions establish a connection between the information received from the actual production and the structured business data generated by the other units of the organization in order to provide an information environment necessary for

making informed decisions, corrective actions and active reaction to what is happening in the company.

The digital economy at the national level is a prerequisite for the transformation of the production model, which will transform the classic industry into an automated process and increase competitiveness at the level of quality and production costs, in the direction of active placement of native goods on world markets.

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Social Media and the Leading Technologies for Their Development

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Abstract—The phenomenon of social media from the point of view of the technologies emerging as engines for its development is the main topic of this article. In addition to the definition of social media and its difference with a social network, the most important applications of this communication channel in the public and individual exchange of information, as well as the needs of society that satisfy them - news, trade, contacts and influence - are also examined.

How social media came about and which scientific developments led to the realization of the critical steps in its development are also some of the issues addressed in the development.

Artificial intelligence and augmented reality are interconnected in their application not only in social media, and therefore they are important to explore, especially from the point of view of intersecting interests of consumers and marketers.

Another important element is radio frequency identification, which is a nodal technology for establishing identity between objects and persons in the exchange of information and data in communication and payments.

The increasing need for security and assurance of data records makes blockchain technology a key link for the future of social media and suggests that it will find new implementations related to it.

What will happen with the growing entanglement of social media and the concept of the Internet of Things is no longer just a matter of prediction, because the value-added opportunities from this collaboration can lead to better risk management and improved automation in industry and in our homes.

Keywords—social media, key technologies, future, concepts

I. SOCIAL NETWORKS AND MEDIA

Over the last decade, digital communication between people has grown at a rapid pace, and it is increasingly apparent that this process will not slow down or reverse its direction, quite the opposite.

It is difficult to determine whether the development of computer networking technologies combined with interaction software or the increased need for digital social interaction is the driving force, but the expansion of the scope, use and number of social networks is a fact.

However, it should be noted that telecommunication networks, such as computer networks in particular, are the basis for the implementation of this type of communication

channel. It is necessary to clarify that we are focusing on social media, not social networks.

The very term "social network", often used and gained popularity to name the digital environment for communication of different communities and groups of people, would not be used correctly in this context.

"A social network is a structure of individuals or organizations connected and interacting with each other. According to this definition, surveying social networks provides a set of methods for analyzing the structure of social units and helps explain the patterns observed in these structures." [1]

Social network analysis is inherently an interdisciplinary field of study that originates from the interaction of social psychology, sociology, statistics, and graph theory. The development of the first sociograms in the study of interpersonal relations is associated with the work of Jacob Moreno since the 1930s. These developments were the basis of mathematical models based on them in the 1950s, and in the 1980s social network theories and methods became widespread in the social and behavioral sciences.

On the other hand, "social media are interactive technologies that facilitate the creation and sharing of information, ideas, interests, and other forms of expression through virtual communities and networks." [2]

Despite the variety of stand-alone and embedded social media services, they have some common characteristics: firstly, they are Web 2.0 Internet-based applications, in which users generate content - photos, videos, comments, reactions, etc., each of which creates a service-specific profile to access the applications and thus become part of its infrastructure.

Thus, in practice, social media create and develop social networks by connecting individual profiles with other individual users or with groups and communities.

In order to justify the need for this development it is good to take a quick overview of the use of social media. The two main modes of implementation in modern society of social media are at the organizational level and at the individual level.

Hardly anyone could have guessed, even after the establishment of social media in its first years, how many implementations they would later receive, and at high and important levels in society.

One of the first is "GeoCities", better known as "Yahoo!", which started as a hosting service in 1994, but the following year already presented its development for communication between customers. Some researchers even trace the roots of social media back to the release of the online chat system "Tocomatic" in 1973, providing real-time communication, with messages being transmitted letter by letter as they are typed. [3]

The development of social media continued with Classmates.com (1995) to lead to the launch of SixDegrees.com in 1997. It is fair to ask why exactly this application is considered the first social media, since there are messaging clients such as ICQ and AOL and chat clients such as IRC(1988). The answer is that SixDegrees.com is the first online platform for users with "profiles, friend lists and school connections" that can be used by registered users. [4] In this way, a line of development is started that reaches the giant social networks (Facebook, Google+, etc.), the platform for video sharing (YouTube), for microblogging (Twitter) and for short videos (TikTok). Each of them, according to the latest statistics, has between 1 and 3 billion users.

Social media has already entered the practice of all major spheres of public data exchange, and this only confirms the importance of this communication channel.

At the organizational level, for example, social media is used by national governments not only to inform their citizens of actions taken, but also to manage their reputation levels.

For example, the government of Egypt in January 2021 launched a campaign among the youth to improve its image among them by using influencers on Instagram to counter the bad reviews of their governance in the press and accusations of non-respect of human rights in the country. [5]

In the US, law enforcement investigates, identifies, and searches for people, and immigration and border officials use social media data to issue visas and then track visa recipients on how they fare after entering the country.

At the same time, social media are undoubtedly an active field for the development of social processes and activities related to them, and during political elections, according to experts, they have already become a major factor in changing attitudes. That is why, through their use, there is already talk of the realization of a new era in politics - participatory democracy.

"The role of social media in democratizing media participation, which its proponents herald as the beginning of a new era called participatory democracy," notes Philip Pond and Jeff Lewis" Participatory democracy, according to Dictionary.com, is the ability for citizens to participate individually and directly in political decisions and policies that affect their lives, not through elected representatives. Thus elements of direct and representative democracy are combined.

Business is one of the sectors most benefiting from the expansion of social media. It uses the channel simultaneously for market research, advertising and selling goods or services.

Also, social media is popular and used by most companies in researching prospective employees for employment.

In science and education, they are used to exchange information, connect for learning and to express opinions, as well as to share achievements in real time in scientific meetings and discussions.

A place must also be found for commenting on the use of social media during the COVID-19 pandemic.

In going through this great test for humanity, social media gained even more popularity and was used massively to share and search for medical information related to the coronavirus pandemic and its impact on public health and attitudes. An important point was also that through the users, data was collected about the development, treatment and consequences of the disease.

Isolated due to the threat of contagion, people were forced to stay in their homes, and social media protected them by connecting them contactlessly and improving their awareness, while helping to overcome the communication breakdown.

For them, as a preferred communication channel, the extraordinary situation related to the coronavirus practically brought not only great benefits, in the form of new subscribers and advertising contracts, but also a great responsibility related to their mediation between people and institutions.

On an individual level, social media has been used for years as a new source of news, weather and shopping information. [6] It is of course well known that they are also widely popular for socializing with friends, meeting new people and participating in interest groups.

They are also preferred for users' self-expression and self-presentation in front of various communities, thereby promoting the idea of creating and managing the image and identity of the person in front of others, the way they would like to be. [7] However, there is research that suggests that a wide range of people are already confusing the replacement of authentic communication with that of social media, and the effect of this is to prefer to write a message when there is a real opportunity to make contact. [8].

II. THE TECHNOLOGICAL DIMENSIONS

The technological prerequisites for the creation of social media are not only logically the basis of their subsequent growth and wide application, but are also important for the analysis and forecasting of their development directions.

As with most startups, at the core of social media is a project that can be seen as key to the future connection of telecommunications networks, computer technology, and social networks.

Right from the start, he shows not only the direction, but seems to predict the main stages in their future. This is the Advanced Research Projects Agency (ARPA), established in 1966, which legitimized the ARPANET in 1969, where "they first connected computers to each other and transmitted the first host-to-host message, and in 1970 the first connection protocol was implemented in a network - Network Control Protocol." [9]

Thus, in practice, in this project, for the first time, the two main technologies for the realization of the Internet are

applied - packet-switching, a concept of Donald Watts Davis, as well as the first implementations of the TCP/IP protocol in 1983, created by order of the Department of Defense of the USA after merging with the developments of the French CYCLADES project.

"The other big steps in software technology for social media are the realization of remote administration, file transfer and email" [10]

Remote administration software was used in the first popular wireless devices such as BlackBerry, Pocket PC and Palm. This concept does not provide full remote access like VNC and Terminal Services, but it allows administrators to perform important and basic commands such as reboot, reset passwords and view system logs, install software and virus protection.

The use of packet switching ensures the transmission of data that is divided into packets. Each packet has a header that describes the content and a data payload to it. File transfer is the transmission of data over a communication channel from one computer to another. This is done according to rules for harmonizing and connecting the two systems called protocols. The two main protocols for transporting data on the Internet, which is based precisely on packet switching, are TCP and UDP.

The File Transfer Protocol is a very important step in the development of communications, as it was implemented by Abhay Bhushan Pandey in 1971, the same scientist who later worked with APRANET and contributed to the development of TCP. This protocol is one of the first and is used to transfer files from a server to a client in a computer network. Users can authenticate with password and username or anonymously depending on server configuration. It wasn't until 2021 that Google Chrome and Firefox browsers disabled their users' ability to use FTP.

The implementation of electronic mail and email also belongs to the software technologies that are the basis of social media. The first electronic mail using the modern user addressing syntax with @ in the middle was again the work of the ARPANET project, but was realized in 1971 through the FT protocol.

III. THE ROAD TO PORTABLE DEVICES

At the hardware level, there is no need to go into detail about the role of the personal computer when talking about the implementations of social media, but it is the first of the main steps in its progress, followed by the laptop and the mobile phone. The road to portable camera devices, however, passes through several important developments - digital imaging and semiconductor image sensor technology.

A digital image is the product of a sensor that, based on different levels of illumination, transmits information used to generate an image. [11] This is done by converting the alternating attenuation of light waves or other electromagnetic radiation.

The basis of modern solid state image sensors is the MOS technology [12], invented in 1959 at Bell Labs, on the basis of which CCD or CMOS sensors were later developed. This led to the widespread use of digital cameras, and subsequently to camera phones.

IV. CONCEPTS WITH A FUTURE

Where social media is going and exactly what are the progress-carrying concepts and technologies is naturally an important question for its development.

One of these concepts is artificial intelligence (AI). Over the years, it has undergone an important and substantial change in its definition, and thus its visionary beginning and adaptability are only emphasized.

Artificial intelligence is the ability of machines to make rational decisions related to the environment in which they are based on input or information collected by them. It appears that there has already been a substantial migration away from the understanding of AI as a machine imitating human cognitive skills, and it is now prioritized in terms of rationality and action to rationality without limitation on how intelligence can be articulated [13]

Social media is welcoming to AI. For example, as early as 2010, Facebook successfully implemented facial recognition by introducing an algorithm for grouping based on interests in posts, targeting user ads and supporting search. It is applied, both on Google for advertising positioning and on LinkedIn, to formulate and make recommendations for work, recruitment and business communication.

At the same time, as an important moment, we can also note the declaration in November 2021 by Jerome Pesenti, Vice President of Artificial Intelligence on Meta's official blog, the intention of the media to abandon facial recognition and delete the data of more than 1 billion users, as a result, the functionality to recognize people in a photo published by a user of the service on the web is no longer available.

AI has already entered our daily lives so much that some developments that used to be of this type, such as the optical recognition of road signs or car license plates, are no longer included in AI, due to the routine application and redefinition of AI. the definition.

The use of augmented reality (AR) in social media is one of the biggest challenges facing its development, but implementations so far only hint and reinforce the weight with which it will be credited in the future.

Augmented reality is the linking of real-world objects with computer-generated content, and it can cover different receptors from visual to auditory to olfactory. [14] An important implementation of augmented reality was the building of an AR-based application by Snapchat. Back in 2017, developers implemented and provided users with a camera filter that allowed them to render an animated version of themselves called "Bitmoji". The same platform is already using AR to build a new kind of communication as well, for example the rapper Bhad Bhabie successfully communicates with subscribers in almost the same way that she could do it in the real world. Through this technology, it is also possible to add customized changes to a photo taken in the sky, such as a starry night, a storm or a rainbow. AR thus enables an unlimited expansion of the space of contact between people, and these are naturally key to social media.

An example can be given with the implementation of augmented reality by the New York Times newspaper in their

project "How the news reaches your home". After downloading their app, for example, anyone can see a New York Times street vending machine on their phone screen as a 3D image. Thus, the possibility of introducing and telling stories expands and becomes more impactful.

A Radio Frequency Identification (RFID) tag is a small radio transponder, radio receiver, and transmitter housed in a single structure that provides radio frequency identification based on electromagnetic fields.[15] When it receives an interrogation pulse from an RFID reader within its range, the tag transmits digital data, usually in the form of an identification number, back to the reader as a response.

Each chip comes with a unique number recorded during its manufacture so that it can be unmistakably linked to the information stored on it. An example of its practical application can be given with concert tickets that have embedded RFID and when registering them through the reader at the entrance of the event, the visitor gets access to a closed group or social media page from where he can download the artist's new recordings or to upload his photos from the concert. In practice, this technology finds great application in the issuance of electronic personal documents and identification in payments (NFC).

Blockchain technology, which has gained notoriety along with cryptocurrencies, is also defined as very promising for social media. It is a distributed database or a continuously growing list of records that are linked together with a cryptographic code and are called blocks, and they can be continuously supplemented by new ones. Even if we only make a literal translation, it will give us a partial answer about the essence of the technology - a chain of blocks [16]

They are distributed across the network, there is no single master copy, and users are equal to each other and follow a certain protocol. So that every block included in the chain cannot be changed retroactively. The blockchain database is managed using a peer-to-peer network and a distributed timestamp server.

Cryptographer David Chaum first proposed a blockchain-like protocol in his 1982 dissertation, "Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups." However, the first fully developed concept has been talked about since it was published in 2008 by a developer under the pseudonym Satoshi Nakamoto.

As with currencies, these technologies are effective against network restrictions and against attempts to impose internet censorship on a particular media or other intellectual product. Blockchain projects make it possible to guarantee access and the ability to manage content with the guarantee that no legal entity will be able to block their records.

The application of blockchain technology will also allow content creators to be negotiated and paid for their labor without delays or unannounced deductions.

Another very serious application of this concept in social media is also in the works. The Meta company envisions their Web 3.0 project to provide an opportunity to exchange the Diem cryptocurrency, at least within the largest social network.

Twitter also announced in late 2021 that they plan to integrate cryptocurrencies into their platform to reward content creators [17].

The list of promising social networking technologies ends with the Internet of Things (IoT), which is at the bottom only in terms of chronology of emergence, not importance.

The Internet of Things represents connected groups of physical objects with sensors, with the ability to process data and specialized software, which are in contact and exchange with other networks. The goal is to make decisions related to the management of these networks and objects. [18]

The concept of the Internet of Things and the very name "Internet of Things" were first mentioned in a speech by Peter T. Lewis in 1985. in Washington. This technology can make social media involved in monitoring and delivering real-time data for decision-making in managing the systems that are part of the IoT. In fact, the popular name of the technology is considered by experts to be wrong, because networks of objects should not be connected to the public Internet, but should only be connected to the network and individually addressable.

IoT is part of the concept of Smart Home (home automation) and the ability to control smart devices and appliances. Thus addressed devices that are connected to the network can be controlled remotely through applications.

For example, using Apple's HomeKit, users can control all devices connected to the iOS ecosystem, such as computers, watches, and more. There are already implemented open source ecosystems that allow other smart devices to be included without the product of a specific manufacturer.

IoT collaboration in social media also takes into account the fact that social media users can be extremely useful in realizing an application related to the condition and risk performance of public infrastructure such as bridges, riverbeds, railways and other safety-related, repair activities and traffic. In fact, social media is an important part of the implementation of IoT and it is hardly possible in full without synchronization with this type of communication channel.

V. CONCLUSION

Already with the first breakthroughs in the development of hardware and software, which brought computers closer to the mass user, a clear request was given for the emergence of social media, because communication is inherent and necessary for man.

Social media has brought social networks into the digital world and gives people an alternative to communicating based on new technical achievements.

They are a powerful means of communication and are preferred by billions of users because of their easy access, and this predetermines their importance and influence, as well as the need to study the technological aspects of their future.

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Management Accounting Aspects of the Customers in the Enterprise

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Abstract—Customers are organizations or individuals that are external to the enterprise. They contribute significantly to its prosperity. This is because customers are the main source of revenue, and hence of profit and cash inflows. The management of the enterprise needs to have information and analytical data about the customers in two main domains – financial and non-financial. This data is provided by the management accounting system, so that the enterprise can successfully continue to carry out its activities. The data concerning the possible risks that may occur with customers, such as the risk of a liquidity crisis and the risk of not concluding commercial contracts with the enterprise, needs to be provided as a part of the non-financial information for them. After the customer information is created, they are evaluated. The aim of the enterprise is to work with the more highly valued customers.

Keywords—*Management Accounting, Customers Accounting, Risk*

I. INTRODUCTION

An enterprise's customers are a key factor that contributes to its prosperity. This is because customers are the main source of revenue and hence of profit and cash inflows. The management of the enterprise needs to have information and analytical data about the customers because a customer who is going bankrupt cannot pay what is owed to the enterprise, and thus can contribute to a significant deterioration of its financial position. In addition, the case where a customer refuses to continue their commercial contracts is also unfavorable.

The main aim of the paper is to present the management-accounting aspects of the customers. To achieve this aim, the following objectives have been set forth:

1. To outline the main information needs of the managers of the enterprise regarding the customers, which are required for enhancing its overall management.
2. To develop and suggest an information model with financial and non-financial criteria for evaluating customers.

The author's hypothesis is that information should be created and analyzed not only based on the revenue and profits gained from customers, but also on other aspects of the relationships with them, in order to develop a comprehensive evaluation of each customer.

The object of research in the current paper is the customers from the perspective of enterprise management and the subject – the created management accounting information about them.

For this research, a literature review has been conducted and the methods of comparison, analysis and synthesis, induction and deduction have been applied.

II. DISCUSSION AND RESULTS

Customers are organizations and individuals who are external to the enterprise from a legal point of view. Since the success of the enterprise depends to a very large extent on them, according to some researchers “A Customer is not an outsider to our business – she is a part of it. A Customer is not dependent on us – we are dependent on her.” [1]. However, the assumption that customers are part of the enterprise cannot be accepted. The main argument for this point of view is that the management of the enterprise cannot control the customers. But it is an indisputable fact that they have strategic importance for every business. The importance of customers for the success of any enterprise is determined by the fact that its ability to generate revenue and cash inflows from the product or service it creates depends on them. Customers are subject to research by financial accounting. The financial accounting view of customers is related to the control of the timeliness of their payments. However, failure to receive the cash for the accrued income on time can cause difficulties regarding the turnover of the business, and even worsen the liquidity of the enterprise. The case of a customer who is not paying what is owed has a particularly adverse effect on the enterprise. Unfortunately, such cases are still observed in Bulgarian enterprises. It also happens that a claim from a customer awarded by the court is not repaid, due to a lack of cash and property to secure the claim. The negative effect on the enterprise in this case is caused by the fact that according to the tax legislation in the Republic of Bulgaria, the amounts not received from the customers are subject to write-off. But firstly, they are reported as an expense that is not recognized for tax purposes and tax is charged accordingly. Hence, this leads to an increase in taxable profit [2].

Information about the timeliness of payments from customers is important, but not sufficient for the management of the enterprise. It needs more diverse customer information, both financial and non-financial in nature. Information related

to whether the customer pays their debt on time, whether they make unfounded claims for what is supplied by the business, whether they purchase similar products or services from other companies, and the likelihood that at some point they will refuse to enter commercial contracts with our company, the degree of their satisfaction, etc.

“Customers are important intangible assets of a firm that should be valued and managed” [3]. The proposition that they are intangible assets cannot be accepted. This is because the characteristics of customers, as assets of the enterprise, do not meet the accounting requirements for identifying intangible assets.

In an environment characterized by limited resources and multiple options for customers to choose suppliers, the role of every single customer is important. This determines the strategic importance of customers. The fact that Customer Accounting is presented on the CIMA website as a separate technique of strategic management accounting [4] is another indicator of the importance of the customers. It concerns the collection of information about customers and data analysis, such as the evaluation of the profit generated by the customer for the enterprise, the volume of sales or the costs incurred by a specific customer or a group of customers, segmented by a given feature (regional, functional). Based on the collected information and findings from data analyses, the customers are ranked, and their profitability is determined (the term “profitability” is perceived in a rather broad sense). According to some authors: “Customer accounting focuses on the financial measurement of customers” [5].

The financial aspect of customers is of great importance. In addition, some of their non-financial characteristics also matter. However, this depends on the specific enterprise, the nature of its activities, the management’s policy regarding customers.

Based on the financial information about the customers, a policy can be implemented to motivate the customers who generate higher revenues, and hence profits for the enterprise.

The enterprise is dependent on its customers. This dependence is observed during crises – for instance when the financial stability of a customer has deteriorated, and they cannot repay their debts to the enterprise. This raises a dilemma for the management – is it better for the enterprise to work with a few large customers or with many small ones? Is the policy of incentivizing large customers more appropriate and how will it affect the enterprise if one of its large customers falls into a state of insolvency or goes bankrupt?

Based on empirical observations, it can be concluded that if the enterprise works with large customers, the risk of bankruptcy of one of them will have a greater impact on the business. To avoid such scenarios, the management accounting system should monitor the financial status of the customers from the officially announced information in their financial statements and, in the event of a risk of insolvency or bankruptcy, take measures to limit the negative impact of such events on the enterprise. This could be achieved by exploring opportunities to find new customers to take the place of the ones with higher risk. However, in such scenarios time is of the essence.

An important part of customer information and data analysis is related to the risk of customers opting out of contracts with the enterprise. If such an event occurs, the sales process becomes more difficult, revenues and accordingly, profits decrease.

The occurrence of events related to customer risks affects the process of achieving the strategic goal of the enterprise. Thus, it is needed to assess their importance, as well as the opportunities for the enterprise to react to minimize the negative impact on the strategy of these customer-related risks. The proposition of the author of this paper on the systematization of customers according to the risks that may occur to them, is presented in the paper “The Role of Strategic Management Accounting in External Strategic Risk Management” [6]. According to researchers working in the field of strategic management accounting, risks related to customers and their management should be an integral part of the strategic management of the enterprise and is a technique inherent to strategic management accounting [7].

For management to work effectively with customers, it needs information and analytical data about them. These are provided by the management accounting system in the enterprise. They cover a certain period, which length is determined by the decision of the management. To provide the information and analytical data in the enterprise, a system for customer evaluation with specific criteria should be developed. The appropriate approach to achieve this is by evaluating their individual characteristics. Based on individual evaluations, it is possible to form an overall evaluation and a kind of customers ranking, in accordance with a scale developed in advance. Accordingly, it is more appropriate for the enterprise to continue its work with the customers who have received the highest ratings. It is possible, at the discretion of the management, to conduct a policy of incentivizing the customers ranked in the first places. However, this approach is not mandatory. The ranking may remain completely confidential and be used for more efficient management only.

The criteria by which customers should be evaluated can be very different. But the main approach of classification is to distinguish between financial and non-financial criteria.

Financial criteria are provided with information most easily because there is already summarized data for them created for the purpose of financial accounting. For management purposes, the information in the management accounting system can be detailed to the extent needed for it to be useful. The financial criteria for customer evaluation have been sufficiently studied and information models have been developed for them [8], [9], [10].

According to the conducted desk research, the financial criteria in the scientific papers are expressed through the following financial indicators:

1. Sales revenue generated by the customer. This information can be detailed by sales of specific types of products (services).
2. Costs (unfounded claims by customers, which are perceived as non-financial criteria, but the costs of such

claims should be included here) for the specific customer. Additional detailed classification can be achieved based on the different types of products. In addition, costs may be systematized differently, depending on the organization of information about them and the management practice.

3. Profit from the customer. Profit is easily determined. And if it is essential to detail income and expenses by types of products purchased by the customer, the information on the profit from the individual customer can be easily detailed as well.

Because of financial indicators, the so-called profitable and unprofitable customers are determined. In the Bulgarian scientific literature in the field of management accounting, Yonkova reviewed this topic in her book "Management Accounting", where in the chapter "Strategic Cost Analysis" she examines customer profitability [11]. In the cited publication, customers are divided into four types according to their profitability.

The topic of non-financial criteria is more complex. There is no universal measure for the non-financial characteristics of a given accounting object in general, and for customers, therefore, each enterprise should develop a model of a system of non-financial criteria.

As the most important non-financial criteria related to customers, the following can be outlined to be included in this model:

1. Timeliness of payments.

2. (No) unfounded claims submitted by the customer for the delivery (quality, price, quantity).

3. Customer satisfaction. There are scientific works in the specialized literature on the topic of satisfaction and this question does not need to be additionally explored in this paper. However, it could be noted that satisfaction is a too subjective characteristic. But a satisfied customer can bring benefits to the enterprise, because by sharing their satisfaction with others, the customer is practically advertising the enterprise's activity at no additional cost. According to some authors, a satisfied customer is a profitable customer [10], [12].

4. Existence (absence) of risk of the client falling into a liquidity crisis.

5. Existence (absence) of the risk of the client's refusal to enter new commercial contracts.

For a better perception of information about financial and non-financial criteria, the information model can be formed

in a tabular form. Two approaches can be undertaken: 1. to create a common table for the fulfilment of both financial and non-financial criteria; 2. to create two separate tables.

Based on the presented model, a complex assessment of the client can be made. The intent is to work primarily with clients who have a high overall evaluation.

III. CONCLUSION

For every enterprise, customers have a particularly important strategic value, because they consume the created products or services, bringing the main revenue streams and cash inflows. This determines the need for the enterprise management to have customer information and analytics to use for effective management. The paper presents the management and accounting aspects of the customers. For this purpose, it outlines the main information needs of the management related to the customers, necessary for successful management. An information model for evaluating customers by financial and non-financial criteria has been developed and proposed. The hypothesis that along with purely financial information about customers, the enterprise should create non-financial information related to them to realistically evaluate each customer and work primarily with the highly rated customers is proven.

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Algorithm for Assessment of Volume Indicators for Manufacture of Products in the Conditions of Industry 4.0

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Abstract—The object of the present development is the production capacities of the industrial economic entities and, in particular, the volume indicators as part of these same capacities. The main goal is to model an algorithm for estimating volume indicators for production by industrial enterprises in the conditions of Industry 4.0. The development presents an algorithm for evaluating production in the conditions of Industry 4.0, which is based on an efficiency coefficient, including the technological capacity and the amount of production. This algorithm details the factors and elements that account for the execution of the production program. In addition, through them, the industrial enterprise can have a direct impact on the production process and its final result.

Keywords—algorithm for assessment, manufacture, cyber-physical production systems, technological capacity, quantity of products

I. INTRODUCTION

At the beginning of the third decade of the 21st century, Industry 4.0 is entering a complete digitization of production and business processes in industrial entities. The main goal of is to introduce cyber-physical production systems, with the management of which to achieve optimization of the industrial capacity of individual enterprises and increase the added value and results of their activity.

A significant emphasis in this regard is the management and monitoring of the volume indicators of the manufacture of industrial enterprises, which monitor the production capacity, including the technological capacity and the volume of the manufactured production. As part of the mentioned technological equipment, the efficiency of its use, as well as the human resources for its management and monitoring have an impact on the production process. In this order, each industrial enterprise must build a suitable algorithm for evaluating the efficiency of its production facilities.

The object of the present development is the manufacturing capacities of the industrial economic entities and, in particular, the volume indicators as part of these same capacities.

The main goal is to model an algorithm for estimating volume indicators for manufacture of products by industrial enterprises in the conditions of Industry 4.0.

The exposition of the present development is limited to the study of the volume indicators related to the production by the industrial enterprises, as well as their results, factors and their constituent elements.

The study complies with the legal regulations of national and European legislation as of July 31, 2022.

II. EXPOSITION

Modern economic development is faced with a number of challenges related to digitization on a global scale, one of the main ones being the intelligent digital transformation of technological processes in industrial enterprises. This is the basis of the fourth industrial revolution, through which the development of economic, technological and production activities follow, which will lead to evolution in the next stage of industrial, economic and social development. At the core of Industry 4.0 are cyber-physical production systems, through which manufacturing processes in industrial enterprises are automated. In this way, intelligent systems are implemented for the production process, which monitor this process from its entry point to the end result - the actual manufactured product and even to its realization.

In order to carry out adequate processes for management and monitoring of production, an objective algorithm for evaluating volume indicators is needed, through which optimization and improvement of processes can be achieved, as well as the decisions made in this regard. For the evaluation of volume indicators for the manufacture in the conditions of Industry 4.0, the author proposes a deterministic combined model for measuring the performance and factor indicators of the used technological capacity for the manufacture and the actual volume of the produced products in natural meters. In fulfillment of the above, it is necessary to derive an efficiency coefficient that represents the adequate results of the implementation of the manufacturing process. The estimation of volume indicators for manufacture modeled in the proposed algorithm through the application of a deductive approach. This algorithm generally includes the following stages through which the performance factor results are detailed:

- Establishing the level of the efficiency coefficient of the volume indicators for manufacture of products

during the current period, by measuring the effect of the technological capacity for carrying out the manufacturing process in relation to the amount of production. In addition to the above, the dynamics of the coefficient is established by comparing the data for the current versus the base period;

- Study of the level and dynamics in the elements of technological capacity, occupying an essential part in the manufacturing process.

The first stage of the algorithm involves establishing the creation of the coefficient of efficiency of volume indicators by creating the technological capacity for the implementation of the manufacturing process in relation to the corresponding structural relation to the volume for production in natural meters. In this way, it is measured with what technological capacity the enterprise produced a unit of product. Metrification can be done in both absolute and relative value.

The value of the coefficient of efficiency of the following production is calculated by applying mathematical formulas:

- Metrification of absolute value of efficiency coefficient:

$$Cef = \frac{Tc_j^n}{VP_j^n}, \quad (1)$$

where:

Cef is efficiency coefficient for the manufacturing of production;

Tc_j^n is the technological capacity for the production of the “j” type in the “n” period;

VP_j^n is the quantity of produced products of the j type in the n period.

- Metrification of a relative value of the efficiency coefficient:

$$\%Cef = \frac{Tc_j^n}{VP_j^n} \times 100 \quad (2)$$

The next moment of the first stage is the calculation of the value of the dynamics in the efficiency coefficient of the volume indicators for the manufacture, in which the value changes of the factors during the current period are compared to the base period. This period can be determined on a monthly, quarterly, six-monthly and annual basis, and it is recommended to take the period of putting the production system into operation by the industrial enterprise as the base period. Also, the periods should be of the same duration in order to be comparable, otherwise the evaluation results were not adequate. For the purposes of designing this algorithm, the author proposes to apply reporting periods that are of a calendar year (from January 1 to December 31).

The dynamics in the efficiency coefficient of the volume indicators of manufacture is established by the mathematical formula:

$$\Delta Cef = Cef^1 - Cef^0, \quad (3)$$

where:

ΔCef – dynamics in the efficiency coefficient of the volume indicators of a production system;

Cef^1 – value of the efficiency coefficient of the volume indicators of a production system for the current period;

Cef^0 – value of the efficiency coefficient of the volume indicators of a production system for the base period.

After measuring the dynamics in the efficiency coefficient, the evaluation algorithm is deepened by detailing and measuring the composition and structure of the reasons for the observed change. Conditional values of the coefficient are applied, which examine the factor changes in the total value of the technological capacity for the production (Tc) and in the quantity of produced products (VP). Factor dynamics are explored based on the factor that is the primary source of causation. For the current coefficient, this represents the technological capacity, because if the enterprise non-invests equipment, technological time and human resources for the manufacture of products, there is no way to reach the desired level of the volume of products. A conditional efficiency coefficient is calculated, measuring the influence of the change in the technological capacity compared to the base value of the volume of the realized production, as follows:

$$Cef^1 = \frac{Tc^1}{VP^0} \quad (4)$$

Next, the dynamics in the efficiency coefficient, established on the basis of the realized factor change in the value of the technological capacity for the current period, is measured. For this purpose, the measured conditional value (Cef^1) is compared to the base value of the coefficient by the following calculation:

$$\Delta Cef (Tc) = Cef^1 - Cef^0, \quad (5)$$

In order to measure the dynamics in the efficiency coefficient, established on the basis of the factor change realized for the current period in the value of the other indicator - the quantity of produced products (VP), on the efficiency coefficient, the difference between the value of the efficiency coefficient of the production system for the current period compared to the conditional value measuring the dynamics for the current period only of the conditional indicator measuring the influence of technological capacity. This is determined by the mathematical formula:

$$\Delta Cef (VP) = Cef^1 - Cef^1, \quad (6)$$

An analytical synthesis should be carried out, the purpose of which is to measure the results of the individual influence of the change of the individual factors on the overall value of the dynamics in the efficiency coefficient. For this purpose, the sum of the change in the factor indicators - technological capacity for production (Tc) and the quantity of the produced products (VP) is determined by the following formula:

$$\Delta Cef = \Delta Cef (Tc) + \Delta Cef (VP) \quad (7)$$

The measured value of the analytical synthesis must be equal to the values obtained when establishing the level of the coefficient of useful action from the mathematical formulas (1) - in absolute value, or (2) - in percentage. In the event that a deviation from this value is obtained, the evaluation algorithm should be revised and the logical relationship between the individual factors should be measured.

The level and dynamics of the efficiency coefficient of the manufacturing volume indicators present the results of the production process in a consolidated form. The obtained results in the value of this coefficient can be diagnosed in the following generalized form:

- When the absolute value of the coefficient is equal to 1 (resp. the relative value is equal to 100%), it is assumed that the industrial enterprise has optimally loaded its technological capacity for the production of a unit of product;
- When the absolute value of the coefficient is greater than 1 (resp. the relative value is over 100%), it is assumed that the enterprise has overloaded its technological capacity, which overtakes the production of a unit of product. In this case, the production process must be optimized, since the enterprise carries out a greater load on its production facilities, and the production results do not sufficiently cover the input resources and incurred production costs, i.e. does not generate added value;
- When the absolute value of the coefficient is less than 1 (resp. the relative value is less than 100%), it is assumed that the enterprise has less burdened its technological capacity for the production of a unit of product and therefore realizes an economy, which can be reflected in less real costs for the implementation of the production process.

The algorithm for assessing the specific reasons for the established value results in terms of the level and dynamics of volume indicators for manufacture, as well as deviations from the production program of the industrial enterprise, implies a more in-depth study of the factors of the structure of the efficiency coefficient presented above.

The second stage of the evaluation algorithm emphasizes the elements of the technological capacity for the production (T_c), because by influencing it a better final result can be achieved in the production of a unit of product. To measure the dynamics in the change of the specified indicator, the reported values for the current period are compared with those for the base period. After that, an evaluation of the individual structural elements is carried out in order to establish their influence on the measured dynamics. The change in the technological capacity to manufacture of products is established by applying the following formula:

$$\Delta T_c = T_c^1 - T_c^0 \quad (8)$$

where:

ΔT_c – the dynamics of technological capacity for manufacture of products;

T_c^1 – value of the technological capacity for manufacture of products during the current period;

T_c^0 – value of technological capacity for manufacture of products during the base period.

The next point in the construction of the evaluation algorithm is the diagnosis of the influence of the structural elements of the technological production capacity on its ascertained value. In general, technological capacity includes the following structural elements:

- Average list number of technological equipment (TE);
- Worked machine hours for one machine shifts (Mh);
- Performed machine shifts from a unit of equipment (Msh);
- Produced products for one machine hour (PMh).

By adapting what has been stated so far to the algorithm for evaluating the volume indicators for the manufacture, the following mathematical formula can be derived for calculating the technological capacity of the industrial enterprise:

$$T_c = TE_j^n \times Mh_j^n \times Msh_j^n \times PMh_j^n \quad (9)$$

where:

TE_j^n – average list number of technological equipment for manufacture of the “j” type product in the “n” period;

Mh_j^n – worked machine hours for one machine shifts for the manufacture of the “j” type product in the “n” period;

Msh_j^n – machine shifts worked by a unit of equipment for the manufacture of the “j” type product in the “n” period;

PMh_j^n – production of the “j” type product per one machine hour in the “n” period.

The detailing of the influence of each individual element on the dynamics is established by the application of conditional indicators in the following sequence:

First, the change in the average list number of technological equipment for the manufacture of products (TE) is measured as a structural element of the technological capacity. In this way, it is presented what impact the change in the average list number of technological equipment for the current compared to the base period has on the technological capacity. In the specific case, the influence of the average list number of the technological equipment for the manufacturing is measured by the calculation of the first conditional indicator, and for this purpose the following mathematical formula is applied:

$$\Delta T_c^1 = TE_j^1 \times Mh_j^0 \times Msh_j^0 \times PMh_j^0 \quad (10)$$

Second, the impact of the element machine hours worked per machine shifts for the manufacture (Mh) as part of the technological capacity structure is metrified. Through the above, the influence of worked machine hours for one machine shift for the manufacture of products for the current relative to the base period, on the level of technological capacity, is presented. The influence of this element is

measured by the calculation of a second conditional indicator with the following mathematical formula:

$$\Delta Tc^{\text{II}} = TE_j^1 \times Mh_j^1 \times Msh_j^0 \times PMh_j^0 \quad (11)$$

Third, it measures the change in the element spent machine shifts per unit of equipment for the manufacture of products (Msh) as part of the structure of technological capacity. In this way, it is presented what effect the change in the used machine changers of a unit of equipment for the manufacture for the current compared to the base period has on the technological capacity. In the specific case, the influence of the spent machine shifts from a unit of equipment for the production is measured by the calculation of a third conditional indicator, and for this purpose the following mathematical formula is applied:

$$\Delta Tc^{\text{III}} = TE_j^1 \times Mh_j^1 \times Msh_j^1 \times PMh_j^0 \quad (12)$$

The next point of this stage of the algorithm is measuring the influence of the elements of the technological capacity on the total value of the dynamics of the same. The set is for measuring the value of individual elements for the current period compared to the base period, on the total value of the dynamics of the technological capacity. The above is measured by successive chronological comparison of conditional indicators by individual elements by applying the following mathematical apparatus:

1. Measuring the influence of the dynamics in the average list number of technological equipment on the dynamics of technological capacity:

$$\Delta Tc (TE) = Tc^{\text{I}} - Tc^0 \quad (13)$$

2. Metrified influence on the dynamics of machine hours worked for one machine shift on the dynamics of technological capacity:

$$\Delta Tc (Mh) = Tc^{\text{II}} - Tc^{\text{I}} \quad (14)$$

3. Measuring the influence on the dynamics in real machine shifts from a unit of equipment on the dynamics of technological capacity:

$$\Delta Tc (Msh) = Tc^{\text{III}} - Tc^{\text{II}} \quad (15)$$

4. Metrified influence on the dynamics of the produced product for one machine hour on the dynamics of the technological capacity:

$$\Delta Tc (PMs) = Tc^{\text{I}} - Tc^{\text{III}} \quad (16)$$

After measuring the differences between the conditional indicators, an analytical synthesis of the results established above is carried out, the value of which should be equal to the difference calculated in mathematical formula (8). In case of deviation from the latter, the reasons for the same should be investigated. The analytical synthesis of the created and the dynamics of the technological capacity of manufacture is established by applying the mathematical formula:

$$\Delta Tc = \Delta Tc (TE) + \Delta Tc (Mh) + \Delta Tc (Ms) + \Delta Tc (PMs) \quad (17)$$

With the presented algorithm for evaluating the volume indicators for the manufacture in industrial enterprises, a sufficient level of detailing of the influence of the level and dynamics of the individual factor indicators for the implementation of the production processes and their constituent elements is achieved. It can also be used to prepare the production program of the industrial entity during the relevant period. In this order, through the application of the present evaluation algorithm, the degree of realization of the production program can be established by comparing the reported versus the planned indicators.

III. RESULTS

The development presents an algorithm for evaluating production in the conditions of Industry 4.0, which is based on an efficiency coefficient, including the technological capacity and the volume of produced products. This algorithm details the factors and elements that account for the execution of the production program. In addition, through them, the industrial enterprise can have a direct impact on the production process and its final result.

A specific mathematical apparatus was developed to establish the level and dynamics of the efficiency coefficient of the volume indicators, as well as the individual influence of the factors and elements of the same indicators. The exposition also presents mathematical calculations for researching the level and dynamics of technological equipment, machine hours worked for one machine shift, machine shifts worked per unit of equipment and produced products per machine hour, which have a direct impact on manufacturing.

IV. CONCLUSION

From exposition of the present study, it can be summarized that with the design of an adequate algorithm for assessment the volume indicators for manufacturing in industrial enterprises, the processes of management and monitoring of the main volume indicators for manufacturing of production will be improved.

In a theoretical-methodological and in a practical-applied aspect, the present development achieves results related to the development of the coefficient of efficiency of the volume indicators, which includes the factors and elements of the technological capacity and the amount of production. A specific mathematical apparatus has been developed that examines the level and dynamics of technological equipment, machine-hours worked per machine shift, machine-shifts worked per unit of equipment and produced products per machine-hour, which have a direct impact on production

The evaluation algorithm in industrial enterprises can be improved by including value indicators, with which to achieve improvement of financial management and control, as well as optimization of the monitoring process on the results and added value of the performed activities.

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Section 2.

TELECOMMUNICATIONS AND INFORMATION TECHNOLOGY

On the Throughput of Pure ALOHA with Different Power Levels for Wireless Sensor Networks

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Abstract—Wireless sensor networks (WSNs) have been a popular area within network domain with a great number of applications, thanks to their simple and easy structure in practical aspects. Medium access control (MAC) protocols hold a significant part for the successful deployment of WSNs, controlling the channel access mechanism of entire WSN nodes. In literature, ALOHA is the first MAC scheme which was implemented in the development of several MAC schemes for WSNs. The throughput performance of ALOHA is unfortunately limited to only 18% under a series of assumptions in theory. This paper focuses on the performance improvement of ALOHA with the aid of exploiting different power levels. In addition to this, a practical observation of ALOHA is provided to understand the performance behavior. Performance outputs prove the efficiency of the proposed mechanism.

Keywords—throughput, ALOHA, output power, capture effect, collision

I. INTRODUCTION

In recent years, innovations and developments in technology have paved way to design more efficient and intelligent systems in all aspects of science and technology. This trend will undoubtedly continue in course of time. In this respect, wireless sensor networks (WSNs) have been gaining an increasing popularity in emerging network domains such as Internet of Things (IoT) [1]. A classical WSN employs diverse number of tiny devices, referring to as nodes, each of which is limited in memory, battery, and process capabilities [2]. All nodes in a WSN sense an environmental parameter such as temperature and humidity. The main target is to deliver the sensed data to a central point to be further processed. One of the effective solutions to improve the quality of such network is to design cost-efficient and resource-friendly medium access control (MAC) schemes [3]. A typical MAC strategy has the potential to enhance the performance of WSNs through coordinating the channel access of nodes, avoiding concurrent transmissions. It is well-known that when more than one node attempt to transmit simultaneously, a packet collision is experienced. The result of collision is the destruction of all packets involved in the collision. This requires retransmission of the collided packets consuming more **energy and channel resources**.

ALOHA with two variants is the first MAC scheme for data transmission in wireless network field [4]. The primary goal of ALOHA is to enable nodes to operate in a shared medium. Hence, each node can communicate with a central point on the same frequency. ALOHA allows nodes to transmit data immediately requiring no coordination with other nodes. This results of course in packet collisions losing high number of transmitted packets. To deal with collisions, ALOHA implements an acknowledgment policy, whereby a successful reception of a packet is acknowledged to inform the transmitting node. To do this, upon reception of a packet, the receiving node sends a small-length packet, called ACK packet, back to the transmitting node. When the transmitting node receives no ACK packet, it schedules a retransmission. The upper limit for retransmission of a packet is set to 7. After 7 successive retransmission attempts without success, the associated packet is discarded from the memory.

The first version of ALOHA is known as pure ALOHA which is already described in detail above. However, the maximum throughput performance can be achieved by almost 18% because of the problem of collisions. To improve the efficiency of pure ALOHA, another version of ALOHA, namely Slotted-ALOHA, appeared to present a double throughput performance. The underlying property of Slotted-ALOHA is that the time is divided in equal-length slots and transmissions are permitted at the beginning of slots. Unlike pure ALOHA, when a node generates a packet in Slotted-ALOHA, the start of next time slot must be waited for transmission. In this scenario, full-length collisions can happen in slots, eliminating partly collisions at different extents. The maximum achievable throughput for Slotted-ALOHA increases to nearly 36%.

The nodes, as one of the key assumptions in ALOHA, transmit packets at the same transmission power. Recent hardware developments ensure various levels of transmission power. For instance, an existing study utilizes two power levels for Slotted-ALOHA which raises the throughput to approximately 53% [5]. As in this work, another study focusing on pure ALOHA with two power levels boosts the throughput to nearly 26% [6]. This paper proposes to evaluate the throughput performance of pure ALOHA with two power levels using a specific radio transceiver unit. To simplify the

coverage, the proposed strategy lets some nodes transmitting at maximum transmission power level while rest of the nodes transmitting at low transmission power level. We systematically increase the number of nodes intending to send using the highest power level. The results indicate that the proposed idea provides superior throughput performance. We then organize the rest of the paper by followings. Section II outlines the basic properties of ALOHA protocol. The working principle of the proposed strategy is presented in Section 3. Section 4 summarizes the performance evaluations. The paper is finally concluded in Section 5.

II. OVERVIEW OF ALOHA PROTOCOL

ALOHA has a key advantage of simplicity which makes it very flexible in practical implementations. The packets are immediately transmitted after the generation. However, there is no coordination mechanism among the nodes which causes a lot of collisions. If the amount of collisions increases, the packet reception rate (throughput) reduces significantly. To receive a packet with success, the required condition is to avoid the transmissions from other nodes during the reception process. An illustrative example scenario for pure ALOHA is depicted in fig. 1. To sum up generally, ALOHA has its basics as followings:

- After a packet is created, it is directly sent which is then followed by a response (ACK packet).
- If ACK packet is not received, the packet is accepted to be lost and retransmission process is started.
- Each node can communicate with center directly.
- Each node generates packets with the same packet length.
- Each node transmits packets at the same transmission power.

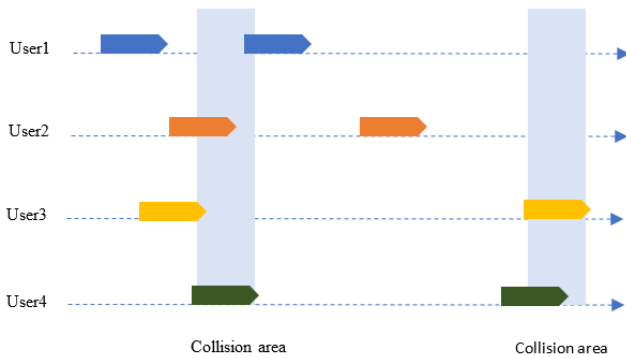


Fig. 1. ALOHA with packet collisions.

To further improve the throughput performance of pure ALOHA, slotted-ALOHA was proposed that doubles the throughput efficiency. It divides time in slots and each transmission is allowed to begin at the onset of slots. By doing this policy, packets can collide fully within slots. An example case of slotted-ALOHA is presented in fig. 2. The throughput performances of pure and slotted-ALOHA can be analytically expressed by followings respectively [7]:

$$T = G * e^{-2G} \quad (1)$$

$$T = G * e^{-G} \quad (2)$$

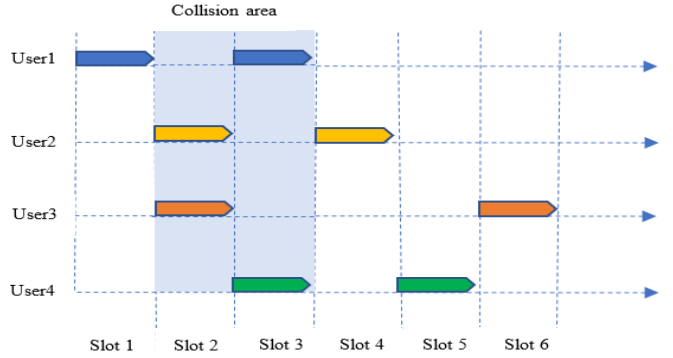


Fig. 2. Slotted-ALOHA with packet collisions.

Here, G denotes the overall generated traffic load in the network. It is worth noting that this formula is dependent only on the traffic load. This is because the number of nodes in the calculation is assumed to be infinite. Our recent study attempted to re-calculate the throughput of pure ALOHA with finite number of users through a binomial type [8]:

$$np(1-p)^{2(n-1)} \quad (3)$$

Where n is the total number of nodes and p represents the probability of a node for transmission. Simply, the probability value of p is equal to each node as each user is given an equal chance to transmit packet. Using this equation, we plot the throughput values for different values of n with respect to varying traffic loads in fig. 3. The results reveal that the throughput approaches to its theoretical value with increasing number of nodes, particularly beyond a node number of 50. Low number of nodes, however, provides higher throughput which should be considered when designing an ALOHA-type network with small number of nodes.

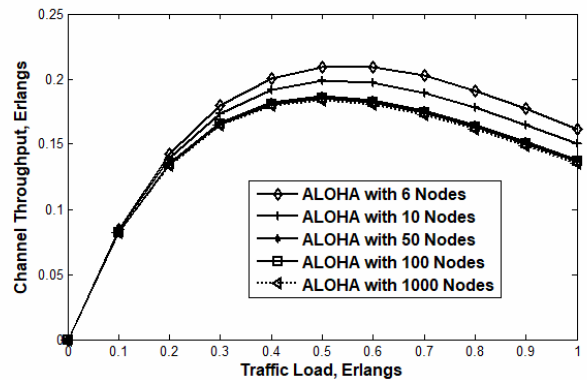


Fig. 3. Throughput of pure ALOHA for different number of nodes.

III. ALOHA WITH DIFFERENT POWER LEVELS

In the experiments of this work, a commercially available low-power radio transceiver unit, known as nRF24L01 [9], is used for packet transmission. This module has an adjustable

data rate on air with 3 options (250kbps, 1Mbps and 2Mbps). The output power level of the module supplies 4 programmable levels (0, -6, -12 or -18dBm) consuming 11.3 mA at 0 dBm power level. Another important feature is the payload length ranging from 1-32 bytes that can be chosen depending on the application specifications. An example view of the transceiver module can be seen in fig. 4 below.



Fig. 4. The appearance of nRF24L01 module.

The main contribution of this paper is to study the throughput performance of ALOHA protocol with different power levels in a single-hop topology created by 6 nRF24L01 modules. In this topology, a central point which also features nRF24L01 module is responsible for receiving packets from the 6 transmitting modules. The throughput is measured in the unit of Erlang in which 1 Erlang means full packet transmission destined to the central point. The Erlang unit, hence, represents the overall traffic load on the channel. We obtain the throughput values with varying the traffic load from 0.1 Erlang to 1 Erlang. To make the issue more comfortable, the lowest and highest power levels of nRF24L01 were selected to let the nodes to transmit. The proposed idea enables several nodes transmitting at maximum power level and rest transmitting at minimum power level. This will create a higher possibility of reception of packets with the highest transmission power. It is well-known that one packet can survive in collisions as long as it carries sufficient power. This phenomenon is referred to as capture effect. Our aim is to compose a network environment that increases the likelihood of receiving more packets involved in collisions. We start with 1 node transmitting with the maximum power and 5 of which transmitting at the minimum power. Then, the number of nodes with the highest power is increased up to 6 nodes. The performance improvements will be discussed in the following section.

IV. PERFORMANCE EVALUATIONS

This part presents the performance outputs obtained from the experiments carried out in the single-hop topology. We first summarize the experiment parameters to provide a better insight. The data rate is tunable and selected as 1 Mbps. The packet length is set to 32 bytes which is the largest size. All nodes generate packets with Poisson traffic model through an exponential distribution type. The list of the parameters mentioned is given in table I.

TABLE I. EXPERIMENT PARAMETERS

Parameters	Values
Topology	Single-Hop
Number of Nodes	6
Data Rate	1 Mbps
Power Levels	0, -18 dBm
Packet Length	32 Byte
Packet Generation Model	Poisson

Table II presents the performance results with varying Traffic loads and the number of nodes transmitting at the maximum power. The throughput results written in red colour reveal the practical observations of pure ALOHA with all nodes transmitting at minimum power. It is surprising that these results are much better than the analytical results presented in section II. This is because some collided packets are also received which are transmitted at the same power level. We, therefore, conclude that the assumption about the collided packets is unrealistic. The maximum effective throughput with the highest traffic load is achieved as nearly 0.38 which is 0.18 in analytical model aforementioned above.

The overall results indicate that packets with the highest power can be captured at the receiver with a higher probability. The proposed strategy boosts the maximum throughput value from 0.38 to 0.42. However, the results also show that when we increase the number of nodes with the highest power, the throughput starts to reduce. This is due to the fact that increasing the number of packets with the highest power in a collision would cause more destruction of collided packets. Another notable result trend occurs at the low traffic loads. In this case, the throughput has almost no increase as collisions are not likely to happen. Here, each result is an average of several runs to precisely reflect the impact. As a result of this study, the throughput of ALOHA in practice is shown to have a different characteristic when compared with the conventional analytical model. It is hoped that the results presented will ensure a future guidance for the forthcoming efforts of researchers in the relevant topic.

V. CONCLUSIONS

This paper revisits the traditional ALOHA protocol to enhance the throughput performance by adjusting the transmission power levels. Capture effect is shown to have a great impact on the throughput performance that allows a successful packet reception among a set of collided packets. By using different power levels, we obtained a better throughput performance with respect to varying traffic loads. The performance evaluations were conducted using a practical radio transceiver unit on a simple single-hop topology. It has been shown that the practical throughput of ALOHA was achieved as approximately 0.42 which is limited to 0.18 in theory.

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TABLE II. ALOHA THROUGHPUT PERFORMANCES WITH VARYING POWER LEVELS

Number of TX nodes with max output power	GENERATED TRAFFIC (TRAFFIC LOAD)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	0.0858	0.1590	0.2169	0.2613	0.3053	0.3221	0.3529	0.3788	0.3920	0.4140
2	0.0830	0.1574	0.2168	0.2679	0.3074	0.3332	0.3665	0.3945	0.3901	0.4256
3	0.0839	0.1577	0.2174	0.2722	0.3178	0.3433	0.3634	0.3803	0.4025	0.4153
4	0.0673	0.1285	0.1791	0.2201	0.2496	0.3225	0.3621	0.3828	0.4035	0.4110
5	0.0678	0.1309	0.1792	0.2155	0.2510	0.3286	0.3629	0.3850	0.3980	0.4139
6	0.0633	0.1302	0.1801	0.2169	0.2500	0.3256	0.3638	0.3778	0.3830	0.4177
<i>ALOHA</i>	0.0866	0.1610	0.2158	0.2702	0.3110	0.3407	0.3549	0.3710	0.3739	0.3806

Modelling, Integration and Management of Data for Health Regions

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Abstract—The task of this work is to propose a common method for data processing in order to form health regions in Bulgaria. The aim is to analyze the data collected in the health system and relate to the health status of the population and the data determining the level of health services in individual districts and regions of the country. Based on the analysis, an approach is proposed to integrate these data into an evaluation system, with the help of which to propose the most adequate distribution of health care on a territorial, demographic and infrastructural principle. Measures for data management in terms of their security and lawful use, communication and storage are also proposed.

Keywords—health regions, data collection, data modelling, data integrating, quality of health care services

I. INTRODUCTION

In an earlier paper on Health Regions, it was noted that in practice there is no clear and unambiguous definition of this concept. Therefore, it is necessary to look for ways to indirectly assess a variety of different data that can form a holistic view of the organizational, functional and medical structure of health regions. These are not just territorial units within a country. This is a complex of demographic, infrastructural, social and medical conditions, which only together can form a good basis for the implementation of high quality health and social services.

II. BACKGROUND

A. State of the Art

Definition of health region: As a health region, a region to be designated in which it becomes a reflected merger of both in the patient care as well as in the healthcare industry adjoining educational and research institutions as well as organizations and people involved in tourism has come out in favor of a new, matched one performance, development and quality events cooperate with each other. In addition to the goals of such economically involved, also the citizens (potential patients) and guests of the services of the health region should benefit [1]. /s. Fig. 1/.

B. Definition of the task

Regarding Health regions in Bulgaria there are only a few research publications. In the implementation of international projects the first steps in the formulation of the need to create



Fig. 1. The four guiding criteria of a regionally presented health care: quality of life, quality of medical results, character of the regional infrastructure (location characteristic), and economic efficiency [1]

health regions were realized: study of the main characteristics of health and social services, which determine the general and specific nature of each region and the information nature of health service parameters. [2]. Based on the analysis of the requirements and recommendations set out in [2], an in-depth study of the sources of information on the health status of the population in Bulgaria was conducted and a generalized model of the functioning of Health Manager of these data was proposed. [3]. Finally, in the hypothesis of already structured and filtered data, a model for multicriteria assessment of the characteristics forming the basic vision for building a health region was proposed. The model is based on fuzzy logic and have shown the option to define the importance of a every parameter (weight) and the correlation between the derived characteristics [4].

TASK: To derive from the available data sets KQI (key quality parameters), to correlate them with the concept of Health Regions, to estimate the weight of the parameters and to structure data whose multicriteria evaluation could give a clear sign - how to form a health region, how to manage the services in it, how to communicate with a centralized structure (for example, the Ministry of Health) and how to manage the new data collected. In order to optimize the structure and the function the health regions.

III. COLLECTING AND PROCESSING DATA ABOUT KQI

The main challenge by the collecting of data about KQI is the heterogeneity of these data, because they are created by different applications, different data types and the different methods of data transfer. We assume that the following

institutions in Bulgaria are the sources of information of the most important KQI:

A. Establishments for primary outpatient care

- staff number and staff structure
- number of visits
- number of immunizations
- number of clinical trials performed

B. Hospitals for active treatment

- staff number and staff structure
- hospitalizations by types of diseases
- usability of bed stock
- number of beds by type
- duration of hospital stay

C. Post-treatment and long-term treatment hospitals and specialized rehabilitation hospitals

- staff number and staff structure
- patients served
- number of beds by type
- duration of hospital stay

D. Medical and social care homes, hospices, dialysis centers

- staff number and staff structure
- number of beds by type

E. Regional Environmental Inspectorate

- air quality
- noise and vibration
- ionizing and non-ionizing radiation
- chemical factors and biological agents

F. Regional Health Inspectorate

- staff number and staff structure
- socially significant morbidities
- morbidities with temporary disability
- financial indicators of the health establishments

G. Territorial expert medical commission

- number of disability decisions issued
- structure of the issued decisions for disability by: age, group, illness, percentage of disability

H. National Insurance Institute

- recompenses paid for temporary incapacity for work by type
- pensions paid by type
- other disbursements related to short-term measures

I. National Health Insurance Fund

- funds paid for: primary pre-hospital care, primary pre-hospital dental care, medical-diagnostic activities, hospital care

- payments for home remedies and medical devices

J. National Statistical Institute (Territorial Statistical Office)

- structure of the population by age, sex and education
- main trends in the number and structure of the population
- birth rate, total and infant mortality and natural increase mortality
- mental and physical development
- main macroeconomic indicators for development of the country
- social environment - social factors (smoking, alcohol dependence, overweight, drugs, etc.)

The structure of these data is heterogeneous because each of these institutions has its own database system. Nevertheless, these data must be stored in a regional database and then in a central database. The regional and the central database will have one and the same data structure.

Therefore /as a first step/ a uniform format for data transfer must be developed. This format is intended to enable the transfer of semi-structured data. Languages such as XML [7] and JSON [9], with the corresponding definitions of the data structure DTD [6], XSD [8] and JSON schema [5], are best suited for this case. The advantage of this approach is that additions and corrections to the structure of the data are easy to be performed.

To generate the data records from the relevant institutions based on the above definitions of the data structure a system of microservices must be developed. These are implemented in every organization. In this way, they will provide up-to-date information to the regional and central database at all times.

After the data about the KQI are already stored in the regional and in the central database, they must be standardized before further processing. After this normalization, the values should be in the interval between 0 and 1. This can be achieved using the following formula:

$$x_{norm}[i] = \frac{x[i] - x_{min}}{x_{max} - x_{min}} \quad (1)$$

IV. BUILDING A HEALT REGION

There are several approaches for building a health regions in Bulgaria. The regions themselves could be of a different type. In the following section the authors proposition will be presented.

A. Evaluation of the data for healt region definition

As already mentioned, in previews works an appropriate fuzzy related approach where proposed and validated based on a hypothetical case [4]. The processing on the data

collection where based on a common approach for structuring regions [3] in order to prove the possibility to cover land areas according the indicators that are defined in [1].

The fuzzy logic related method is based on the idea for pairwise comparison of every pair of indicators. In terms of modern psychometric theory probabilistic models, which include Thurstone's approach (also called the law of comparative judgment), the Bradley–Terry–Luce (BTL) model [10] and general stochastic transitivity models, [11] are more aptly regarded as measurement models. The Bradley–Terry–Luce (BTL) model is often applied to pairwise comparison data to scale preferences. The BTL model is identical to Thurstone's model if the simple logistic function is used [12]. Thurstone used the normal distribution in applications of the model. The simple logistic function varies by less than 0.01 from the cumulative normal ogive across the range, given an arbitrary scale factor.

We used 4 common indicators (Table I), that have the corresponding value, according the data collected and described in paragraph III. For each indicator we have defined a number of attributes, based on the data structure, explained above.

TABLE I. DEFINITION OF HEALT INDICATORS AND SUBINDICATORS

No.	Health Region	
	Indicators	Attributes
1	S1 - 57	S11 - 31 S12 - 11 S13 - 5 S14 - 24 S15 - 55
2	S2 - 78	S21 - 77 S22 - 65 S23 - 71 S24 - 45 S25 - 76
3	S3 - 100	S31 - 99 S32 - 93 S33 - 45
4	S4 - 14	S41 - 7 S42 - 11 S43 - 8 S44 - 6

Table I shows the selected indicators, used in the model. Each one of them is decomposed in a number of sub-indicators or attributes.

S1 indicator represents “Health related quality of life”, S2 – “Regional Infrastructure Features”, S3 – “Regional Quality of Care” and S4 – “Economical Superiority” respectively.

The attributes for indicator S1 (S11 – S15) represent the KQI's listed above under “National Statistical Institute (Territorial Statistical Office)”.

The attributes for indicator S2 (S21 – S25) represent the KQI's listed above under “Hospitals for active treatment”.

The attributes for indicator S3 (S31 – S33) represent the KQI's listed above under “Post-treatment and long-term treatment hospitals and specialized rehabilitation hospitals”.

The attributes for indicator S4 (S41 – S44) represent the KQI's listed above under “National Health Insurance Fund”.

The values of the indicators represent the relative impact

of the corresponding indicator over the common process of building a health region. The sub-indicators, or attributes, represents different characteristics of the indicators being chosen for the model. The values of the attributes represent the weight of the corresponding characteristic on the indicator value. The goal of the model is to find the most significant attributes that could have the greatest impact on the formation of a health region.

B. Significant Attributes Analysis

The significant attributes of health regions are the key attribute variables of the attribute layer which distinctly correlate to the objective layer. Because: of the large numbers of hospitals (actually in each municipality); of the uneven location of specialized hospitals; of the difference in the life conditions in different areas in Bulgaria; of the health status of the population; of the administration of the common healthcare system, the original data of health system hierarchy is high dimensional sparse feature data. This paper adopts the fuzzy cluster analysis method [12] to find the significant attribute.

According to the rough set theory, data of the objective layer and attribute layer can be defined as $S = (U, A, V, f)$. Here: $U = \{u_1, u_2, \dots, u_n\}$: the set of regions where n is the total number of customers. $A = \{a_1, a_2, \dots, a_m\}$: the set of variables of the objective layer and of the attribute layer. $A = C \cup D$, where C is the characteristics set of the attribute layer, and D is the characteristics set of the objective layer. V is the set of the region attribute parameters. The value of $f(u_j, a_i)$ indicates the value of u_j about a_i .

In the BTL model, the probability that object j is judged to have more of an attribute than object i is:

$$\Pr\{X_{ij} = 1\} = \frac{e^{\delta_j - \delta_i(n-1)x^2}}{1 + e^{\delta_j - \delta_i}} = \sigma(\delta_j - \delta_i) \quad (2)$$

where δ_j is the scale location of object i ; σ is the logistic function (the inverse of the logit). For example, the scale location might represent the perceived quality of a product, or the perceived weight of an object.

The BTL model, the Thurstonian model as well for measurement are all closely related and belong to the same class of stochastic transitivity.

TABLE II. PAIRWISE COMPARISON OF HEALT INDICATORS

Item	S1	S2	S3	S4
S1	=	$\geq$	$\geq$	$\leq$
S2	$\leq$	=	$\leq$	$\leq$
S3	$\leq$	$\geq$	=	$\leq$
S4	$\geq$	$\geq$	$\geq$	=

The next step includes the calculation of the similarity matrix for the indicators used, according the condition

After that the calculation of the fuzzy similarity matrix R using Euclidian Distance measure was performed.

$$r_{ij} = \sum_{k=1}^m (a_{ik} a_{jk})^2 / \sqrt{\sum_{i=1}^m a_{ik}^2 \sum_{j=1}^m a_{jk}^2} \quad (3)$$

where a_{ij} are the values of the corresponding elements.

At the end of the calculation process the fuzzy transitive closure $t(R)$ of the fuzzy similarity matrix R with the square method [12]. If the fuzzy similarity matrix can be expressed as $R = (r_{ij})_{n \times n}$, then

$$R \circ R = (t_{ij})_{n \times n} \quad \max_{k=1 \text{ to } n} (\min(r_{ik}, r_{kj})) \quad (4)$$

If $[R]^{2^k} \circ [R]^{2^k} = [R]^{2^k}$, then the fuzzy transitive closure $t(R) = [R]^{2^k}$.

Using the cluster method to analyse $t(R)$ with intercept λ and to determine the significant attributes set the following where obtained as a result of the evaluation:

C. Data Analysis

Step 1. For each one group, after partitioning A into C and D the membership degree of each one attribute is calculated. For example: For the objective 1 (S1) and the corresponding attributes the following set A is obtained: The value of indicator 1 is 57 ($N = 57$) – the relative weight of the indicator. The elements in set A are calculated according the pair-wise comparison of the attribute value (Table I).

$$a_{ij} = \frac{e^{\delta_j - \delta_i}}{1 + e^{\delta_j - \delta_i}} = \log it^{-1}(\delta_j - \delta_i) \quad (5)$$

where δ_k is the scale location of object k and $\log it^{-1}$ is the inverse logit function.

Here the calculations for the “Health Region” are shown: So the fuzzy set A is obtained:

$$A = \begin{bmatrix} 1 & 0,56218 & 0,57444 & 0,54157 \\ 0,43782 & 1 & 0,51250 & 0,47918 \\ 0,42556 & 0,48750 & 1 & 0,46672 \\ 0,45483 & 0,52082 & 0,53328 & 1 \end{bmatrix} \quad (6)$$

Then, on Step 2, the fuzzy similarity matrix R is calculated:

$$R = \begin{bmatrix} 1 & 0,95463 & 0,94595 & 0,95094 \\ 0,95463 & 1 & 0,98009 & 0,96527 \\ 0,94595 & 0,98009 & 1 & 0,96527 \\ 0,95094 & 0,96527 & 0,96527 & 1 \end{bmatrix} \quad (7)$$

After that the transitive closure $t(R)$ for the set of parameters is calculated according equation (3). In all cases, being studied, the intercept λ is chosen from the values obtained for $t(R)$.

$$t(R) = \begin{bmatrix} 1 & 0,95463 & 0,95463 & 0,95094 \\ 0,95463 & 1 & 0,98009 & 0,96527 \\ 0,95463 & 0,98009 & 1 & 0,96527 \\ 0,95094 & 0,96527 & 0,96527 & 1 \end{bmatrix} \quad (8)$$

Here we can have the following values for λ . For each λ we can define the corresponding clusters of parameters:

$$\lambda=1 \{S11\}, \{S12\}, \{S13\}, \{S14\}$$

$$\lambda=0.98009 \{S12, S13\}, \{S11\}, \{S14\}$$

$$\lambda=0.96527 \{S12, S13, S14\}, \{S11\}$$

$$\lambda=0.95463 \{S11, S12, S13, S14\}$$

Then we build the dynamic cluster diagram, from which the most significant parameters can be obtained. As shown on the figure below, for the investigated group “Health Region”, the most significant parameters of the objective S1 – “Health related quality of life” are the attributes coded as S12 and S13 (Fig. 2).

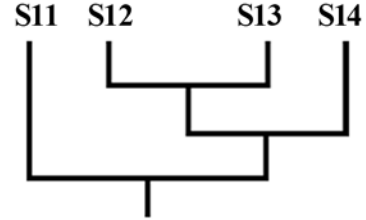


Fig. 2. Dynamic cluster diagram

All others parameters are concatenated one after another to the base cluster, built from these two parameters. This dynamic cluster diagram can be implemented later as a model of deductive database for easier search of significant attributes also in cases of greater amount of parameters or in case of deeper investigation of the significant parameters. An appropriate method for cost effective search in such database structures is the 2P-Method introduced in [13].

Following the same steps the following calculation and results could be achieved for all other objectives in correspondence to the indicators being studied.

TABLE III. SIGNIFICANT PARAMETERS

Indicator	λ (highest value)	Parameter cluster	Significant Parameters
S1	0.98009	{S11}{S12,S13}{S14}	S12, S13
S2	0.96113	{S21}{S22,S24}{S23}	S22, S23
S3	0.93725	{S31, S33}{S32}	S31, S33
S4	0.95469	{S41,S44}{S42}{S43}	S41, S44

Here, from all other calculations, only the highest grade of λ , the corresponding parameter clustering and the final result – the most significant parameters for all indicators are shown (Table III).

D. Building Health Regions

The last step in forming Health regions is to map the areas with similar significant parameters over the land map. Bulgaria is divided in 26 administrative areas and 266 municipalities. Most of them have their own hospitals or at least medical centers.

In the past years the hospitals where built according the number of population in the municipalities, but not according the needs of healthcare services. This has led to situations in which many hospitals and medical centers remain empty because of the demographic conditions. The budgeting of such health service objects is very difficult and most of them have huge financial liabilities to the health insurance fund.

Another important aspect of the formation of health regions is the optimization of logistics services within the respective region [14], including in the conditions of emergency situations with a determining impact on society as a whole [15].

This is the reason to optimize the structure of the healthcare services in Bulgaria.

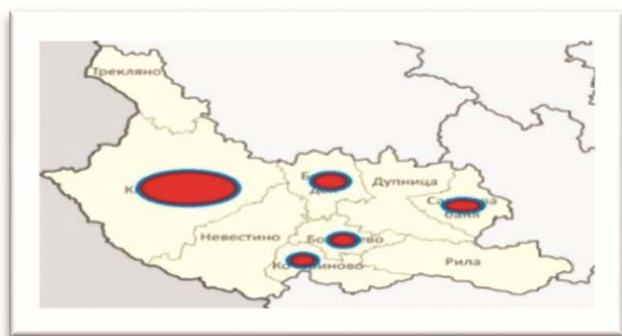


Fig. 3. Health Region diagram

The following example is based on acceptance that the municipalities being labeled with same colors, have equal significant parameters (Fig 3). As can be seen, it might not be obligatory to have neighborhood under the municipalities in order to build a common health region. It would be possible to concatenate municipalities from neighbor administrative areas in order to have a definite health region with defined level of healthcare services delivery.

V. CONCLUSIONS

The proposed work is a part of a long term process, which should start in Bulgaria in order to achieve a high quality health care with optimizing the old structure of health services delivery.

The idea is to give the medical administration an appropriate tool for investigation, analysis and modeling a new, progressive and efficient health care structure.

The tool itself could be upgraded in several directions:

- Precise normalization of the data collected (the KQI's);
- Implementation of Neuron Networks for achievement of an intelligent product, based on neuro-fuzzy logic in order to perform accurate evaluation of the KQI's;
- Building a common Database, which should include all necessary optimized data for all aspects of the health service delivery in Bulgaria.

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Compressing High Throughput Sequencing Data – Models and Software Implementation

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Abstract—The rapid progress of next generation genomic sequencing technologies produces huge amounts of data, which need to be stored and processed. This development is facing real problems in storage of these expanding amounts of data. These data, in terms of quantity and quality, are an obvious challenge for modern computer science and bioinformatics related to compression and decompression of data sets. The presented work is devoted to the elaboration of models and their software implementation for compression of sequencing data. The main goal of the work is to develop a web-based sequencing data compression system that provides opportunities for faster and more accurate compression and decompression, noise protection and error correction. For the purposes of this study, we developed models for compression and decompression based on the methods of literal coding. The developed optimized models are related to the well-known methods of Huffman and Shannon-Fano. Also, there were developed: a web-based module (with user interface), a library of noise protection algorithms for the compression and decompression of omics data, and a server component to make the library accessible on the Internet. The implemented web module with user interface provides easy access to server methods for compression and decompression of sequences. Used data formats allows the module to be integrated with open access systems such as NCBI, UniProt, Ensembl and other well-known external resources.

Keywords—Sequencing data, Compression, Noise protection, Web-based system

I. INTRODUCTION

The advent of next generation sequencing technologies is characterized with a generation of massive new data of biological profile. These data originate mainly from genomic sequences and other omics related outcomes of the applied high throughput technologies. The rapid progress of launching this vast amounts of data sets has several features to be considered as challenges for their storage and analysis: increasing number and size of new projects concerning genome and proteome sequencing, generation of new biological knowledge related to these large data sets, constant improvement of the sequencing technologies, generating more and more data with increasing length and new formats [1].

The process with data storage and subsequent analysis is related to the use of ASCII characters and their combinations with different genomic semantics. Such an approach is quite

straight forward but also too much time and space consuming and the bioinformatics' and data analytics society looks for better and quicker compression applications and tools, providing opportunities to work with new formats and to use the common software languages for access and analysis of such data [2].

Most approaches for sequencing data compression are based on two of the most popular algorithms in recent years - Shannon-Fano and Huffman. These algorithms are compared to an optimized new version, developed in our study, which we will hereafter refer to as the "Optimized Algorithm", based on the theory of literal codes, but with an improvement in code uniformity and compression / decompression speed. Huffman and Shannon-Fano's algorithms result in compression as a result of non-uniform code, the main disadvantage of which is that it is prone to loss of information (in data transfer) and hence incorrect data recovery. With the Optimized Algorithm, a uniform code is obtained, which would easily identify the data loss and prevent the wrong data recovery. In addition, for large volumes of data (long DNA / RNA sequences) compression by a uniform code produces better results than a non-uniform compression.

II. RELATED WORK

The main methods for compression of nucleotide sequencing data are based on statistics and entropy - by exploiting compression algorithms using repetition detection and consequence statistics [4]. The increasing number of re-sequenced genomes has led to many new suggestions for compression algorithms. In general, compression algorithms can be divided into bitwise encoding, vocabulary-based compression, statistical and referential approaches.

Bitwise encoding - a compression algorithm that can process input strings of any format. For the first common DNA characters (A, C, G, T as well as N (unknown)), seven-bit encoding is used for three consecutive characters. Any other non-standard character is encoded with seven bits per character. Up to 128 additional characters can be encoded in this way. The free eight bit distinguishes whether a byte encodes three of the first main characters or some other, specific character [3].

Dictionary-based compression - performs with multiple iterations over the input data. With each pass, it detects longer sequences and gradually enriches the dictionary. The

algorithm runs until the dictionary is changed or the frequency threshold is reached. The created dictionary is used to encode DNA sequences and is partially stored together with compressed data. This encoding allows random access to the compressed DNA sequences [5].

Another approach is so-called tree-based compression [6]. Splay trees are self-tuning binary search trees in which items that are last accessed are accessed faster. This property can improve the performance when you encounter local frequency changes. The methodology refers to the process of rearranging the trees as a specific element is placed at the root of the tree. Like evolutionary trees, symbols close to the root have shorter codes than symbols in other nodes. Another problem is the unequal distribution of DNA across the genome. One possible solution is to split the input of blocks and encode each block individually using different Markov models [7].

In [8], a “gene wise compressor” is proposed as a mean for encoding non-repetitive portions of DNA sequences. In the initial implementation, the probabilities of the characters are evaluated and the corresponding Huffman coding is selected. The result is divided into blocks. Finally, each block is restructured in a way that allows efficient coding of the execution length to be used in the final step. Another approach is when the input sequence is fragmented into blocks that do not overlap. For each block, a set of agents competes for coding: a Markov model, a two-bit base representation, and an approximate repetition that identifies repetitions interrupted by only a few SNPs (single nucleotide polymorphisms). The model that broadcasts the shortest code length is selected and the compressed output is subjected to additional arithmetic compression. Unfortunately, this approach can handle only four main characters in the input sequences. A method is proposed where non-repetitive regions are encoded as well as discrepancies in repetitive regions or mutations like SNPs with arithmetical coder, based on a Markov model. The resulting bit stream is split into blocks to allow random access.

Mixed approach for compression: there are many variations and different views and discussions in the literature. It is suggested that to store the differences between the input compression sequence and the reference sequence [9]. They look at three types of single based features: insert, delete, and replace. The main contribution of their work is to analyze the process of encoding integers for absolute and relative reference positions in the sequence. However, the authors emphasize that the choice of reference sequence has a greater impact on the compression ratio than the actual overall coding scheme. Similarly, other sources present a compression reference algorithm that only accepts SNPs and many basic INDELs between inputs and reference sequences. Each compression record consists of a reference position and additional data such as coincidence length or raw sequence.

TABLE I. COMPRESSION ALGORITHMS COMPARISON

Compression method	Compression
Bitwise encoding	2:1 – 6:1
Dictionary-based compression	4:1 – 6:1
Statistical model	4:1 – 8:1
Mixed model	1:1 – 400:1

Once the sequence is compressed, it must be sent over the network. The algorithms used for compression, namely Huffman, Shannon-Fano, and the optimized algorithm, which belongs to the class of literal coding, are very susceptible to errors. If even one bit is confused when transmitting network information or reading to and from the recorder, restoring the correct sequence is not possible. For this purpose, it is necessary to use error correction algorithms. Literature sources cite noise protection algorithms as one of the most widely used for this purpose [10]. They are applicable in all places where it is necessary to correct errors at the lowest possible level (bit-wise). In damping waves, artificial intelligence models are also widely used in pattern recognition and error correction in generated images. One of the most common algorithms is that of Reed Mahler, suitable for data transmission in places where the connection is poor or very weak [10].

III. SUGGESTED METHODOLOGY

The suggested compression approach in this study is based on coding and more specifically on the Shannon-Fano and Huffman algorithms. The main idea behind these algorithms is to set a binary code to match each of the characters in the input message (in our case bases in the input sequence). The algorithm has the following characteristic properties:

The length of the codes is variable (the code is uneven). Here is our first modification of the algorithm, where the length of the codes is always the same i.e. the compressed message has a uniform code. The sequences being considered for compression are of the same length, and this comes from the most used formats such as FASTA and FASTQ, where the length of the sequence is always specified, which can be used in advance to build a classification tree. Another feature of the code length is that when the individual characters in the message are replaced with their corresponding binary values, a compressed message of different sizes may be received. This is because for each symbol, a different binary value is given, which in some cases can be 1 and in others it can be a combination of 0 and 1. For example, for "A" a value of 11 can be calculated, for "T" - a value equal to 101, which causes also change in the string size. This can be improved when using DNA sequence data because they have a small number of characters that can be encoded with equal length.

The letters with higher probability are more likely to be encoded in fewer bits than those with less likely ones. And this is the next modification of the algorithm we suggest: an approach how to calculate the probability of occurrence of individual characters in the message using frequency analysis, which is the most time-consuming process in this algorithm. In the case of sequence compression, we make an improvement where there is no need to perform frequency analysis because the characters included in the sequence are countable small number. For DNA and RNA sequences, the symbols are 4 in number, for which mapping (aligning) has been prepared preliminary for their respective binary sequences. The message shall be decoded unambiguously.

Advantages: When we encode the more common characters with shorter bit sequences and the less common

ones with longer bit sequences, we get better results with respect to the length of the message being transmitted.

Disadvantages: A major disadvantage of uneven codes is their sensitivity to wrong bits. For them, a wrong bit can cause the entire message to be decoded incorrectly or impossible until the end. Whereas, with uniform codes, one wrong bit causes only one character to be corrupted.

A. Building the optimal code

An optimized algorithm developed in the study, according to which sequences based on the theory of optimal letter coding will be compressed has following operational features:

Sequence type recognition (RNA or DNA).

1. Depending on the sequence, predefined binary values for each of the symbols used in the sequence are selected - using the predefined values saves the following procedures, which are necessary to construct the optimal code for each arbitrary message in the Shannon-Fano algorithms and Huffman:

- The set of symbols of source A is arranged in order to reduce the probability of message occurrence – p_i
- The set of probabilities P_i is divided into two groups ($p_1, p_2, \dots, p_j$) and ($p_{j+1}, p_{j+2}, \dots, p_m$), so that the difference shown below is minimal:

$$\sum_{i=1}^j p_i - \sum_{i=j+1}^m p_i \quad (1)$$

- The characters whose probabilities are in the first group are assigned with the r^{th} code letter 0 and those in the second group are assigned with the r^{th} code letter 1.
- For a single-element probability group, the procedure is completed, and for each of the other groups in the multi-step procedure, the elements are numbered from 1 to m and go recursively ($r = r + 1$) to step 2.

2. Each of the characters in the sequence is replaced by the corresponding binary entry.

Following the changes made to the Shannon-Fano algorithm and the Huffman algorithm, all properties of the letter algorithms coming from the definitions and theorems related to those algorithms retain, ignoring the steps for frequency analysis and computation of the binary comparison tree. Once the sequence is compressed, it can be stored or sent in a much smaller size. Reading the compressed sequence is another major problem with the Shannon-Fano and Huffman algorithms. In the Optimized Algorithm suggested in this study, this problem is solved by using a predefined coding tree. In Shannon-Fano and Huffman's algorithms, in order to decode a properly transmitted message, it is necessary to have the same encoding tree generated when compressing the message. The transfer of message for both algorithms consists of two parts - the encoded message, and the coding tree so that the message can be read. These two parts do not always need to be transferred together. Because algorithms can also be used in the context of information security, where not everyone can decode the message, i.e. not everyone should have a coding tree. In bioinformatics, this is an important feature for working with sequences.

In the proposed method, only one has a coding tree. Each compressed / encoded sequence can only be read by the same programming apparatus with which it was compressed / encoded. This is because a unique hashing algorithm is used to generate the coding tree in order to ensure the uniqueness of each coding tree. Each sequence has its own encoding tree and can only be decoded / decompressed by this encoding tree. This approach eliminates the shortcomings of both Shannon-Fano and Huffman's algorithms for decoding and protecting information. In the proposed Optimized Approach, each of the characters will be encoded with exactly 2 bits. As before the compression, each character occupied 8 bits, here is the first place where we have a 1:4 compression. After applying the algorithms, a compression of up to 1:400 can be achieved.

B. Compressing algorithm comparative analysis

The three algorithms' coding/decoding abilities were tested with a 20-letter, 160-bit sample DNA sequence: AACTTTGACGGTATACGCAA.

The Shannon-Fano and Huffman algorithms code the sample in three steps: 1) symbol frequency analysis, 2) grouping, 3) assigning each symbol a binary code. Once the binary codes for each of the four symbols are assigned, a coding binary tree is generated, resulting in coding the sequence as 41-bit string:

00110101010111011011111110010011011111000

Decoding requires the generated binary code and the coding tree, which is traced from root to leaves depending on the input symbol – left path for 0 and right – for 1.

The Optimized Algorithm omits the frequency calculation step and assign a two-digit bit code to each of the four symbols: A=00, C=01, G=11, T=10. This coding table is static and doesn't need to be generated each time. Coding is done by simple substitution, resulting in the following 40-bit string:

0000011010101100011111100010000111010000

Decoding the sequence requires the coded sequence and the static table, thus omitting the need of a coding tree.

As shown in Table 2, the Optimised Method produces 5% less bit length than Shannon-Fano and Huffman methods. The result code is also uniform, which may prevent possible bit loss, while in uneven code such errors cannot be detected due to different length of bits in coding sequence.

TABLE II. COMPARATIVE ANALYSIS OF COMPRESSION ALGORITHMS

Coding method	Input length	Compressed length
Shannon-Fano	20 bases, 160 bits	41 bits
Huffman	20 bases, 160 bits	41 bits
Optimized method	20 bases, 160 bits	40 bits

C. Software realization and user interface

The application utilizes several platforms combined under Ubuntu Linux OS. There are three main software components:

- User interface

- C++ library
- Programming adaptor to connect the library to an intermediate language

The user interface is based on Vue.js, Vuetifie, node.js, and npm version manager. Vue.js uses Javascript templates to generate HTML in real time which allows the interface to work on different devices and different screen resolutions, because each HTML is generated for the specific device. Vuetifie is a programming module that upgrades Vue.js by adding predefined templates. Node.js allows javascript to be used as server provisioning method by dynamic building in executable code. It provides the possibility to call each individual HTML element in the user interface separately, and visualize the result when ready – an approach called „reactive programming“. Javascript was chosen because of its compatibility with RESTful services and JSON data transfer format.

Version management of the used Vue.js, Vuetifie and Node.js modules is done by npm, which allows multiple storage for the modules to be registered, and automatically detects and downloads them.

D. Choosing programming medium for the compression algorithms

C++ was chosen for the algorithms for literal and noise protection coding, for its execution speed and lower memory usage, compared to other languages. It also allows direct memory access, easy and intuitive realisation of bitwise operations and lower-level resource management. These advantages make algorithms written in C++ more optimal than C# and Java [11][12]. This is one of the main reasons to include connections between platforms in this application, because it utilises both C++ and C#.

IV. RESULTS AND DISCUSSION

Our web-based application for sequence data compression is adapted for various device screen resolutions – from mobile phone (375x812) and tablet (768x1024) to 8k (7680x4320). The user interface is shown on Figure 1 (mobile device). Filed (B) allows the selection of file(s) to be compressed. The application accepts FASTA and MULTIFASTA file formats, and one or multiple files can be selected, thus allowing parallel compression. The selected files are listed as labels (A) in field (B), and can be deleted by pressing the “clear” symbol (C).

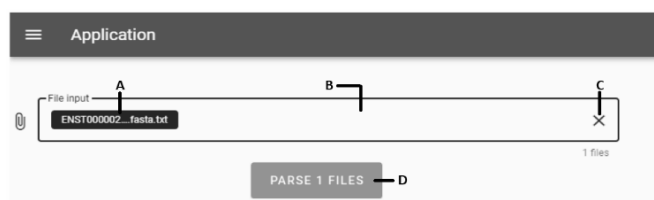


Fig. 3. User interface – File input field (B) with one file uploaded (A) and confirmation button (D)

Button (D) confirms the query and shows how many files are selected for compression. Then, the files are parsed to extract metadata such as sequence IDs, file size (in bytes), and sequence length (in number of nucleotides).

For test compression, four sequences with different length from the Ensembl database were saved as a single, multifasta file:

- ENST00000288602.11 - BRAF-201, B-Raf proto-oncogene serin/threonine kinase
- ENSE00001025715.1
chromosome:GRCh38:X:38317316:38317465:-1
- ENSE00001025717.1
chromosome:GRCh38:X:38321027:38321089:-1
- ENSG00000157764.13
chromosome:GRCh38:7:140719327:140924928:-1

Each sequence is compressed with the three algorithms, and the time needed for compression is calculated. Figure 2 shows the result for each sequence in the file as a separate, auto-expandable field (B). Each field shows information about the sequence:

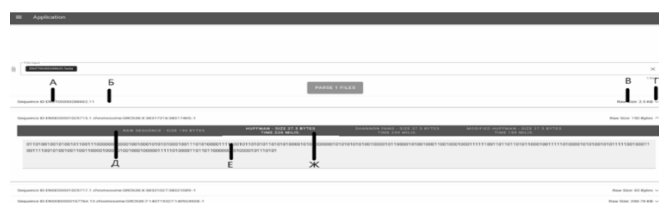


Fig. 4. Visualization of compressed sequences

- Sequence name (A) – this is obtained from the FASTA format, and if it matches a naming pattern from an entry in one of the public sequence databases, a hyperlink to that entry is created
- Current sequence size [in bytes] (B) – this is the sum of the byte size of the ASCII characters corresponding to the letters coding each nucleotide. Then, depending on the sequence length, it is converted to the closest B, KB, MB, GB or TB value by following the International Electrotechnical Commission (IEC) standard where 1 KB = 1024 B.
- Drop-down arrow (G) shows/hides detailed information about the compressed sequence
- In the detailed field, (D) is the sequence name and size label, and by clicking on it the original, uncompressed sequence is shown. (J) shows the sequence after compression (E) by each of the three algorithms. Additionally, for each algorithm, a summary of the size [bytes] and time [seconds] of compression is shown.

In the current example, there is practically no difference in the compressed sequence size between the three algorithms; considerable difference is seen when compressing sequences of several GB in size.

Different access points on the server are used for each of the three sequence compression algorithms. The calling for each algorithm is also parallelized for each sequence, as seen in Figure 3:

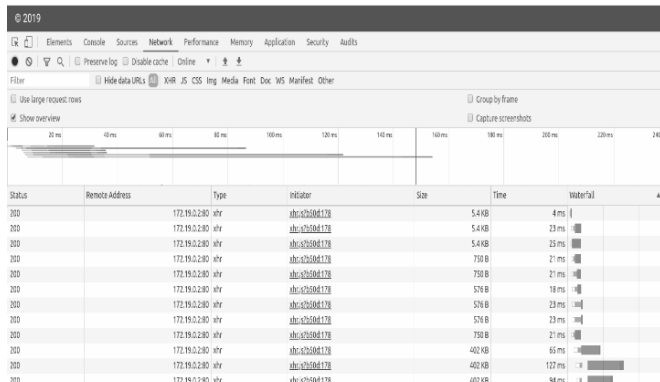


Fig. 5. Parallel execution of queries for each compression algorithm

Another part of the server provides remote access to compression algorithms, developed as libraries. The library is accessed either through the server or by downloading and compiling it, thus making it usable by applications without Internet access. The library can be used as a DLL from several high-level programming languages, such as C# and Java.

During development, several compression algorithms were tested, and the performance of each is summarized on Figure 4:

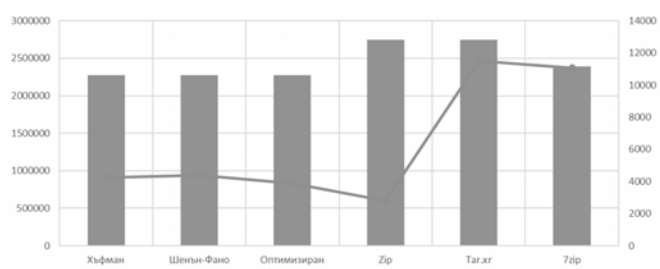


Fig. 6. Compression methods comparison: left vertical scale shows size in bits, right scale shows time in milliseconds. Bars indicate the sequence size after compression, and line shows the time.

The illustrated above is based on the compression of a 9,219,726 byte sequence, obtained from the public database Genome, part of NCBI. This is the entire genome sequence of the bacteria *Bradyrhizobium japonicum*, which can be accessed from Genome's own FTP servers, or through the RefSeq database under the ID NC_017249.1.

Six compression methods were applied to the sequence, including the already discussed in this paper Sannon-Fano, Huffman, Optimized Algorithm. They were compared to: 1) Zip algorithm, developed for compressing and archiving one or multiple files; 2) Tar.xz – Unix- and Windows-based compression software which allows no-loss compression; and 3) 7zip – open-source file archiving software.

The results clearly show the advantage of the first three algorithms that utilize bitwise coding, which result in a very similar performance, producing smaller compressed file and are generally faster than the others (with the exception of Zip).

Huffman and Shannon-Fano give similar results when working with DNA sequences. This is due to the fact that DNA uses only 4-letter alphabet, thus creating similar

frequency analyses and overlapping trees with each of those algorithms. The other three methods perform poorly due to them being versatile for various data types and not having been optimized to work with sequences.

The main advantage of our Optimized Algorithm is the speed, because it omits the multiple frequency calculations and tree generation of the other two. It also performs better with sequence decompression, not needing to send or store the compressed sequence tree. This results in faster and safer data transfer, because a sequence coding tree is also sensitive information in terms of software security. All datasets, samples and the software realization itself, are available at:

https://github.com/BroyanaPulova/DNA_compression_web

https://github.com/BroyanaPulova/DNA_compression

V. CONCLUSION

The Optimised Algorithm proposed in this paper is developed specifically for sequence data compression, and performs better in terms of speed, noise-reduction, and compression size than similar methods such as Shannon-Fano and Huffman. A library with these bitwise coding algorithms was created, with compression/decompression methods for each. The library utilises low-level primitives so that it can be re-used on various platforms.

The Optimised sequence compression algorithm was implemented in a number of software products with web-based user interface that allows easy, multi-device and multi-resolution access to the server. All components work in a container-based environment, which allows fast and easy regulation.

Future work on this project is going to expand its abilities by adding more compression algorithms, the ability to choose which one(s) to use, and updating the library to work with more programming.

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Functional Concept of the Intelligent Health Monitoring System

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Abstract—The goal of this work examines the current trends in the development of telemedicine from a technical point of view. Telemedicine solutions such as telemonitoring and teleconsultations are becoming increasingly popular in the modern world. The main factor for this are: the development of IT technologies, demographic problems and the need for cost-effective healthcare. The global telemedicine market is categorized on the basis of: specialty, processes and regions. In Bulgaria, telemedicine is mainly implemented through health information portals and platforms for monitoring patients with chronic diseases. The telemedicine solutions of six leading Bulgarian companies are examined, with the possibilities they provide and the concepts they implement.

The authors aim is to suggest conceptual diagram of Intelligent Health Monitoring System. The system includes three main functional blocks and three accompanying ones. The functioning of the system is based on four databases. A process flow of one possible case of use of the system is shown.

A part of database system with geospatial data and some parameters based on regulatory documents of the Ministry of Health of the Republic of Bulgaria is designed using RDBMS PostGre.

Keywords—telemedicine, conceptual diagram, Health Monitoring System, Distributed systems

I. INTRODUCTION

Digitization in all areas of healthcare has recently become a key priority for national governments. In addition to the priority of implementing digital solutions for comprehensive neonatal screening and screening of socially significant diseases, telemedicine solutions are increasingly being imposed. This priority is particularly important for emergency medical care and pre-hospital care in remote areas.

The COVID-2019 pandemic has had a huge impact on telemedicine services. This influence is based on the practices of self-isolation and social distancing introduced in many countries.

The Covid pandemic has also forced people who previously had no IT experience to learn how to use

computers. Mostly, this applies to people over 65 years old. Hundreds of millions of users who had no experience using video conferencing software and equipment before were forced to learn to use them. Ultimately, many had to switch to working remotely during the quarantine. People were forced to consult doctors virtually. Medical facilities have been forced to limit in-person patient examinations at the expense of the growth of telemedicine consultations. On other hand, this led to a change in the ratio of the "doctor-patient" mode and the "doctor-doctor" mode. Globally, the ratio of telemonitoring compared to teleconsulting is 48% to 32%[1].

The dynamics of telemedicine services worldwide, according to data from leading analysts from Global Telemedicine Market Outlook, BBC Research and P&S Market Research, is presented on Figure 1. An average annual growth of 19.3% is forecasted, which would lead to exceeding \$175 billion to 2026 [1].

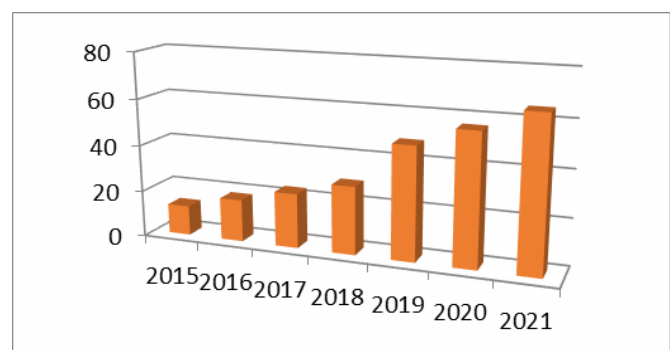


Fig. 1. Dynamics of the global telemedicine market, billion dollars [1]

The main reason for this growth is the increased percentage of chronically non-infectious patients. The increasing use of smartphones with high-definition cameras and the penetration of the Internet in the most remote corners of the world has had a positive effect on the growth of telemedicine. Other factors for this growth are: an increase in the number of the world's population,

demographic aging, the spread of chronic non-communicable diseases, a constant increase of health care costs with a simultaneous increase of the scarcity of resources, including personnel, an increasing need to save costs in providing health care, favorable government initiatives. On other hand, there are also disincentives based on unresolved patient data security issues and lack of awareness of telemedicine in emerging and underdeveloped countries. Using a telemedicine solution without proper protection can result in massive losses of confidential and critical information. In addition, smartphones with telemedicine applications are vulnerable to various cyberattacks due to inadequate protection. Cyber attacks are considered the top five risks to global stability, according to the World Economic Forum. All this can adversely affect the results and confidence of the companies, hindering the growth of the market. Recent years have seen increased investor interest in telemedicine startups, with 2020 breaking all previous records for digital health funding, according to statistics. Investments in the telemedicine sector have helped six startups rise to unicorn status, i.e. their valuation reached \$1 billion, Hinge Health, Dispatch Health, K Health, Innovaceer, Modern Health and Evidation.

The global telemedicine market is categorized based on:

- Specialty: Cardiology, Dermatology, Neurology, Orthopedics, Emergency Care, Internal Medicine, Gynecology, Others.
- Process: Tele-education, Tele-training, Tele-consultation, Tele-surgery, Tele-monitoring, Tele-care.
- Region: North America, Europe, Asia Pacific, Latin America, Middle East & Africa.

International programs in the field of telemedicine:

MDIS – European Bone Marrow Donor Information System;
EPIC – European model for integrated treatment;
FEST – Knowledge base for European telemedicine services;
ISAAC – Integrated Telecommunications System;
SHINE – Strategic Health Information Network of Europe;
TELEPRIM – Telematic services for providing first aid;
TRILOGY telematic services of the health system.

In Bulgaria, telemedicine is mainly implemented through health information portals and platforms for monitoring patients with chronic diseases. Examples of this are:

- Check Point Cardio - is an innovative Bulgarian company that produces a complete system for remote monitoring of patients. It consists of three components - a hardware device that is placed on a person's body, software that digitizes information from measurements of vital signs in real time and sends it via Bluetooth to a mobile application. Subsequently, the application sends data to the server in a cloud platform, through which doctors can monitor the condition of patients. The system also includes a smartphone that transmits data in real time and provides the patient with an additional opportunity to call the doctor who monitors his condition in case

of concerns. Monitors for individual use keep track of over 8 vital signs 24/7. They can be used to supervise the condition of patients at home by measuring pulse, blood pressure, pulse pressure, blood saturation (blood oxygen saturation), respiration, body temperature and at what position and activity of the body these indicators occur. These monitors are also certified for use in a hospital environment, with the possibility of replacing hospital equipment [2].

- Consent: is a 21st century, technology company that develops a cloud-based platform in the field of healthcare. It enables all participants in the healthcare process to work together – doctors, pharmacists, dentists, healthcare professionals, healthcare professionals, patients, administrators, agents, insurers and everyone else involved in this industry [3].

- Sqilline: The company is the creator of the Danny Platform – one of the leading analytical platforms based on real data from oncology and cardiology. The platform integrates information from many different sources such as hospital information systems, registries, etc. and provides fast, aggregated real-time analysis. With built-in machine learning algorithms, the application provides advanced tools for comprehensive searches and analyzes of heterogeneous patient data, including various possible diagnoses, therapies and specific clinical indicators. In addition, it analyzes how specific factors influence the improvement of patients' conditions and allows comparison of the effectiveness of different types of treatments in order to improve patient care [4].

- Play Reha offers an online system for tracking the condition and reporting the recovery progress of patients, through standardized questionnaires approved by the Orthopedic Organizations in Europe and America [5].

- Diasyst is a platform for remote monitoring of chronic disease patients and pharmacotherapy management. Includes control of diabetes and hypertension [6].

- Healee - a platform to help patients find the right doctor and connect with him quickly. On the other hand, a software application was created to organize their online communication with patients. It can be used to send medical records, lab test results, medical photos and images. Patients can provide details of their medical condition and everything needed for a full medical examination [7].

II. SYSTEM CONCEPT

Various aspects of building telemedicine information systems are presented in [8], [9] and [10]. Based on the research and proposed solutions, we offer the Functional concept of the Intelligent Health Monitoring System. The concept of the system proposed is based on the following main functional blocks and roles – Figure 2:

- User of the system – A user of the system can be a person with an established disease, a patient covered by a personal health monitoring system or any individual in need of (immediate) health care. For this purpose, three different options for accessing the service are foreseen: through the used personal health monitoring system, through a mobile application or through the mediation of a call center;

– Personal health monitoring system, mobile application, Call-Centre - In the first two cases, data is transferred to the cloud service directly in the format with which the service works. The personal health monitoring system sends the health status data in the generally accepted format of the relevant health characteristics. In the mobile application, the user selects from preset menus his current symptoms in a form that he understands. The mobile application should correlate the current symptoms indicated by the user into causally determined health parameters and submit them to the cloud service. In the third case, when using the Call Centre, the operator applies a desktop application, analogous to the mobile one, which also contains the correlation (mediator) function.

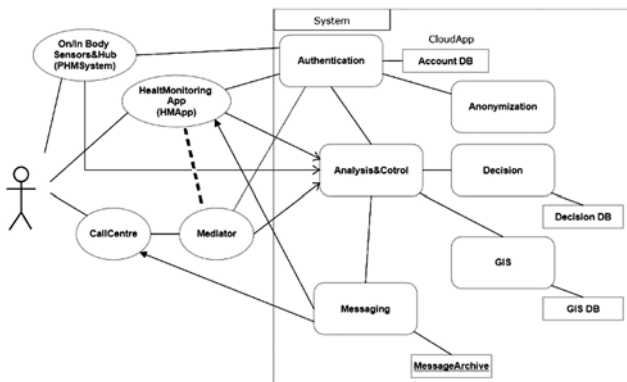


Fig. 2. Functional concept of the Intelligent Health Monitoring System

The concept of the system proposed is based on the following main functional blocks and roles – Fig. 2. The system consists of four data bases, each one is serving the separate functions.

The collected data are sent to the “Analysis&Control” block, but they are not being analyzed until the Authentication function sends an trigger-signal, that the request is processed and the user is authenticated for using the application. The authentication process includes an anonymization function, according to the GDPR rules. A new record is made in a separate Account DB.

The most important and the most complex function is provided by the “Analysis&Control” function. The function finds e decision for actions needed to be sent to the users according to their pains, moans, symptoms or data from their personal health systems. The function should use self-learning features and artificial intelligence capabilities. New correlations between signs of ill health and possible diagnostics are stored to the corresponding data base, and the decisions are made will be stored to the decisions data base.

After that, using the “Messaging” function, a message to the user is constructed. The message contains the action needed. In case of necessity of visiting a health center, with help from the “GIS” (Geographic Information System), the location and the road to the nearest health center is included in the message. The messages are stored to the Message archive for further analysis and control.

On Figure 3 a process flow of one possible case of use of the system is shown.

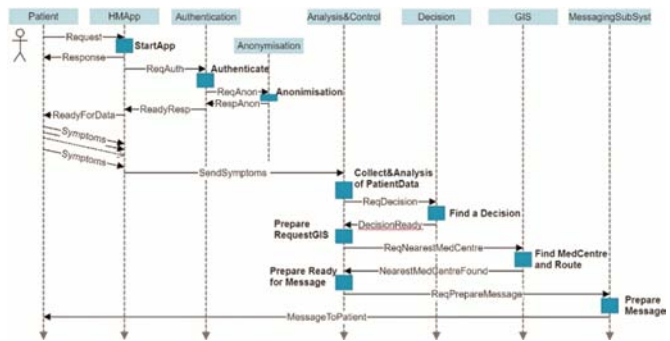


Fig. 3. Sequence diagram of a system functionality

III. DATABASE STRUCTURE

Four main groups of databases must be developed for the needs of the project: (1) Account DB to store the personal data of the registered customers of the system, (2) Decision DB to store medical data (data from telemedical measurements, diagnoses, proposed solutions etc.), (3) GIS DB to store geospatial data about medical centers and their competencies, and (4) Message Archive to store messages and message templates. SQL Databases are suitable for building Account DB and GIS DB, because information is subject to strong structuring and the created structure is stable over time. NoSQL Databases are suitable for building GIS DB and Message Archive due to the weak structuring of the collected information.

In this publication, we present an essential part of the GIS DB, designed to store information about medical facilities, the medical competencies that their units have and the level of competency. The range of competences of the individual units of the medical facilities is determined by the medical standards [11]. A level of competence in relation to the relevant medical standard is defined for each unit. The level can be a number from 1 to 3, with 1 being the hiest level of competence. Information about the health facilities in the Republic of Bulgaria, their units, areas of activity and the level of competence is determined by the Ministry of Health in the "Register of medical facilities for hospital care, mental health centers, skin and venereal disease centers, complex oncology centers, homes for medico-social care, dialysis centers and tissue banks" [12].

A database using RDBMS PostGre (Figure 4) was developed in accordance with the above regulatory provisions. It describes the medical facilities by administrative address and geospatial data, their units, the areas of competences and the levels of competence. A description of the medical staff working in the department is provided. The description includes: field of activities for which the respective person has competences, academic position, scientific degree, specializations and admission time.

The Analysis&Control module (Figures 2 and 3) generates a decision on what competencies are needed in response to patient messages. This decision is sent to a GIS module, which retrieves information about medical facilities possessing such competencies and recommends a visit to the nearest one or the one with the highest level of competencies. Information about all medical facilities that offer the required competencies can be presented in tabular form, arranged by distance or by level of competency.

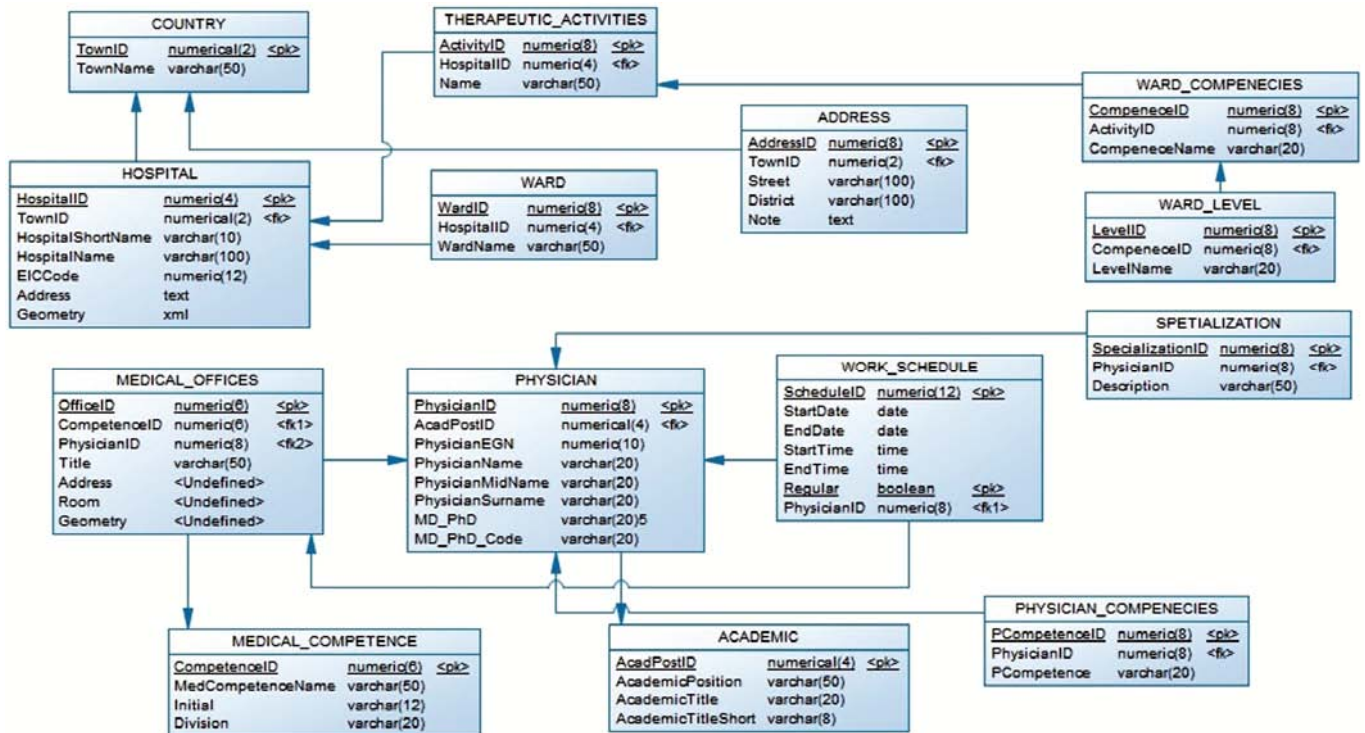


Fig. 4. Designed part of GIS DB

The proposed database, is to be further developed so that a map of hospital care coverage can be built for each area of medical competence in the country; coverage map with pre-hospital care offices for each medical specialty by region in the country; to map the incidence of specific diseases and compare it to the coverage map with hospital and outpatient care units with competencies to treat these diseases.

IV. CONCLUSION

In the scope of this study we discussed the main trends in development of telemedicine and applied technologies. Information portals in the field of telemedicine used around the world and in our country have been studied. Functional concept of the Intelligent Health Monitoring System is proposed and the main functional blocks and roles are discussed. Process flow of one possible case of use of the system is presented. The Database prototype of the GIS is proposed.

Further work

Development of fully functional systems implementing the functional blocks. In the end; the structure is reorganized based on the microservice infrastructure. It is carried out with a modern architecture and is moving towards becoming a service-based distributed and integrated system.

ACKNOWLEDGMENT

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Spatial Analysis for Locating New Medical Centers in a GIS Environment

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Abstract—Health regions are not just territorial areas, but represent a set of demographic, infrastructural, social parameters, as well as the good conditions provided by the states for qualified health care. For this reason, determining the location of needed health care centers by region is a function of this set of parameters. In this regard, the use of Geographical Information Systems methods for optimally determining the geographic location of the necessary health centers appears to be the most appropriate, due to the integration of the above mentioned parameters with the geographic coordinates of the settlements.

This article presents the cluster method developed by the authors for determining the location of new health centers for a certain populated region in Bulgaria, according to a basic requirement for access to these centers within a certain time interval. For this purpose, the necessary shape file was created and a study was conducted for different distances of the settlements.

The results for a certain number of clusters representing the new health centers are presented and analyzed.

Keywords—health regions, spatial databases, data integration, cluster analysis

I. INTRODUCTION

Currently, there is a lot of research on the established health networks in Europe and analyzes on the necessary expansion of the complex of health services provided by health regions [1,2]. Along with summarizing the perspectives and measures for improving health care, the different approaches to implementing these measures have been analyzed [3,4].

Health regions are not just territorial areas, but represent a set of demographic, infrastructural, social parameters, as well as the good conditions provided by the states for qualified health care. For this reason, determining the location of needed health care centers by region is a function of this set of parameters. In this regard, the use of Geographical Information Systems (GIS) methods for optimally determining the geographic location of the necessary health centers appears to be the most appropriate, due to the integration of the above mentioned parameters with the geographic coordinates of the settlements.

But there is still a lack of models for automated determination of the optimal location of the necessary newly created health centers/hospitals/diagnostic facilities, in

accordance with the demographic and territorial distribution of the population in the administrative regions. This distribution should be determined both according to existing hospital and diagnostic centers and according to the time required to reach these centers.

This article presents the cluster method developed by the authors for determining the location of new health centers for a certain populated region in Bulgaria, according to a basic requirement for access to these centers within a certain time interval. For this purpose, the necessary shape file with the necessary spatial database, was created and a study was conducted for different distances of the settlements.

The results for a certain number of clusters representing the new health centers are presented and analyzed. This method will look at spatial and mesh tools analysis. Thanks to them, two new emergency medical centers will be located in Pleven municipality, so as to ensure that the people from the settlements in it will be able to receive emergency medical care no more than 25 or 20 or 15 minutes away by car. The task that the municipality of Pleven sets itself is to join forces and improve the conditions for access to emergency medical care for the population that falls within their scope borders. For this purpose, they want to build six new emergency medical centers on the territory of Pleven Municipality, so that emergency teams can reach the people they have in no more than 15 minutes need. For this purpose, they want to carry out a spatial analysis to select the best locations. For the purpose of the study, a licensed software product, ArtGisPro was used.

II. CREATION OF A SHAPE FILE WITH POINTS DESCRIBING THE EXISTING MEDICAL CENTERS IN PLEVEN REGION

The website of the Ministry of Health [5] was used as a source of information about medical facilities, where all medical facilities are described establishments in the country. With the help of Google Maps, the addresses and coordinates of the medical facilities in the Pleven region have been located.

A geo-browser can be used to build a file with a description of these points that is suitable for processing in ArcGIS for the needs of this development. The most popular geo-browsers are Google Earth, ESRI's Explorer for ArcGIS, and GeoFusions' GeoPlayer. Google Earth [6] comes in three main versions. Google Earth Pro is a professional version that is available for free download and installs on a desktop system. It offers full

functionality, including creating files in KML format intended for sharing. KML format files can be easily converted to SHP format files that are processed directly by ArcGIS. The other two versions are a browser-based version and a mobile version that has less capabilities. Google Earth offers the ability to search, create panoramic views, zoom, rotate and tilt the earth's surface. It gives information about both latitude and longitude as well as altitude. Google Earth is a geo-browser, but it is not a geographic information system.

ArcGIS Explorer [7] enables viewing and sharing of geographic services. ArcGIS Explorer is available for free download and installation on a desktop machine. It allows sharing of maps and GeoWeb services. The Environmental Systems Research Institute (ESRI) provides many free maps that can be processed and analyzed, as well as combined with other user-created maps. ArcGIS Explorer does not have the functionality to create files with new geographic information, but is designed to process already created ones.

GeoFusions's GeoPlayer [8] is designed to process and visualize spatial images of both Earth and Mars. Provides a toolkit and database for both geospatial data processing and virtual walks. It does not allow an easy toolkit to create new geospatial data.

Looking at the capabilities of these three geo-browsers, we decided to use Google Earth to create a file with basic information about the treatment centers. Using Google Earth, files with geospatial information in KML format are created. KML (Keyhole Markup Language) is designed to describe geospatial information in XML notation. It was developed for use with Google Earth, but more and more GISs support and handle it. A standard KML file can contain [9]:

- Placemarks
- Descriptive HTMLin Placemarks
- Ground Overlays
- Paths
- Polygons

In newer versions of KML files can also be described as:

- Styles for Geometry
- Styles for Highlighted Icons
- Screen Overlays
- Network Lin

The SHP file format [10] allows storing geometric location information and additional attributes. The geometry of geographic objects can be represented as points, lines, or polygons. They can contain dBASE tables to store additional attributes.

For the purposes of our development, a KML file was created using Google Earth for each medical center from Pleven region. Point type geometry in blue color is selected for the visualization. Google Earth created files in KML format are converted to SHP format using Python functions in the Jupiter environment. After which they are merged into a common SHP file with point geometry. The resulting SHP file has the following more important fields: Name – for the name of the medical facility,

popup info – the full name to be displayed when specifying the point, geometry – the spatial coordinates of the point.

The obtained shape file, contains the necessary source spatial data, including the spatial geographic coordinates of the settlements in the administrative district of Pleven.

III. CLUSTERING MODEL

The established model for determining the location of new medical centers consists of the following steps:

- initially two main layers are introduced, namely a sketch layer of the territory of the Pleven district and a point layer containing the location of the settlements in the district. A function is set to merge the two layers.

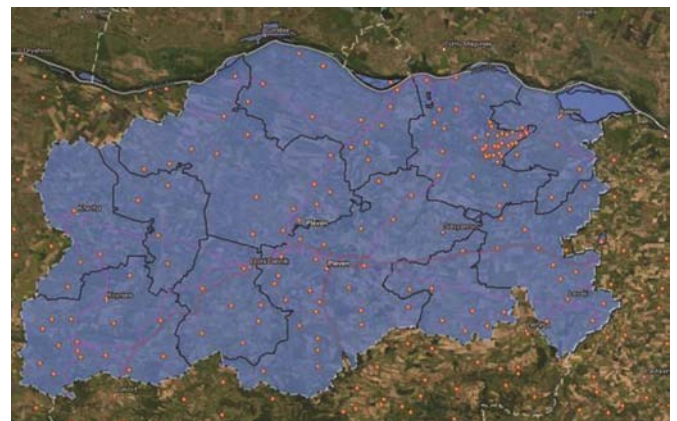


Fig.1. Result layer after execution of merge function

- In the next step, it is necessary to determine which settlements are located 15, 20 and 25 minutes away by car, to the "G. Stranski" hospital in the city of Pleven.
- The Create Drive-Time Areas tool is used for this purpose.
- Thanks to mathematical calculations and analysis, this tool creates a polygon that includes all the points that can be reached in the corresponding fixed time through the street network and depending on whether the distance is covered on foot or by vehicle.
- In the Analysis menu, different driving areas are created (Create Drive-Time Areas) by filling in the following parameters:
 - The name of the point layer for the calculation of the zones (Point layer) is set - "G. Stranski", for the driving time (Driving time) successively selecting 15 min., 20 min. and 25 min. to obtain different zones of remoteness. For (Travel direction) – Away from Facility is selected
 - The new layers appear in the layer list, and the map displays the polygon that encloses all street-accessible locations within a 15, 20, and 25-minute drive.
 - The resulting polygons are shown in Figures 2, 3 and 4, respectively.
 - Figure 5 represents all calculated areas and merged into one layer.

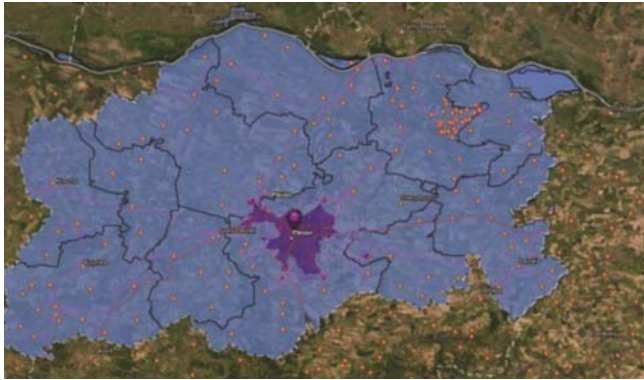


Fig. 2. Polygon that encloses all street-accessible locations within a 15 min drive

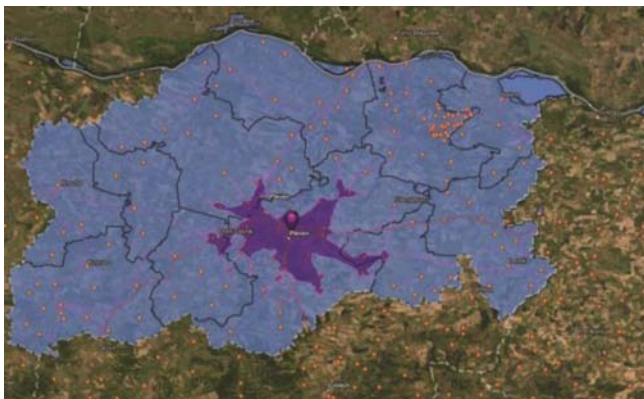


Fig. 3. Polygon that encloses all street-accessible locations within a 20 min. drive

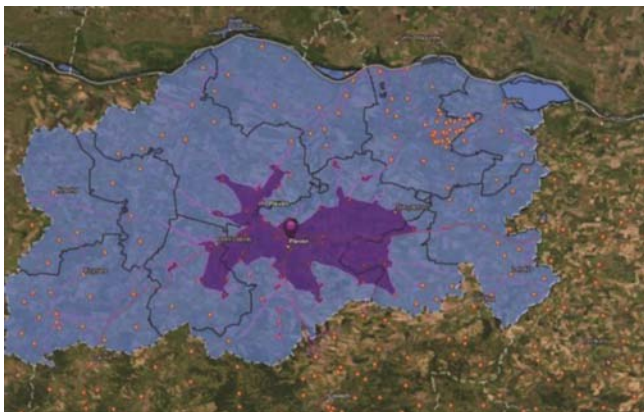


Fig. 4. Polygon that encloses all street-accessible locations within a 25 min.drive

- In the next step, a selection is made of the settlements not falling within 15 minutes from the hospital. In order to create a layer in which only the settlements for which new centers will be created will remain, it is necessary to overlap the two layers Zone 215 min from G.Stranski Hospital and a point layer of settlements. This is possible through the function Overlay layers (Overlay layers).

We enter the following parameters:

- Input layer: Population_points
- Overlay layer: Area 15 minutes from G. Stranski Hospital
- Overlay method: Erase
- Result layer name: Settlements for analysis

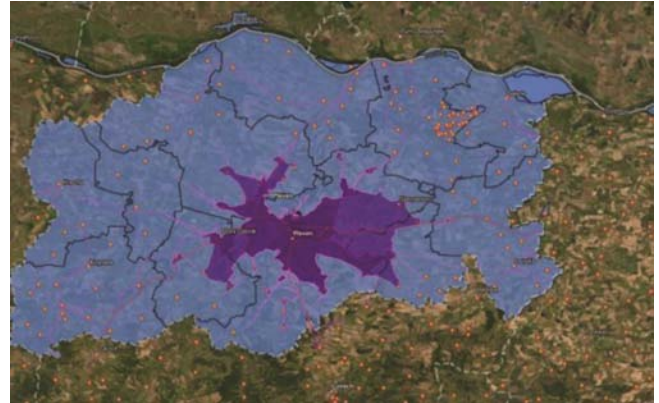


Fig. 5. All Polygons that encloses all street-accessible locations within a 15, 20 and 25 min drive

- The next step involves determining the best locations for new medical/diagnostic centers

In this step, through the software, a network analysis will be applied, with which it will be established in which settlements it is most appropriate to create such centers, so that teams reach the majority of the population of the municipality of Plevna, for no more than 15 minutes by vehicle.

This will be done through the Choose Best facilities feature, following Select Analysis (Find Locations), (Choose best facilities) - Minimize Travel, filling in the following parameters:

- Measure (Driving Time)
- Travel Direction - Facility to Demand
- Demand Locations layer - Populations for analysis
- Maximum travel range - Constancy - 15 minutes
- Candidate Facilities Layer - Population_points
- Number of clusters with a potential match for an address to choose (Number of candidates to choose) – 6
- Result layer name (Result layer name) – Best locations

IV. EXPERIMENTAL RESULTS

Figure 6 represents the results for 6 cluster centers.

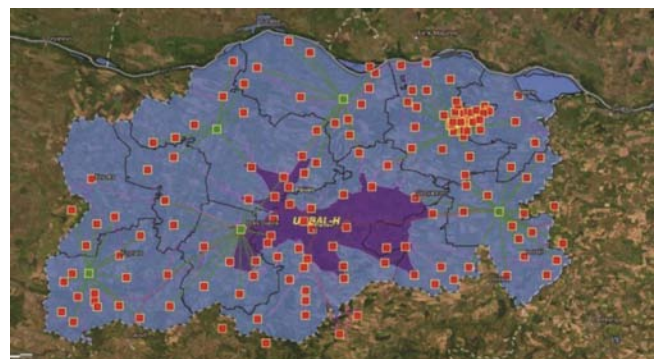


Fig. 6. Obtained 6 cluster centers with attached settlements (green points)

- In the final step, the time to reach from any settlement to the new or existing center can be calculated, so that the patient can estimate which location is the fastest to access.

For this purpose, the navigation function in the Map Viewer is applied. (Directions) is selected, with the settlement on Dolni Lukovit selected as the starting point of the journey, and one of the two nearest new medical centers - Dolni Dabnik and Orehovitsa, respectively - being selected as the end point. Driving time must be selected from the drop-down menu.

The results show that the travel time between to Dolni Dabnik is 25 min. and to Orehovitsa is 33 min. To obtain different results, you can experiment with another scheme with a different number of initially set clusters.

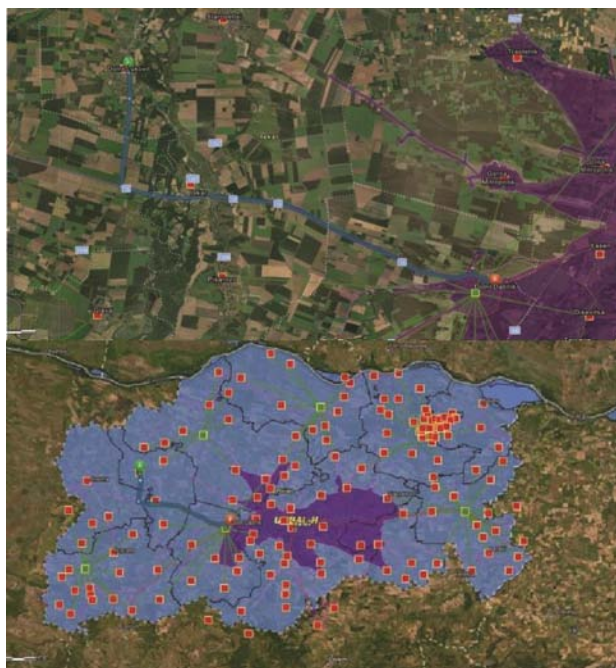


Fig. 7. Obtained road route to the cluster point Dolni Dabnik



Fig. 8. Obtained road route to the cluster point Orehovitsa

CONCLUSION

This article presents the cluster method for determining the location of new health centers for a populated Pleven region in Bulgaria, according to a basic requirement for access to these centers within a certain driving time interval. For this purpose, the necessary shape file was created and a study was conducted for different distances of the settlements.

The proposed method allows conducting different experiments with changing the parameters in the individual steps of the algorithm, such as varying the number of clusters, in order to obtain an optimal distribution for the settlements. As a continuation of the development, other parameters from the spatial data such as population density, age distribution, etc. can be included.

ACKNOWLEDGMENT

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Application of Information Systems in the Process of Telecommunications Structure

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Abstract—Information systems within an organization are the main control mechanism of the management apparatus. We look at the implementation of business software in the telecommunications structure, as a multicomponent system, through which relevant services representing information exchange are created and provided. The main criteria for a successful telecommunications company is the operational efficiency of management approaches, which step on a properly integrated information system.

Keywords—management, telecommunications, integrated, systems, organization

I. INTRODUCTION

The purpose of the present study is to examine the nature of business software in a telecommunications structure. We assume that it is a multi-component system that consists of: technologies and connections, information systems, digital facilities and others. The main task is the creation of telecommunication services based on information exchange, which requires integrated information systems, as supporting the management process in the organization. Management information systems/MIS/ is a set of technical part (hardware), program (software), ongoing processes and means of telecommunication with the ability to process, store and exchange information for the purposes of the management process. Through them, optimization of processes, delivery of quality and secure services, protection of own assets and others are achieved. The breakdown or ineffectiveness of any of the control mechanisms in the organization poses a direct risk to the overall delivery of services, which will have a negative impact on the customers of the enterprise.

II. ANALYSIS OF THE MODERN SITUATION IN THE DEVELOPMENT OF MANAGEMENT INFORMATION SYSTEMS

In the modern market structure, the implementation and use of management information systems is practically inevitable. Their benefit is expressed in higher efficiency of processes, optimization of information flows, increase in the level of management process, security of data transfers and others. The benefits of the integration of MIS for the activities falling under regulatory requirements, such as data security, health and safety working conditions, environmental protection from industrial processes, are also inevitable.

The concept of MIS has the meaning of systems providing the information management process and tracking the results

of the activities in the organization, i.e. carriers of information related to the management process. They provide feedback on the way the organization is functioning and assist with control. The main functions of the MIS include the following:

- Generalization of information and data from the activity in the organization;
- Designing future activities;
- Performing a control function regarding the organization's assets;
- Stock tracking;
- Information provision of the financial and accounting process.

Product of the integrated information systems in the management process of an organization are: monitoring of financial flows, execution of periodic reports, tracking of profits and losses, control of expenses in the organization, generation of financial statements, checks for stock availability and others. A typical example of information systems are (Enterprise Resource Planning), which are used to plan resources in the organization.

III. NECESSARY PREREQUISITES FOR BUILDING A MANAGEMENT INFORMATION SYSTEMS IN A TELECOMMUNICATIONS STRUCTURE

The main reason for implementing an information system is reporting and assessing the risk of the management structure of the organization. A basic requirement of the management of any organization is to build and maintain the necessary control in each of the activities, which is a guarantor of the quality of the management processes, subject to compliance with the regulatory requirements.

Currently, there is no single generally accepted standard that would be criteria for the construction and implementation of MIS in a telecommunications organization. We have the possibility of comparative analysis between different elements of systems used in the economic sphere. For the purposes of this study, we will indicate definitions for the structure of the MIS:

- Monitoring and analysis;
- Control mechanisms;

- Risk management;
- Information flow and communication.

To the necessary conditions for the implementation and construction of a MIS model in a telecommunications structure, we will indicate the following:

- the model is defined for the management of corporate structures in the field of information and telecommunication technologies;
- the model is developed with a sufficient degree of parameter development while allowing for a multitude of specific variations, each unique to each structure. Parameters - optional and required:
- the model requires calibration through the particular interpretation, the particular conditions and the type of product/service;
- the model does not include management of finances and research and development;
- the model is entirely managerial and as a result provides the management framework, not including the technical implementation of the relevant mechanisms.
- For the operation of a properly structured MIS, it is essential to build and have the correct architecture, it is the carrier of the logical and model, as a set and describes the information and aspects. Each functional area of management in a given organization has a specific information system to serve the three levels of management. According to the administrative level of application, information systems are determined at the following levels: strategic, tactical, operational. As they are tied to the following functional core areas: sales and marketing, production, finance and accounting, human resources, as shown in Fig.1:

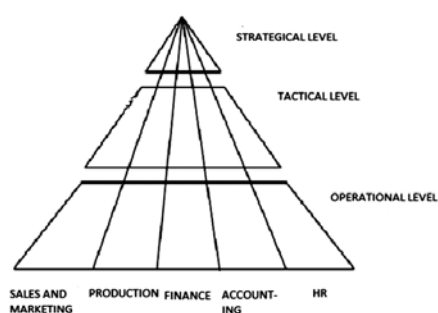


Fig. 1. Types of information systems

The specified model for managing a telecommunication structure, based on an integrated internal system, contains a method for identifying and applying similar controls in operational activity. Most authors claim that the purpose of preventive control mechanisms is to prevent the development of risk into an event, because this will have an adverse impact on the achievement of management goals in the organization.

IV. RISK MANAGEMENT THROUGH INFORMATION SYSTEMS

Risk assessment is a process aimed at identifying, treating and dealing with risks. This requires the implementation of the appropriate information system to ensure the efficient and smooth running of the processes in the organization. To achieve the corporate or other goals in the organization, it is essential to properly prepare the risk assessment, as a systematic process for assessing events that pose threats to the activity. Risk assessment is carried out at the various management levels. It is a continuous process that requires an integrated management approach to be able to provide timely and up-to-date information on each of the possible risks. Phases of a business cycle for a telecommunications organization from the point of view of risk assessment:

❖ I Phase (Strategy Development):

- Mandatory integration of risk in strategic plans;
- Analysis of risk probabilities and ensuring consistency with the strategy;
- Allocation of economic assets by risky activities;
- Determining performance goals;

❖ II Phase (execution of the processes):

- Mandatory integration of risk in strategic plans;
- Determining the probability of risk and ensuring compatibility with the strategy;
- Efficient allocation of economic assets;
- Determination of performance objectives;

❖ III Phase (risk assessment):

- Collected data from past processes;
- Preparation of a report with results and recommendations;

A systematic approach is required to define steps to perform a risk assessment. After a detailed analysis of the collected data from the information systems used in the activity carried out in the organization, the following steps should be performed:

- Analysis of processes and assets;
- Determination of criteria and requirements for operational activity;
- Determination of risks;
- Assessing the degree of each of the risks;
- Undertake responses to risks.

The next step in risk management is the preparation of control mechanisms to stop it. Such mechanisms may be:

- Implementing an information security policy;
- Development of procedures for preventive actions;
- Physically restricting access to information or assets;

In summary, we can note the following conclusions typical of the management process of a telecommunications organization, they are respectively:

- Risk assessment needs to be integrated into the management process to provide timely information on possible risks/threats and their prevention;
- Risk assessment is a systematic process that is managed and integrated into the work process all the way from the strategic planning of the goals to obtaining the final product of the organization;
- The risk assessment, as an integral part of the whole process, is activated when atypical circumstances arise outside the normal line of activity;

V. ANALYSIS OF THE EFFECTIVENESS OF INTRODUCING A MANAGEMENT INFORMATION SYSTEMS IN A TELECOMMUNICATIONS STRUCTURE

For the purposes of the present study, it is necessary to develop a model based on which to objectively evaluate the effectiveness of the implementation of an information system. To develop the specified model, we will make several basic proposals as follows:

- It is suggested to work with control groups. As for each possible threat (risk), we will find a separate control group. We explain that each of the groups has a certain control mechanism corresponding to the type of control performed by the group / for analysis, for prevention, for threat removal/;
- We assume that the final efficiency of the implemented information system will be an average value between the sum of efficiencies of the used control groups.

Based on the above, we will use the following calculation formulas as follows:

- $Ac=0$, $AEF=Const1$ /in the absence of adverse events/;
- $Ac \neq 0$, $Trisk \leq T_{surch}$ and $T_{correct} \leq T_{def}$, $AEF=Const2$ /in case of failure of the preventive control mechanisms, as the analyzing and correcting ones have been involved in the specified time/;
- $Ac \neq 0$, $Trisk > T_{surch}$ and $T_{correct} \leq T_{def}$, $AEF=Const3$ /in case the control mechanisms work, but with the clarification that the preventive mechanisms did not fit into the reaction time, but only the corrective ones reacted in time/;
- $Ac \neq 0$, $T_{correct} > T_{def}$, $AEF=Const4$ /when only the corrective mechanisms worked, but outside the reaction time/;

Explanation of the symbols used:

AEF – operational efficiency of the methodology;

EF – Task control group;

Ac - Security Incidents;

T_{surch} - Defined time to detect the incident;

T_{def} - Defined incident removal time;

$Trisk$ - Time of occurrence of the security incident;

$T_{correct}$ - Real-time information security incident remediation;

*We make a clarification that we take the value of the used constants as limit values, specifically:

$Const1=100\%$, $Const2=75\%$, $Const3=51\%$, $Const4=0\%$,

We set a threshold of the level of effectiveness of a management information system of 75%, therefore $Const1$ and $Const2$ should not take a value below 75% of effectiveness, for each of the control groups, this is a mandatory condition to consider a given MIS as operationally effective in terms of risk control.

After the terminology mentioned so far and the formulation of specific risks, we will also consider a variant of the algorithm for determining the effectiveness of a given MIS, the gradation is as follows:

1. Determination of types of risks/threats to the operational efficiency of the MIS;
2. Detection, analysis and reporting of incidents;
3. Determination of specific requirements regarding the expected/required reaction of each of the control mechanisms;
4. Development of control groups to report operational efficiency;
5. Specific valuation of operational efficiency / in percentages/;
6. Correction of the control mechanisms in case of detected inaccuracies or omissions;
7. Secondary verification of operational efficiency / in the case of applied corrections in the control mechanisms/.

VI. A STRATEGY OF SYSTEMATIC AND CONTINUOUS IMPROVEMENT OF A MANAGEMENT INFORMATION SYSTEM IN A TELECOMMUNICATION STRUCTURE

Correct and effective functioning of any information system in an organization is a direct consequence of active activity in continuous consideration of variable factors / internal and external / for the organization, which have a direct or indirect impact on the activity of a telecommunications structure. We will dwell in detail on the algorithm indicated by most authors, which is applicable to the process of implementing an information system, for the purposes of management activity in a telecommunications structure. When breaking down the process, we can distinguish the following arrangement of stages, typical of the MIS we are considering, namely:

1. "Thorough analysis" stage - It is typical for a comprehensive review of the state of a given organization/structure determined to be improved through the implementation of a management system;

2. "Development of the model" stage - What is essential here is expert development of the information system/business software, which will optimize the future implementation process;

3. "Actual implementation process" stage - Carrying out the implementation by qualified experts of the information system in the organization/structure;

4. "Commissioning" stage - After the implementation of the system comes the moment of a series of activities that will lead to its successful and complete use;

5. "Certification and documentation" stage - Preparation of the required documentation regarding the product provided to the client.

The MIS model is based on organizations whose activity is in the telecommunications sector, it was created with the aim of minimizing problems that are often present in telecommunication structures.

VII. CONCLUSION

In the present scientific study, we indicated as the main goal, the questions related to a full analysis and optimization of the implemented, integrated information systems in the telecommunications structure, for the needs of information provision of the management process. As for defining the model described by us, we adopted a business system that is

built on the basis of unifying and standardizing the integration process in the direction of optimization and high final efficiency, that is, a customer-oriented product that has clear logical connections, maximum functionality and is a guarantee for full management control of resources in the organization.

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Comprehensive Review of Service Modeling and Monitoring

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Abstract—Information Technology (IT) is developing rapidly. Business relies more and more on the advancement of IT reliability, flexibility, and agility. It is of crucial importance to have a competitive ability over the competition. Research and development in blockchain, big data, artificial intelligence, machine learning, automation, virtualization, containerization, serverless applications, and many more are prerequisites for the broad possibilities of competitive basis. Business services combine and manage the synergy between individual technologies to provide the value they are intended to deliver to the customers. Once a service becomes in production, then it must be carefully monitored. The monitoring provides information on the different components and, of course, how the service runs. But from another, the collected data could be used for various analyses and capacity planning. This research aims to comprehensively review the possibilities for service modeling and end-to-end service monitoring from an IT perspective. It examines the existing monitoring solutions, provides a classification of the different monitoring approaches, and describes the services modeling with the underlying infrastructure components.

Keywords—business service, application, monitoring, synthetic probe, agent-based, agentless, configuration management system (CMS), events correlation, time-based correlation, topology-based correlation, ITIL, discovery

I. INTRODUCTION

The Services could be grouped into three major categories: Business Services, Social Services, and Personal Services. There are different types of business services. Some of them are essential to nearly all businesses. Others have supporting functions. A few examples of business service types are Software services, Training services, Consultancy services, technical support services, Project management services, Security services, Health and Insurance services, Marketing services, Legal services, Delivery and Logistics services, Real estate services, Maintenance services, etc.

There are different definitions of the generic term “service”. According to the set of detailed IT practices - IT Infrastructure Library (ITIL) [1], a service is “a means of delivering value to customers by facilitating outcomes customers want to achieve without the ownership of specific costs and risks”. According to the newer and updated version of the library [2], services “are the main way that organizations create value for themselves and their customers”.

From a business perspective, business services are compositions of other business services, business applications, IT infrastructure services, and any combinations. The focus of this research is on the IT services which are built on and depend solely on different IT domains. In other words, an IT service is a business service that the IT organization provides to support business services or IT’s operations. According to the service offerings, the business service must be available to propose value to the customers. Many factors impact the services’ design – world and country regulations and compliance, the company’s security standards, policies, etc. Some of those requirements must be laid out in the design phase.

To provide real value to customers, the business services, which primarily rely on the underlying IT infrastructure, must be thoroughly monitored, maintained, and tuned if needed. All services, applications, integrations, and configurations must be kept in a place the business and the IT personnel could use as the so-called single source of information. Such places are the configuration and management systems (CMS). The CMS systems have a built-in model of component types and relationship types. Some of the types could have relationships between them. Those components are called configuration item (CI) types, and the connections are called relationship types. Together, they built the model. Commercial systems have such built-in models and give flexibility for modifications and customizations. The information for application and infrastructure services, components, and their relations must be stored in such CMS systems. The process of finding IT components and their relationships from existing IT infrastructures and keeping them in the CMS system is called discovery. This process could be fully automated. Of course, only active IT components can be discovered automatically. Some elements cannot be discovered: business service names, application service names, and their relationships. Different techniques exist for feeding such information in CMS – for example, a manual, import from a specific file format, etc. Finally, one of the purposes of the CMS system is to store the most current and actual map of the used IT components and their relationships. Once the business service components are identified, they can be used for service modelling.

The first and significant step of service monitoring is to identify and store all participating components and their

relationships in a central repository – in a CMS system. The second step is monitoring. The third step is to harness at work all collected data for the statuses, performance behaviour, capacity, and resource consumption, to reflect the overall service's presence and availability. Many other factors also impact service delivery – for example, business processes [3]. For monitoring, services will be reviewed as a stand-alone, built on top of IT infrastructures, applications, and integrations.

II. SCOPE AND DEFINITIONS

Authors in [5] review three layers of a service-based application – the business process management layer, service composition layer, and service infrastructure layer. Service management, also known as IT Service Management (ITSM), is an approach from a process point of view to manage IT services. Business process management aims to help keep businesses running their operations smoothly and analyze the processes for possible improvements. There is a difference between business process management and service management. For that reason, the focus will be on the service's structure and the underlying infrastructure components. The proposed division of layers is somehow not descriptive because the infrastructure layer should be part of the service structure – but not reviewed as a separate layer. The paper will use the more general term “business service structure” instead of “service composition”.

Authors in [6] describe the monitor as a separate physical system that observes the target process without influencing it. They also state that the monitor and target process share the same hardware and software. Years ago, this might have been the only possible way to observe. Nowadays, different techniques exist, like agentless monitoring (remote checks and monitoring), execution of measuring the end-user behavior (synthetic probes - also remote), etc.

A way to present an infrastructure-monitoring architecture is shown in [7]. The authors state that the infrastructure must be monitored at the hardware, service, and application levels. They do not give any explanation of what service means in their research. Their approach does not consider the software layer and does not reflect any dependencies from other systems (integrations).

There is another review of monitoring tools in [4] concerning monitoring runtime software faults, suitable for developers.

III. SERVICE MODELING

A. Configuration Management Systems

Some commercial products like Universal Configuration and Management DataBase – UCMDB (proprietary of MicroFocus, formerly Hewlett-Packard/HPE), Configuration and Management DataBase – CMDB (part of the cloud-based ServiceNow service and operations management platform) realizes the CMS concept.

Every configuration item has its definition type in the CMS system – out-of-the-box attributes and relationships. Every relationship type has a definition type and attributes. Each data model has pre-defined relationships; from their

turn, they have directions. So, we talk about relationship types. One of the essential relationship types is the so-called “composition relationship”. It defines a strong parent-child relationship. For example, a physical computer must have a network interface card (NIC). In the data model, those configuration items – the physical computer and the NIC are linked with the composition relationship type. In other words – the NIC cannot exist on its own – if the physical server is deleted (removed), then the NIC card will also be automatically deleted from the system. Another relationship type is the so-called “containment relationship”, which links two or more configuration items but can exist independently. An example of such a relationship is one host (could be physical or virtual) connected to a shared network file system (NFS) – it is said that the “host is linked to a shared network file system with containment relationship”. The types of relationships are important because they define the impact of any related to each other configuration items to the overall service. The relationships have directions. Suppose one of the linked items gets any status change event or performance degradation metric. In that case, it will change its status, which could be propagated to the upper level in the service definition (in general, to its parent configuration item). If, as part of monitoring, the server's CPU utilization generates a performance degradation event for one or all of its CPUs, then the server will change its status. This change will not affect any underneath CIs – like NIC cards, internal disk, memory, etc.

B. Components Discovery

Both described in the previous section products are surrounded by powerful mechanisms for infrastructure and applications discoveries.

Initially, they include information for the most common infrastructure and software components and applications and provide additional functionalities for building a set of steps and rules for the discovery of new elements. Also, the existing models can be extended and supplemented – in terms of new or updated current attributes, building new relationships between the configuration items, removing existing ones, building new types of configuration items, etc.

In general, the discovery process is filling information into a CMS system. The discovery could happen in different ways – automatically, based on integrations with third-party products, and manually. By definition, every configuration item type must have a rule or set of rules which identify its instances uniquely. Based on these rules, a newly discovered component is compared to the existing CIs, it is either being merged, or a new CI is being created.

There are different techniques for component discovery. For example, network devices are usually discovered via SNMP protocol, while Windows servers – are via WMI protocol, etc.

C. Service Modelling (Mapping)

Any service could have two layers – the business and the software and infrastructure. Fig. 1 is presented this very high-level overview.

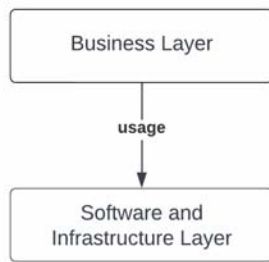


Fig. 1. Business Service – A high-level overview

The following figure, Fig.2, presents the conceptual model – a more detailed layered model. Follows a description of the layers:

- Business Enablement layer - models the business functions, services, processes, and activities. A business service can represent either a business or an IT-provided service. A business service is a service that a company provides to another business (business to business - B2B), or that one organization provides to another (e.g., payment processing). An IT service is a business service the IT organization provides to support business services or IT operations.
- Application and Services - an application is a set of components supporting a business activity, seen as a whole and known by a specific name. (network services, database services, naming services, desktop services, and Windows administration services).
- Software - Individual installations of software elements. These are physical components (executables) that can be deployed, or are deployed, on a logical system.
- Infrastructure - used to model both logical (virtualization and clustering) and physical (storage devices, network devices, and servers) systems.
- Facilities - Location, site, building, room, rack, etc.

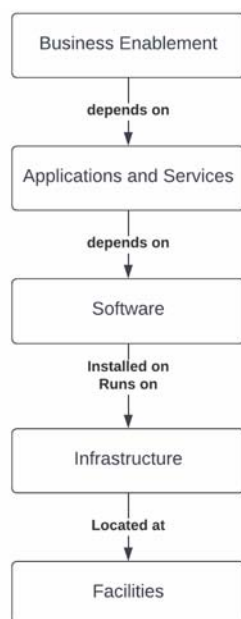


Fig. 2. Business Service – A conceptual model

The first two layers, Business Enablement and Application Services, could be represented in a bit more detailed manner to achieve a better understanding of the structure. The diagram is presented in Fig.3. The Infrastructure Element is moved out from the Business Layer. It will be described later on in the paper.

Of course, the last layer could also be represented in detail to show the components and their relationships. The details are presented in Fig. 4.

In Fig. 4, there are two types of nodes – the physical and the virtual nodes. Virtual nodes have components like OS, file systems, NIC cards, etc. Although they are positioned slightly above the physical nodes, they have similar elements with relationships. It is not shown in the figures with the idea not to make the diagrams very complicated. For that reason, when presenting a Physical Node in Fig. 5, the left side of the graph is written: “Node” (applicable to all CIs of type Node).

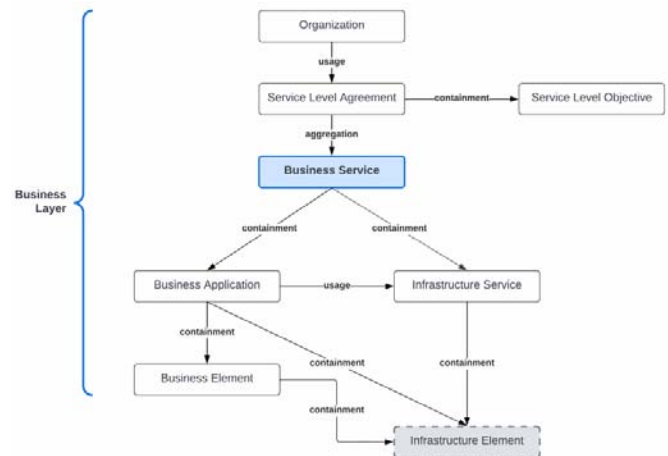


Fig. 3. Business Layer Structure – components with relationships

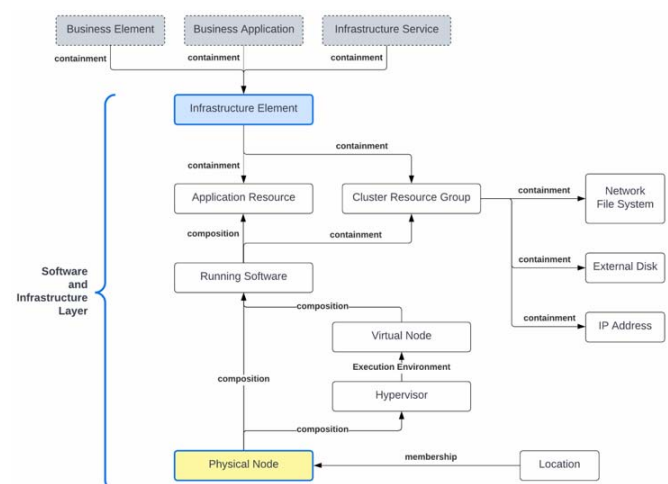


Fig. 4. Software and Infrastructure Layer – components with relationships

The presented in Fig. 3, Fig. 4, Fig. 5 and Fig. 6 illustrate an overall structure of a service. This model could be called Service Generic Model (SGM). Not all of the components are needed for all services. Also, for some services, new CIs and relationships might be required.

D. Monitoring Concepts

The monitoring tools could be divided into two main categories:

- Commercial – the tools from this category have the full support and management of owning the company. For example, customers could benefit from resolving issues and problems when new patches and versions are released. Also, the planned enhancements could be part of new releases, etc.
- Open Source – the forums are the main point of contact where customers can find any help. There might be significant communities behind open-source products and solutions. Fixing issues and problems is dependent on the free will of the community. But on the other hand, these tools are free of charge. Every company could have its employees educated and trained well in these products. So, they could provide a certain level of administration and support.

Depending on how discovery and monitoring work, the tools could be divided into two types:

- Agent-based – there are a lot of pros and cons for agent-based systems. One significant advantage is that monitoring a system with an agent keeps all collected metrics locally. So, in case of network connectivity issues with the management server, everything could be transferred once the connectivity appears. The biggest cons are that the agents as software components utilize some node's resources – like memory and CPU.
- Agentless – everything is concentrated in a central server. There are no installed agents on the nodes. In case of network connectivity issues – the monitoring data is lost. A central server must have complete information for every monitored node – credentials, used protocol and port, details on what and how to run, etc. If the central monitoring server is compromised, this could severely impact the monitored systems.

Usually, the production systems are used combinations of both types.

The monitoring systems could be divided into a few other categories:

- Active monitoring – includes techniques such as polling, synthetic probing (checks and measures response times from end-user perspective)
- Passive monitoring – this is reactive monitoring – the monitoring system relies on receiving traps, for example – for any status changes in the monitored components. Although the UDP protocol is not so reliable, the SNMP protocol uses it, so the generated by the network devices traps rely on it.

E. Comparison of the existing monitoring solutions

In Table I is presented a comparison between thirteen of the most famous monitoring tools in the market. A characteristic for the comparison is the type of license (commercial and open source), agent-based and agentless.

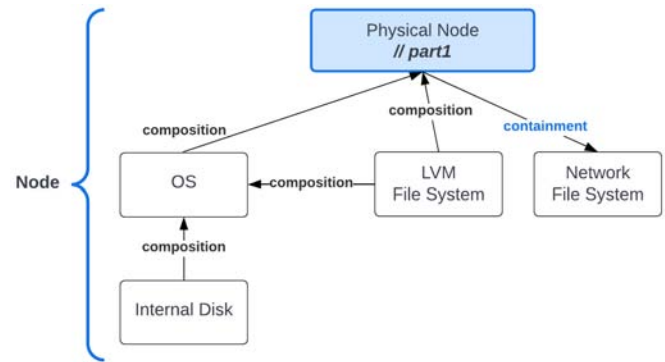


Fig. 5. The Physical Node (part 1) – components with relationships

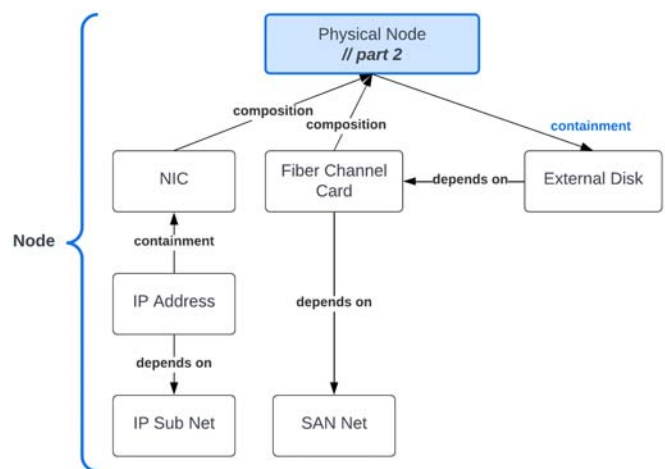


Fig. 6. The Physical Node (part 2) – components with relationships

F. Fine-tuning of the data flow

Every monitoring system has two significant information flows – the flow of the data (CIs with their relationships) and the flow of events and metrics. For some complicated issues and problems, different events might be generated – from various sources, for example. Having all such events could be very difficult to process and administer. There are situations where such events could be combined and, if needed, some be suppressed. The events correlation techniques could help reduce the number of events (either on the managed nodes or the management server).

Two very commonly used event correlation techniques are topology-based and time-based. In the topology-based events correlation, the received events are combined based on a rule(s) depending on the underneath CIs topology. In the time-based events correlation techniques, event suppression happens at intervals. For example, the time is considered if a particular event is triggered. If another such event appears between the defined period, then an event will be generated and placed into the management server. Otherwise, if a new event is not generated during the measured time interval, the first event is ignored.

TABLE I. MONITORING TOOLS MAIN CHARACTERISTICS

#	Tool	Company	License	Agent-based	Agentless
1	Dynatrace	Dynatrace Inc.	Commercial	yes	
2	HPE Operations Manager (OMi)	MicroFocus	Commercial	yes	
3	SiteScope	MicroFocus	Commercial		yes
4	Hyperic HQ	Hyperic	Open Source (GPLv.2)	yes	
5	IBM Tivoli Monitoring	IBM	Commercial	yes	yes
6	ManageEngine OpManager	Zoho Corporation Private Limited	Free/Paid	yes	yes
7	Nagios Core	Nagios Enterprises LLC	Open Source (GPLv.2)	yes	yes
8	SolarWinds	SolarWinds Corporation	Commercial	yes	yes
9	WhatsUp Gold	Ipswitch Inc.	Commercial	yes	yes
10	Zabbix	Zabbix LLC	Open Source (GPLv.2)	yes	yes
11	SCOM	Microsoft	Commercial	yes	yes
12	ServiceNow	ServiceNow	Commercial	yes	
13	Zenoss	Zenoss Inc	Commercial (as of 17.03.2022)	yes	yes

These tools are very different from another perspective – they are initially designed to monitor a specific IT domain – for example, network and infrastructure (Nagios), application monitoring (Hyperic), etc.

IV. CONCLUSION

In this research, the monitoring concepts are reviewed. There is a comparison between thirteen of the most famous worldwide monitoring solutions. A detailed review of the business services components from an IT perspective is presented. The idea behind the CMS systems is presented. The business layer and the underneath infrastructure layer are reviewed and drilled down to the level of different CI types and their relationships. The detailed description of the service modeling is described.

V. FUTURE WORK

The presented work could be extended by adding Key Performance Indicators (KPIs) to the SGM model. Also, the model could be developed by adding some mode relationships showing, for example, the types of relationships – in terms of “one-to-one”, “one-to-many,” and “many-to-many”. The model could be extended by adding some cycle relationships. For example, it is possible one business service to use another business service or one infrastructure service to use another infrastructure service or services, etc.

ACKNOWLEDGEMENT

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A Review of Merkle-root Hash Value Computation Techniques

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Abstract—This paper proposes an efficiency improvement algorithm for a blockchain network that contains specific values in its header part. One of those values is the Merkle-root hash, which represents cryptographically the included in the block body transactions. In the bitcoin network, the computation of this value relies on the double SHA-256 hash function (the SHA-256 function takes, as input, the result of the same SHA-256 function previously computed from a transaction or an intermediate value). The entire binary tree formed by the transactions included in the given block bears the name of its inventor - Ralph Merkle. Therefore, the root of that tree is called Merkle-root. This research proposes a way to speed up the time of Merkle-root hash value computation by dividing the Merkle tree into Sets. The overall results are based on previously measured times for hash calculations within three cloud infrastructures (Amazon AWS, Microsoft Azure, and Google GCP). The idea is to use various hash algorithms, spread in different Sets, and apply multiple Sets for the root computation. One of the essential attributes in each block is the Merkle-root hash, which must undoubtedly represent the included transactions. The proposed solution presents improvements in two areas - security by using a few hash functions (instead of one) and the overall time for Merkle-root hash value computation.

Keywords—*blockchain, Merkle-root, Merkle-tree, cloud vendors, aws, azure, gcp, block header, hash, SHA2 family, SHA3 family*

I. INTRODUCTION

Blockchain is a type of distributed database. The proposal behind it appears back in the 80s [3]. The idea of immutable information blocks linked to each other with hash values in a chain appeared in 1979 in Ralph Merkle's Ph.D. thesis [4]. He explains how the information can be linked in a tree structure - currently known as "Merkle's hash tree" (Merkle-tree). A tree structure allows a more efficient way of chaining information together than a linear structure.

Blockchain is a chain of interconnected blocks. There are two types of blocks - one specific block that sets the beginning of the chain (the so-called main block) and all remaining participating blocks, which are prepared and linked to each other the same way. A hash value is computed from a block header and is stored in the next block. Every block consists of two parts - the header and the body. The block header contains some attributes, one of which is the

calculated hash value from the previous block. Another attribute is the computed hash value from all participating transactions (stored in the block body). Usually, the number of transactions is different in every block.

The term "transaction" is generally precise for bitcoin, other cryptocurrencies, financial networks, etc. In general, it should be understood as a "transaction or any other type of data" [5] because blockchain, except in the financial sector, can be used in many other areas. The included in given block transactions participate in the creation of a hash-value, called Merkle-root, from a binary tree (Merkle-tree). In his publication [6], Ralph Merkle suggests using such infinite trees of one-time signatures. He randomly chooses binary tries to illustrate his idea, assuming that there will be used k-ary trees in reality. Merkle-root hash value is a fundamental attribute in the blockchain blocks [4], [6], [11], [12].

In the bitcoin network, the computation of the Merkle-root hash value is based on the double SHA-256 hash function. All the calculations bottom-up from the leaves to the tree root are being processed with this only function.

The presented research is a logical and natural extension and improvement of two previous author studies [1] and [2] around the security improvements in blockchains. In [1], the author suggests dividing the hashes calculations in the Merkle tree into four Sets and using four hash functions - SHA-256, SHA-512, SHA3-256, and SHA3-512. This paper reviews one hash functions distribution in the four Sets: Set 1 (with SHA-256) - this is the Set with the most computations (from all the leaves), Set 2 (with SHA3-256), Set 3 (with SHA-512), and Set 4 (with SHA3-512). In [2], the author is still using the same four hash functions, but reviewing three different distributions (options) of the hash functions in Sets:

Combination 1 (Set 1 - SHA-256; Set 2 - SHA3-256; Set 3 - SHA-512; Set 4 - SHA3-512) - four different hash functions

Combination 2 (Set 1 - SHA3-256; Set 2 - SHA-256; Set 3 - SHA3-512; Set 4 - SHA-512) - four different hash functions

Combination 3 (Set 1 - SHA3-256; Set 2 - SHA-256; Set 3 - SHA3-256; Set 4 - SHA-256) - two different hash functions

The Sets are numbered from the leaves to the root – the lower, the number – further down in the tree.

The author of this research takes the bitcoin’s hashes computation with the “double SHA-256” function as a baseline. The focus of the exploration is around the hash function and the way of Merkle-root hash value computation from the binary tree. From one side, different hash functions will be considered as possible usage. And from another, the processes of calculation of Merkle-root will be investigated. Together with the already mentioned four hash algorithms, another twelve hash algorithms are included in the research. Also, there are reviewed (in addition to the four Sets) three other grouping options for Merkle-root hash value computation – dividing Merkle-tree into two Sets, dividing it into eight Sets, and finally – dividing it into sixteen Sets.

The following sections follows: section 2 - Standard Hash Algorithms describes very briefly the used hash algorithms and gives basic parameters, and those functions are used in the experimental environment – for average values computation and for the computation times comparison with the double SHA-256 function; section 3 - Proposed Idea describes the grouping, the hash algorithms distribution into Sets, and the computation of all needed hash calculations in the different Sets, and in total; section 4 - Experimental Environment lists the used for the tests virtual machines, the used programming language and the way average values are generated; in section 5 – Results, are given the results per cloud infrastructure vendors, a comparison between them, and also – the overall results for the proposed Sets, finally is present a comparison with the double SHA-256 function to demonstrate the suggested computation improvement (the speedup); follows section 6 - Conclusion, in which the results are compared to some statistics from ECB and from Statista; follows sections Future work, Acknowledgement and References.

II. STANDARD HASH ALGORITHMS

For the computation of two attributes in the blockchain block’s header containing hash values are used two hash functions – one for the computation of the hash value from the previous block (it is the same for all blocks in the chain), and the second one – for the computation of Merkle-root hash value:

- hash function HBH() for computation of hash value from a block header
- hash function HT() for computation of hash value from transaction TXN

The two hash functions may be the same, but they may also be different. In the bitcoin network, these two functions are the same. A cryptographic algorithm SHA-256, applied twice, is known as “double SHA-256”. The functions are presented in (1) and in (2).

$$H_{BH}(Block) = SHA256(SHA256(Block)) \quad (1)$$

$$H_T(T_{XN}) = SHA256(SHA(256(T_{XN})) \quad (2)$$

The hash function $H_T(T_{XN})$ must be used for all layers

from the first one up to the root of the binary tree to compute the Merkle-root hash value for a specific block.

Table 1 contains sixteen hash algorithms, together with their digest sizes. These hash functions are used in the different Sets for Merkle-root hash computation in this research.

TABLE I. HASH ALGORITHMS WITH DIGEST SIZES

#	Hash Algorithm	Digest Size, [bits]	Digest Size, [bytes]
1	SHA-256	256	32
2	SHA-512	512	64
3	SHA-224	224	28
4	SHA-384	238	48
5	SHA-512/224	224	28
6	SHA-512/256	256	32
7	SHA3-256	256	32
8	SHA3-512	512	64
9	SHA3-224	224	28
10	SHA3-384	238	48
11	SHAKE128	512	64
12	SHAKE256	512	64
13	BLAKE2s-224	224	28
14	BLAKE2s-256	256	32
15	BLAKE2b-384	384	48
16	BLAKE2b-512	512	64

The two hash algorithms SHAKE128 and SHAKE256 are used with generated output of 64 bytes.

A. Optimizing the Merkle tree computation

There is a possibility of splitting a Merkle tree into Sets in a direction from the leaves to the root. This would serve as a modified algorithm for faster (and more secure) computation of the Merkle-root hash value. The transactions that are contained within the block are added into a binary tree, i.e. the Merkle tree. It is a binary tree whose leaves are the transactions, and the levels above them up to the top represent the hash values of participating from the previous level. Two transactions or two hash values from the lower layer generate one new hash value.

The idea for security improvement is based on using a few different hash algorithms instead of just one (for example, in the bitcoin network, only a double SHA-256 hash is used). The previous two research papers used only four hash algorithms, and those are SHA-256, SHA3-256, SHA-512, and SHA3-512. These functions can be combined in different ways in Sets. One such possible grouping is the following: at the lowest possible level, where are calculated the hashes from participating transactions can be used SHA-256 algorithm, in the next level – SHA3-256 algorithm, in the third level – SHA-512 and then at level four – all hash calculations can be done with SHA3-512 algorithm. If the fastest time for Merkle-root hash is considered, then the optimal way of grouping is the following:

Set 4 – to be used a hash function slower than the one in Set 3

Set 3 – to be used a hash function slower than the one in Set 2

Set 2 – to be used a hash function slower than the one in Set 1

Set 1 – this is the level with the most hash computations (from all the participating transactions) – to be used the fastest possible hash function

This review is focused on the review of the existing techniques for Merkle tree computation with two Sets, eight Sets, and sixteen Sets. The computation time is increased for one transaction. Still, in certain types of blockchain implementations, the number of transactions per block is enormous, as example: the bitcoin network - block is formed every 10 minutes. The indexed SHA names (SHA1, SHA2, ..., SHA16) show the usage of hash functions, which can vary or may even be alike.

B. Hash function usage

Table I lists the sixteen hash functions which have found their place within this review. The hash functions go into four selection groups for hashes selection in the Sets. The SHA3 functions in Selection #1, SHA2 functions in Selection #2, the BLAKE functions in another selection group - Selection #4, and the remaining four hash functions in the last selection group – Selection #3. This selection grouping is only needed as a starting point to ease the hashes selections:

Selection #1 (SHA3-224, SHA3-256, SHA3-384, SHA3-512)

Selection #2 (SHA-224, SHA-256, SHA-384, SHA-512)

Selection #3 (SHAKE-128, SHAKE-256, SHA512-224, SHA512-256)

Selection #4 (BLAKE2s-224, BLAKE2s-256, BLAKE2b-384, BLAKE2b-512)

There were defined 4 combinations, based on these selections of hash-functions, by the following criteria:

Combination 0 - Standard double SHA-256 – for each of the three infrastructure providers is used the double SHA-256 function in all Sets

Combination 1 - The slowest hash function from each selection:

For the 2 Sets- there are considered Selection #4 and Selection #1;

For the 8 Sets- the slowest hash function from each selection – this is repeated from the bottom to the top – twice

For the 16 Sets- the slowest hash algorithm from each selection – this is repeated from the bottom to the top – four times

Combination 2 - The fastest hash functions from each selection:

For the 2 Sets- there are considered Selection #4 and Selection #1;

For the 8 Sets- the fastest two hash functions from each selection – the fastest two hash functions from selection #4 are used for the leaves and for the next level; the fastest two hash functions from selection #3 for level three and four and so on.

For the 16 Sets- the fastest hash function from each selection – this is repeated from the bottom to the top – four times

Combination 3 - The fastest hash function (bottom-up) for every Cloud Provider, regardless of the selections

For two Sets, the selection of hash functions, according to the above explanation, is present in Table II (Combination 1):

TABLE II. TWO SETS, COMBINATION 1

Set #	Amazon	Microsoft	Google
Set 2	SHA-512	SHA-512	SHA-512
Set 1	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512

For two Sets, the selection of hash functions, according to the above explanation, is present in Table III (Combination 2):

TABLE III. TWO SETS, COMBINATION 2

Set #	Amazon	Microsoft	Google
Set 2	SHA3-224	SHA3-256	SHA3-224
Set 1	BLAKE2s-256	BLAKE2s-224	BLAKE2s-224

For four Sets, the selection of hash functions, according to the above explanation, is present in Table IV (Combination 1):

TABLE IV. FOUR SETS, COMBINATION 1

Set #	Amazon	Microsoft	Google
Set 4	SHA3-512	SHA-512	SHA-512
Set 3	SHA-512	SHA3-512	SHA3-512
Set 2	SHAKE-256	SHAKE-128	SHAKE-128
Set 1	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512

For four Sets, the selection of hash functions, according to the above explanation, is present in Table V (Combination 2):

TABLE V. FOUR SETS, COMBINATION 2

Set #	Amazon	Microsoft	Google
Set 4	SHA3-224	SHA3-256	SHA3-224
Set 3	SHA-384	SHA-224	SHA-224
Set 2	SHAKE-256	SHA512-256	SHA512-256
Set 1	BLAKE2s-256	BLAKE2s-224	BLAKE2s-224

For eight Sets, the selection of hash functions, according to the above explanation, is present in Table VI (Combination 1):

TABLE VI. EIGHT SETS, COMBINATION 1

Set #	Amazon	Microsoft	Google
Set 8	SHA-512	SHA-512	SHA-512
Set 7	SHA3-512	SHA3-512	SHA3-512
Set 6	SHAKE-256	SHAKE-128	SHAKE-128
Set 5	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512
Set 4	SHA-512	SHA-512	SHA-512
Set 3	SHA3-512	SHA3-512	SHA3-512
Set 2	SHAKE-256	SHAKE-128	SHAKE-128
Set 1	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512

For eight Sets, the selection of hash functions, according to the above explanation, is present in Table VII (Combination 2):

TABLE VII. EIGHT SETS, COMBINATION 2

Set #	Amazon	Microsoft	Google
Set 8	SHA3-224	SHA3-224	SHA3-256
Set 7	SHA3-384	SHA3-256	SHA3-224
Set 6	SHA-224	SHA-256	SHA-384
Set 5	SHA-384	SHA-224	SHA-224
Set 4	SHA512-224	SHA512-224	SHA512-224
Set 3	SHA512-256	SHA512-256	SHA512-256
Set 2	BLAKE2s-224	BLAKE2s-256	BLAKE2s-256
Set 1	BLAKE2s-256	BLAKE2s-224	BLAKE2s-224

For eight Sets, the selection of hash functions, according to the above explanation, is present in Table VIII (Combination 3):

TABLE VIII. EIGHT SETS, COMBINATION 3

Set #	Amazon	Microsoft	Google
Set 8	SHA-224	SHA-256	SHA3-384
Set 7	SHA-384	SHA-224	SHA-224
Set 6	SHA512-224	SHA512-224	SHA512-224
Set 5	SHA512-256	SHA512-256	SHA512-256
Set 4	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512
Set 3	BLAKE2b-512	BLAKE2b-384	BLAKE2b-384
Set 2	BLAKE2s-224	BLAKE2s-256	BLAKE2s-256
Set 1	BLAKE2s-256	BLAKE2s-224	BLAKE2s-224

For sixteen Sets, the selection of hash functions, according to the above explanation, is present in Table IX (Combination 1):

TABLE IX. SIXTEEN SETS, COMBINATION 1

Set #	Amazon	Microsoft	Google
Set 16	SHA-512	SHA-512	SHA-512
Set 15	SHA3-512	SHA3-512	SHA3-512
Set 14	SHAKE-256	SHAKE-128	SHAKE-128
Set 13	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512
Set 12	SHA-512	SHA-512	SHA-512
Set 11	SHA3-512	SHA3-512	SHA3-512
Set 10	SHAKE-256	SHAKE-128	SHAKE-128
Set 9	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512
Set 8	SHA-512	SHA-512	SHA-512
Set 7	SHA3-512	SHA3-512	SHA3-512
Set 6	SHAKE-256	SHAKE-128	SHAKE-128
Set 5	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512
Set 4	SHA-512	SHA-512	SHA-512
Set 3	SHA3-512	SHA3-512	SHA3-512
Set 2	SHAKE-256	SHAKE-128	SHAKE-128
Set 1	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512

For sixteen sets, the selection of hash functions, according to the above explanation, is present in Table X (Combination 2):

TABLE X. SIXTEEN SETS, COMBINATION 2

Set #	Amazon	Microsoft	Google
Set 16	SHA512-224	SHA3-256	SHA3-224
Set 15	BLAKE2s-256	SHA-224	SHA-224
Set 14	SHA3-224	SHA512-256	SHA512-256
Set 13	SHA-384	BLAKE2s-224	BLAKE2s-224
Set 12	SHA512-224	SHA3-256	SHA3-224
Set 11	BLAKE2s-256	SHA-224	SHA-224
Set 10	SHA3-224	SHA512-256	SHA512-256
Set 9	SHA-384	BLAKE2s-224	BLAKE2s-224
Set 8	SHA512-224	SHA3-256	SHA3-224
Set 7	BLAKE2s-256	SHA-224	SHA-224
Set 6	SHA3-224	SHA512-256	SHA512-256
Set 5	SHA-384	BLAKE2s-224	BLAKE2s-224
Set 4	SHA512-224	SHA3-256	SHA3-224
Set 3	BLAKE2s-256	SHA-224	SHA-224
Set 2	SHA3-224	SHA512-256	SHA512-256
Set 1	SHA-384	BLAKE2s-224	BLAKE2s-224

For sixteen Sets, the selection of hash functions, according to the above explanation, is present in Table XI (Combination 3):

TABLE XI. SIXTEEN SETS, COMBINATION 3

Set #	Amazon	Microsoft	Google
Set 16	SHA3-512	SHA3-512	SHA3-512
Set 15	SHA-512	SHA-512	SHA-512
Set 14	SHAKE-256	SHAKE-128	SHAKE-128
Set 13	SHAKE-128	SHAKE-256	SHAKE-256
Set 12	SHA3-256	SHA3-384	SHA3-384
Set 11	SHA3-384	SHA3-224	SHA3-256
Set 10	SHA3-224	SHA3-256	SHA3-224
Set 9	SHA-256	SHA-384	SHA-256
Set 8	SHA-224	SHA-256	SHA-384
Set 7	SHA-384	SHA-224	SHA-224
Set 6	SHA512-224	SHA512-224	SHA512-224
Set 5	SHA512-256	SHA512-256	SHA512-256
Set 4	BLAKE2b-384	BLAKE2b-512	BLAKE2b-512
Set 3	BLAKE2b-512	BLAKE2b-384	BLAKE2b-384
Set 2	BLAKE2s-224	BLAKE2s-256	BLAKE2s-256
Set 1	BLAKE2s-256	BLAKE2s-224	BLAKE2s-224

III. EXPERIMENTAL SETUP

For this review, a dedicated infrastructure, similar to the described in [13] has been deployed in the environment of the three biggest cloud providers – Microsoft Azure, Amazon Web Services (AWS) and Google Cloud Platform (GCP). It is a feature of every IaaS provider to provide fast access to various types of hypervisors and guest machines (virtual machines -VMs) – with different amounts of CPUs, memory, disk, network throughput, etc. There were used 20 VMs in the AWS environment, 19 VMs in Azure, and 17 VMs in GCP. The selection of the different hosts is based on the standard VM types with general purpose and compute purpose (according to the vendors’ descriptions for each VM). The number of CPUs varies between 1 and 8. The memory varies between 1GB and 16GB (for one of the used VM types, the memory was 64GB).

IV. RESULTS

The average time (from all three cloud infrastructures) for double SHA-256 hash function computation is 1815.94 ns. Easily can be calculated the average needed time, having all those hash function distributions in the different sets. All measured times for computations are used to generate average values per cloud infrastructure vendor and, finally, the overall average times.

Calculations were made for 100K transactions (a binary tree with 100K leaves) using the overall average times from the measurements to evaluate the proposed solution. Table XII contains the average percentage increase/decrease of the total time for computation of Merkle-root, in comparison to the classical way (double SHA-256 function for the whole Merkle-tree):

TABLE XII. COMPARISON BETWEEN CLASSICAL AND PROPOSED SOLUTION

Hashes arrangements	AVG, %
Two Sets, Combination 1	-6.72
Two Sets, Combination 2	9.81
Four Sets, Combination 1	-6.99
Four Sets, Combination 2	15.65
Eight Sets, Combination 1	-7.81
Eight Sets, Combination 2	25.37
Eight Sets, Combination 3	27.77
Sixteen Sets, Combination 1	-7.81
Sixteen Sets, Combination 2	13.52
Sixteen Sets, Combination 3	27.67

The negative values show that the relevant set with the selected hash functions is slower than the classical way of computation. Nevertheless, there are improvements with all the sets. For two sets (combination 1) gives a 9.81% computation speed increase. For four sets (combination 2) provides a 15.65% speed increase. For eight sets (combination 2) gives 25.37% and combination 3 – 27.77% increase. The results with sixteen sets are similar – for combination 2, the speed increase is 13.52%, and for combination 3, the computation speed increase is 27.67%.

V. CONCLUSION

Areas with intensive records (transactions) generation like cryptocurrencies, the financial industry, health care, and many more can benefit from the proposed solution. Authors in [9] are offering an approach for classifying the potential category of medical poisoning from patient medical records in National Language Processing (NLP), which can be applied to the data (tens of millions of records) from the World Health Organization (WHO). The Health sector is just another niche, an example, which can benefit from faster block generation, utilizing the proposed solution with blockchain networks.

According to the payment statistics for 2020 by European Central Bank (ECB) [7], the number of processed transactions by retail payment systems is around 46B for the whole 2020 year. Suppose those transactions are currently registered in a blockchain with the proposed solution. In that case, the mount of transactions that could be recorded for the same time will be between 50.51B (two sets, combination 2) and 58.73B (eight sets, combination 3).

The proposed solution improves the needed time to compute the Merkle-root hash value. It also enhances the overall blockchain security because of using different hash

algorithms – between two and sixteen.

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Using Open Source Systems for Security Monitoring and Prevention

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Abstract—In recent years, thanks to the massive increase in the number of computer literate people and the realization of the benefits of open source programs, systems and tools, more and more being created the are free and in no way inferior to commercial ones, with huge communities that support and update them. This allows more and more companies to succeed in finding solutions to numerous problems in adapting to the digital world and regarding their competitiveness.

This document shows the way of installing, configuring and deploy open source softwares which are used in security purposes.

Keywords—software, security, testing, cyberattacks, ethical hacking

I. INTRODUCTION

With the increasing popularity of cybercrime, the need for better and safer protection against hackers is becoming greater as well. The Intrusion Prevention System (IPS) is one of the best ways to protect your system and infrastructure against computer attacks.

II. SURICATA

A. What is Suricata?

Suricata is Intrusion detection system (IDS) and Intrusion Prevention System (IPS). It was developed by the Open Information Security Foundation - OISF. Suricata is a free and open source application that can be installed on Windows, Mac and Linux operating system. The beta version was released in late 2009 and the first standard version in July 2010 [1].

The application is not requiring a lot of resources for the installation and proper in a functioning. It gives you a great insight into what is happening in your network from a security perspective. Also, Suricata can use several cores at the same time so this gives us the opportunity to process more data without having to apply a larger number of rules. Depending on what is our purpose and plan of using this tool and what KIND OF A server is being used, it depends on how much CPU and RAM you will need. Usually you need between 4-8 RAM and at least 2 cores for a production environment [2].

B. Installation and configuration of Suricata

The installation of Suricata starts like any other installation of a software with the command below, so already installed packages in our virtual machine can be updated.

```
sudo apt update (1)
```

With the next command, we add the PPA repository maintained by the Open Information Security Foundation (OISF). When it is added, we will get the latest and stable version of Suricata.

```
sudo add-apt-repository ppa:oisf/suricata-stable (2)
```

In order to install Suricata, we use the command below.

```
sudo apt-get update && sudo apt-get install suricata -y (3)
```

Once the installation is finished, we can check the status of the instrument using the next command.

```
sudo systemctl status suricata (4)
```

After the application is installed, we should make the basic changes to its configuration. The configuration file named *suricata.yaml* is located in the */etc/suricata* directory. This configuration file has many different settings depending of its purpose of using.

Note that there are several default settings in the configuration file that you need to change before using Suricata. It is mandatory to set HOME_NET. There we add the IP address where the application is located. In our case, the address is 192.168.20.55/24.

After the basic configuration, the next step is to update the rules that the tool will use to monitor the traffic. By default, the Suricata package has a limited ruleset that detects only the most common Internet protocols found in the */etc/suricata/rules* directory.

Suricata has a tool called *suricata-update* that will help you download more rulesets from third-party providers. This command writes new rules in the following directory: */var/lib/suricata/rules/*.

In order to list all third-party providers and to list all sources, use the command below.

```
sudo suricata-update list-sources (5)
```

Once you choose ruleset, it can be installed with the following command. In this case, we will install ruleset named *malsilo/win-malware*.

```
sudo suricata-update enable-source malsilo/win-malware (6)
```

In order to load the new ruleset, perform again *suricata-update*.

Finally, when we're done configuring and installing the ruleset, we need to validate the changes and make sure everything is working as expected. The Suricata package has a built-in validation service that allows us to see any deviations found in the new configuration. To perform the validation, we write the following command:

```
sudo suricata -T -c /etc/suricata/suricata.yaml -v (7)
```

To check if the configured rules are working as expected we will do the following test:

```
curl http://testmynids.org/uid/index.html (8)
```

And, finally, we can check the monitored traffic at *fast.log*.

```
sudo cat /var/log/suricata/fast.log (9)
```

The result of this command is given below.

```
root@Ubuntu:~# sudo cat /var/log/suricata/fast.log
```

```
09/06/2022-11:32:20.735532  [**] [1:2013028:7] ET
POLICY curl User-Agent Outbound [**] [Classification:
Attempted Information Leak] [Priority: 2] {TCP}
192.168.20.55:40186 -> 18.66.192.128:80
```

```
09/06/2022-11:32:20.767607  [**] [1:2100498:7] GPL
ATTACK_RESPONSE id check returned root [**]
[Classification: Potentially Bad Traffic] [Priority: 2] {TCP}
18.66.192.128:80 -> 192.168.20.55:40186
```

```
09/06/2022-12:23:42.608637  [**] [1:2013028:7] ET
POLICY curl User-Agent Outbound [**] [Classification:
Attempted Information Leak] [Priority: 2] {TCP}
192.168.20.55:47830 -> 172.67.133.228:80
```

Simulation:

After installation following the official documentation steps and that of Proxmox, a simulation -SYN scan for open ports from the local machine to the remote Proxmox server was done (Fig. 1):

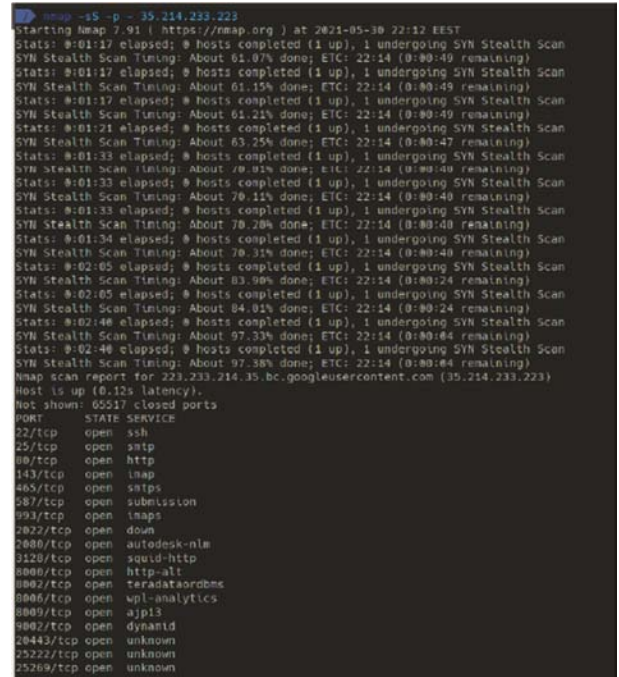


Fig. 1. And the successfully detected Suricata scan



Fig. 2. Successfully detected scan by Suricata

Because the internal communication between Caddy and the WordPress installation is not encrypted, in the investigated network, Suricata immediately catches this vulnerability, and provides options to trace the entire flow.



Fig. 3. Information from Suricata about detected vulnerability

After that, dashboards were imported with various ready-made metrics for any of the technologies that were used, such as (Fig. 7, 8, 9):

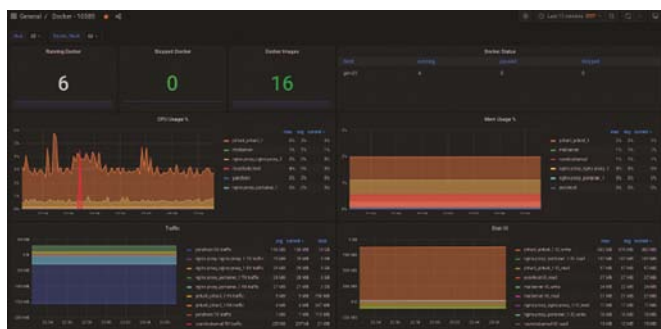


Fig. 7. Dashboards with various ready-made metrics



Fig. 8. Dashboards with a second type of prepared metrics



Fig. 9. Dashboards with a third type of prepared metrics

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Classification of Server Network Traffic for DDoS Attacks Using MapReduce

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Abstract—With the widespread Internet consumption leading to more intensive usage of the web, it also brought continuously increasing demand for servers and made them valuable targets for attackers, who use various methods to attack said servers. One of the most common methods is Distributed Denial-of-Service (DDoS) which attempts to flood online services with fake traffic in an attempt to block the server from serving. Huge amounts of data need to be processed to determine if the incoming traffic is made of legitimate requests or an attack. One of the methods that can be used for this purpose is Map-Reduce, a method that is useful for the computation of distributed batch jobs. In this study, traffic coming to FTP, SFTP, HTTP, HTTPS, and SQL ports has been collected and classified using MapReduce to determine whether a DDoS attack is taking place. As a result of this study, data of incoming packet traffic to the server from specific IPs have been obtained and then classified using the MapReduce method. For the study, incoming traffic of the ports mentioned above was collected over periods of 30 seconds. According to the results, the average packet count was 155.975, and the average packet size was 47500.65 bytes, while the average Mapping time was 1.17665 milliseconds and the average Reduce time was 0.01055 milliseconds. Future studies will be on feeding the results of this study to artificial intelligence algorithms in order to determine whether the traffic to the server is a DDoS attack or legitimate traffic.

Keywords—*mapreduce, ddos attack, network sniffing, pipelining*

I. INTRODUCTION

In today's world the Internet is being used more and more with each passing day, and the traffic flowing through the internet has grown proportionally. Determining and classifying whether the traffic data is legitimate data or data resulting from malicious attacks to disrupt services is crucial to keep the services up and running. The complexity of network management and the cost of mutual communication between servers require the classification to be done as quickly and error-free as possible. The confidentiality, integrity, and availability model, also known as the AIC triad, was designed to regulate the policies of information security. And measures exist when there are threats [1]. The most important threat is Distributed Denial-of-Service (DDoS) attacks, which cause host and network resources to be wasted

and the services using those resources to be disrupted [2]. Numerous studies have shown that DDoS attacks have a periodic character of their own [3]. Determining whether traffic is regular traffic or a DDoS attack can be done in the light of this periodic character information analysis. For that, one of the important techniques used is the frequency-domain analysis [4]. On the other hand, more and more DDoS attacks are being launched each year as the possible target count increase proportionally with the user count. For example, in the year 2020 AWS, a cloud service provider, mitigated a 2.3 Tbps DDoS attack [5].

Some of the studies done on detecting DDoS attacks are shown in Table I.

TABLE I. A SUMMARY OF RELATED WORK

Research work	Model used	Details
[6], 2012	Fuzzy estimators	A method that can operate near-real-time and detect DDoS attacks on ordinary computers with an accuracy of more than 80%, using the fuzzy estimator and the arrival time information between packets, is proposed. By adding packet-specific information, protocol information, etc. of the packets, the estimator can be developed to allow more sophisticated detections to be performed. The method is not suitable for parallel programming.
[7], 2016	Artificial Neural Networks	Using Artificial Neural Networks, a method that performs DDoS attacks in TCP, UDP, and ICMP protocols by separating the characteristic patterns in real traffic from the pattern in the attack is proposed. The method can detect DDoS attacks with 98% accuracy and 96% sensitivity. As long as there is data flow, the success rate increases as the ANN continues to learn. However, in the case of an encrypted packet header, it cannot detect the attack.
[8], 2017	FPGA	An application has been developed that can detect DDoS attacks in less than 1 ms on the FPGA. The method has a detection rate of more than 99%. Since it is implemented directly on the hardware, it works faster than software-based attack detection systems.
[9], 2020	Mahalanobis distance and Kernel-based learning algorithm	A method is proposed that can detect DDoS with 99.55% accuracy and 95.24% sensitivity by measuring the Mahalanobis distance of the elements on the dictionary in every T time, assuming there is no pattern for network traffic or DDoS using a kernel-based learning algorithm using the entropy features. The method has

Research work	Model used	Details
		difficulties in detecting different types of DDoS attacks and detecting simultaneous high-volume traffic.
[10], 2021	Fourier transform	FFT and entropy-based DDoS detection method [FEDDM] method, which they developed with the help of a Neural network trained using Fast Fourier Transform (FFT) coefficient and entropy, is proposed. The proposed method can detect with 99.99% accuracy. Since UDP and UDP-Lag packet headers are similar to each other, it is difficult to detect attacks in these protocols.
[11], 2022	IQR-based approach	An IQR-based approach, which is a statistics-based method, has been proposed. The method can detect with up to 95% accuracy by processing up to 300 packets/second packets.
[12], 2022	Minimum Redundancy Maximum Relevance (MRMR)	A method is proposed that extracts special features using the MRMR feature selection algorithm and Bayesian hyperparameter optimization support DT classifier and trains a machine learning algorithm to classify. It detects attacks on Software-Defined Vehicular Ad Hoc Networks (SD-VANETs) in 0.0984 seconds with 99.35% accuracy.
[13], 2023	GRU-BWFA classifier	A method using the Gated Recurrent Unit Neural Network based on Bidirectional Weighted Feature Averaging (GRU-BWFA) classifier is proposed on the data obtained by selecting the optimal feature with the Enhanced Salp Swarm Optimization technique. It can detect attacks with 99.36% accuracy and 99% sensitivity. The training and test processes of the algorithm used for classification and prediction take a long time.

In this study, the MapReduce programming model, as a part of the preprocessing step, is used to classify network traffic packet data to prepare it for the analysis to detect any DDoS attacks. MapReduce is divided into the Map and the Reduce steps [14], [15]. During the Map step, the data to be processed is divided and distributed to the worker nodes [16]. During the Reduce step, the data returned from the worker nodes are consolidated, then the data set is analyzed in detail.

In its origins, the main concern of the MapReduce process is not throughput but scalability and fault tolerance. The data set is optimized and the basic operation that needs to be done on the data is done simultaneously on all sub-nodes, allowing for great performance achievements [17].

A MapReduce process usually consists of the example shown in Fig. 1, explained below.

Map: Mapping is the process of filtering and sorting data into sequential groups to make the Reduce process and further processing easier and more convenient. The full data to be mapped is loaded, split and the data of interest are copied to another place. In mapping, each worker runs the same mapping function on the data to be processed, then the output data is written to the distributed file system. The master node coordinates the mapping process, ensures it is done without any errors, and keeps a copy of the whole data [14]–[18].

1) **Reduce:** Reducing is the process of summing sequential data into single results to get a summary. Sequential data is grouped, and all data values are summed, then copied to another place. In this step, the workers group the output data as key-value pairs [14]–[18].

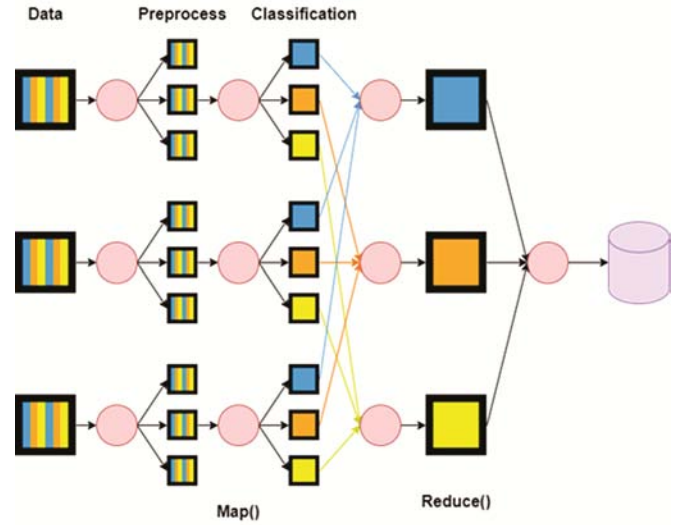


Fig. 1. Phases of MapReduce process

To perform the process mentioned above in Fig. 1, the MapReduce operation was applied to the data set consisting of Time, Source IP, Destination IP, Protocol, and Length information after the splitting process. With the Map function data has been divided into smaller portions. The divided data has been sent to the Reduce function after sorting, and the Reducing process has converted the divided & sorted data into key-value pairs. Lastly, the output of the Reduce function consisting of map time, reduce time, packet count, total packet size, and IP-information statistics was classified.

II. METHOD

In this study a method was developed to detect the source and the intensity of the traffic on a server. The method works as is shown in Fig. 2.

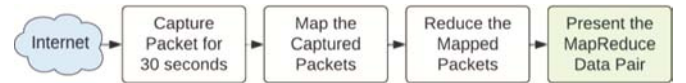


Fig. 2. Steps of method

A packet library called Scapy [19] was used to acquire data to be used for this study. Scapy is a packet manipulation library that allows for actions like listening to filtered network traffic, creating network traffic, scanning, probing, etc. Nodes in computer networks communicate over layered architectures. The most widely used architecture is the Open Systems Interconnection (OSI) Model. The OSI Model is a model used to describe the seven layers, compared to the much more abstracted TCP/IP (with 4 layers). In this study, we have looked into the 3rd (Network), 4th (Transport), and the 7th (Application) layers of the OSI Model, for packet data, the port number used, and the protocol, respectively.

The MapReduce method is used to classify the raw packet data collected with the Scapy library. The data is classified by applying the method. In our study, we also add the map and reduce the methods' duration for each data snippet to the data. The overall pseudo-code is shown in Algorithm 1.

Algorithm 1. Pseudo-code for developed method

```

while True do
  start capturing process
  capture packets
  terminate the capturing process
  map the process's output data
  reduce the mapping of the output data
  write data to the output file
end while

```

In the proposed method all TCP ports are listened at regular intervals. While listening, all the packets with the protocols HTTP, HTTPS, FTP, and FTPS are captured.

The method is designed in accordance with the pipeline architecture. A pipeline architecture is a processing architecture designed with a specific idea in mind: Instead of having one single monolith process, the monolith process is broken down into small and simple pieces, called microprocesses (or microfunctions in programming), and the data in process transfers between them in order, allowing for data to be sent sequentially, which in turn eliminates waiting, and brings speed & efficiency onto the table. How a fast-food restaurant processes customer orders is a great example of what a pipeline is [20].

This allows for flexibility in the individual processing of data without having to go through the full process while sacrificing nothing from the workflow. The packet-capturing function runs on another process and is terminated after a designated delay. Then, the data is processed by the Map and Reduce functions into the IP - [packetsize, packetcount] pair format. Map time, Reduce time, packet count, total packet size, and IP-data pairs are then written to a .csv file to be analyzed further for DDoS attack detection.

III. RESULTS

The application that was developed in the scope of this study was tested on a computer with the following specifications: Intel Core i7-10750H CPU @ 2.60GHz, 16 GB of RAM. The method was run for packets with HTTP, HTTPS, FTP, and FTPs protocols. The test results are shown in Table II.

TABLE II. TEST RESULTS

Protocol	HTTP / HTTPS	FTP / FTPs
Avg. Packet Count	157.2	154.75
Avg. Packet Size in 30 sec.	81567.8	13433.5
Avg. Map Time (ms)	0.6949	1.6584
Avg. Reduce Time (ms)	0.0086	0.0125
Total MapReduce Time (ms)	0.7035	1.6709

The test results for the HTTP and the HTTPS protocols show that the average packet size in 30 seconds is 81567.8 bytes, the average packet count is 157.2 packets, the average Map time is 0.6949 milliseconds, the average Reduce time is 0.0086 milliseconds and the total MapReduce time is 0.7035 milliseconds.

The test results for the FTP and the FTPs protocols show that the average packet size in 30 seconds is 13433.5 bytes, the average packet count is 154.75 packets, the average Map time is 1.6584 milliseconds, the average Reduce time is 0.0125 milliseconds and the total MapReduce time is 1.6709 milliseconds.

According to the results of the study, this method was found to be more performant compared to the existing studies [11-13] in the literature.

IV. CONCLUSIONS

Determining whether the intense traffic that the servers handle is legitimate activity is crucial to ensure users receive better quality service. One of the primary reasons for service disruption for servers is DDoS attacks. In this context, the MapReduce method is used to classify the incoming packet data into data of density and source IPs, to the port for the network communication of the application served by the server to detect whether the network traffic is a DDoS attack or not. In the application developed for this study, the HTTP/HTTPS and FTP/FTP's ports were listened to for 30 seconds periodically. The data was MapReduce'd when each period was over. According to the results; the average packet size is 47500.65 bytes, the average packet count is 155.975 packets, the average Map time is 1.17665 milliseconds, the average Reduce time is 0.01055 milliseconds and the average total MapReduce time is 1.1872 milliseconds.

As busy network traffic was not able to be gathered in this study, the listening periods were set to be 30 seconds long each to have more data to classify. In real-world environments where the traffic would be more intense, the listening period intervals would probably be shorter and even down to a few seconds, or else the attack might not be detected and the service might be disrupted. Even though, it is believed that the data intensity would not increase too much and the results would be similar overall. How the classification process can be done without increasing the server's current load means that the service quality will not be affected, and the system resources & runtime will be scalable in future studies.

In addition to the positive aspects mentioned above, the fact that it does not require any additional hardware unlike the method developed in [8], and is a completely software-based solution will make the development and application of the method easier. One of the most important reasons for using MapReduce in this study is that it is suitable for parallel programming. Using MapReduce, we were able to overcome the parallel computation problem seen in [6]. In this way, it can provide higher performance under higher traffic than studies [11-13]. However, since only HTTP, HTTPS, FTP, and FTPs ports have listened in this study, tests for other protocols were not performed. For this reason, it is thought that there may be problems in detecting attacks to other ports and under simultaneous genuine but high-volume traffic.

The data classified by MapReducing will be used as input data for our next study which is about developing an artificial intelligence method to determine whether the incoming traffic is a DDoS attack or legitimate traffic.

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Characteristics of Modern Techniques for Cybersecurity Assurance in Education Infrastructure

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Abstract—This paper presents an overview of contemporary techniques used for protecting infrastructure and data for institutions within Higher Education. We present tools and techniques for deployment as well as the sets of necessary measures that need to be taken for protecting the privacy and data in order to raise cybersecurity awareness in technical professionals. Components are described for building a threat detection framework for protection of academic assets to cope with the protection of personal data and digital assets in the academic sphere. It is crucial to build proper protection for digital intellectual property and personal data which are prone to numerous types of attacks and threats. The components described can be incorporated in a system allowing rapid deployment, contains self monitoring and can be applied to other industries.

Keywords—cybersecurity, intrusion detection, intrusion prevention, artificial intelligence, education

I. INTRODUCTION

It is well known that the DevOps methodology is suitable for ensuring that continuous integration and continuous deployment are flowing uninterrupted within the software development life-cycle. This methodology, although it is taught in government funded organization, is not widely adopted for the management of the infrastructure and assets. Thus, many Bulgarian academic organizations seem to be dependant on the ‘shadow IT’ mode of operation to this day. Our aim is to show that the threats are extremely common and protection is necessary. Following the unfortunate attack reportedly conducted by a hacking group, funded by an eastern country, which managed to completely disable the Government service of Bulgarian Post in the beginning of 2022, efficient data protection and restoring strategies as well as evaluating cybersecurity risks have been growing in significance.

Smartphones, tablets and smartwatches have become some of the most used devices in everyone’s personal and professional lives. The mobile apps we install on them help us become more productive, communicate and share with others, exercise, learn and have fun. However, it is important to remember to use them in a safe and responsible way.

In recent years, cybercriminals have directed their skills to create and distribute dangerous applications that appear

trustworthy at first glance. With their help, they can gain complete control over your device and data [1].

In this study, the issue that is addressed is cybersecurity incidents within the public sector. The authors [3] describe that the focus in terms of cybersecurity issues is directed on building various the incident response. In addition, they also point out that the aspect of incident prevention is lagging behind and stress the. Furthermore, the authors argue that previous research has shown that organizations do not utilize the knowledge gained from dealing with knowledge from incidents that already occurred and thus indicate that there is a significant flaw in the mechanism for collaboration and communication used by the security teams and higher management. According to the authors [2], with proper preparation of the organization for handling of various types of cybersecurity incidents, in the more likely event of a cybersecurity incident, it will be able to recover its systems quickly while minimizing the impact and instilling confidence in customers, employees and citizens. Furthermore, it is known that with the improved preparation of organizations cybersecurity incidents, it may be possible that prevention can be implemented. The phase of preparation is critical but easily overlooked likely because of lack of competent technical support, business awareness or financial or technical resources. The authors further provide argument that in order for an organization to be considered prepared properly in terms of cybersecurity:

[...] it must be able st any time to perform assessment of the criticality of its key assets; analyze the threats that may occur; also put in place a set of additional controls to ensure an appropriate level of cyberprotection. Consider the implications and the multiple facets of the implications for people, processes, technologies, and sensitive information; then one organization should be able to update cybersecurity response capabilities and review security preparedness posture.

In addition, [3] organizations are cautious about sharing information during cybersecurity investments because spending too little can show that the organization is underprepared for attacks, while spending much budget and efforts can indicate that the organization is subject to frequent attacks due to the valuable assets that it holds. In this way, sharing such type of information could potentially damage the

organization's image and affect student, employee and customer confidence in that organization. They also describe that thanks to the different levels of knowledge, expertise, experience and vulnerability of organizations, this affects the degree of prevention of incidents in the field of cybersecurity.

Regarding the public sector, which includes academic institutions, cybersecurity vulnerabilities can have a negative effect on the productivity of all individuals, impact on the organizations, administration and governance structure. Threats emerging range from identity theft, financial fraud and personal abuse, and also to espionage and terrorist activity: these may pose a threat to public safety and even national security. Moreover, today the public sector is characterized by a certain degree of stability. There are multiple weaknesses and potential optimizations have been identified and need to be further explored. Amidst the cyber threat spectrum we find ourselves in today, it is turning critical for public sector leaders to be informed about protection measures, and to implement these measures if they provide added value. Public sector institutions need to take into account the acceptable implementation and improvement of their existing emergency management measures to establish an acceptable level of security, and senior authorities are often required to fulfil their responsibility in terms of handling with cybersecurity with proper internal policies [3].

The author, also argues that in public media and social networks, computer hackers and cybercriminals are often portrayed, while plausible facts suggest that information security incidents are more often caused by the actions of internal employees. Furthermore, the implemented technological solutions may be of great value and have the required features, but if the culture of the education organization wouldn't embrace information security, in this case even the most modern and best technology in the universe won't be able to help. We recognize an additional need for actionable insights into how academic organizations can implement the required protection mechanisms proactively to prevent these incidents from happening. The study, also highlights the significant value for creating sustainable socio-technical networks of knowledge sharing, suggesting that 'soft skills' such as organization culture, company climate, personal goal orientation, etc. influence the success of the prevention mechanisms in cybersecurity. As cybersecurity in the public sector in many publications is regarded as an emerging field, we wish to contribute and complement the field of cybersecurity with insights on incident prevention in one significant part of it: namely education.

The most common attacks that should be: hacking and espionage; DDoS; Hardware wreckage; viruses; botnet; malicious disgruntled users/behaviour detection. There exists a case where employees at a bank receive an email from their HR team offering them personal fuel vouchers, the only requirement to take advantage is to click on a link and sign up. Two thirds of the employees would follow the link from their work computers without spending a slight thought to the possibility that it might be dangerous. And it is just that - a phishing email sent by the bank's IT department to check whether staff can tell the difference between attempts to break into the system. The case is real and shows how real and close

cyber threats are to any organization, whether it's a small company or a large financial institution with thousands of employees [2].

Every private or public organization needs protection, especially in a time of growing threats and increasingly prepared cybercriminals. There are researchers and professionals who are confident they have the answers that their clients are looking for in cybersecurity, thanks to both their highly trained team and world-class know-how. At the heart of the strategy of the company, which in recent years has reached a market-leading position in IT consulting and engineering services with over 400 specialists, is zero tolerance to risk, as well as the use of new technologies

II. CHARACTERISTICS OF CYBERSECURITY ASSURANCE

The potential organizational problems within the academic institutions can be categorized as follows: Insufficient funding, Insufficient training or lack of expertise, Incidents caused by incompetent or disgruntled individuals, and External risks.

There are the following types of attacks on education infrastructure: Malware; Human Error; Insider threats; Zero-day exploits; Misuse of legitimate applications; Fileless/in-memory attacks.

Our research team lists the following main challenges to cybersecurity assurance in academic institutions: Time Commitment; Staff Skills; No internal expertise; Leadership confirmation; Obstacles in-place (different nature); No Data-Driven prioritization of activities; Lack of cyber-tools to effectively perform assessment; Lack of sufficient funding; Consolidating reports/extract valuable insights; Lack of security coverage 24/7; Speed of incident response; Detection and response capabilities; Cost of in-house implementations; Zero-visibility into overall memory attacks; Inability to meet compliance requirements; Lack of visibility over correlation rules and reports.

The occurring cybersecurity incidents have the following impact on the organization: Reduced employee productivity; Disrupted education activities; Disrupted administrative activities; Increased time to deploy IT resources for triaging and remediation of issues; Increased time-to-recover damage; Dissatisfaction of employees/students; Dataloss within the education institution or theft of intellectual property; Regulatory fines.

A. *Characteristics of techniques for cybersecurity protection systems used in higher education*

The following list of aspects has been identified from previously analyzed attacks on academic endpoints:

- Loss of productivity of individual contributors
- System Downtime
- Loss of IT staff productivity
- Reputation and brand damage
- Theft of information or intellectual property
- Increased costs/budget impact

The damage to the IT infrastructure of the education institution can potentially be followed by lawsuits or regulatory actions. There are some techniques on which we would like to raise awareness, such as: usage of integrated solutions, like IDS/IPS with built-in endpoint security components; Backup and Data Protection systems; Compliance management capability; Physical Security and Biometric Access Control; Zero-Trust approach. There will be more details within the next sections of the article [7].

B. Usage of integrated solutions for IDS,IPS and EPS

There exist various options for implementation of such systems, like: Integrated solutions; vendor-provided; open-source. Some of them have available built-in Detection capabilities and allow the IT Staff handle incident response in an efficient way; allow IT Security operations to be handled by IT department with limited capabilities for infrastructure and process management.

The involved activities for the IT personnel are efforts for triaging and investigation of the incidents including root cause analysis.

An academic organization can achieve the implementation of an efficient incident response. For this it would be necessary to perform isolation of the endpoint from the network. Sometimes it is necessary to force stop a process or application that has been identified as threat and quarantine the executable. The engineers may also need to rollback malicious changes and delete threatening apps, files or registry keys. The affected system or individual user's accounts need to be locked and the corresponding credentials or certificates to be revoked. In many occasions reimaging of the endpoint or recovery to a working state is performed.

In this way, the following solution features are required for Efficient handling of incidents: Network connections; File modifications; Registry Changes; Process information; User information; Memory content and structure; Binary file analysis; Event correlation; AI-based integration of data from various cybersecurity tools.

Before the pandemic, most cyber attacks seemed to have a focus on high-risk industries such as healthcare, finance and information technology. With the COVID-19 pandemic there is a shift observed where, almost all companies have switched to a remote working policy, transitioned to e-commerce and moved their day-to-day operations online. In earlier times, security was not considered a priority, especially for smaller education institutions, and for this reason, many of them were not prepared to deal with modern online challenges, which also made them easy targets.

According to our research, the rapid changes have also necessitated a shift in thinking, towards the paradigm of "Zero-Trust strategy". It puts user identity, access and data management at its core. It doesn't only focus on some technological solution, but a whole new model and approach that the company says requires focusing on three core principles: nothing is taken for granted, verification of everything and limited access.

Under Zero-Trust, education organizations in general must be proactive by constantly receiving analytics and automated

responses for potential attacks. The key requirement here is for the organization to consistently collect, inspect and analyze traffic across the entire ecosystem, with maximum real-time visibility into both the data users are accessing and the potential for malicious activity.

C. Emerging Role for Cybersecurity Engineers in Education

In the past, the concept of Perimeter Network Security was widely accepted, i.e. a general fortress was built. This model quickly has become obsolete after the advent of COVID-19, when there were dramatic changes - everyone started working from home, using personal devices, accessing systems went to a work from anywhere mode. Academic institutions were not prepared and had to change their behaviour. So in came the Zero-Trust strategy, which is actually not new - it's been around for the last decade and a half, but the idea behind it now is not to create these security parameters and not to build walls, but not to take it for granted that if information flow comes over a secure connection, it would be considered secure. Everything has to be vetted, assess what the risks are associated with it, and based on that information develop a solution that covers those risks.

III. USING AI AND BIG DATA IN CYBERSECURITY FOR EDUCATION

It is technology that allows the Zero-Trust approach to be so effective. Cybersecurity by design has good synergy with technologies like AI and Big Data. The ability to analyze huge amounts of data has allowed us to not be reactive, but to intercept everything as it happens.

The Education Cybersecurity team itself must constantly keep up with new, ever-changing technologies. In order to build such a security system based on Zero Trust, the IT staff has to get the skills inside to work with the new technologies. Security is an ongoing process, the involved specialists are constantly subjected to various training and expanding their knowledge. Education Cybersecurity organizes academies every year and covers courses and certification exams for its employees [4].

Since security is everyone's responsibility, not just the IT department, which means a very good symbiosis between administrative, business and IT competencies is required.

IV. EVALUATION OF CYBERSECURITY SOLUTION IN EDUCATION INSTITUTIONS

According to our observations, there is significant gap between the new technologies, subjects that are taught and actual security implementations in academic institutions. The user security still uses mainly a username and password. With Zero-Trust people have to use so-called Flexible Authentication. In addition, different authentication mechanisms can be integrated - systems like two-factor authentication, biometric recognition, etc [5].

There are already many products on the market, mainly cloud-based, but also those for local installation in a data centre, which can cover the entire identity management process. In Bulgaria there seem to be very few higher education institutions that are using such systems, and even fewer have implemented them properly.

This is why the Education Cybersecurity team stress that one of the elements of Zero-Trust is the need for the security system itself to be part of an organization's modernization strategy from the outset.

V. IMPLEMENTATION OF ZERO-TRUST APPROACH

The Zero-Trust approach puts user identity, access and data management at the heart of cybersecurity. This strategy enables secure access to an organization's information and resources through continuous monitoring and ongoing analytics. No one inside or outside the corporate network is automatically granted access - every user must prove their identity. Even if they have a valid username and password, access to the system is denied if the device is not validated or the required level of trust is not achieved. The key requirement here is for the organization to consistently collect, inspect and analyze traffic across the entire ecosystem, with maximum real-time visibility into both the data users are accessing and the potential for malicious activity.

Education institutions must be proactive by receiving timely analysis and automated responses to potential attacks [6].

Key requirement is to consistently collect, inspect and analyze traffic across the entire ecosystem, with maximum real-time visibility into both the data users are accessing and the potential for malicious activity.

VI. CONCLUSION

The threats to organizations are the same, but the post-pandemic reality does not allow traditional methods of protection to be used and businesses are having to adapt to a new way of working. And with the emergence of new technologies, for example Facebook as a new social network years ago, it has become clear that people need to learn to protect their personal data. New technologies have a number of advantages, but they also bring a number of security risks. Accordingly, countries, in this case the EU, have stepped in and brought in a new regulatory framework to safeguard personal information. Every new technology does not come with security already in place, and the reality shows that many different threats come to the fore with its integration into society.

Cloud services are gaining traction not because they are cheaper or more secure, but because a very large number of companies cannot manage their IT environments adequately. And this is where the misconception comes in that if one thing is in the cloud, it is more secure. It's not, but the cloud is better because it offers tools that are available and ready to use without having to buy and go through a long implementation. For example, every cloud has good event

collection systems and there is the ability to do very sophisticated cross-sections on these datasets, to bring in Big Data, to use AI.

AI has changed a lot the way systems are currently administered. Previously, a cybersecurity department was huge in terms of human resources because there were no technologies and systems to analyze a huge volume of data and there was no artificial intelligence to recognize different patterns. Back then, it was all done by hand, every signal had to be analyzed by a human, and the teams themselves were large but shallow in terms of knowledge. Now the business is realigning to fewer people but extremely well prepared, i.e. the way the team is structured is changing. The human element must always be acknowledged in the equation as far as cybersecurity response efficiency is concerned.

ACKNOWLEDGMENT

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The Impact of the Economic Background on Cybersecurity

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Abstract—Dynamic economic processes and global developments have permanently established themselves as a model for the development of the cyberattacks worldwide. This report examines the ways in which hacker groups are taking advantage of various global issues and are increasing their cyberattacks.

Keywords—cyberattacks, cybersecurity

I. INTRODUCTION

With the digital revolution, all businesses, organizations and even governments rely on computer systems to manage their operations and thus become a prime target of hacker groups for various online attacks or unauthorized access. Constant changes in technology are leading to a shift in cybersecurity trends. News of data leaks, ransomware and hacks are becoming the norm.

In the wake of the COVID-19 epidemic, the world faced new challenges. Global economic turmoil from high inflation and Russia's invasion of Ukraine led to a reorientation of various segments including cybercrime. All these crises have made it possible for cybersecurity not to be on the agenda again. According to Forbs, cyberattacks in the first half of 2022 increased by 42% compared to 2021 [1].

Cyber attacks are starting to take on a whole different dimension and become an aggressive business model. This is evidenced by the FBI's constant reports of increasing cyberattacks [2].

II. ANALYSIS OF THE SITUATION IN CYBERSPACE

A. Analysis of the situation in cyberspace made by Check Point Research

Just days after Russia invaded Ukraine, Check Point Research reports a 196% increase in cyberattacks against Ukraine. They also report increased cyber activity by various hacking groups. Pursuant to the analysis, the average weekly number of attacks per organization worldwide reached over 1130 [3].

Figure 1 shows the average weekly number of attacks per organization worldwide [3].

At the same time, the Check Point Research reports that the education sector is attacked twice as much as other industries.

Figure 2 shows average weekly attacks per organization [3].

Since the shift to online learning due to COVID-19, academic institutions have become a target of hackers due to accelerated digitization and lack of good cybersecurity training.



Fig. 1. Statistics for average weekly number of attacks per organization worldwide.

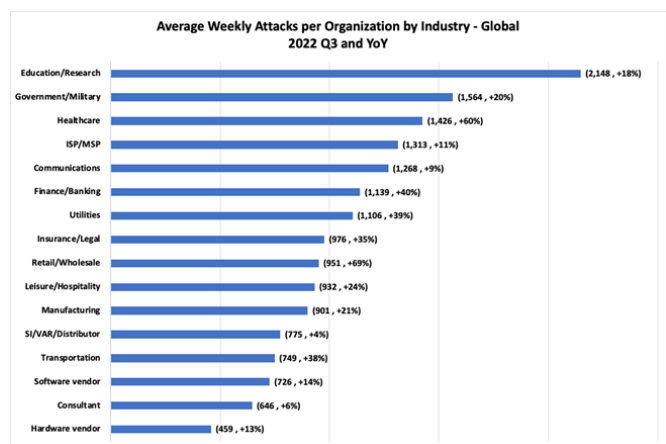


Fig. 2. Statistics for average weekly attacks per organization.

B. Analysis of the situation in cyberspace made by INTERPOL

In its report, Interpol states that financial crime and cybercrime are the most serious problems for police globally in 2022.

Financial crime and cybercrime are linked, as much financial fraud is committed through computer networks and systems. At the same time, hackers also depend on financial fraud to be able to 'launder' stolen money.

According to Interpol, in 2022 there is an escalation of cyberattacks in all regions of the world. The most common attacks are business email compromise, e-commerce fraud and investment fraud. Ransomware attacks mainly target large corporations, governments and critical infrastructure [4].

Figure 3 shows top crime threats in Interpol global crime report 2022 [4].

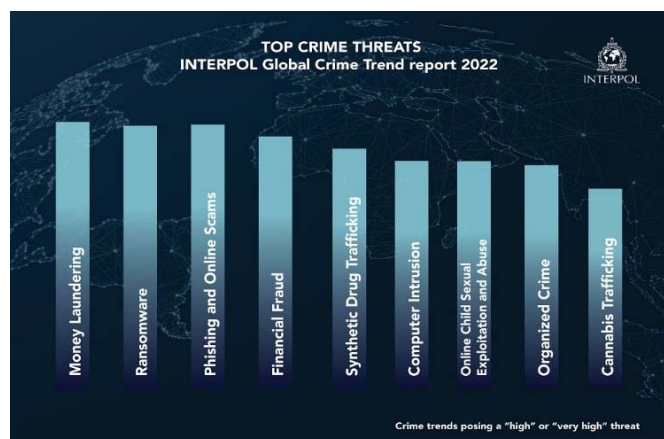


Fig. 3. INTERPOL – Top crime threats 2022

Pursuant to Interpol's regional studies, the biggest threats for 2022 are dispersed as follows [4]:

- (a) Africa - phishing and online fraud;
- b) Americas and the Caribbean - illicit trafficking of firearms;
- c) Asia Pacific - Financial crime;
- d) Middle East and North Africa - the trafficking of precursor drugs;
- (e) Europe - phishing and online fraud, money laundering and synthetic drug trafficking.

From the above data, it can be established that despite the recognition of the increasing intensity of cyber attacks in all regions, other threats overshadow this problem.

C. Analysis of the situation in cyberspace made by European Union Agency for Cybersecurity (ENISA)

The “Threat Landscape 2022” report of European Union Agency for Cybersecurity (ENISA) states that Ransomware is still considered as one of the main threats, and Phishing is already identified as the most common initial vector of such attacks. Other threats that rank highest among Ransomware are Availability attacks, also referred to as Distributed Denial of Service (DDoS) attacks. In addition to seeing an increase in the number of threats, ENISA also identified the emergence of a broader set of vectors, such as Zero-day exploits and AI-enabled disinformation and deepfakes. As a result, more malicious and widespread attacks with more damaging impact are emerging [5].

Figure 4 shows eight threat groups highlighted in the Threat Landscape 2022 in the ENISA report [5].

ENISA sorts threats into several groups [5]:

- Ransomware is identified as one of the most serious threats since pursuant to surveys more than 50% of reported affected organisations may have paid ransom demands
- Malware: 66 disclosures of zero-day vulnerabilities observed in 2021
- Social engineering: Phishing remains a popular technique but there are new forms of phishing arising such as spear-phishing, whaling, smishing and vishing
- Threats against data: Increasing in proportionally to the total of data produced
- Threats against availability: Largest Denial of Service (DDoS) attack ever was launched in Europe in July 2022. Internet: destruction of infrastructure, outages and rerouting of internet traffic.
- Disinformation – misinformation: Escalating AI-enabled disinformation, deepfakes and disinformation-as-a-service
- Supply chain targeting: Third-party incidents account for 17% of the intrusions in 2021 compared to less than 1% in 2020.



Fig. 4. ENISA – Threat Landscape 2022.

According to the ENISA report, Zero-day exploits are the new resource. Since Russia's incursion into Ukraine, there has been a new wave of hacktivism. DDoS attacks are increasing and becoming more sophisticated as well, moving to mobile networks. Disinformation and fake news are becoming an increasingly used method of conducting propaganda in cyberspace.

At the same time, the Russian hacking group Killnet launched a large-scale cyberattack against government websites of countries that criticize Russia or support Ukraine. Killnet, using the most famous DDoS attack method, tries to discredit the security systems of the attacked countries and thus draw attention to itself.

In parallel, against the backdrop of everything happening, cryptocurrencies began to lose their value sharply. Billions of dollars disappear almost overnight in a series of business crashes, most notably the evaporation of crypto exchange FTX in November 2022. For cybercriminals, this means that their ill-gotten gains have recently been completely devalued.

Some analysts, such as a report from Security Boulevard, suggest that this could mean a boost in criminal activity. State-sponsored cybercrime groups have been instructed to strike harder and more often, according to the report. Such states include Russia, China and North Korea – each of which has been particularly affected by the current global economic crisis.

The global economic movement, the various military conflicts, and others are undeniably changing and building on cyberattacks. This is turning them into an aggressive business model that is trying to permanently establish itself in cyberspace.

According to Allianz’s 11th survey (Allianz Risk Barometer), which polls multiple business environments, identifies and ranks cyber incidents as a top business risk for 2022. In the previous 2021 survey, cyber incidents were ranked third ahead of Business interruption and the COVID-19 pandemic outbreak [6].

Figure 4 shows the most important global business risks for 2022 [6].

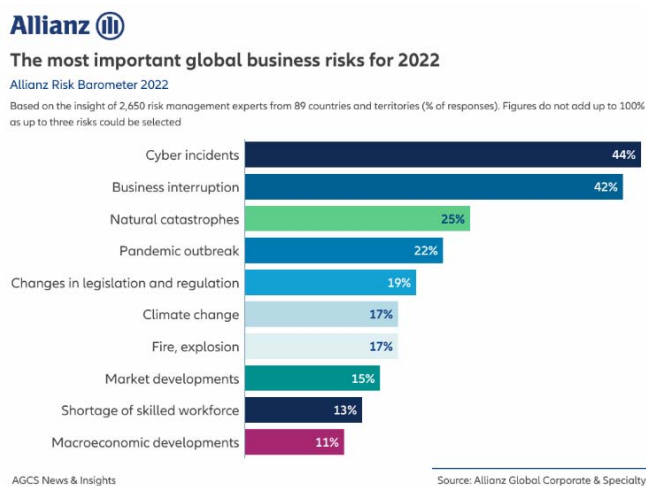


Fig. 5. Allianz Risk Barometer- Global business risks for 2022.

Figure 4 shows the most important global business risks in the last 10 years [6].

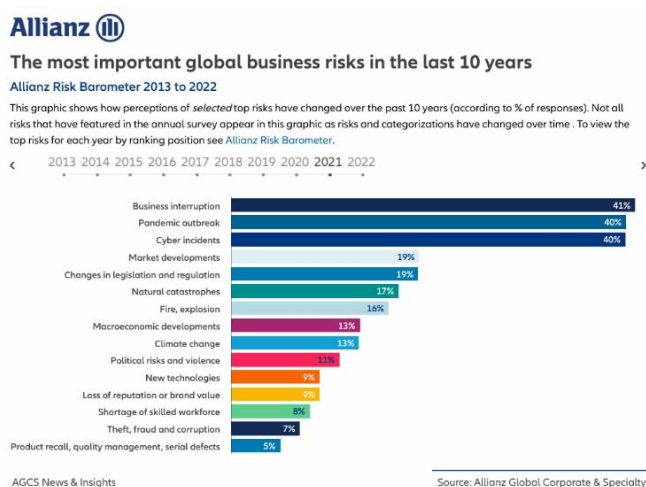


Fig. 6. Allianz Risk Barometer- Global business risks for in the last 10 years.

III. CONCLUSION

More and more European countries are now starting to urge their citizens to limit their use of electricity and put in place mechanisms to save various resources. Galloping market prices for various cybersecurity solutions will severely delay strategies to implement and update cybersecurity systems in most business environments. Analysing all the facts, businesses will put all their efforts to survive and stay in the market, which will probably lead to a change in priorities and cybersecurity will not be at the forefront. This will give hacking groups the freedom to be increasingly active in pursuit of their goals.

Analysts at Cybersecurity Ventures estimate in their official 2022 report that cybercrime will cost the world \$8 trillion in 2023. Their call is that if this trend continues it is very likely that the damage from cybercrime will reach \$10.5 trillion in 2025 [7].

Global economic development has inevitably linked the development of cybersecurity. Whatever happens in the coming years on the world stage, cybersecurity issues will continue their trend. Cyber resilience is becoming an increasingly serious challenge amid global problems.

More and more vendors are starting to incorporate artificial intelligence into their cybersecurity solutions. This is thought to increase the ability to detect threats and protect systems. Some analysts predict that artificial intelligence will also be used in parallel by hacker groups to construct their phishing attacks.

New solutions are increasingly being sought to combat cyberattacks.

Every newly introduced cybersecurity solution is monitored by hacker groups and every opportunity is sought to overcome it. In recent years, social engineering has become fundamental in detecting cyberattacks. This is due to the persistent trend that the human factor remains the weakest link in cybersecurity.

Former cyberattacks like Ransomware, Business Email Compromise, DDoS are still relevant. This will probably continue in 2023 because of the problems in the economy. We have seen many tech companies lay off and reorganize staff in 2022 and this is likely to continue next year. Working with a smaller staff leads to taking on new responsibilities and overloading staff. It can certainly be expected that some companies will become increasingly vulnerable to data breaches and other types of cyberattacks because of this.

The constant surrounding dynamics and anxiety makes every user in cyberspace to be more careless in their actions. More and more users are using their mobile phones to check their email correspondence, edit a document and visit a website. All this happens while driving or walking. Nobody pays attention to whom they are replying to in the email, whether the file they are opening is a malicious application, whether they are entering their personal details or bank card details on a legitimate page.

The release of new models of mobile phones and new versions of their operating systems with different functionalities, shifts the focus of users and they fail to be careful enough in their cybersecurity. Therefore, mobile

phones will be the new opportunity for hacker groups to successfully conduct their attacks.

Whatever happens in the coming years, the economic and global environment will define cybersecurity for every region of the world.

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Network and Web Applications Vulnerability Testing Using Ethical Hacking

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Abstract—In today's computerized world every day, every hour, every minute, new risks for information security. Never mind if we are talking about personal or of a company. Connecting with the internet allows a hacker to target us or our company. Hacker attacks can vary from innocent pranks to attempts of stealing personal and sensitive information, which they use for personal gain. Cyber crimes have turned into a great business, and cyber risk is the focus of organisations and governments worldwide. The main purpose of this document is to help find vulnerabilities in networks and applications, using penetrating tests, to better protect their integrity, availability and confidentiality. There are numerous instruments for detecting vulnerabilities. In our case, the analysis and evaluation are done with the following instruments: NMap and Legion for networks and Zed of OWASP (a proxy instrument for generating attacks) for applications. The operating system used is Kali Linux, where some of the instruments are integrated.

Keywords—Ethical hacking, NMap, Legion, ZAP OWASP, Penetration Testing, NIST, OWASP

I. INTRODUCTION

Today, the internet is an inexhaustible world.

These days everyone uses an app to send and receive information. Applications use need an internet connection on web servers and networks to transmit information. Hackers' tactics consist of identifying backdoors and vulnerabilities in servers and networks to steal personal or sensitive information, which can then be used for personal gain. Cybercrime is becoming a huge business and cyber risk is the focus of the world's organizations and governments. Over the past two years, with the onset of the COVID-19 epidemic, we have witnessed hacker attacks against vaccine laboratories as well as the World Health Organization. With the outbreak of war in Ukraine, groups of hackers backed by various governments have been seen taking down government and information sites. In Bulgaria, on April 16, 2022, the systems of the Bulgarian post office were attacked, and a few years ago (July 15, 2019), the data of millions of Bulgarians was leaked from the NRA's information arrays. Financial and reputational risks are high if companies or government organizations do not have a proper cybersecurity plan in place. The saying "if you fail to plan, you plan to fail" rings true for the ethical hacking process. [1]

As technology advances, hacker waves find new opportunities for financial gain, and thus representing this is a huge challenge for cybersecurity professionals. Ethical

hackers or «pen-testers» simulate hacking attacks by using the same applications and techniques as hackers to find system vulnerabilities, thereby supplementing security measures.

Many security professionals test networks and applications to find to find research vulnerabilities and fix them. In the article “Testing for Security Weakness of Web Applications using Ethical Hacking” [2], R. Sri Devi and M. Mohan Kumar are testing an internet infrastructure for vulnerability. An analysis and assessment are measures finding the security breaches in the network, computer system, or web applications of the institution with the appropriate knowledge and understanding of network infrastructure, and knowing of the possible threats to the environment. Imrana Abdullahi Yari in his article “Exploiting Vulnerabilities of Linux Based Machine: Penetration and Incident Response Procedure” [3] dissolves problem work whit Metasploitable2, indicates a vulnerability in Metasploitable2 and how to exploit it.

I aim to make the demonstration of an insecure server that was built for testing, and of a functional university server. This might allow us to acquire more information to have an efficient survey of vulnerabilities in our networks and applications and to maintain data security. Using the same applications and techniques as hackers, with the purpose of finding system vulnerabilities, and with that complementing the security measures.

II. TOOLS AND TESTING

This report examines the possibilities for finding vulnerabilities in networks and applications. It will make a point of the vulnerabilities and the danger of their admission at first, and then will present a comparison of the instruments used for finding these vulnerabilities. The analysis and assessment of networks were made using NMap and Legion, for the applications ZAP OWASP was used, and the operating system Kali Linux was processed.

A laboratory including a server with virtual machines and operating systems ready to experiment was built for this purpose.

A compromised server, containing applications, and a database was installed. The experiments on a UTP were possible thanks to the people of charge agreement.

A. NMap and Legion - instruments for network scanning

Networks scanning is an interception of data packages, exchanged in layer 3(Network) of the OSI model.



Experiment 3 - testing of the application on a laboratory machine and UTP site with ZAP instrument for identifying vulnerabilities (fig.3,fig3.1 and fig.3.2).

Cross-Site Scripting (Dom based and Reflected) – Cross-Site Scripting (XSS) is an attack where malicious code is injected into benign sites. These attacks succeed when the application uses user input within the output it generates without validating or encoding it. The end user's browser has

[illegible]

Fig. 3. Vulnerabilities on Metasploitable2 through ZAP OWASP

Path traversal – “A path traversal attack (also known as directory traversal) aims to access files and directories that are stored outside the web root folder. By manipulating variables that reference files with “dot-dot-slash (../)” sequences and its variations or by using absolute file paths, it may be possible to access arbitrary files and directories stored on file system including application source code or configuration and critical system files. It should be noted that access to files is limited by system operational access control (such as in the case of locked or in-use files on the Microsoft Windows operating system). This attack is also known as “dot-dot-slash”, “directory traversal”, “directory climbing” and “backtracking”.”[10]

Remote File Inclusion is a remote file inclusion (RFI) or local file inclusion (LFI) vulnerability common in poorly written web applications. The vulnerability occurs when the web application allows the user to send input to files or upload files to the server. [11]

Remote OS Command Injection – “Command injection is an attack in which the goal is the execution of arbitrary commands on the host operating system via a vulnerable application. Command injection attacks are possible when an application passes unsafe user-supplied data (forms, cookies, HTTP headers etc.) to a system shell. In this attack, the attacker-supplied operating system commands are usually executed with the privileges of the vulnerable application. Command injection attacks are possible largely due to insufficient input validation.

In Command Injection, the attacker extends the default functionality of the application, which execute system commands, without the necessity of injecting code.”[12]

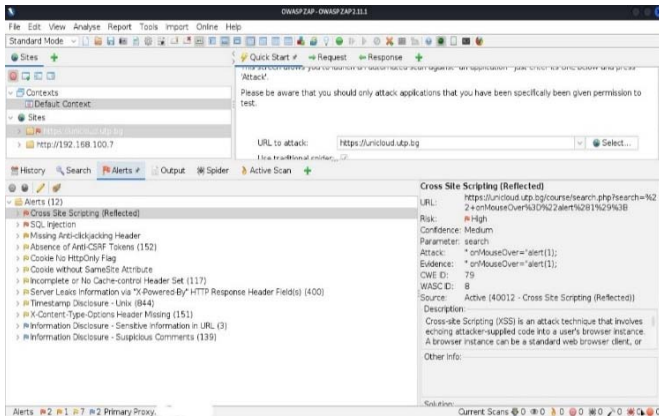


Fig. 3.1. Vulnerabilities on UTP site through ZAP OWASP – 02.2022

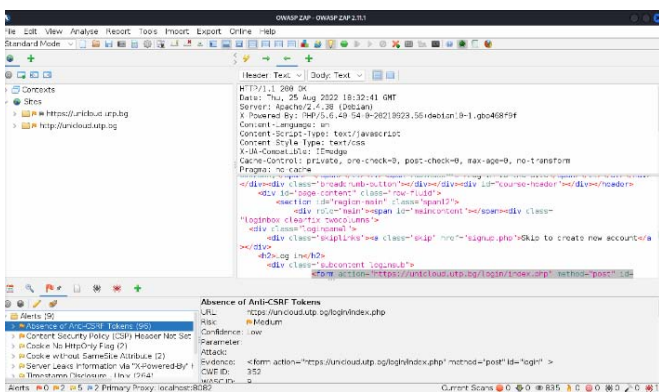


Fig. 3.2. Vulnerabilities on UTP site through ZAP OWASP – 08.2022

The conducted experiment in the lower right angle, marked in different colour flags, allows for the identification of vulnerabilities. The flag colour corresponds to the severity and the urgency for fixing. Vulnerabilities in dark red colour are those with the highest priority, which decreases for the orange, yellow and blue coloured. Each flag is considered and the instrument shows us where exactly in the code containing an error adds to the vulnerability. UTP site administrators have taken into account the canning made earlier this year. It made a demonstration of two extremely dangerous vulnerabilities, if used the main results would be the site's crash, SQL Injection and cross-site scripting. After their removal, the actual site benefits from higher protection.

IV. CONCLUSION

In table I, we compared the performance of the two network scanning tools – NMap and Legion.

TABLE I. EXPERIMENT RESULTS

	NMap	Legion
Scan ports	V	V
Services	V	V
Version	V	V
Vulnerability	V	V
Passwords	V	V

The experiments carried out established that the instruments for detecting vulnerabilities in networks are identical. Every user, according to his preferences, chooses the instrument to work with. The established vulnerabilities need to be removed or mitigated, to provide better data protection.

Cyber security is developing, but hackers do not give up - they respond with a high number of attacks and social engineering. This is counteracted with multiple verifications, network behavioural analysis, threat intelligence and updating automatisations, real-time protection, forensics and mirror copy, and firewalls of web applications. Regular pen testing helps with increasing security and keeping data away from illegal access.

ACKNOWLEDGEMENT

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- [10] [online]available<https://owasp.org/wwwcommunity/attacks/Path_Traversal>
- [11] [online]available<<https://www.offensive-security.com/metasploit-unleashed/file-inclusion-vulnerabilities/>>
- [12] [online]available<https://owasp.org/wwwcommunity/attacks/Comm_and_Injection>
- [13] [online]available<<https://cve.mitre.org/cgi-bin/cvename.cgi?name=cve-2011-3192>>
- [14] [online]available<<https://nvd.nist.gov/vuln/detail/CVE-2022-31813>>

Using Open Source Systems for Monitoring, Logging and Notification

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Abstract—Since COVID-19 pandemic started, the world is faced against the challenging situation to do the most of the things remotely. The need from reliable online connectivity, proper and secure way to transfer the data extremely growth. During past two years information technologies, together with the most popular programming languages made a huge jump developing the new technologies, not only on hardware and software level, but on monitoring, security, auditing, automation and management level as well. Together, programmers, developers and IT support showed the world the power of open-source tools and services as Proxmox, LXC containerization, Unix based Operating systems, but not on last place a contemporary, secure monitoring and auditing tools has been developed and improved. They allow automation of the tasks and processes for better system management and security.

Keywords—Proxmox, Docker, InfluxDB, Grafana, Telegraf, Monitoring

I. INTRODUCTION

In this report are used most of the newest technologies based on open-source solutions as server solutions, containerization, virtualization and for the proper auditing and monitoring setup is performed with high level open-source tools. They are able to monitor whole environment and to track the events, metrics, auditing etc. for their good and proper functioning and health.

To be able to more easily and quickly identify a problem and find dependencies between different kind of events from which to draw some conclusion, whether it refers to debugging a program or script, or to find the cause for any anomaly, good practice requires the implementation of logging and monitoring systems and tools that usually work together. Simply put, logs are records of events and metrics that can be configured to be collected for each program and depending on its important parameters that need to be monitored to ensure its correct and continuous operation, to set up notifications (alerts) in the monitoring system, which will signal when any of the configured rules are triggered. Monitoring is accordingly the process of monitoring these metrics and logs from an operating system or other software for possible current or future problems (with predictive algorithms).

With their proper use, the possibility of various incidents is reduced and the chance of an attack being caught in time and measures taken to limit it increases. Accordingly, in the

absence of good practices and poor configuration of components, it is possible to miss a critical event and lead to the network being compromised or the monitoring data to be "false positive" that must be reviewed manually.

Scheduled monitoring can be easily expanded to include more metrics and integrate with given software solutions as is shown on workflow diagram below (Fig. 1). To protect whole env and to track the changes Rsyslog [1] has been installed on Proxmox [2] host, in addition Telegraf [3] agent has been installed on Proxmox host, LXC [4] and Docker containers [5] to pull the events to InfluxDB [6] which stores the data. For monitoring and alerting configurations of whole architecture is used InfluxDB, for exact and well visualized data timeseries Grafana was used.

In the experimental part a separate LXC container with Docker composer container has been built over Proxmox, the purpose is to develop a pull agent using Python [7] client for InfluxDB and visualize the results with Grafana.

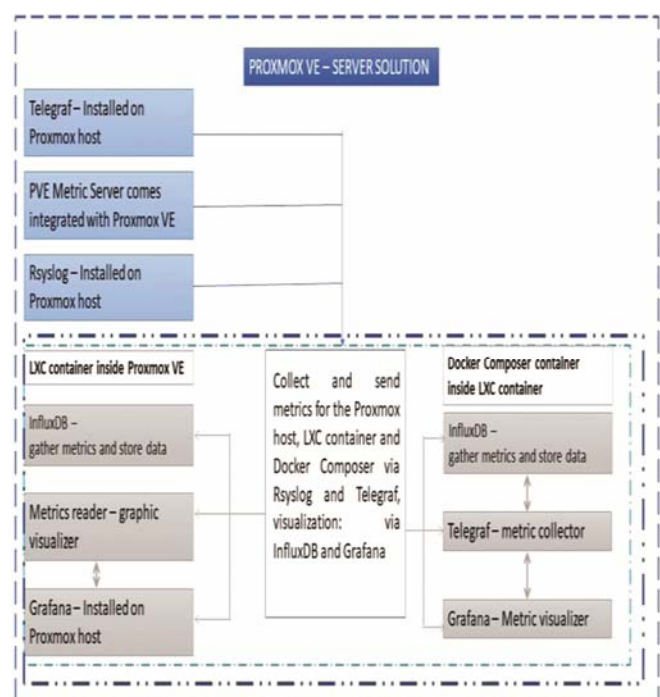


Fig. 1. Workflow diagram

II. PROXMOX

Proxmox Virtual Environment is an open-source server solution platform for virtualization. Integration of Linux Containers (LXC) and KVM hypervisor is easy for setup and administration. It supports also web-based user interface, which allows easily management of different kind of virtual machines, containers, clusters and disaster recovery operations. On (Fig. 2) is shown Proxmox server configuration architecture which contains 1 node and two LXC containers for the purpose of the project research and development [8].

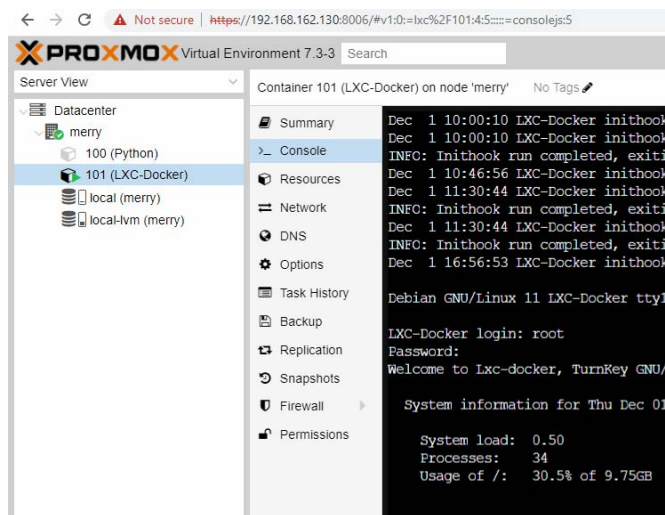


Fig. 2. Proxmox – Web Interface

III. INFLUXDB

It is an open source database specializing in the collection of time series data type - metrics and events. A language similar to SQL – InfluxQL[9] - is used to work with it.

Advantages:

- Open source, large community and frequent improvements;
- Proxmox supports direct integration with it;
- Grafana supports direct integration with it;
- Possibility to use variety of programming languages libraries (fig. 3);

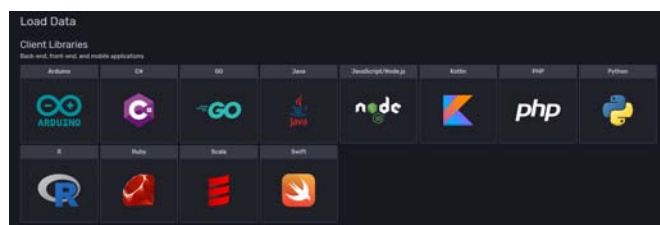


Fig. 3. Client libraries - InfluxDB

- Easy to set up and maintain;
- Creating Alerts and schedule tasks;

Alternatives:

- Prometheus[10], Graphite[11] and others;

Implementation:

For the purposes of the research and the development few installations of InfluxDB are made. First is installed with a few steps from the official documentation, in an LXC (Linux Container) container, and then a Metrics Server is configured from Proxmox, which sends to InfluxDB with ip address: 10.10.1.2 directly over UDP:

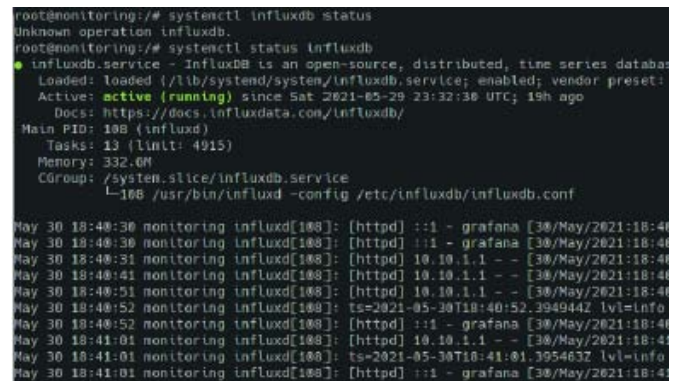


Fig. 4. InfluxDB installation over LXC container

The output from the console on (fig. 4) shows that first installation of InfluxDB is successful, services are up and running. On (fig. 5) are shown configurations through UDP connection from Proxmox server web-interface.

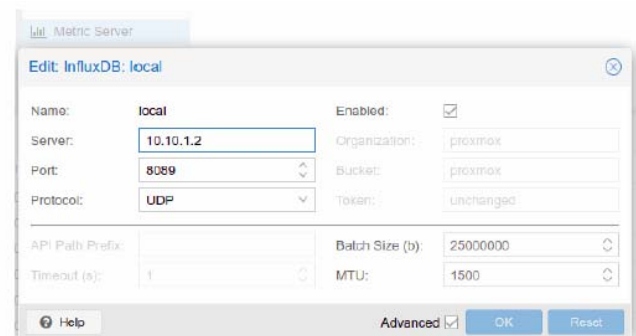


Fig. 5. Metrics Server configuration from Proxmox

Two databases are created (besides the system _internal) - Proxmox is for metrics only from Proxmox, and db_telegraf_proxmox receives metrics from Telegraf installed on Proxmox itself (Fig. 6):

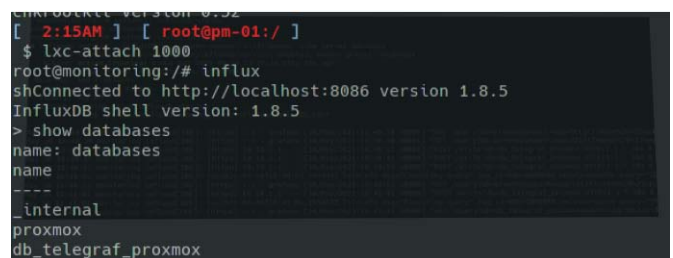


Fig. 6. db_telegraf_proxmox receives metrics from Telegraf

This setup of configuration is created to gather and visualize data from the host and LXC containers which are

installed over Proxmox. Database named “Proxmox” will collect the data from Rsyslog, the database named “db_telegraf_proxmox” is configured to collect the data send from Telegraf metric collector tool.

Inside the LXC container a Docker compose container has been built and installed in order to configure second installation of InfluxDB. Composition file “docker-compose.yml” for docker container consists three important elements: InfluxDB, Telegraf which will serv to send the data to InfluxDB through TCP protocol and Grafana is used for metrics visualization. Database inside the docker container is named Telegraf (fig. 7):

```
root@LXC-Docker ~/docker-composer# cat docker-compose.yml
version: "3"

services:
  influxdb:
    image: influxdb:2.1.1
    volumes:
      - influxdb-storage:/var/lib/influxdb2:rw
    env_file:
      - .env
    entrypoint: ["/.entrypoint.sh"]
    restart: on-failure:10
    ports:
      - ${DOCKER_INFLUXDB_INIT_PORT}:8086

  telegraf:
    image: telegraf:1.19
    volumes:
      - ${TELEGRAF_CFG_PATH}:/etc/telegraf/telegraf.conf:rw
    env_file:
      - .env
    depends_on:
      - influxdb

  grafana:
    image: grafana/grafana-oss:8.4.3
    volumes:
      - grafana-storage:/var/lib/grafana:rw
    depends_on:
      - influxdb
    ports:
      - ${GRAFANA_PORT}:3000

volumes:
  grafana-storage:
  influxdb-storage:
```

Fig. 7. Docker Compose configuration file

Docker compose installation is completed, services for database, metric collector and monitoring visualization are up as shown on (fig. 8).

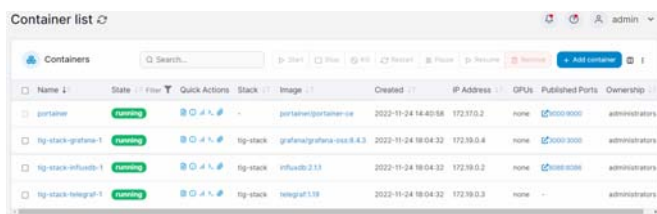


Fig. 8. Docker configuration – Grafical interface

Purpose of this configuration is to observe in details the behavior of docker container resources and the tools for monitoring and auditing.

Replication of LXC and Docker container was created with the same system parameters in order to get prepared the environment for the experimental part of the research. Python programming language have been used to pull the metrics and events and to send the data to InfluxDB via influx python client, visualization is performed with Grafana.

IV. GRAFANA

Grafana is an analytics and monitoring tool that also offers notification options. Provides the ability to create any custom dashboards to visualize data. Alerts can be created on these dashboards, for example if specific data exceeds a certain preset limit. This open-source tool is powerful with its flexibility and the variety of options which provides.

Depending the operating system and monitoring requirements different kind of log and trace files could be enabled with queries. The process of work of this tool is to enable the queries which collect data turn the data time-series database into graphs and visualizations.

Advantages:

- Open source, large community and frequent improvements;
- Large set of data sources - can connect to over 15 types of databases and read data from them;
- The large set of ready-made panels for certain technologies (Proxmox, Docker, Telegraf) saves a lot of time in the initial setup;

Alternatives:

- Kibana;

Implementation:

Grafana is installed with a few steps from the official documentation in the same LXC container as InfluxDB (Fig. 9). Three datasources have been added - the three InfluxDB databases (Fig. 10):



Fig. 9. Grafana-server installation

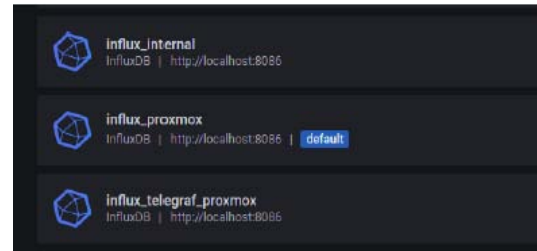


Fig. 10. InfluxDB – data sources

Example of notifications for excessive use of specific resources have been created (Fig. 11). Most of the main resources like: CPU I/O Wait, CPU Load Average, CPU Usage, Memory usage, server storage, server uptime, KVM CPU etc. are configured for monitoring and auditing.

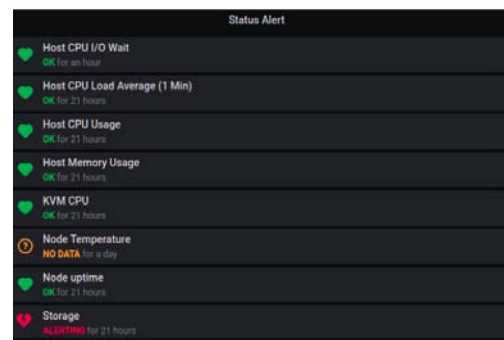


Fig.11. Example for Alert notifications

As of now, only the alert notification for disk usage has been activated, because the disk space is almost full. There is no data for Node Temperature because Proxmox is installed on a virtual machine and it does not have a temperature sensor. Another panel with metrics from the host is configured to monitor the usage of resources like RAM, processes, swap memory, network traffic etc. (Fig 12).



Fig. 12. Grafana – Host Monitoring Panel

V. TELEGRAF

A tool that installs as an agent on a server and runs constantly, and while running sends selected data, such as metrics about resources used (RAM, CPU power, disk space, etc.), system events (logs), and other information to a database.

Advantages:

- Open source, large community and frequent improvements;
- Supports collection of metrics and logs from many other software solutions (currently over 204);
- Extremely flexible - it can transform the data it collects in real time before sending it;

Alternatives:

- StatsD[12], Collectd[13], Metricbeat[14] and others;

Implementation:

Metrics specifications could be modified in Telegraf configuration file. By default, path location of this file is: “/etc/telegraf/telegraf.conf”. To be able to send data timeseries to InfluxDB in the configuration file should be performed additional settings for connection to the database. Installed (Fig. 13) on the host and configured to collect metrics from LXC and Rsyslog and then send them to InfluxDB.

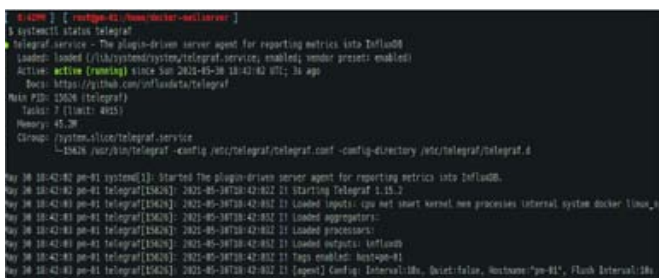


Fig. 13. Telegraf installation

Default configuration settings are used for the purpose of the research shown on (fig. 14).

```
# Configuration for telegraf agent
[agent]
## Default data collection interval for all inputs
interval = "10s"
## Rounds collection interval to 'interval'
## ie, if interval="10s" then always collect on :00, :10, :20, etc.
round_interval = true
```

Fig. 14. Telegraf – default configuration settings

VI. EXPERIMENTAL PART

For the experimental part are created two LXC containers with same system parameters over Proxmox server. First host named **LXC-Docker** have Docker Compose installation with configurations and integrations as follow: InfluxDB, Telegraf, Grafana. To setup and secure installation, a key token has been generated using OpenSSL with command line: “**openssl rand hex 32**” [15] utility as is shown on (fig. 15). OpenSSL Project develops and maintains the OpenSSL software - a robust, commercial-grade, full-featured toolkit for general-purpose cryptography and secure communication. Hex parameter in the command line generates the token as a hex string.

```
DOCKER_INFLUXDB_INIT_ADMIN_TOKEN=changeme

# Primary InfluxDB organization & bucket definitions
#
DOCKER_INFLUXDB_INIT_ORG=changeme
DOCKER_INFLUXDB_INIT_BUCKET=changeme

# Primary InfluxDB bucket retention period
#
# NOTE: Valid units are nanoseconds (ns), microseconds(us), milliseconds (ms)
# seconds (s), minutes (m), hours (h), days (d), and weeks (w).
DOCKER_INFLUXDB_INIT_RETENTION=4d

# InfluxDB port & hostname definitions
#
DOCKER_INFLUXDB_INIT_PORT=8086
DOCKER_INFLUXDB_INIT_HOST=influxdb

".env" 35L, 932B written
root@LXC-Docker: ~/tiq-stack# openssl rand -hex 32
96a41731ea5045ff4087ed5c5b917935cedf398a2848cd108360bc4ea7b56bf5
root@LXC-Docker: ~/tiq-stack#
```

Fig. 15. OpenSSL key token generation command line

Key token has been implemented in the configuration file of docker composer named ‘docker-compose.yml’ (fig. 16).

```
root@LXC-Docker: ~/docker-composer# cat docker-compose.yml
version: "3"

services:
  influxdb:
    image: influxdb:2.1.1
    volumes:
      - influxdb-storage:/var/lib/influxdb2:rw
    env_file:
      - .env
    entrypoint: ["/.entrypoint.sh"]
    restart: on-failure:10
    ports:
      - ${DOCKER_INFLUXDB_INIT_PORT}:8086

  telegraf:
    image: telegraf:1.19
    volumes:
      - ${TELEGRAF_CFG_PATH}:/etc/telegraf/telegraf.conf:rw
    env_file:
      - .env
    depends_on:
      - influxdb

  grafana:
    image: grafana/grafana-oss:8.4.3
    volumes:
      - grafana-storage:/var/lib/grafana:rw
    depends_on:
      - influxdb
    ports:
      - ${GRAFANA_PORT}:3000

volumes:
  grafana-storage:
  influxdb-storage:
```

Fig. 16. Implementation of Key token

After the installation a bucket ‘Telegraf’ is created inside InfluxDB (fig. 17).

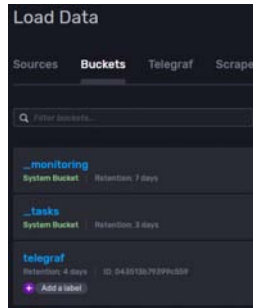


Fig. 17. Telegraf bucket – InfluxDB

Purpose of the bucket is to pull data and send it to InfluxDB for visualisation. On (fig. 18) is introduced an example which delivers information for total system disk usage.

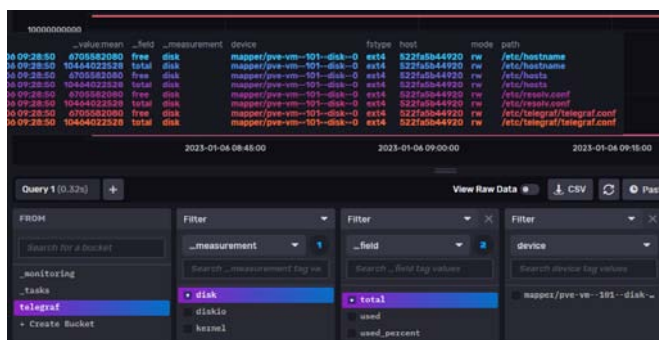


Fig. 18. InfluxDB Visualization – total disk usage

Code written on JavaScript [15] could be easily determined via code descriptor menu from InfluxDB graphical interface. It describes that it pulls data from Telegraf bucket, for specified time range, while filter from system bucket _measurement to be equal to disk, from next system bucket named _field it filters for total free space on the server (fig. 19):

```

1 from(bucket: "telegraf")
2 |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
3 |> filter(fn: (r) => r["_measurement"] == "disk")
4 |> filter(fn: (r) => r["_field"] == "total")
5 |> aggregateWindow(every: v.windowPeriod, fn: mean, createEmpty: false)
6 |> yield(name: "mean")

```

Fig. 19. Total Disk usage - JavaScript code, InfluxDB

To visualize the data with Grafana additional configuration settings are performed via graphical interface following the menu configurations and sub-menu data source.

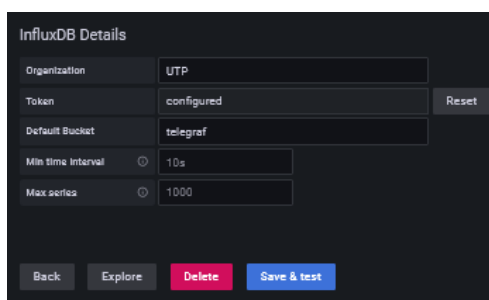


Fig. 20. InfluxDB configuration settings

Once accessed data source sub-menu is required to add InfluxDB as a source in order to be able to make settings configurations for HTTP connection to the DB, type of authentication method, Custom HTTP Headers and InfluxDB Details. To configure required parameters for connection and authentication to the database next fields needs to be configured in InfluxDB Details: Organization, Token, Default Bucket, Minimum time interval, Maximum number of series. After successful configuration for connection to InfluxDB, data visualization for total free disk space metric has been uploaded to Grafana using JavaScript code from script editor via InfluxDB web-interface. Once data is visualized Grafana allows to convert the data timeseries in JSON [16] programming language (fig. 21). For future analysis Grafana allows to download the timeseries in csv format.

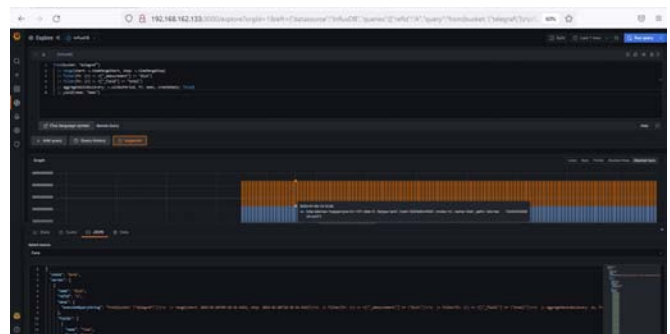


Fig. 21. Grafana – Disk usage visualization

For the second Docker container additional configurations and installations of python programming language have been performed. Python virtual environment was configured, for the connection to InfluxDB is used InfluxDB Client which serves to establish connection to the database. Once Docker compose container is installed with InfluxDB and Grafana, additional configuration file is created with tokens which secure the access to the database as it was performed for the security configurations for the first host.

After docker compose installation is finished with success on the second LXC host named python, a virtual environment has been built, for connection to the database it was installed and used “InfluxDB Python Client Library” [17] with key features:

- Provides API access to all InfluxDB Write and Read functionality, settings, and advanced features
- Write data in InfluxDB line protocol, point data structure, or as a pandas dataframe
- Easily configure timeouts, delays, and request retries
- Batch data to InfluxDB to gain greater efficiency
- Return InfluxDB data as a Flux Table Structure, string, csv, stream, or dataframe
- Panda dataframe integration

Python Virtual environment (venv) is activated using following command line: ‘source ./venv/bin/activate’, also shown on (fig. 22). Purpose of venv is to protect and isolate the server from eventual failures.

```

root@python ~# cd tig-stack/python_test/
root@python ~/tig-stack/python_test# ls -la
total 24860
drwxr-xr-x 5 root root 4096 Jan 5 16:31 .
drwxr-xr-x 5 root root 4096 Jan 5 21:14 ..
-rw-r--r-- 1 root root 2205 Jan 5 11:18 MF.py
-rw-r--r-- 1 root root 4733 Jan 5 16:14 MF_MF.py
drwxr-xr-x 17 root root 4096 Jan 4 19:46 Python-3.9.1
-rw-r--r-- 1 root root 25372998 Dec 7 2020 Python-3.9.1.tgz
-rwxr-xr-x 1 root root 443 Dec 2 03:03 _init.py
-rw-r--r-- 1 root root 9501 Dec 2 01:23 Configuration.py
drwxr-xr-x 16 root root 4096 Jan 5 10:54 influxdb-client-python
-rw-r--r-- 1 root root 4203 Jan 5 16:31 merry.py
-rw-r--r-- 1 root root 417 Dec 2 00:31 python.py
-rw-r--r-- 1 root root 15219 Dec 2 01:22 rest.py
-rw-r--r-- 1 root root 320 Dec 2 01:42 setup.py
drwxr-xr-x 6 root root 4096 Jan 4 19:26 venv
root@python ~/tig-stack/python_test# source ./venv/bin/activate
(venv) root@python ~/tig-stack/python_test#

```

Fig. 22. Python – venv activate

To configure secure connection between InfluxDB Python Client which will serve as pull agent and Influx DB it is required to access the database via graphical interface and to create a bucket, in this case the bucket is named “Python”. Next step is to generate API token which needs to be implemented into the InfluxDB Python client API. Once accessed via Web-interface a token key is generated it needs to be integrated into python virtual environment and InfluxDB config files. On (fig. 23) is shown token generator from InfluxDB web-interface.

For more detailed and up to date information check out the [GitHub Repository](https://github.com/influxdata/influxdb-client-python)

Install Package

```
pip install influxdb-client
```

Initialize the Client

```

from datetime import datetime

from influxdb_client import InfluxDBClient, Point, WritePrecision
from influxdb_client.client.write_api import SYNCHRONOUS

# You can generate an API token from the "API Tokens" tab in the UI
token = "pqunn1z9bu3K0jppUosQTKVG4F7154-zZfhvwxVPMa023x1Y0mj3x0VhntBzKNTiqd8OAGIaW5-ly0KCyBg=="
org = "UTP"
bucket = "Python"

with InfluxDBClient(url="http://192.168.162.137:8086", token=token, org=org) as client:

```

Copy to Clipboard

Fig. 23. InfluxDB configuration settings

To finish security configurations and to establish connection it is required to perform API authentication from python environment. Parameters which require to be integrated are Organization, bucket, token, and URL for client connection. Detailed information is presented on (fig. 24).

```

(venv) root@python ~/python_test/influxdb-client-python# python
Python 3.9.2 (default, Feb 28 2021, 17:03:44)
[AMD64] 10.2.1 20210110 on linux
Type "help", "copyright", "credits" or "license()" for more information.
>>> token = "pqunn1z9bu3K0jppUosQTKVG4F7154-zZfhvwxVPMa023x1Y0mj3x0VhntBzKNTiqd8OAGIaW5-ly0KCyBg=="
>>> bucket = "Python"
>>> org = "UTP"
>>> client = InfluxDBClient("http://localhost:8086", token, org, bucket)

```

Fig. 24. Python API token monitoring setup

After the security configuration is done, checks are made from InfluxDB interface, the results show that “Python” bucket is ready for further actions and metrics configurations and data collections. Additional menus for measurement and field are configured to collect data from the server and docker container. These menus have different functions the main one is to filter by different parameters and metrics. On (fig. 25) is visualized the result from API token configuration and python metrics installation.

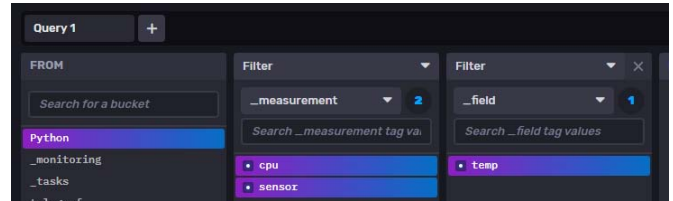


Fig. 25. Python Client API configurations result

For the experimental and analysis part is used CPU parameter. A python library “psutil” (fig. 26), (process and system utilities), i.e. cross-platform library for retrieving information on running processes and system utilization (CPU, memory, disks, network, sensors) in Python. It is useful mainly for system monitoring, profiling and limiting process resources and management of running processes. It implements many functionalities offered by classic UNIX command line tools such as ps, top, iotop, lsof, netstat, ifconfig, free and others. psutil currently supports the following platforms [18]: Linux; Windows; macOS; FreeBSD, OpenBSD, NetBSD; Sun Solaris; AIX.

```

import time
import psutil
from collections import namedtuple

import influxdb_client
from influxdb_client.client.write_api import SYNCHRONOUS

```

Fig. 26. Metrics configurations with callbacks

Source code is modified in order to extract data for all parameters which belongs to CPU usage, i.e.: user, nice, system, idle, iowait, irq, softirq, steal, guest_nice.

First server which have Telegraf installed contains these metrics by default. To compare the results between Telegraf and Python the same code extracted from script editor via InfluxDB interface is used to visualize data through Grafana. Results from the performed research during project activities gives us clear information that Python client API have the same success as Telegraf (fig. 27). For data comparison was used CPU iowait.

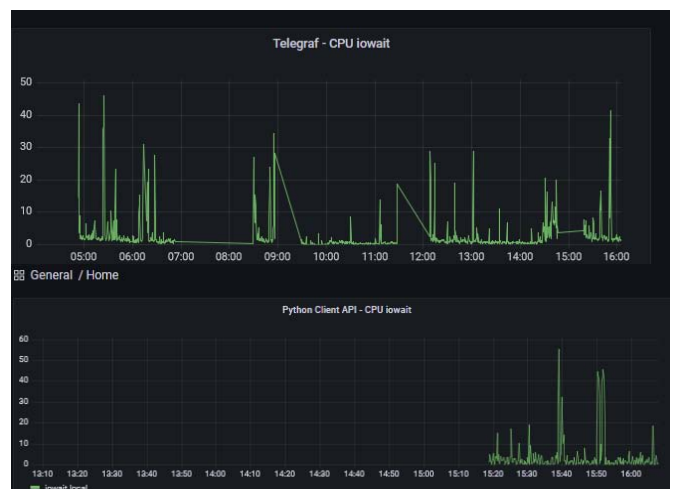


Fig. 27. Results from comparison analysis

InfluxDB Python Client API to be developed and modified for the needs of the project in order to monitor whole environment and to reach visualization and alarm results via Grafana as Telegraf automation. Purpose is to improve the code related on future analysis and comparisons. An example for finished data timeseries visualization is show on (fug. 28).

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Fig. 28. Results Visualization with Grafana pulled by Telegraf agent

VII. CONCLUSION

Monitoring, logging and notification systems are extremely flexible and can be configured to notify service personnel via almost any modern communication channel. All of these solutions would satisfy the needs of almost any small to medium business if properly configured.

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