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Quality management system-ISO 9001 in the context of industry 4.0

Chukalov Konstantin, Sabev Sabi
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Abstract: *The article will examine the principles, approaches and documented information of the quality management system ISO 9001 in the context of Industry 4.0. will be analyzed the structure, implementation and maintenance of the quality management system in the conditions of Industry 4.0. Recommendations for future change of the version of the standard in the presence of digitization will be made.*
Keywords*: INDUSTRY 4.0,ISO 9001.*

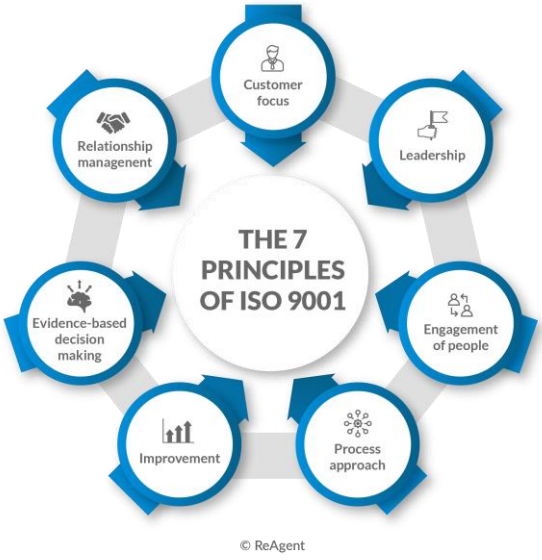
1. Introduction

Quality management systems{ISO 9001} are an integral part of industrial companies worldwide, as their goal is to ensure high quality, low cost of goods and services, more stable and greater market share. In practice, quality management system represents a competitive advantage of companies.Precisely for this reason, the question of how the quality management system will be implemented, maintained and managed in the context of Industry 4.0 and what will be the barriers to using their full potential as a strategic factor is relevant[1],[2].

To a large extent, the expected goals at implementation of Industry 4.0 overlap with those of the quality management system, but concerns that acquisition of one competitive advantage will limit another competitive advantage remain[3]. Developments in this direction are important for the discussion of a new version of the quality management system with focus not only on availability of electronic documents, but also their automatic maintenance, management, storage and improvement.

2.The principles of quality management system

The principles of quality management system are as follow[fig.1]



.***Fig.1*** *The 7 principles of quality management system[4]*

- Customer focus

Customer focus is important for both the quality management system and Industry 4.0, as the creation of the concept of Industry 4.0 is related to flexible and individual production, entirely designed as a pull process. The differences in this point are related to which determines the level of quality, because in the quality management system it is determined by the company, and in the philosophy of Industry 4.0 it is determined by the customer, similar to TQM, but in general the direction is the same

- Leadership

Leadership is related to strategic planning, the effectiveness and efficiency of key decisions in the business environment. When there is unity of leaders it leads to successful development of strategies. The implementation of Industry 4.0 is a typical example of leadership, so this principle will be respected.

- Engagement of people

The quality management system is based on the principle that everyone is engaged in the processes. The inclusion of people will increasingly give way to the implementation of vertical and horizontal integration in order to include machines in the smart factory.

- Process approach

. A process-oriented approach means comprehensive documentation of all key processes in the company, such as customer relations, resources, production management, quality control and management, risks, etc. To a large extent, the implementation of this principle will be related to possibilities for horizontal and vertical integration, equipment compatibility, software and hardware capabilities, availability of digital twins, degree of automation, etc.

- Improvement

Improvement is an integral part of the dynamic business environment and it must be present at all management levels. Flexible automatic production systems and modularity of Industry 4.0 enable technological improvement.

- Evidence-based decision making

The big concerns related to this principle are that autonomy of cyber-physical systems on one hand leads to timely and adequate decisions, but on another hand wrong data or defects in database can lead to system errors at the level of factory-degraded quality, wrong orders, damaged tools and equipment, etc.

- Relationship management

Relationship management will give way to communication management through the Internet of Things, the Internet of Services and ERP systems.

3.Documented information

Documented information is information for which there is a certain requirement to be controlled and stored by the company and the media on which it is stored. It is divided into documentation required by the standard and documentation determined to be necessary for the efficiency of the system. Documented information is divided into 4 levels{fig.2}.

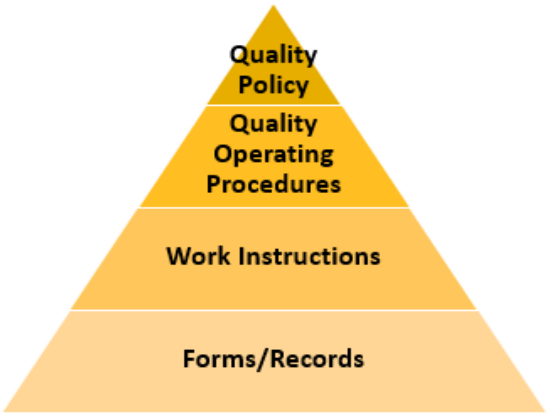


Fig.2 *Levels of documented information [5]*

Documented information{fig.3} should have a name, numbering, version and date in order to ensure identification and traceability, and there is no requirement for format (paper, electronic or combined),.

	Identical number	Version	
	ISO 9001:2015	Page	
	Name of the document	Signature	Date
Created by:			
Confirmed by			

Fig.3 *Headline of a documented information*

In the context of Industry 4.0, documented information at all levels should be fully digitized, but the following obstacles exist:

• Templates and content of documented information will be different because they will depend on the existing software and hardware of the equipment.Оне control card will be presented differently on different machines.

• The identification of the documented information will be only by name, it will not be possible to use numbering, which is a significant inconformity.

• Archiving of documented information will be limited to storage capacity of the equipment.

• Electronic documents are more difficult to be protected

All these obstacles will lead to combined and duplicated information, which complicates management and storage.

4.Clauses analyze of ISO 9001

The clauses of the entire ISO 9001 and the approach of the system is shown {fig.4}[6].The context of the organization and determining the expectations of interested parties(fig.5} is also part of the orientation of the company as a whole, but the implementation of Industry 4.0 would lead to their revision and updating. The context of the organization cannot be done automatically, even with artificial intelligence, because it includes environmental, technological, economic, natural, resource, competitive context, as well as culture, corporate image and values of the company. In general, section 4 is too specific to be completed automatically.

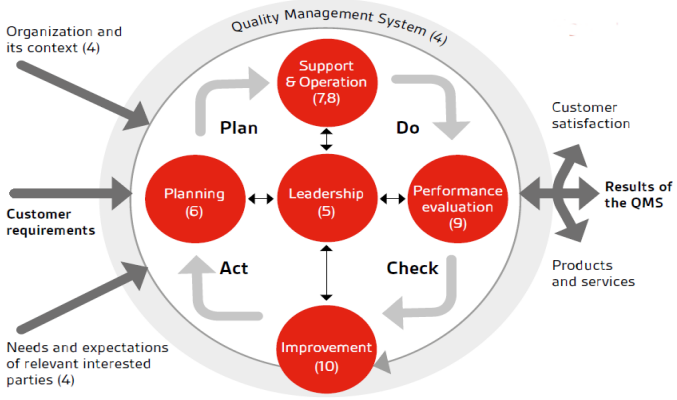


Fig.4 *Structure of ISO 9001 and the PDCA approach[6]*

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Fig.5 *Interested parties*

Responsibility of management, are aimed at the successful functioning of the company, making a profit based on satisfying the requirements of customers and other interested parties.Management of the company demonstrates personal commitment through leadership and active participation in the management of all processes necessary for the system. Clause 5 includes the quality management policy, the organizational structure and roles and responsibilities in the company, also a risk management procedure{fig.6}, legal and regulatory requirements, quality objectives,

These are entirely management functions, which will not change in the conditions of Industry 4.0. Planned actions are carried out, in which circumstances and requirements of an external and internal nature are taken into account and the risks and opportunities that must be taken into account are determined in order to:

• create confidence that the system can achieve the intended results;
• increase the desired consequences;
• prevent or reduce unwanted consequences;
• achieve improvement.

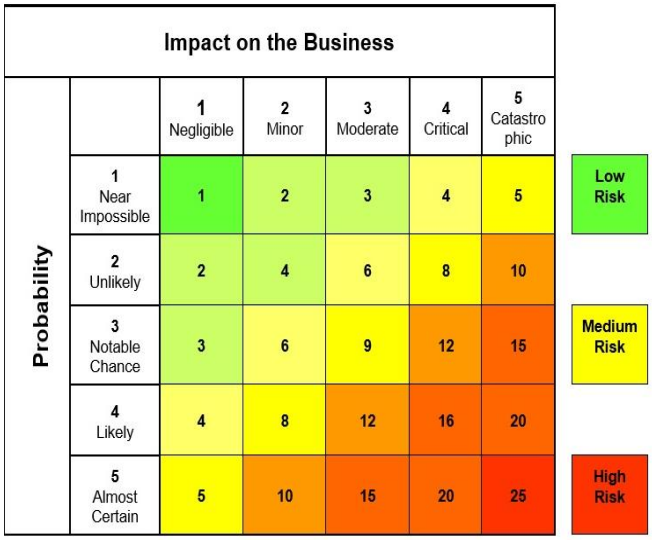


Fig.6 *Part of a risk procedure, FMEA example.*

The quality goals should be consistent with quality policy and should be specific, measurable, realistic, achievable and timely. The quality objectives in the context of Industry 4.0 will be limited to the technical capabilities of the smart factory, they will be a function of the horizontal and the vertical integration, capabilities of the digital twins, modularity, level of the cyber-physical systems, etc. Higher quality goals will be associated only with a higher class of equipment. All activities in this clause may be supported by elements of Industry 4.0, but will hardly be fully automated

. By determining and securing the resources necessary to achieve goals, management ensures that customer requirements are met. In the context of Industry 4.0, focus from human resource management will increasingly shift to a focus on infrastructure. One of the goals of Industry 4.0 is complete autonomy of infrastructure, as a large part of the information for planning and support will be electronic in the software of the machines themselves and it will be managed as Big data.

A barrier to the quality management system implementation to Industry 4.0 are the processes related to monitoring and measuring resources. The monitoring and measuring resources should be implemented in the control station equipment itself and control of the monitoring and measuring resources should be fully automated. This can lead to to serious difficulties regarding compliance with relevant standards, as regards measurement accuracy, measurement frequency, number of measurements, dimensions, testing conditions, etc. Another big problem is about the calibration of resources for monitoring and measuring of such equipment, due to the lack of appropriate tools and standards in this direction.

Points knowledge and experience, competence and awareness should be completely focused on machine learning. Keeping these points in a future version should have a completely different interpretation.

Planning determines the resources needed to meet product and service requirements. The activities in clause 8 are customer-related processes, new product design, production planning and control, non-conforming product management, process management and products from external suppliers. Almost all activities in this section, except for design of a new product, may be carried out with full integration of the principles of Industry 4.0 automatically, though, Internet of things, Internet of services, machine-machine communication.

The design of a new product is usually a long main procedure that goes through following stages-design planning, determining the input data (normative, functional and operational requirements, information from previous developments), design results (compliance with the input data, characteristics related to safety), design review (evaluation of results, non-conformance analysis, verification of the entire design process, confirmation and validation. In any case, this procedure would be difficult to fully automatically implementation, due to the great variety of potential new designs and the heuristic nature of the process.

Clause 9 contains the main procedure of internal audit and management review. In any case, the concept of Industry 4.0 presupposes conduct of a digital internal audit and all activities to be performed automatically without human intervention [7]. This will lead to independent verification by internal audit and higher results from its conduct. The management review will remain in its same format.

Clause 10 contains the points of corrective actions and continuous improvement. The corrective actions are expected to be performed primarily digitally by machine, as the prerequisites for this are the possibilities for processing Big data, timely decision-making.

Continuous improvement will continue to be based on the Deming-PDCA cycle because it is fundamental to the entire system.

5.Conclusion

The principles of the quality management system will remain for the most part even with the full implementation of Industry 4.0, as the inclusion of people will move more to the inclusion of machines in a smart factory, The management of relationships will move to management of digital communication. Changes in the principles of the quality management system will not change the integrity and objectives of the system.

Along complete digitization of the documented information of the quality management system, the question how the documents will be identified by numbers remains problematic. It would be good if the identification remains only by the name, but for this purpose a change in the standard is needed. The analysis of the structure of the standard shows, that some clauses will be very difficult to become digitized-Context, Leadership, Planning. The rest of the clauses-Support, Operation, Performance evaluation and Improvement may be digitized with appropriate technological development.

The combination of 9001 and Industry 4.0 should lead to a synergistic effect, and for this purpose the future version of the ISO 9001 standards should be related to Industry 4.0 and be normatively more flexible towards digital processes, in order to increase the competitiveness of industrial companies

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Guidelines for the application of artificial intelligence in the study of the influence of climate change on transport infrastructure

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Abstract: *We are witnessing the massive and impressive penetration of artificial intelligence (AI) into many areas of human activity. This process is expected to intensify in the next few decades. In most technical fields, there will be a preponderance of the so-called narrow artificial intelligence with clearly defined tasks and functions. It is usually a coherent set of neural networks trained to solve specific problems. The advantage of narrow AI is that it is entirely controllable and, at the same time, has excellent capabilities. This publication aims to outline guidelines for applying narrow artificial intelligence in investigating the impact of climate change on transport infrastructure. After a brief introduction to narrow artificial intelligence and climate change, various possible areas suitable for AI modeling are explored. Directions and preparatory tasks for collecting climate-sensitive local data on the condition and changes in the transport infrastructure in Bulgaria necessary for AI training are identified.*
Keywords*: CLIMATE CHANGE, ARTIFICIAL INTELLIGENCE, AI, ARTIFICIAL NEURAL NETWORKS, BIG DATA*

1. Introduction

In recent years, climate change has been felt more and more sensitively. Humanity's efforts are therefore increasingly focused on tracking, understanding, and preventing the impact of climate change on various aspects of life, including transport infrastructure. In this regard, artificial intelligence (AI) can offer new and innovative solutions to this challenge.

Narrow AI [1] is a coherent set of trained neural networks with clearly defined tasks and functions that is controllable and very safe. This article proposes and discusses guidelines for using narrow AI to investigate, prevent, and adapt to climate change impacts on transportation infrastructure. The manuscript suggests relevant modeling areas that can be explored using narrow AI. Also, the article addresses the tasks required to collect climate-sensitive data on transport infrastructure in Bulgaria that can be used to train AI.

In continuation of a previous publication [2], dedicated to the impact of climate changes on transport infrastructure in Bulgaria, the authors launched a project called "Impact of climate changes on transport infrastructure in Bulgaria – a conceptual approach to assess the potential impact on achieving sustainability and safety of elements from the transport sector" to RCDC of UACEG, of which this article is a part.

To ensure the sustainable development of transport infrastructure, AI can help reduce the impact of climate change. This technology is expected to offer new opportunities for analyzing large volumes of data, allowing scientists to understand climate's influence on transport infrastructure better. Ultimately, using technologies like narrow AI can lead to better decisions and more efficient use of resources in the future.

After the first section, an introduction, the article's second section describes the features, advantages, and disadvantages of narrow artificial intelligence. A third section is dedicated to climate change and its impact on transport. The fourth section examines various possibilities for applying narrow artificial intelligence in research on the impact of climate change on transport infrastructure. Several key areas that can be modeled with AI are presented, such as analyzing traffic flows, studying the impact of climate on the road and bridge network, and assessing the condition of transport infrastructure.

In conclusion, the paper highlights the importance of applying narrow artificial intelligence in research on the impact of climate change on transport infrastructure. It suggests directions for future research in this area. The development of new AI technologies and data processing methods will allow scientists to make more accurate and reliable assessments of the impact of climate change on transport infrastructure and take adequate measures to protect it.

2. Narrow Artificial Intelligence

2.1. Definition and characteristics

Narrow artificial intelligence (AI), also known as weak or applied AI [1], is a type of artificial intelligence that is designed to perform very specific tasks within a limited and predefined scope. The system gains knowledge from performing the task, but this knowledge is not applicable to any other tasks.

For the AI to perform well on the given task, it must be trained on a very specific dataset and be designed to perform a narrow set of functions. If the dataset is well chosen and the process of learning is strictly following good practices, the AI system will often perform the given task with better accuracy and efficiency than a human can do it.

Narrow AI systems use machine learning algorithms such as neural networks, decision trees, and support vector machines to analyze the training data and make predictions or decisions based on that data. These systems typically require large amounts of training data so that they learn everything from them. Their performance on the given task solely depends on the data we are using, and that is why we must choose precisely what data we are using for the training process.

The large language models chatGPT [3] and Bing [4] summarize, based on their training with numerous publications, ultimately six characteristics of narrow AI:

- Task-specific: These systems are designed to perform a specific task. They are not capable of generalizing to other tasks or adapting to new situations;
- Limited in scope: These AI systems are designed to work within a limited scope, and they are not capable of handling tasks that fall outside their programmed parameters;
- Rule-based: Narrow AI systems rely on pre-programmed rules and algorithms to perform their tasks successfully. They cannot learn or adapt on their own;
- Data-driven: Narrow AI systems require large amounts of data to learn and improve their performance. They rely on machine learning algorithms to analyze and make predictions based on the data;
- Not self-aware: Narrow AI systems are not capable of self-awareness or consciousness. They do not have emotions, feelings, or desires;
- Generally low-risk: Narrow AI systems are designed to perform specific tasks and are not capable of causing harm beyond their intended function.

Narrow AI differs a lot from General AI, and these terms should not be mistaken. General AI aims to replicate human-level intelligence across a range of cognitive tasks and find a solution for every task that is given, even if it is unfamiliar. Many experts are skeptical that General AI will ever be possible [5]. Others question whether it is even desirable. In the context of Industry 4.0, General AI is not really a point of interest. In the study [6], the authors have

shown that the gap between the AGI studies and the industrial needs is very high, unlike the gap between the needs and Machine Learning studies, which is almost closed.

It can be expected that applications that combine chatbots and specialized plugins to them that implement narrow solutions through AI will become more and more and will be applied in various areas of the economy.

2.2. Applications

Most forms of modern AI systems can be classified as narrow AI. The main topics from our everyday life in which it is used today are:

1) Images and facial recognition systems, like those used by social media companies like Facebook and Google, automatically identify people in photographs. In the transport sector, this technique is used to detect defects in the infrastructure through images and videos [7];

2) Chatbots and conversational assistants like Google Assistant, Siri, and Alexa, also included are simpler customer-service chatbots, such as a bot that assists customers with online shopping [8];

3) Self-driving vehicles. Autonomous or semiautonomous cars, such as some Tesla models and autonomous trains, drones, boats, and factory robots [9]. These types of narrow AI enhance safety, enable more efficient speed profiles, and improve the energy efficiency of vehicles. The International Association of Public Transport (UITP) has even defined five Grades of Automation (GoA) concerning train operation ranging from GoA0 to GoA4, so such a system can be evaluated [10];

4) Predictive maintenance and failure models. These models rely on data from machines, often collected through sensors, to help predict when a machine part may fail and alert users ahead of time. That is also valid for road maintenance. Thanks to data from such sensors narrow AI system can predict a defect or a failure of the transport infrastructure or predict when an object will need maintenance [11];

5) Recommendation engines. The systems that predict content a user might like or search for next. In the same way, a narrow AI system can recommend which public transport a passenger uses to be as fast as possible or which will be the cheapest;

6) Traffic Planning and Management – this includes traffic state prediction and rescheduling, analysis of passenger and freight transport, estimation of traffic demand and capacity, scheduling of cars and crews [12], etc.

2.3. Pros and cons

The narrow AI has its advantages and its flaws:

The main advantage of narrow AI is its specialization. Because the Narrow AI systems are designed to perform specific tasks, they can be highly optimized for those tasks, leading to high levels of accuracy and efficiency. Also, narrow AI systems are cost-effective. Developing and maintaining narrow AI systems can be fast and cheap because we are focusing our efforts on one specific area. And if this area is of interest, we can use a lot of the knowledge that has already been developed about it, making our work even easier. Narrow AI systems are also very easy to use once programmed. It can be used even by people who don't have a programming background or have any knowledge about artificial intelligence. Another significant advantage of narrow AI systems is their practical applications. Narrow AI is already widely used in various industries [13], such as healthcare, finance, and manufacturing. From a security perspective, the narrow AI is highly controllable because it is targeted to specific tasks and functions. This makes it safer and suitable for applications in critical systems and areas such as healthcare and automotive.

The narrow AI systems have their flaws. The main one is its limited functionality. The main issue is that narrow AI systems are very limited in their ability to perform tasks outside of their specific domain. They cannot apply their knowledge to new and unfamiliar situations or tasks. Also, they lack creativity. Narrow AI systems don't possess the creativity and innovation that AGI systems do, making it difficult for them to solve novel problems or generate new ideas. Another issue is the risk of scaling: narrow AI can run into scaling issues, especially if used to solve complex problems where there are many factors to consider. Also, narrow AI systems are highly dependent on data. That is why the training data must be large and diverse enough, so the system can be effective. This dependence on data can also lead to biases in the AI's decision-making. And lastly, the need for specialists - Narrow AI requires programming to accomplish the task it is designed to solve. This means that programming must be done by computer science professionals, which can be expensive and time-consuming.

3. Climate changes

3.1. Definition and consequences

Climate changes are defined as significant, long-term changes in the Earth's climate, particularly those related to global temperature, precipitation patterns, and other atmospheric conditions. It is primarily driven by human activities, such as the burning of fossil fuels, deforestation, and intensive agricultural practices, which release greenhouse gases like carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) into the atmosphere [14].

These greenhouse gases trap heat from the sun, causing the Earth's average temperature to rise. This phenomenon is known as global warming. As a result, the climate system becomes more unstable, leading to various impacts on ecosystems, biodiversity, and human societies. Some consequences of climate change include [15]:

- Rising temperatures: Increased global temperatures can exacerbate heatwaves, affect agriculture, and alter ecosystems and their inhabitants.
- Melting ice and rising sea levels: Warmer temperatures cause polar ice caps and glaciers to melt, contributing to rising sea levels, which can lead to coastal erosion, flooding, and the displacement of human populations.
- Changes in precipitation patterns: Climate change can lead to more extreme weather events, such as intense storms, droughts, and floods, which can damage infrastructure, agriculture, and ecosystems.
- Ocean acidification: The absorption of CO_2 by seawater increases its acidity, which can harm marine life, particularly shell-building organisms and coral reefs.
- Biodiversity loss: Changing climate conditions can disrupt ecosystems, leading to the extinction of vulnerable species and the disruption of essential ecosystem services.

Addressing climate change requires global cooperation and implementing mitigation and adaptation strategies. Mitigation involves reducing greenhouse gas emissions by transitioning to renewable energy sources, improving energy efficiency, and protecting and restoring forests. Adaptation involves adjusting to the impacts of climate change by developing climate-resilient infrastructure, protecting ecosystems, and planning for sea-level rise and other climate-related risks.

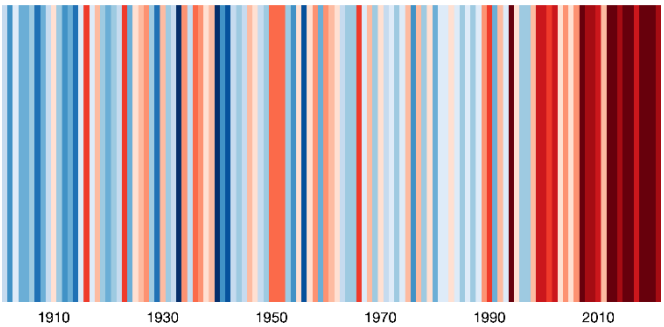


Fig. 1 *Temperature change in Bulgaria since 1901 [16].*

3.2. Consequences of climate change for transport infrastructure

Climate change has significant implications for transport infrastructure, as it can affect various transportation systems' design, construction, maintenance, and operation. The consequences of climate change on transport infrastructure include:

- Flooding and inundation: Rising sea levels and more intense precipitation events can increase the risk of coastal and inland flooding, which may damage roads, bridges, railways, ports, and other transportation infrastructure. This can lead to disruptions in transportation services, increased maintenance costs, and the need to relocate or adapt vulnerable infrastructure.
- Heat stress: Higher temperatures and heat waves can cause thermal expansion of materials, softening of asphalt, and deformation of railway tracks, leading to buckling or other forms of damage. This can result in increased maintenance and repair costs and temporary service disruptions.
- Permafrost thaw: In cold regions, the thawing of permafrost due to rising temperatures can destabilize the ground, leading to the sinking or shifting of roads, railways, bridges, and other infrastructure. This can cause damage and require costly repairs or replacements.
- Geological risks (landslides, collapses, and erosion): Changes in precipitation patterns and more frequent extreme weather events can increase the risk of landslides and erosion, damaging roads, railways, and other infrastructure, particularly in mountainous or coastal areas.
- Storm surges and hurricanes: More intense and frequent storms can lead to storm surges and hurricane-force winds, which can cause significant damage to transportation infrastructure, such as ports, airports, roads, and bridges.
- Combinations of climatic events: The formation of phenomena such as freezing rain, in which all elements of the linear infrastructure are iced, the formation of “black ice” on the roads concerning road safety, reduced visibility in fog and smoke (from fires that occurred as a secondary effect from prolonged droughts in the conditions of high mean day and night temperatures) and others.
- Changes in demand patterns of transport services: Climate change can affect transportation demand by altering seasonal patterns, such as increased demand for cooling or reduced demand for heating in buildings, and shifts in agricultural production, which can affect the transport of goods.

To address the impacts of climate change on transport infrastructure, governments, and policy-makers for the transport sector need to integrate climate change considerations into infrastructure planning, design, and maintenance. This may include updating design standards to account for future climate conditions, investing in more resilient infrastructure, and implementing adaptive management strategies to minimize disruptions and ensure the continuity of transportation services.

Environmental elements such as solar radiation, amount and intensity of precipitation, temperature inversions (extreme high/low temperatures or a wide mean diurnal temperature range), snowfall including in high wind conditions, fog, and combinations thereof, may result in acceleration and/or complicating the processes that negatively affect the operational design indicators of the transport infrastructure. As a result, one can expect unwanted and unforeseen traffic interruptions, increased risk of accidents, the deteriorated performance of the routes and their facilities, the need for more frequent repairs with expanded scope and cost, etc.

3.3. Effects on elements of transport infrastructure in Bulgaria with correlation to climate change

The combination of climatic zones and geographical relief in Bulgaria leads to many problems in the transport infrastructure. These issues concern the interaction of road, rail, airport, and port infrastructure with extreme climate events. Some main problems include damage to asphalt surfaces and pavements, thermal expansion of railway tracks, erosion and geological hazards, fires, and overloading of drainage systems in urban environments. All these factors can lead to disruption of road safety and traffic. Significant rainfall and extreme temperatures lead to numerous problems in transport infrastructure, such as overloading of river capacity, damage to bridges and roads, and freezing of road surfaces [2]. These factors can lead to reduced visibility, icing of equipment, and risk to road safety. The formation of “black ice” and “ice rain” also poses a threat to traffic safety. Snowfall and snowdrifts cause additional difficulties by disrupting traffic flow and limiting visibility.

4. Investigating the impact of climate change on transport infrastructure using narrow artificial intelligence

4.1. Difficulties in assessing the dynamics of the impact of climate change on transport infrastructure

Different climate scenarios describe how the planet's climate could change. The reasons for their existence come from the uncertainty in climate models and the complex interaction of climate factors over the long term.

Meteorology is progressing toward increasingly accurate weather forecasting within a few days to weeks. Weather forecasting in the next few seasons is getting more and more accurate. But there is significant uncertainty over periods longer than a few years, although the changing trend is known to a large extent, as regular changes in climate parameters determine it. In the short term, uncertainty comes from the stochasticity of climate phenomena.

Neural networks, which are a type of AI, can be used to create dynamic models, i.e., to have a predictive character. Thus the result can be extrapolated into the future. This is the subject of AI application in the field of climate models.

Regarding the impact of climate change on transport infrastructure, it is important to define for periods of 5 (or 10) years: 1) the trend of climate change, as well as 2) the maximum deviations from it, and 3) the expected frequency of deviations (increasingly warm winters can be expected, but this does not exclude sometimes very cold winters due to the instability of the Polar Vortex [17] due to climate change).

For a future assessment of the short-term climatic conditions in Bulgaria, there is some accumulated data (on temperature, solar radiation, humidity, precipitation, wind strength, and direction, etc.), mainly in international databases with free or paid access [18, 19]. Most often, they are based on satellite observations, which give a uniform and dense coverage of the entire territory, but at the same time, there is a deviation within a few percent of the actual values measured in meteorological stations. Terrestrial meteorological data measured in Bulgaria and stored for decades in the National Institute of Meteorology and Hydrology of Bulgaria [20] have not yet been digitized and are not available online, which as a result, holds back the development of the assessment of the impact of climate change in various areas, for example, the construction of buildings and transport facilities.

There are also problems regarding the accumulated data on the transport infrastructure problems in Bulgaria. This data should be collected and structured in one database, summarized, and prepared for future use. The interaction between climatic parameters and transport infrastructure highly depends on the location, the local climate, and the construction technologies used. For this reason, there is no significant probability that AI trained with data from other countries with different climates and other construction technologies will also give adequate results for Bulgaria. This requires launching a campaign to accumulate local data on Bulgaria's infrastructure if we want to benefit from this cutting-edge technology in Bulgaria in 5 or 10 years. The reliability of its results is directly related to the correctness of the data with which the AI is trained.

Difficulties in adapting transport infrastructure to improve its resilience against climate risks are related to the possibility of parameterizing the degree of uncertainty. Currently, this leads to a refusal to formulate prerequisites for the scope of the investment area when making decisions in the stages of design and operation of the transport infrastructure, which take into account the influence of climatic phenomena.

Despite the difficulties mentioned, the procedures for adapting to climate change in the transport sector should contain an analysis of climate impacts on the life cycle of transport infrastructure by region in the country.

For this purpose, a research resource and a relatively long period must be allocated for collecting and accumulating climatic data for the country's various regions. Our preliminary studies in [21] combined with the rapid development of AI give reason to believe that AI will significantly speed up and improve the determination of climate priority impact zones while making an algorithm to verify the expected effect on all participants in the implementation of transport services.

4.2. Collection of data to track the impact of climate change on transport services and transport infrastructure

In view of what is stated in section 3.3, it is of great importance to collect the following data to assess the impact of climate change on transport infrastructure:

- Extreme temperature values (maximums/minimums);
- Periods of droughts - with prolonged high/low temperatures without being in constant extremes;
- Amounts of precipitation exceeding the average value of liters per square meter;
- Snowfall;
- Mists;
- Extreme range wind gusts;
- Climatic combinations – fogs with low temperatures, snowfall with wind, and storms, including (wind-rain, hail-wind, excitement, and others).

Climate change tracking data on transport services and transport infrastructure can be collected through the following methods and technologies:

- Geographic Information Systems (GIS) – these can be used to collect data on transport infrastructure such as roads, bridges, railways, airports, and ports. GIS systems can provide information on the geographic location of infrastructure and its condition and use;
- GPS systems – these can be used to collect data on road traffic and the movement of large vehicles such as trucks and ships. This data can be analyzed to determine the impact of transport on the environment and climate;
- Sensors and IoT (Internet of Things) devices installed on various vehicles, such as cars, trains, planes, etc., can help collect data on their movement. These devices can connect to IoT networks, enabling automated data processing and collection;
- Sensors and IoT (Internet of Things) devices installed on transport infrastructure, such as bridges, roads, and railways, to measure temperature, humidity, wind speed, and other meteorological parameters. This will help monitor climate impacts on transport infrastructure in real-time.

The data collected through the technologies mentioned above can be analyzed using various analytical tools, software platforms, and AI. These analyses can help identify trends and changes in traffic, greenhouse gas emissions, and other environmental impacts of transportation.

5. Conclusions

This publication aims to explore guidelines for the application of AI in researching the impact of climate change on transport infrastructure. This would enable real action on climate change adaptation in the transport sector. The implementation of neural networks and artificial intelligence is a long-term task and requires long-term planning and foresight to ensure the timely collection of reliable and accurate data. The application of AI requires significant progress in the accumulation of climate data and data on changes in the state of the transport sector. In the future, this could lead to the creation of working models for climate change simulations on a territorial basis. This will make it possible to assess the severity of the impact they cause on the elements of the transport infrastructure; accordingly, it will be possible to set an increased capacity of the transport routes already within the norms for design, project preparation, operation, and maintenance, response to emergencies, building institutional capacity, adapting to changing demand and others.

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Nature of hybrid saturation in the stages of industrial development 4/5 Technical Revolutions.

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Summary: *The future of industrial development brings to the fore the problem of searching for approaches and ways to quickly and totally apply the principles of 4/5 industrial revolutions. The difficulties in achieving this goal come from the fact that it is influenced by many and different factors. With this report, we aim to specify the global goal of industrial development and its particularities. The need for hybrid specialists and activities, their essence and their saturation with novelties. Duration and their importance in the stages of industrial revolutions. A proposal is made to specify the resources by grouping them into two groups, material and human, and to propose approaches and ways for their effective use. Special attention is paid to the preparation and qualification of hybrid specialists to implement this process.*
KEYWORDS: *HYBRID SPECIALISTS, HYBRID TECHNOLOGIES, AUTOMATION, HYBRID ZONES IN 4/5 TECHNICAL REVOLUTIONS, DEVELOPMENT OF THE TRAINING PROCESS.*

1. Introduction

It is accepted that industrial development is considered in stages, and the change of these stages takes place with the so-called industrial revolutions. The first stage of development of the industrial revolutions began at the end of the 18th century, lasted over a hundred years and was connected with the mechanization of industrial activities and processes. Already at the end of the 19th century and the beginning of the 20th century, the signs of the second industrial revolution characterized by rationalization and mass production were noticed. This stage lasted for about 60-70 years. The third industrial revolution began in the 70s of the last century and was characterized with automation and computerization of processes and activities. It lasted for about 40-50 years. After it began the stage of the fourth industrial revolution, which continues even now and is characterized by integrated concepts based on cyber physical systems. It is characteristic that the signs of a new fifth industrial revolution are already visible.

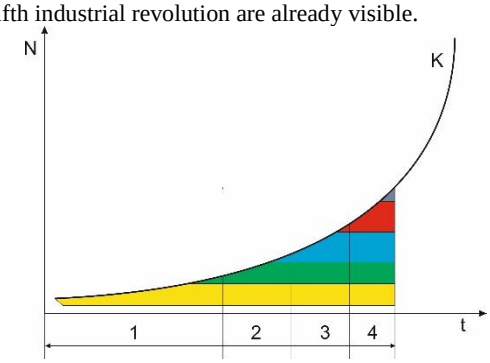


Fig. 1 *Hybrid sub-stages defines the technical level.*

where
K- curve of novelty;N- level of novelty; t-time period

Analysis shows that each subsequent stage of industrial revolutions has a shorter time period, which is accepted as a regularity in this development. The other characteristic feature is that when overlapping with novelties at the beginning and end of each of these stages, so-called hybrid zones that form a new regularity.

This hybridity is characterized by the fact that for each subsequent stage it is shorter in time and more saturated with novelties. Therefore, each of these hybrid sub-stages defines the technical level reached at the current stage and the levels of the new "hybrid" components at the next stage as shown on figure 1.

2. Purpose of industrial development bringing public benefit

The main objective of industrial development for all stages up to now has been to increase social productivity and reduce manual labor. For the fourth stage (Fourth Industrial Revolution), this goal is complemented by programmed development of artificial intelligence. It is expected that the fifth stage (Fifth Industrial Revolution) will also include research related to changes in the functional essence of man.

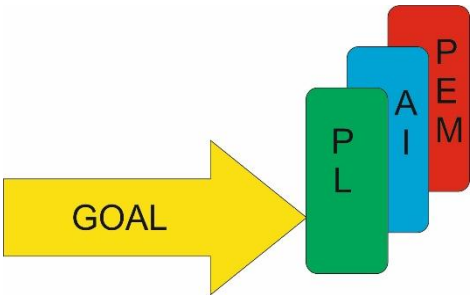


Fig. 2 *Continuity and flexibility of the goals of the industrial revolutions.*

where
PL- Performance level
AI- Artificial intelligence
PEM - Physical essence of man

3. Peculiarities of the time stages of hybrid saturation

Each of these temporal sub-stages or phases of hybrid saturation passes through the following levels of technical development and change. These are the levels of quantitative accumulation and the levels of qualitative change at which the regularities of both the current and the future industrial revolution operate. Examples from practice a lot. Stepless gearbox on passenger cars; application of artificial intelligence in the regulation of production processes and activities; the use of information modules in technological concepts, etc. The special thing about these hybrid zones is that so far few people know them and can pass on their knowledge and experience to others. Either we do not have sufficiently prepared teachers (professors), and secondly, we do not have accumulated production and research experience in this new direction. (Figure on quantitative and qualitative changes in technology)

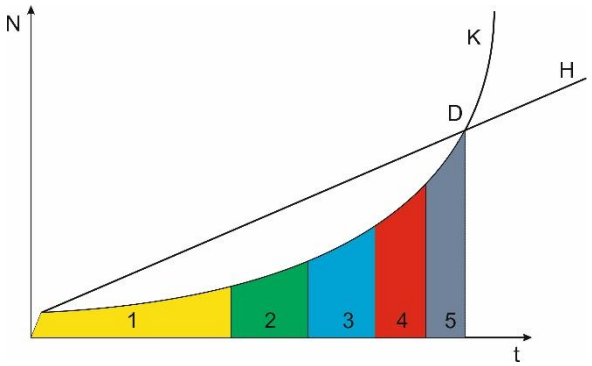


Fig. 3 *Quantitative and qualitative changes in technology*

Where
H- line of human possibility
K- technological development curve
D- point of depletion of the human resource

4. Resources

Two types of resources will be needed to solve this problem in the future; material and human.

The material will be expressed in the allocation and inclusion in the national budgets of the EU member states of a large monetary resource for use, mainly in the field of new technologies, artificial intelligence, cyber physical systems, experimental research, experimental conclusions, etc..

Human resources, on the other hand, will cover the training of specialists in new educational programs to work in the hybrid environment. Essentially, this means restructuring higher technical education along the following lines;

Training of specialists with a conventional profile mainly for implementation, operation, maintenance, diagnosis and repair of conventional technologies. This can be a subject of activity of higher technical schools. Training of specialists for work in a hybrid environment and cyber technologies will require a radical restructuring of Higher Education. First, reducing the volume of the lecture material (Eliminating everything unnecessary) and secondly increasing the quality of the lecture material. It should be clear, understandable and saturated with innovative solutions. The ratio of lectures to exercises should be 1 to 5-10. The old idea of exercise must also be changed. These should be methods of research and experimentation with research laboratories, experimental units and other such related cyber physical technological concepts. Technical universities will be the most suitable for achieving this goal.

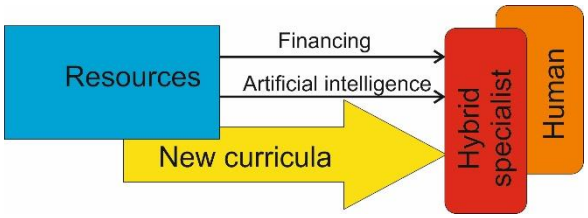


Fig. 4 *Ratio of material / human resources.*

5. Expected results

Increased resource squeeze effect from hybrid zones.

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Security related BPMN-extensions for RPA

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Abstract: *Direct Robotic process automation (RPA) has received a lot of attention because of the increasing demand for solutions to improve the efficiency of business processes in an organization. With RPA, organizations can develop robots that automate a large number of processes. However, despite its relevance, RPA is a relatively young field and many of its concepts remain open to discussion. One of the primary tasks in creating a robot is the identification of threats at the design stage, which reduces the number of possible attacks, identifying vulnerabilities, thereby increasing the security of the robot itself. The increasing use of RPA-based solutions in mission-critical systems has created a need and interest in assessing their threats. The foundation for successful creation, launch and use of a secure RPA-based solution would be application of classical design techniques and evaluating the risks on all SDLC cycle stages. But in order to perform this appropriate tools taking into consideration the specific nuances of the domain area are needed. BPMN notation, used for describing business processes can be seen as a good candidate for designing RPA solutions. However, BPMN is not able to cover the description of all aspects in the robot process, namely, issues related to the specifics of RPA security remain unaccounted for. This study analyses business process notation (BPMN) as a modelling tool for the design of automated processes in RPA, proposes an approach for defining security-related extensions of BPMN using its own extension mechanism, that can be used for risk analysis on different SDLC stages.*
Keywords*: RPA, BPMN-EXTENSIONS FOR RPA, SECURITY RPA, THREATS OF RPA.*

1. Introduction and problem discussion

Robotic process automation (RPA) is the use of scripts and software algorithms to efficiently and safely automate repetitive and routine tasks that are typically performed by company employees.

Before integrating software, it is important to have a good understanding of robotic process automation. In small companies, the process of robotization is usually quite simple: an analyst describes the process, and then RPA is implemented. In large companies, things are much more complicated. Using BPM, it is necessary to identify processes suitable for robotization, evaluate the effectiveness and potential of robotization, develop an algorithm and launch the robot.

Therefore, a structured modeling language is essential for mapping concepts related to the implementation of a robot.

A common solution for process modeling, including robotization steps, is to apply traditional business process modeling methodologies. There are several standard business process modeling languages.

Business Process Model and Notation (BPMN) is considered to be one of the major standards among others. BPMN was developed by the Business Process Modeling Initiative (BPMI) and is now adopted by the Object Management Group (OMG), which provides a business standard for representing business processes or procedures using graphical notation. It covers business functions of an organization by modeling the interaction between different departments and processes. However, it does not provide any mechanisms to show the security requirements of these processes, which is the main concern of today's IS. There are goal-based and threat-based approaches to analyze the security requirements. The goal-based approach is an abstract approach that highlights the goals that can be achieved and includes all threats underlying the goal. While the threat-based approach is more detailed and analyses-specific threats define security requirements [1]

Traditionally, security requirements are considered only after defining the business process. However, this will inevitably increase the vulnerability of the system due to the functional behavior of the system and security is usually are not independent of each other. It calls for security experts cannot get enough feedback on the system safety requirements. Therefore, security must be not only considered at a technical level, but also at an abstraction the level at which the business process was first defined.

This study analyzes business process notation (BPMN) as a modeling tool for the design of automated processes in RPA, proposes an approach for defining security-related extensions of BPMN using its own extension mechanism, that can be used for risk analysis on different SDLC stages.

2. Objective and research methodologies

An analysis of the modeling of conduct cases on the use of RPA made it possible to determine that the most common type of attack is spoofing, due to the presence of a large amount of data exchange. Data leakage and theft are the two main threats. Critical data, such as passwords of RPA bots or consumer data processed by RPA, can be accessed by attackers if the appropriate security measures are not taken[2].

Also, conducted threat analysis using RPA shows that the cybersecurity risks associated with implementing RPA are not much different from the traditional cybersecurity risks that are commonly encountered when working with other systems (fig.1).

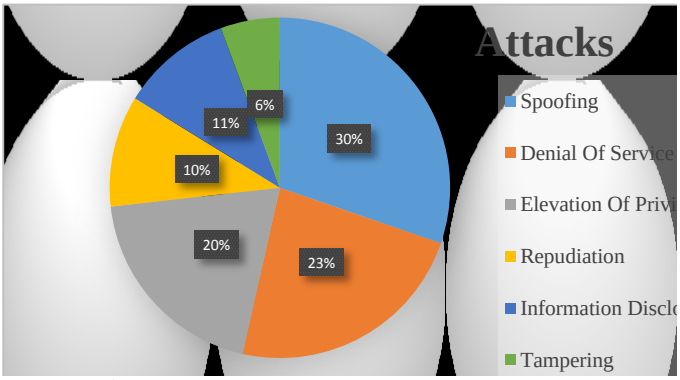


Fig.1 *Type of attack in cases using RPA.*

However, you should pay attention to the presence of specific threats that are unique to RPA systems. To visually display up-to-date information, a security ontology for RPA was created [3].

To create the security related BPMN-extension, deliberate non-physical threats to the RPA were used from the ontology(fig.2).

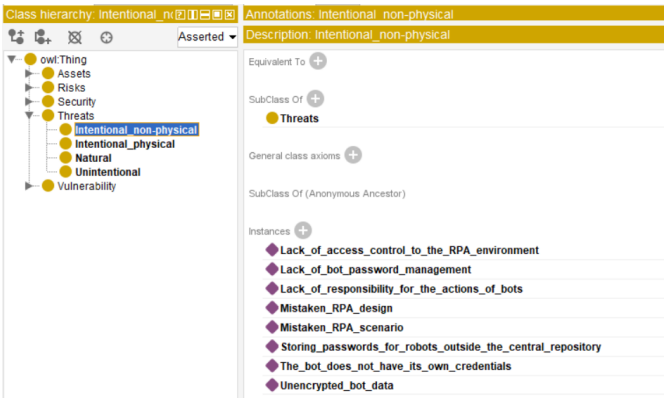


Fig.2 *Non-physical threats to the RPA.*

The next step was the development of the BPMN diagram, for this was used Bizagi Modeler 3.8.

Was create the case «Contract management process». The "gear" icon marked blocks that can be robotized(fig.3).

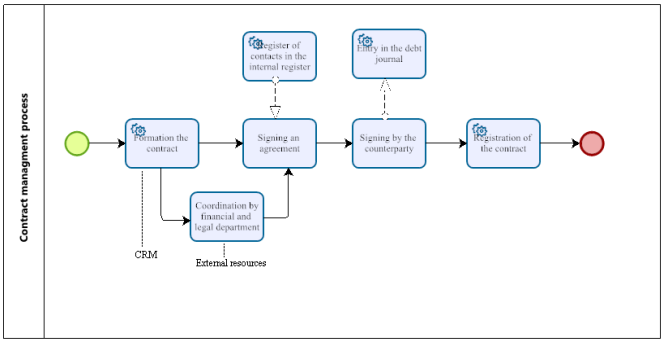


Fig.3 *Case «Contract management process».*

Table 1 lists the design of the new extended notations.

Table 1. *Extended elements for security requirements*

Element	Design
Retracing data in unsafe location	
Data leakage (credentials)	
Unencrypted bot data (own credential)	
Data change	
Third party access	
Generates consistent logs	
Lack of access control to the RPA environment	
Changing data in a robot report	
Mistaken RPA script	
Lack of bot password management	

Further, it was necessary to add the developed set of extensions to the Bizagi Modeler tool for its further use. Extensions were added as new custom artifacts (fig. 4).

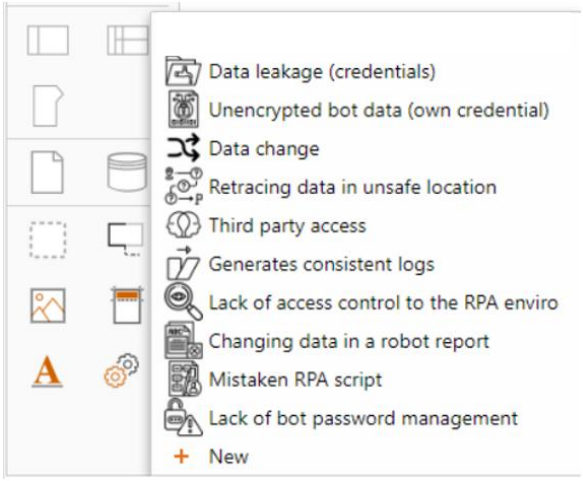


Fig.4 *Custom artifacts.*

In Figure 5 we demonstrate an extended version of the BPMN diagram with the help of our newly designed security elements for representing the security requirements within BPMN. There are several security requirements that are demonstrated here.

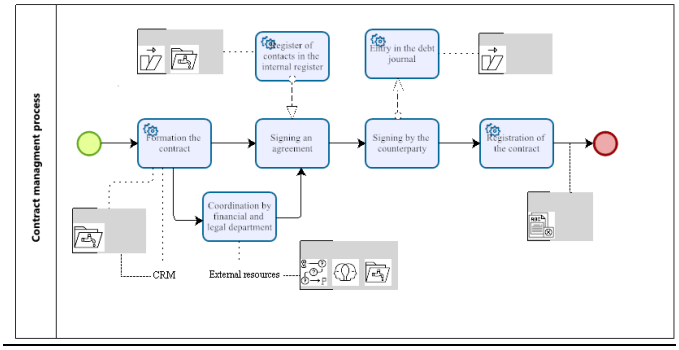


Fig.5 *Case «Contract management process».*

The issue of safety in the application of RPA technology is becoming increasingly relevant. This is critical for reflecting safety requirements in the conceptual business process flow, which is a preliminary step in the development of a robot.

In this article, we extend the BPMN standard to accommodate Security Requirements in the first place. It provides an opportunity to improve and increase security awareness in RPA. A set of security extensions is implemented in Bizagi Modeler as a custom artifact. The usage of the security extensions are illustrated with a simple an example of the contract management process.

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Virtual workplace: current knowledge, changes and a new perspective on the way of work. A Systematic Literature Review.

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Abstract**:** *Today's world is full of rapid changes, accompanied by an unsustainable pace of technological development. Thanks to the advent of virtualization, the way of working is changing as the dependence on time and space ceases to influence work opportunities. Globalization, information, and communication technologies mean that we are encountering more and more concepts such as virtual teams, virtual leadership, or remote working in companies. At the same time, virtualization, accelerated by the COVID-19 pandemic, opens up a range of new issues that require greater interest from researchers - such as the specifics of women working from home, the gender gap, ways of coping with stress, and others. Our paper is therefore dedicated to a systematic review of the literature on virtualization. Based on a qualitative analysis of the 30 most cited works from the Web of Science database that relate to the topic of the virtual workplace and were published in 2018-2022, we provide an overview of the current issues and challenges facing the corporate sector today. The VOSviewer and Voyant Tools software were used for the systematic literature review. Our research provides an overview of the most important topics related to virtualization while presenting problems and existing research gaps.*
Keywords**:** *VIRTUALIZATION, VIRTUAL WORKPLACE, VIRTUAL ORGANIZATION, VIRTUAL TEAM, VIRTUAL LEADERS*

1. Introduction

In the field of technological innovation, there is currently an unprecedented boom and improvement. A major change is also virtualization and the emergence of a virtual work environment where physical distances or time zone differences no longer matter. Companies are responding to technological innovation by digitally transforming their processes. The crisis related to the COVID-19 pandemic has had an even greater impact on the digitalization and virtualization of the world of work.

Many companies have decided to reduce the risks by relying on remote or home working to prevent contact between people and thus the spread of the virus itself. In the immaterial world, the constraints of the material environment are disappearing and opportunities, but also obstacles and risks related to the use of the virtual workplace are emerging. This situation brings new issues for management that reflect the challenges of the business environment, such as labor productivity in a virtual environment [1-3], the issue of gender when working from home [4, 1, 5, 6] the quality of videoconferencing in a virtual environment [7] or the issue of leadership in a virtual environment [8], as well as mental health, stress and well-being. Not only new topics are emerging, but also new concepts such as work from anywhere [2] gig work and gig workers [9].

Current technological development is focused on finding new ways for people and technology to interact. Growth as the only acceptable outcome is driving companies towards increasingly sophisticated concepts of competitiveness. Technological progress is shrinking the physical world and shaping a virtual world whose potential seems limitless. The world of work in the age of virtualization is also a reason to reflect on the changes in the nature of work, the demand for work, and social insecurity, as well as on the management of work performance and the building of employee value in times of virtualization of work. Systemic, technological, and above all value-based changes, which are a consequence of progress, not only determine modern concepts of human resource management but also create a new perspective on work, the management of work performance, and the creation of value in the 21st century. The aim of our contribution is therefore to map the current state of research on virtualization and to provide a comprehensive overview of the current challenges for companies. Our research provides an overview of the most important issues related to virtualization while highlighting the problems and existing research gaps.

2. Theory background

The digital economy is a term that signals the use of information and communication technologies, especially in the production sectors and thus in society (digital society). Digital transformation is leading to far-reaching changes in all areas of value creation, resulting in more efficient business processes, stronger customer orientation, and new business models [9]. In the virtual environment, the content of the performance and the responsibility for it are changing. Relationships are transformed. Performance is the outcome, not the complexity and hassle of getting there. Current knowledge about the impact of digital transformation on work raises the question of e readiness of companies to manage a new generation of employees and, at the same time, the readiness of employees to work in a virtual environment. A virtual organization is a flexible network of independent entities linked by telecommunications and computer technologies to share knowledge, skills, and access to expertise in a non-traditional way. It is a form of cooperation between companies, institutions, but also individuals who offer a product or service based on a common business interest. Individual subjects cooperate and present themselves as a single organization [11]. The current pandemic period has accelerated the transition from a traditional form of organization to a virtual organization. The foundation of a virtual organization is information and communication technologies (ICTs) [12]. Based on the above facts, the main characteristics of a virtual organization are the following: flat organizational structure, dynamism, informal communication, flexibility in all areas - e.g. working hours, multidisciplinary teams, focus on achieving goals, pro-customer orientation, working from home – an absence of a physical shared workplace, information sharing, use of outsourcing, the expertise of employees and managers. We believe it is important to explore the development and use of technological innovations in line with the demands of the digital world and at the same time with the appeal to humanize work. The potential of digitalization and working in a virtual environment is currently not fully explored. We, therefore, consider it essential to define basic terms such as virtual organization, virtual team, remote work, and virtual leadership.

2.1 Virtual organization

The development of the Internet and the subsequent emergence of ICT have led to the emergence of virtual organizations. These are defined as temporary groupings of companies that work together and share their resources, knowledge, and skills to better respond to

changes in the external environment. For the first time, the term virtual organization appeared as early as the 1980s in the work of Mowshowitz, when the author spoke of such an organizational arrangement in which there is a consistent separation between the requirements and the ways to fulfill them. Somewhat later, the term appeared in the work of Malon and Davidow in the 1990s, with the authors emphasizing the temporality aspect - the structure is created to fulfill a specific business objective, after which it is dissolved. For a virtual organization, the use of ICT is key [12]. A virtual organization is created through the intensive use of ICT and has no specific structure. Based on the possibilities offered by technology today, the virtual organization functions independently of the concept of time and space. An organization can also have a digital structure and also provide opportunities to be closer to customers and markets. Virtual collaboration is thus defined by technologies that focus on socially integrative and easily connecting technologies. As we have already mentioned, the virtual organization is based on the strict separation of requirements and the way they are fulfilled [13]. This separation allows managers to easily and flexibly change the way requirements are fulfilled depending on the current circumstances - and this is exactly what the flexibility of this structure is based on. This makes the need for specialized management activities that examine and monitor the abstract requirements necessary to achieve a particular goal and at the same time, independently, examine and determine the concrete means of meeting those requirements, extremely demanding. At the same time, this creates pressure to coordinate activities to a high degree. By logically separating the requirements from the means of meeting them, management creates an environment in which the means of achieving the goal are constantly and routinely evaluated against explicit criteria. This governance structure ensures that requirements are always met as adequately as possible [13]. A virtual organization is characterized by a continuous organization through virtual teams and alliances, a unique management culture and set of norms, information and knowledge sharing enabled by information technology, and employee self-management [14]. In modern literature [15] the term virtual network structure is already used today, which seems to underline the fact that the virtual organization is only a superstructure of the network structure and is taken to a new level mainly through the use of ICT and the shift of the work environment to the virtual world.

2.2 Virtual team

A virtual team is a group of people working across different time zones, locations, and organizational boundaries, connected by communication technologies. They have complementary skills and are committed to common goals, have interrelated performance-based tasks, and share a work approach in which each member of the virtual team is personally accountable. Virtual teams are geographically dispersed and enable companies to collaborate and hire the best people regardless of location [16] point out that virtual teams consist of geographically separated employees working on a common goal and communicating with each other via information technology.

2.3 Remote work

Remote working increases the quality of life and allows employers to get the best employees wherever they are. Remote working also leads to savings in office costs. In practice, remote working can take the following forms:

Home office or work from home, i.e. working from home. By home office we usually mean an occasional situation where an employee stays at home for some reason to work from home, homeworking is used in cases where working from home is a pre-agreed norm.

The term telework is used for forms of remote work (from the Greek word tele - far) where the employee works either from home or from another location outside the employer's workplace, making full use of current modern technologies.

The literature also mentions the term telecommuting, where this term includes employees who have a traditional office but work from another location 1-3 days a week.

***Table 1**: Advantages and disadvantages of remote work*

Advantages of remote work	Disadvantages of remote work
Employees often perceive it as a benefit.	Little opportunity to control employees.
It provides employees with a sense of freedom and flexibility.	Great demands on the organizational skills of individuals and managers.
Time-saving (commuting to/from work as well as on business trips is eliminated).	Demanding on employees' self-discipline.
Saving commuting costs for the employee.	High costs of hardware and software equipment.
Saving office space costs.	Brain drain - even if employees do not physically move to their employer's country, they often provide their talent abroad.
The opportunity to employ people from abroad who do not have to travel or leave their homes.	The emergence of new ethical problems - employment of cheap labor force from abroad and non-respect of human rights.
The opportunity to obtain a cheaper labor force from abroad, without the need to move for work.	The risk of mutual alienation of employees.
The opportunity to work even with certain health restrictions - (e.g. a broken leg) or when treating a sick child.	Absence of non-verbal communication.
Lower environmental impact due to elimination of travel.	Social isolation of employees. [17] state that the more people use the Internet, the more they feel lonely and depressed, experience more stress, and their communication with family members is tied, and their circle of friends narrows.

Source: Skorková, Z. 2019. Práca na diaľku ako inovatívna forma organizácie práce = Remote Work as an Innovative Form of Work Organization / Zuzana Skorková. - VEGA 1/0109/17 In: Aktuálne trendy v manažmente [electronic resource]: peer-reviewed collection of scientific papers, České Budějovice : Vysoká škola evropských a regionálních studií VŠERS, ISBN 978-80-7556-058-2. - S. 158-167 CD-ROM.

2.4 Leadership in the virtual workplace

The question of leadership is of course related to the development of virtualization. One of the biggest challenges for virtual teams is leadership. We define leadership as a relationship between a leader and his/her followers who work together to implement changes that lead to the fulfillment of their common goals [18]. In a virtual environment, the influence of transformational leadership of people is highlighted, which can increase performance, satisfaction [19], and motivation [20]. According to [21], there are three basic roles of a virtual leader:

- liaise between team members to interpret events and the overall environment.

- it is necessary to ensure a consistent specification of purpose, while the goal of each activity must be consistent with the overall goals and intentions of the team.
- the main role should be played by the response coordinator to identify the right resources and develop tactics to solve problems.

The main reason for the unsatisfactory state of virtual work is its leadership aspect, which has been underestimated and overlooked. From the perspective of some researchers, virtual teams are independent and have no formal leadership [19].

3. Research methods

3.1 Research question and data selection

The aim of this systematic literature review is to identify the current theoretical level and the current changes in the area of virtualization, especially in connection with virtual workplaces and remote work. Our research provides an overview of the main topics related to virtualization, while also presenting the issues and existing research gaps.

At the beginning of the research activity and to achieve the goal of this paper, the following research question was defined:

RQ: What is the current level of knowledge and structure of research in relation to the virtual workplace?

For the purpose of developing a systematic literature review, the authors used a standard procedure through a keyword search. In the field of the virtual workplace, which is the primary topic of this review, the following group of keywords was used:

Used keywords: virtual workplace, remote workplace, virtual office, home office, telecommuting, virtual work.

To the point of the research, the scientific database Web of Science was used, from which the 30 most cited research papers were selected based on keywords and the number of citations. This selected database was further analyzed more deeply through two online tools.

3.2 Data analysis

Two analytical tools were used to process the results: Voyant Tool and the VOSwiever tool. For word analysis, we used Voyant Tools. Voyant Tools is web-based text reading and analysis environment. It is a scholarly project that is designed to facilitate reading and interpretive practices for digital humanities students and scholars as well as for the general public (voyant-tool.org, 2022). We analyzed the headings and abstracts of the 30 most cited articles in Web of science, which were focused on virtual and remote work. In Voyant Tools, for correlation, it is used Pearson's correlation coefficient. The correlation coefficient is calculated by comparing the relative frequencies of terms (relative to each document for the corpus or relative to each segment of the document). A coefficient that approaches 1 indicates that values correlate positively, they rise and fall together. A coefficient that approaches -1 indicates that values correlate negatively; frequencies rise for one term as it drops for the other. Coefficients that approach 0 indicate little correlation, positive or negative. This value is Pearson's correlation as calculated by the Apache Math Commons Library Simple Regression class.

VOSwiever is a software tool for constructing and visualizing bibliometric networks. Our used network includes 30 selected research papers and it was created based on the citation score in the area of virtual workplace research. VOSviewer also offers text mining functionality, which is used for the purpose of data analysis and the discussion of this systematic literature review.

4. Results and finding

4. 1 Data analysis: Voyant Tool

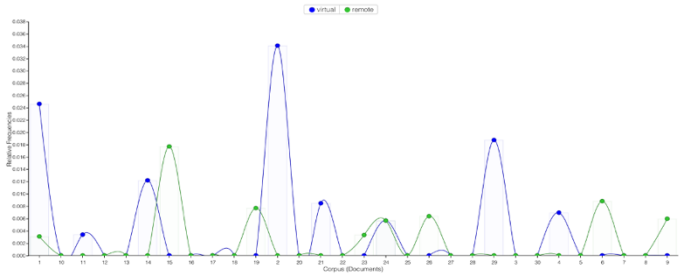
This corpus has 30 documents of 30 abstracts and includes 7,111 total words and 1,677 unique word forms. Most frequent words in the corpus: work (172); covid (64); home (61); research (50); job (50). The most used words are shown in Table no. 2.

Table 2: *The most frequently used words*

TERM	COUNT	TERM	COUNT
work	172	employees	46
covid	64	pandemic	38
home	61	telework	30
research	50	telecommuting	29
job	50	performance	29
working	46	effects	29

Resource: data analysis

Trends in Graph 1 is a visualization that represents the frequencies of terms across abstracts in the corpus. Each series in the graph is colored according to the word it represents, at the top of the graph a legend displays which words are associated with which colors – the word virtual and the word remote. The word virtual is more common in the whole corpus, it is more used by authors. Virtual work and remote work are similar concepts, but they have some differences. Virtual work refers to a type of work where employees use technology to perform their job functions from a location outside of the office. Remote work, on the other hand, is a broader term that includes virtual work. Remote work can refer to work done from home or a co-working space. The word virtual has become increasingly popular in recent years, as advances in technology have made it easier for employees to connect and collaborate from virtually anywhere.



Graph 1: *The most frequently used words*

Collocates Graph 1 represents keywords and terms that occur in proximity as a force-directed network graph. We used 25 words that relate to the word virtual. The strongest connections are with work, covid, research, service, employees, and leadership. The words in the maroon color are indirectly connected with the word virtual.

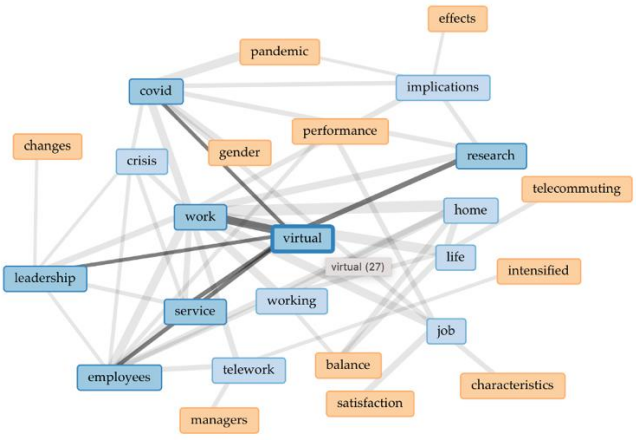


Figure1*: Links with word virtual*

According to Figure 1, the strongest positive correlation is between Work and Virtual, but the significance is weak. Other correlations are irrelevant because the significance is high (Table 3). It could be also because of the small number of values.

Table 3: *Correlation and significance among the most frequently used words*

Term 1	Term 2	Correlation (r)	Significance (p)
Work	Virtual	0.182	0.335
Covid	Virtual	0.049	0.711
Satisfaction	Virtual	0.019	0.705
Leadership	Virtual	0.006	0.891
Effects	Virtual	0.005	0.902
Family	Remote	0.002	0.940
Woman	Virtual	0.001	0.982
Man	Virtual	0.001	0.983

Resource: data analysis

4.2 Data analysis: VOSwiever tool

By using the analysis in the VOSwiever tool, the visualization of selected articles on the topic of the virtual workplace was processed according to specific parameters, which were the publication category Web of Science categories (figure 2), and citation topics meso (figure 3).

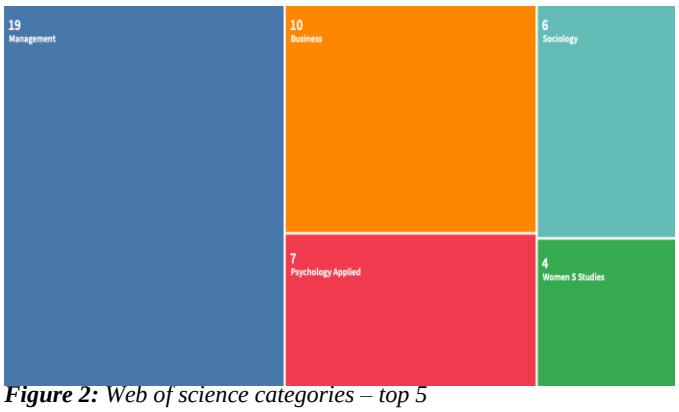


Figure 2: *Web of science categories – top 5*

The topic of the virtual workplace is very popular within the categories of Management and Business, the third category is Psychology Applied, which in practice means that this topic is also closely connected to psychology as a scientific field.



Figure 3: *Category: Citation topics meso*

The most cited articles in the field of the virtual workplace were published in the USA, but the topic is also actively addressed in Europe (a total of 14 articles published), most in Germany.

5. Discussion

5.1 Qualitative synthesis of selected research papers

The most cited research paper from the analyzed database (in a total of 30) was subsequently processed qualitatively. A brief overview of the structure of the research papers according to the research method used and according to the focus of the results is shown in the following tables 4 and 5.

Table 4*: Type of the research in analyzed research papers*

Type of the research	**Number of the research papers**
Meta-analysis - Research based on the analysis of existing findings	4
Research processed from already existing data databases	3
Qualitative analysis	1
Original research – original data collection – research sample to 50 respondents	2
Original research – original data collection – research sample from 50 to 500 respondents	12 *Avrg:233 respondents*
Original research – original data collection – research sample from 500 to 1000 respondents	2
Original research – original data collection – research sample over the 1000 respondents	3
Literary research, comparative review	3

Resource: data analysis

Most of the research papers (12 out of the 30) used original data collection, while the range of the research sample was from 50 to 500 respondents.

According to the purposes of the research and results, the database of 30 research was clustered in four areas (Table 5). The first one with a focus on job satisfaction, work-life balance, motivation and well-being contained 11 research papers [22, 23, 8, 24, 25, 3, 26, 27, 28, 29, 30]

The second cluster was focused on job performance and leadership in the conditions of the virtual workplace, online and remote jobs [8, 31, 2, 32, 33, 34].

The third one contained results and conclusion about gender and women, especially in regard of inequality and different conditions of remote work [4, 1, 35, 36, 5, 6].

The last cluster pointed out virtual jobs in online environment and its technical parameters and tool [37, 38, 39, 40, 7, 41, 42].

Table 5: *Structure of results in the research paper*

Clusters of results/research outputs	**Number of the research papers**
Job satisfaction, work-life balance, motivation, and well-being	11
Job performance and leadership	6
Gender and women	6
Virtual job, tools, and parameters	7

Resource: data analysis

Summary of the Research Methods: 27 out of 30 research papers contained original data analysis or meta-analysis with formulated research questions. The most common method was hypothesis testing and analyzing the dependencies between selected variables.

5.2 Summary and overview of the key results

On the basis of a selective analysis of the most cited research papers, a clear graphic synthesis of the most frequent and used words was processed (figure 4). Then a graphic visualization containing a time factor was processed (figure 5), which shows gradual changes between individual keywords in the analyzed articles. The shift in 2020 compared to 2019 shows the new topics that appeared in connection with the virtual workplace, namely well-being, gender, and job satisfaction.

From the analyzed database of 30 research papers, the largest number of articles was published in 2020 (13), and five of them were published in 2021. The others were published before the COVID-19 pandemic, in 2018 there were 3 research papers and in 2019 were published 9 of them.



Figure 4: *Visualization of the most frequented words across the entire*

Resource: data procession Voyant

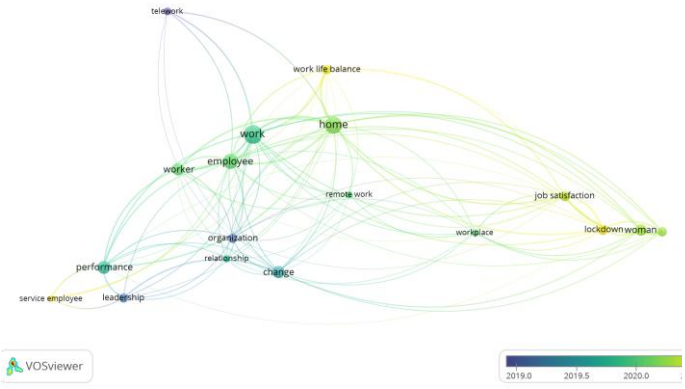


Figure 5: *Overlay visualization – changes among the crucial words over time*

Resource: Data procession VOSviewer

Based on the analysis of the most cited articles and scientific outputs (N=30), the authors defined essential current variables and key research areas that can be the object of data analysis in further research aimed at looking into the virtual workplace and remote work. In the monitored period of 2019 and 2020, there was a shift towards topics that closely connected the virtual workplace with job satisfaction, work-life balance, and gender issues.

It appears that the following research areas are essential for further study in the field of virtual workplace and remote work:

- methods and possibilities of managing work-life balance and building well-being strategies, managing stress, and building resilience;
- the area of developing mindfulness (Mindfulness is beneficial in overcoming the difficulty of disconnecting from work; difficulty in maintaining concentration on work tasks and reducing fatigue from exposure to the screen);
- identification of the optimal and effective leadership style - task orientation versus people orientation, adaptive leadership, transformational leadership, authentic leadership, virtual leadership;
- improving job satisfaction and methods of motivating employees - factors at the individual level, factors related to tasks, and factors at the company level;
- voluntariness and the possibility of choice in the case of a hybrid model of work – involuntariness causes lower performance and resistance to work as well as more conflicts, the possibility of choice reduces the level of stress and the intention to leave work. The agreement is beneficial for both parties;
- changes in the style of work, communication, and cooperation, ways of measuring performance in remote work, higher autonomy and degree of independence = greater emphasis on self-management and intrinsic motivation;
- key prejudices hindering the support of work from home by the employer and possibilities of the optimal implementation of the remote model in the companies;
- fundamental barriers and differences in the perception of men and women working from home in relation to productivity and job satisfaction, deepening of the "gender gap", remote work, and gender inequality.

The identified areas above should be analyzed together with measurable performance factors: productivity, employee satisfaction, turnover rate, and employee engagement.

6. Conclusion

The boundaries of the labor market, working hours, and working environment are disappearing as the global workplace enters a virtual environment. The current challenge for people management caused by the pandemic crisis is social distancing. The validity of researching the management of people in a virtual environment is also supported by an intensive appeal for sustainability and new forms of management and leadership of people in a virtual space that affects work performance. We consider it important to explore the post-pandemic people management trend associated with the virtual workplace, which defines the future of work and education .

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Preventing potential hazards in the development of machinery

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Abstract: *The article focuses on the definition of industrial business risks that are associated with risk management. Following the description of the risks, the article then focuses on the elimination of the hazard or the reduction of each of the two criteria that determine the risk in question, such as the severity of the damage caused by the hazard and the likelihood that the damage will occur, separately or simultaneously, are two ways to achieve the purpose of risk reduction. The article is highly relevant to the implementation and development of technical systems and equipment.*

Keywords*: INDUSTRY, SAFETY, HAZARD, RISK*

1. Introduction

The manufacturing industry forms the backbone of many nations' economies. This is especially true for countries like Slovakia where their share of total economic output is much higher than in several other national economies. With the rise of new technologies and ways of working, traditional manufacturing is facing enormous changes that pose huge challenges to established business models as well as to the way manufacturing processes are organised today. At the same time, many opportunities are arising from these developments, leading to new business models that focus, for example, on the individualisation of production, as well as on cost and efficiency gains as a result of shorter innovation cycles, shorter time-to-market or self-adaptation of production. Risk management is becoming increasingly important, especially in view of the constantly changing economic situation. Negative market developments and societal risks can lead to significant financial losses and, in the worst case, to the closure of a business. As a result, it is important that risks are not overlooked and risk management should be part of every company's activities. Despite the fact that the company faces risks, the company also has opportunities which, if properly exploited, can help it to compete or gain a better position in the market.

Risk management is getting more and more crucial at the moment, especially given how frequently the economic climate changes. Risks and unfavorable market trends that affect society can lead to significant financial losses, and in the worst situations, the closure of an enterprise. Because of this, it's critical that hazards are not undervalued, and risk management should be a part of any business. Despite the fact that the company is vulnerable to dangers on the one hand, they also have chances that, if they can take advantage of them, can help them compete or improve their position in the market.

The most crucial component of every equipment, gadget, and system in today's advanced society that has a mechanically active component is safety. This is a series of precautions to stop any part of the human operator from coming into contact or colliding with the machine during this movement. It is not at all easy to ensure the safety of machinery and equipment.

It is essential to address it at the outset of the project/application design and to incorporate it as effectively as possible right from the start of the mechanical building of the machines. It is necessary to treat or secure electronically any risks of danger that cannot be eliminated or suppressed by mechanical components (machine structure, covers, etc.).

2. Prerequisites and means for solving the problem

We describe risk management as a process in which the management makes appropriate suggestions to lessen the impact of negative effects and attempts to prevent the impact of current and future risks. On the other side, offers the chance to benefit from favorable consequences.

Business risk effects include:

- positive - they inspire the business entity and are viewed as a success if there is a profit,
- negative - they provide poorer results than anticipated and are connected to the development of a loss later on.

Business hazards can be divided into several different categories. Following is a breakdown of business risk by business area:

- production risks: insufficient resources or quality to ensure the production process,
- hazards associated with technical development of new product technologies,
- economic hazards, such as rising energy and raw material prices, international commerce, inflation, and conducting business in another state,
- business (market) risks include the availability of products on the market, competition, customer opinion, and the expansion of the firm itself,
- financial risks, such as the potential need for investment loans, changes in market interest rates, and accounting mistakes,
- political hazards, which are determined by the nation's political climate (economic policy of the government),
- media hazards - the impact of the media on an organization's market position,
- risks associated with information are tied to the advancement of communication and information technology.

The identification of potential dangers that could lower the degree of safety is accomplished through risk management. In order to set priorities and develop methods for mitigating them, the organization uses risk management, which is a method of analyzing, rating, and categorizing the risks that are encountered. Risk management, as we define it, is a continuous, systematic strategy to dealing with risk and uncertainty, in which we employ a variety of tools, methods, and strategies. It is a component of management that aims to guarantee the security and reliability of the system, procedure, undertaking, or business activity in general. [3]

Organizational risk management is used to assess and control organizational uncertainty in the form of adherence to corporate strategy and people, processes, and technology. The following principles must be adhered to in order for risk management to be applied inside the organization:

- complete backing from senior management,
- the application used by the entire company,
- educating all organization's human resources about risk management implementation,
- developing efficient methods for monitoring risk. [4]

Protecting and improving an organization's assets is the function of risk management. The following are the organizational goals that are supported by risk management in order to attain these objectives:

- provides better decision-making, planning, and prioritization based on a thorough and organized comprehension of business operations, project possibilities, and threats,
- aids in the company's usage and distribution of cash and resources more effectively,
- lessens turbulence in non-critical business areas,
- enhances and safeguards the business's resources and image,
- expands and supports the company's knowledge base as well as the expertise of its personnel,
- improves operational efficiency. [5]

Several standards and norms can be used in the firm to implement risk management. Each company chooses these standards and norms on an individual basis depending on their needs or the demands of its partners. ISO 31000: 2018 Risk management is the international standard that outlines general risk management practices. It is the source of STN ISO 31000: 2019 Risk management - instructions, the Slovak version of the standard. The standard, which is valuable to all individuals and groups without violating the law against discrimination - private, public, and social - is created for certain categories in the industry. [6]

The stages of the risk management process depicted in FIG. 1 are listed in this standard.

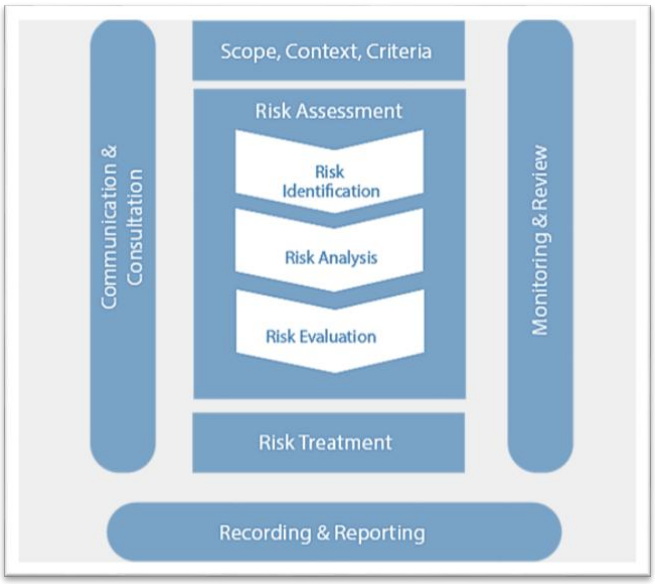


Fig. 1 *Risk Management Process (Modified from: [6]).*

The stages of the risk management process are a series of related actions and results that together form a cycle. This procedure, which is a crucial component of business management, needs to be adjusted to reflect modern business practices and corporate cultures. [3]

The risk database or the risk checklist is used to record identified risks. It is not advised to identify risks exclusively using this database and checklist.

The risk database is a compilation of organized data from previously completed projects. For usage in other projects, a formal risk information file serves as a suitable data retention mechanism.

The risk checklist is a list of potential danger zones. The issues are specific to a certain business. The list has been created expressly for a certain industry or type of business. Identification is not something we perform once, but rather something we do repeatedly or continually, depending on the situation. For this, we employ monitoring or early warning systems. On the basis of chosen indicators, they highlight the elevated risks associated with the responsible party when the development of such risks exceeds the predetermined limitations or at other regular intervals.

In conclusion, I want to underline that the most crucial and time-consuming step in the risk management process is risk identification. It involves prior experience, systematic thinking, the capacity to foresee even those things that we do not yet expect and about which we know nothing, collaboration, and a focus on the future. [3]

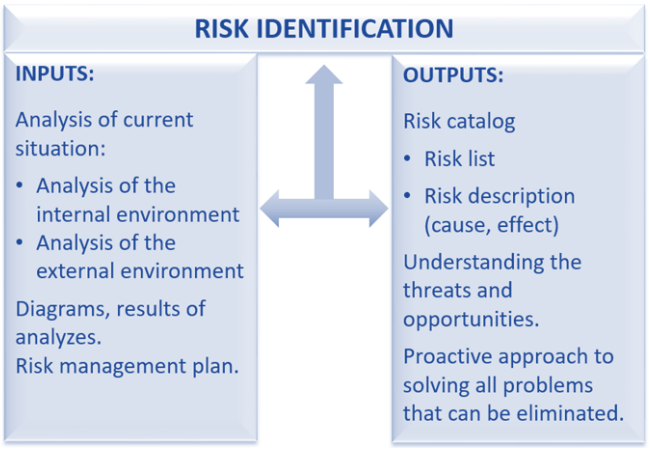


Fig. 2 *Identification risk (Modified from: [3]).*

If no precautions have been implemented on the machinery, it is assumed that an accident will eventually occur due to its inherent risks. To apply the principles of safe machinery design, one must first comprehend the use of the machinery, the history of accidents and medical records, the technologies available to reduce risk, and the legal context in which the machinery is to be used. [7]

Any machine design that may be justified today must no longer be true if technical developments make it possible to build the same machine with less risk. It is advised that a group of people do the risk assessment, while it is possible that several groups analyzing the same machine may not reach the same result. The process of assessing risk is unique to each person. The flowchart for the full process of risk assessment is shown in Figure 1. [8]

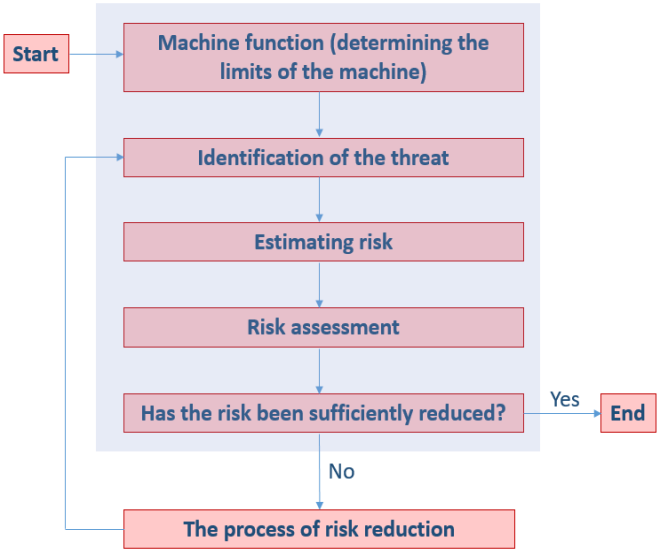


Fig. 3 *Process of risk assessment of machinery.*

3. Solution of the examined problem

The so-called "3-step method," where the machine manufacturer is required to adopt the following principles in the following order when selecting a measure, must be employed if the risk assessment has highlighted the need for further measures to minimize the risk.

Construction safety features

Developed design safety features lessen risks or minimize hazards by utilizing the machine's right design components and/or by interacting with exposed people and the machine. Hazards can only be removed at this stage, which eliminates the need for additional protective measures like safety guards or supplemental protective measures. [9]

Safety protection and additional protective measures

If it is not practicable to completely eliminate the hazard or sufficiently decrease its equivalent risk through built-in design precautions, suitable safety protection and extra protective measures may be used to lessen the risk, taking into account the predicted use and expected abuse. [9]

Usage information

The information for use must specify any residual hazards that exist even after taking additional preventive measures, safety safeguards, and built-in design safeguards. This information must at least contain the following, but not only that:

- recommended safe working practices for the use of the machinery and training requirements described accordingly; sufficient information, including warnings of residual risks for the various phases of the machinery's life,
- adequate information, including warnings of residual dangers for the various phases of the machinery's life,
- recommended safe working practices for the usage of the machinery and training requirements defined correspondingly,
- detailed description of any personal protective equipment that is suggested, including information on how to use it and what instruction is needed.

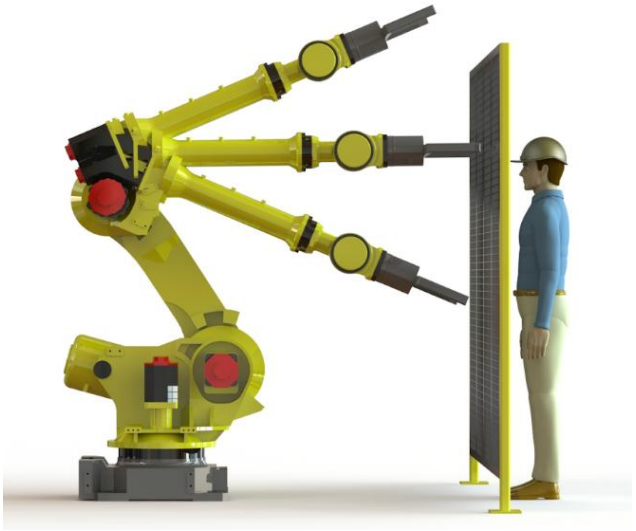


Fig. 4 *Illustrative security protection [4].*

The information provided for use is not intended to replace the proper use of any additional protection measures, safety guards, or built-in construction safety precautions. The likelihood that the operator will use risky technical interventions in the event of technical difficulties is reduced by the appropriate safeguards associated with each operating mode and intervention procedures. [7, 9]

4. Results and discussion

Constructed-in safety precautions

Including safety measures into the design itself is the first and most important step in the process of risk reduction. This is because the machine has inherent built-in safeguards that are always effective, but history has shown that even well-designed safeguards can break down or be evaded, and that usage instructions might not always be followed.

Built-in design safety measures are accomplished by removing hazards or reducing risks by choosing the proper design characteristics for the machine itself and/or interactions between exposed humans and the machine. If the built-in design safety measures are insufficient, chapter 6.3 of STN EN ISO 12100 describes the safety protection and supplemental protection techniques that can be used to achieve the risk reduction goals (three-step process). [11, 12]

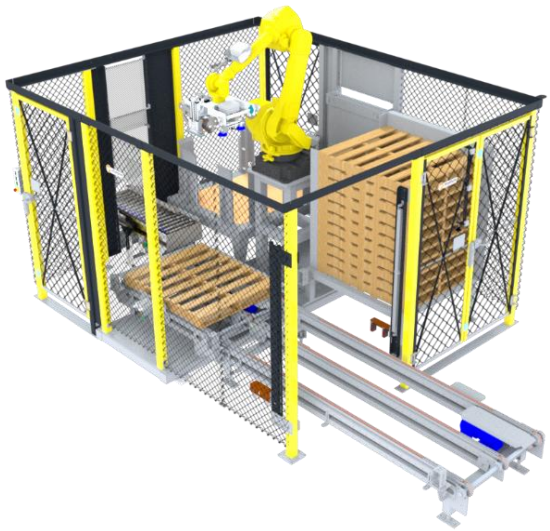


Fig. 5 *Safe robotic cell [7]*

Safety protection and additional protective measures

Guards and protective devices must be put in place for the protection of people if a built-in design safety precaution hasn't been able to entirely eliminate the risk or drastically reduce the risks. Additional safety measures could be taken by using other devices, like emergency stop devices.

By employing specific safety equipment, it is possible to avoid being exposed to various risks. A permanent guard, for instance, can be used to block access to a location with mechanical risks by reducing noise levels and capturing dangerous emissions. [11, 12]

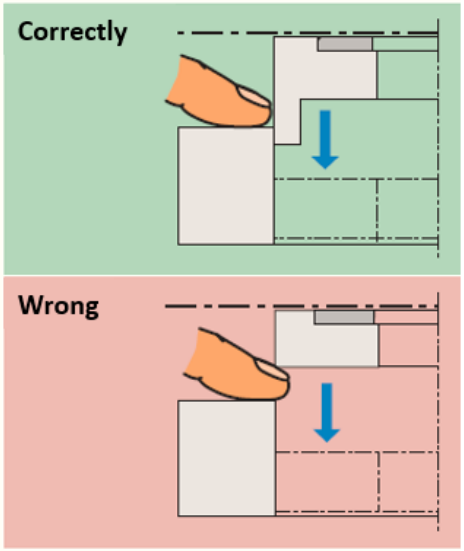


Fig. 6 *Example of cutting point elimination [7]*

Usage information

Machine design must include information design for use. The user is given the information using a variety of communication tools, including text, words, signs, signals, symbols, and diagrams, either separately or in combination. The recommended practices are intended for both professional and/or casual users.

The user must be given information on how the machine should be used, taking into account all of its operational modes.

The literature must contain all the instructions required to ensure that the machine is used safely and correctly. The user must be made aware of the lingering risk in this regard and informed of it. If training, personal protective equipment, or additional guards or protective devices may be necessary, it must be specified in the material as needed

Users must be made aware of the dangers of using the equipment in ways other than those recommended in the instructions for use, especially if misuse is anticipated. Use of the equipment that is expected to be reasonable given its intended use and description must be permitted.

The information for use must cover all of the following, either individually or collectively: transportation, assembly and installation, commissioning, use of the machine (setting up, learning/programming or changing the process, operating the machine, cleaning, fault-finding and maintenance), and, if necessary, decommissioning, dismantling, and disposal. [11, 12, 14]

Pictograms

Safety labels are a critical element of the usage instructions that machine manufacturers provide to users and are frequently the only instructions that many users can see. Because of this, the layout and positioning of safety labels are essential to their efficiency. The risk associated with improper or excessive use of safety labels is the same. Machine designers and users frequently opt for generic labels that are easily accessible from catalogs rather than having the chance to create labels that are unique to the machine and the risk. [15]

Table 1. Example of pictograms which can be used in risk assessment of machinery. [15]

Pictograms used	**Meaning of the brand**
	Caution, danger of being pulled in
	Caution, danger of crushing
	Attention flammable liquid
	Hand protection command

5. Conclusion

Every business should continuously adapt to changing client needs and the dynamic business environment if it hopes to establish or maintain its reputation in the market, make money, and improve its worth. The company is confronted with many risks as a result of the internal and external environments' rapid changes, and it is important to estimate these risks in a timely manner and take the necessary precautions to stop them from occurring or to decrease them to an acceptable level. Because of this, risk management for the firm is becoming especially critical.

Making sure that machinery and equipment is safe is not at all simple. It is crucial to take it into consideration from the very beginning of the project/application design and to incorporate it as effectively as possible from the very beginning of the mechanical construction of the machines. Risks of danger that must be managed or protected electronically because mechanical components cannot eliminate or suppress them (machine structure, coverings, etc.). Therefore, the residual risk needs to be explained in more detail in the documentation and on the equipment labels.

Safety against mechanical movements of machines has long been neglected, despite the fact that it can result in injuries just as severe as electric shocks, despite the fact that it is generally understood to be very important. Because the movement of modern automatic or semi-automatic machinery is now typically controlled by the program of the control unit, the structure of which is known only to the manufacturer's programmer, its behavior is not always predictable. Regardless of the machine control's unexpected behavior brought on by errors or unresolved error states. Using a purely "peasant approach" is not always possible: "When I am careful."

6. Acknowledgement

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Metaverse in Education

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Abstract: *The presence of technology in everyday life has also entered the field of education, including as a virtual environment. Metaverse is one of the technologies that can bring new learning and teaching processes. It is a virtual environment that allows multiple users to interact in a 3D space. This technology can bring new ways of learning and teaching, such as simulations, virtual visits to museums or historical sites, virtual exercises, and more. The use and development of applications for these technologies, as well as artificial intelligence, is the connection between ICT and educational techniques. The goal of this article is to define metaverse and describe the roles of virtual, augmented, and mixed reality. The use of artificial intelligence and applications in metaverse can also bring new opportunities for personalized learning that adapts to the needs and preferences of individual students. For example, based on the analysis of the data from previous interactions and results there can be created recommendations for students and their learning.*
Keywords*: METAVERSE, TEACHING, VR, AR, MR, INTERNET, EDUCATION*

1. Introduction

In today's world, there is an increased interest in using technology to improve educational goals. Metaverse is a virtual world environment that allows for the creation and interaction with virtual objects and characters. Due to its functionality, the Metaverse has great potential in the field of education. One example of using the Metaverse in schools could be a virtual learning environment where students can interact with various virtual objects such as cell structures, landscapes, or even planets. Such an environment can be an interesting and innovative way for students to learn new information. The Metaverse can also help in language teaching. Creating a virtual world in which students must communicate in a foreign language with other characters can be a very effective way to learn a language. Additionally, the Metaverse can be used in the field of training and education in the workplace. Employees can use the Metaverse to learn new procedures or train for various situations, which can lead to improved performance and reduced risk of errors. However, it is important to note that the Metaverse is a technology that is in its early stages of development and there are technological limitations that may affect its use in education. Furthermore, due to its dependence on technology, the use of the Metaverse should be carefully considered and healthy boundaries for students should also be considered.

2. Mevaverse

The Metaverse is a combination of the prefix “meta” which means transcending, with the word “universe” which describes a parallel or virtual environment connected to the physical world. The Metaverse was first created in 1992 by Neal Stephenson in his sci-fi novel Snow Crash, which imagines a virtual reality based on avatars on the internet. Since then, the Metaverse has been defined and considered distinct from virtual environments, including collective spaces in virtual worlds, mirror worlds [1], embodied internet/spatial internet [2], a new type of internet application and social form that integrates a range of new technologies, a post-real universe including a persistent multi-user environment that connects physical reality with virtualization [3].

In academic literature, it is stated that “Metaverse means a world in which virtual and reality influence each other and develop socially, economically and culturally to create value” [4]. From these two definitions, it follows that Metaverse simply does not combine physical and virtual worlds; on the contrary, it is a continuity of the physical world in the virtual world to create an ecosystem that connects both worlds (physical and virtual). Knox [5] supports the idea that the Metaverse is an ecosystem and emphasizes its scope and emphasizes that the Metaverse ”is not just an ordinary platform developed by one company, which indicates the usual limitations of monopolization (users of one network)”. The idea that the Metaverse is an ecosystem is also mentioned.

3. VR, AR, MR = xR

The term “VR”, “AR”, and “MR” are abbreviations for virtual reality (VR), augmented reality (AR), and mixed reality (MR) technologies [6]. These technologies are also used in education, where they allow for the creation of realistic environments for simulations, training, interactive learning materials, and other forms of teaching. The use of these technologies in education allows the students and the employees to better understand and remember the subject matter, improves their practical skills, and provides an interactive and engaging form of learning.

The Metaverse is built using a wide range of new technologies, it’s online, it’s a social network, and it provides immersive experiences through AR, MR, and VR. This world is a replica of the real world with an economic system based on blockchain technology and blends the real and virtual worlds in its economic, social, and identity system, where every user can create content and modify their world without cultural and political constraints. So, we can see replicas of buildings, environments, spaces, and objects from the real world, although the Metaverse is not an exact copy, it presents its properties and functions. Based on VR technology, AR can increase the penetration between virtual and physical space. The AR system creates a virtual 3D model through interaction technologies between human and computer, optoelectronic display, real-time 3D animation, computer graphics and tracking registration technology. The virtual model is displayed in the real world to connect the user to a combined environment and gain new experiences [7]. Additionally, AR systems increase the ability to capture information beyond the scope of human perception in the real world. Human perception expands as these pieces of information are processed by the AR system, making them perceptible to humans. Some of the potentialities and limits of the Metaverse and xR technology applied to education are like those in e-learning, such as location: both the student and the teacher can be located anywhere in the world. The Metaverse and xR technology in education offer a more immersive and interactive learning experience. Students can engage with learning materials and environments in a more natural and intuitive way, using their whole body and multiple senses. This can lead to a deeper understanding of the subject matter and better retention of information.

Another potential advantage of the Metaverse and xR technology is the ability to simulate real-life situations and experiences, which can be particularly useful for training in fields such as medicine, engineering, and aviation. Students can practice skills and procedures in a safe and controlled environment without the risk of harm to themselves or others.

However, there are also limitations to the use of Metaverse and xR technology in education. One of the main challenges is the cost and accessibility of the technology. Creating and maintaining virtual environments and providing the necessary hardware and software for students to access them can be

expensive. There is also a risk of over-reliance on technology, which can lead to a loss of personal connection and communication between students and teachers. It is important to ensure that the use of Metaverse and xR technology is balanced with face-to-face interaction and other forms of learning.

Finally, there are concerns about privacy and security in the Metaverse, particularly regarding the collection and use of personal data. It is important to establish clear guidelines and regulations to ensure that students' privacy is protected, and their data is used responsibly.

4. Results and discussion

This article provides a brief description and evaluation of the metaverse and xR technologies. It shows that the fundamental characteristics of VR/AR/MR and the Metaverse, which are immersive and multi-sensory interactive experiences, can be introduced into education.

VR is a popular choice among college students as a supplement to teaching, despite related costs and side effects such as nausea. AR has shown the greatest potential for independent study. Larger and long-term studies are needed to determine the real effectiveness and consider the clinical relevance of these technologies. In addition, the potential for monetization through the use of the Metaverses in education should also be considered. For instance, schools can potentially monetize the use of virtual classrooms, where students can interact with each other and their teachers in a virtual environment. This could potentially be a source of revenue for schools and a way to fund the implementation of new educational technologies.

Furthermore, future research could explore the use of different platforms and projects for different subjects and catalogue various platforms and projects according to their effectiveness in transferring educational experiences. Another possibility is to develop a curriculum for these platforms/projects that would help educators become more familiar with the Metaverse.

In conclusion, while there is much potential for the use of VR/AR/MR and the metaverse in education, there is still much research needed to determine their true effectiveness and clinical relevance. However, with the ongoing advancements in technology and the increasing demand for innovative educational experiences, the future of education in the Metaverse looks promising.

5. Conclusion

Metaverses can provide schools with opportunities for monetization. In future works, authors could test different platforms/projects with different subjects and bring insights into which ones could be most useful, and catalogue various platforms/projects for comparison of age/subject with regards to effective transfer of educational experiences. Another possibility is to approach the curriculum of these platforms/projects or create a curriculum plan that will help educators become more familiar with the Metaverse.

Another possibility for research could be exploring the potential of the Metaverses for educating specific groups of students, such as children with autism spectrum disorder. Research could also examine what are the most suitable ways to integrate metaverses into educational programs, what is the impact of using metaverses on student motivation, and what are the best ways to evaluate educational outcomes in Metaverse environments.

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An Interactive PLC Programming Application on Unloading and Handling Systems with Undergraduate Engineering Students

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Abstract: *This article describes an experimental setup for the practical teaching of process control in an undergraduate mechanical engineering curriculum. The system is practice-oriented and is based on developing students' skills in control system application of real process systems. A PLC (Programming Logic Controllers) program is proposed to introduce simulation aspects and final control design practices in scale processes (Unloading and Handling Station). It is based on the principle of introducing a PLC-supported, Siemens Simatic S7-200 PLC controller-controlled production system with the help of SIMATIC Step 7 Programming Software, presenting the scenario for the system and writing the PLC program accordingly. This algorithm prepared for the Unloading and Handling Station operation is not unique and without alternatives. The aim here is to enable students to get to know the system and program the system with different approaches according to the algorithm they have developed.*

Keywords*: S-200 PLC, SIMATIC STEP 7 PROGRAM, PLC ALGORITHM, UNLOADING AND HANDLING SYSTEM, EDUCATIONAL TRAINING*

1. Introduction

The advent of the PLC began in the 1970s and has become the most common choice for manufacturing controls [1]. PLCs are an important part of the electric-electronic technology field, which is the locomotive of technology [2]. PLCs are ubiquitous in automation practice and 74% of process controls job advertisements seek applicant familiarity with this equipment [3].

In traditional engineering courses, the theoretically taught concepts of control systems, usually a physical simulation of production facilities, are reinforced by the participation of students in experiments carried out in a laboratory setting. Today's schools must equip students with the knowledge and skills they need to succeed in an uncertain, constantly changing tomorrow [4]. It is very important in the control and automation curriculum to gain practical experience in monitoring, supervising, and controlling the industrial process, especially before stepping into working life [5].

In process control, experimentation helps students observe dynamic phenomena that are often difficult to display in a classroom by traditional means [6]. The continuous development of science and technology has promoted the continuous development of enterprise units, and the corresponding equipment applications and technical fields have been upgraded and broadened [7].

Relays, contactors, timers, and counters are conventionally used as elements in control circuits [8]. Using PLC is gradually increasing instead of these elements. The use of PLC equipment has been increasing day by day being parallel to progress in the systems of controls nowadays [9]. Changing the PLC programming is enough if any modification is demanded in the control function.

PLC has a wide area of use in the industrial sector, defense industry, agriculture, and the energy sector, where you can think of automation [10]. Some of these are elevator systems, automated packaging, oil wells, unloading and transport systems, conveyor belt systems, filling systems, automobile industry systems, vacuum systems, gate control systems, electrical installations, storage systems, etc.

In this study, the PLC-based unloading and handling system which is used actively in Trakya University Mechanical Theory and Dynamics Laboratory will be experimentally run with the students, so they will be experienced in the system parameters and the program before being involved in the industry.

The content of this paper is organized as follows. Section 2 introduces the components required to develop the physical demonstration setup introduced as the proposed PLC, and experimental materials and devices are illustrated. In section 3, the recommended scenario is included. In addition, detailed information is given on the PLC program and some of our student observations and feedback. Finally, the paper is concluded in section 4.

2. Materials and Methods for PLC-based Uploading and Handling System Experiment

2.1 Uploading and Handling Experiment Set and Its Components

In this experiment, we, therefore, concentrate on comparative observation. Yıldırım Elektronik Y-0044A unloading and handling experiment set is illustrated in Figure 1. The unloading and handling station components, which consist of two parts, are shown in detail in Figure 2.



Fig.1 *Uploading and handling system experiment set*

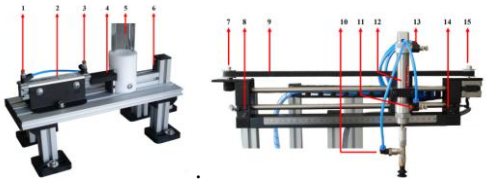


Fig 2. *Component of Unloading and Handling Station*

The components of the system are in numerical order below as shown in Figure 2.

1. Uploading LeverForwardSpeed Adjustment, **2**.Uploading Lever Forward/Reverse Double Acting Piston,**3.** Uploading Arm Reverse Speed Adjustment, **4**. Unloading Arm, **5.** Magazine **6**.Unloading Lever Forward Limit Switch, **7**.Trigger Belt Tension Adjustment Screw, **8**. Handling Left Limit Switch**, 9.** Timing Belt, **10.** Vacuum (Suction) Air inlet, **11.** Handling Arm Up Speed Adjustment, **12**. Handling Arm Up/Down Double Acting Piston, **13.** Handle Down Speed Adjustment, **14.** Handling Right Limit Switch, **15**. Handling Unit Right/Left Motion Motor (Step Motor)[11].

2.2 PLC

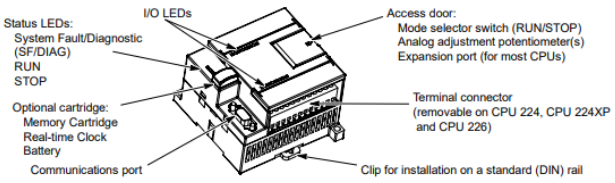


Fig.3 *S7-200 PLC*

This type of device is a microprocessor, an integrated power supply, input circuits, and output circuits in a compact housing to create a powerful PLC [12]. The PLC used in the system; is a 10-bit digital output, and 14-bit has a numeric input. Digital outputs with semiconductor elements (MOSFET) are driven. Digital input/output signals use voltage levels of 0/+24V. There are 4096-word user program memory, 2560 word data memory that can be stored permanently. PLC is supplied with 24 VDC voltage and draws a maximum current of 700 mA depending on the load situation. PLC has one serial port for programming. PLC is programmed by connecting the programming cable to port 0.

2.3 Limit Switch

Generally speaking, a limit switch is often used for controlling machinery as a part of its control system, as a safety interlock, or to count objects passing a point [13]. A mechanical state is converted into an electrical signal with a limit switch. When a moving part collides with a limit switch, the limit switch becomes closed. At the same time, the controller can detect the voltage change of the corresponding I/O port. And then, the follow-up actions could be taken by PLC. This switch has three ends. Common end (COM: Common), normally closed end (NC: Normally Close), and normally open end (NO: Normally Open) and illustrated in fig4. It is used to learn the forward position of the material feeding arm and the right or left side of the transport.

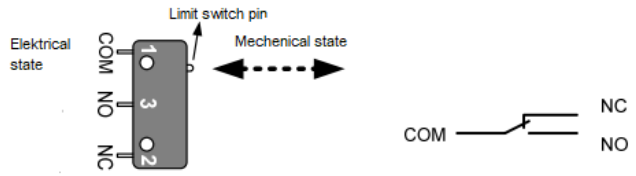


Fig. 4 *Limit Switch Schema*

2.4 Solenoid Valve Group

The solenoid valve group, which can be controlled by an electrical signal, takes the filtered (dried, cleaned) compressed air at 5-6 bar level required for the operation of the system from a single point and transmits it to different points.

The points controlled by the valves used in the system are shown in Figure 5.



Fig. 5 *Selenoid valves group*

2.5 Vacuum Switch

It is an electronic device that measures the reverse air pressure at the inlet of the vacuum switch. With this device, information is obtained on whether the material is retained as a result of the vacuum. When the transport piston does not hold the material, the vacuum switch will not be able to generate a signal because there is more than enough air suction. When the transport piston is requested to move after holding the material, the PLC program flow will be executed accordingly with the signal generated by the vacuum switch.

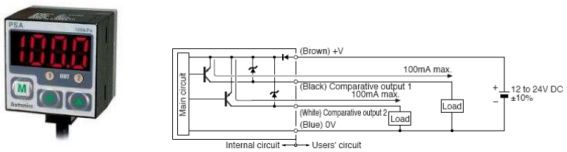


Fig. 6 *Vacuum Switch and Electrical Circuit Shema*

2.6 PLC Software (Step 7-Micro/WIN)

It is the original software used to develop/edit the PLC program for the Unloading and Handling Station and to monitor the system's inputs/outputs in the computer environment. The interface of the Step7-Micro/WIN program is illustrated in Fig7.

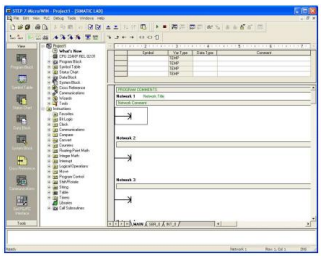


Fig. 7 *Step7-Micro/WIN program*

3. Scenario and Students' Feedback

3.1 Scenario

If we briefly summarize the operation of the system, it consists of the process of unloading and handling the materials filled into the magazine. To put it more broadly, the materials loaded in the magazine are advanced with the magazine piston until a signal is received from the limit switch. When the signal is received from the limit switch, the magazine piston waits for the holding piston to come down to receive the material. When the material is held by the vacuum effect, the vacuum switch generates a signal. Then the magazine plunger retracts to release the material. The handling piston moves the material upwards when the vacuum switch signals. The material unloading process continues until the material runs out. When the material runs out, the magazine piston cannot press the limit switch, so it concludes that the piston is retracted after a certain period of time and the system stops by going to the stop position.

After the material taken from the magazine is pulled up for handling, the conveyor mechanism which is connected to the step motor moves to the right until the right limit switch generates a signal and then stops the step motor. Then handling piston is lowered. The vacuum effect is cut off and the material is released and the piston is retracted. Then the system is brought to the starting position.

In order to operate the unloading and handling station in accordance with the scenario and algorithm (flowchart in fig.9) software above, the PLC inputs/outputs and system inputs/outputs were determined by the students, and a table was created. The system is ready for operation after connecting the intermediate cables between the input and output points given according to the values in Table 1.

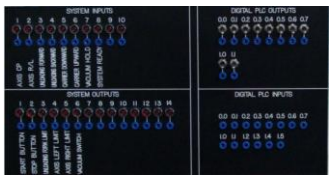


Fig. 8 *Unloading and Handling Station in/out ports*

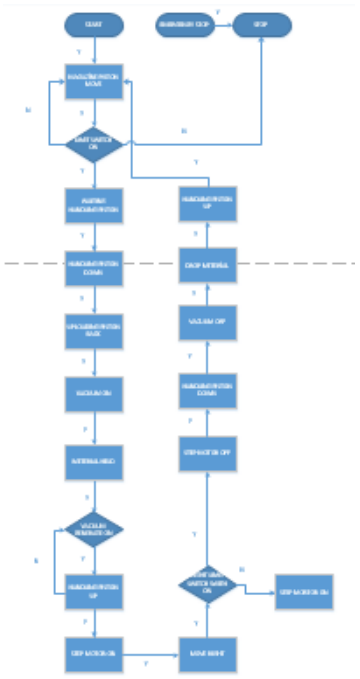


Fig. 9 *Flowchart of Algorithm*

Table 1: *PLC System Input/Output Connections.*

PLC System Input/Output Connections.					
System Inputs	PLC Outputs		System Outputs	PLC Inputs	
Axis CP	Q 0.0	Digital Outputs	Start Button	I 0.0	Digital Inputs
Axis R/L	Q 0.1		Stop Button	I 0.1	
Unloading Forward	Q 0.2		Unloading Forward Limit	I 0.2	
Unloading Backward	Q 0.3		Axis left limit	I 0.3	
Carrier Downward	Q 0.4		Axis right limit	I 0.4	
Carrier Upward	Q 0.5		Vacuum Switch	I 0.5	
Vacuum Hold	Q 0.6				
System Ready	Q 0.7				

3.2 System Diagram

The unloading and handling system diagram is shown in Fig.10.

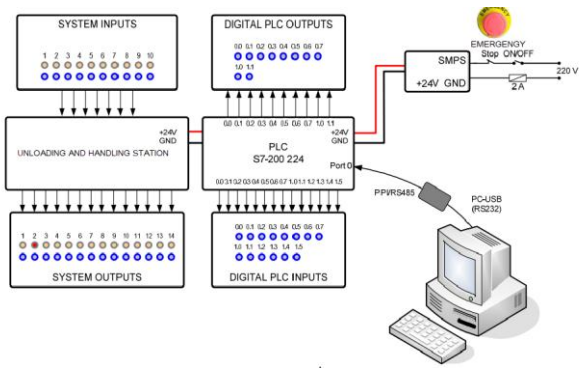


Fig. 10 *Uploading and Handling System Diagram*

3.3 Uploading and Handling Operations

While preparing a program for PLC, students created a very useful method by assigning symbolic addresses to the symbol table for all input/output, memory, counters, and timers in Table 2 and in Fig.11. Thus, the program writing speed increased and the probability of making mistakes decreased.

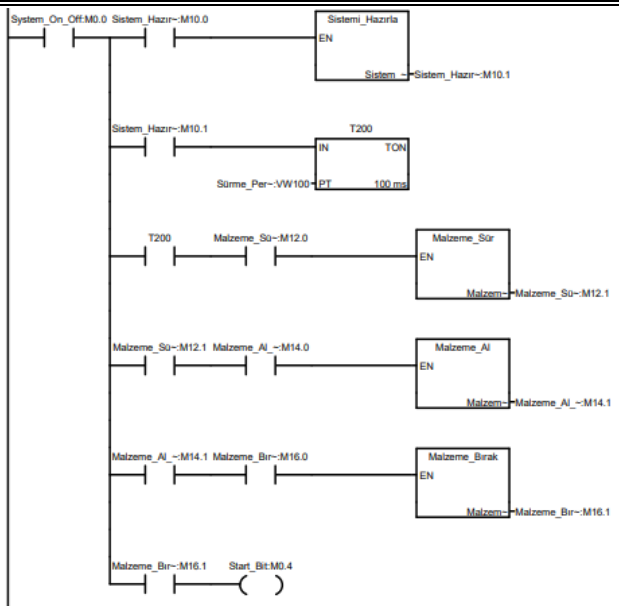


Fig. 11 *A Sample of the Ladder Diagram part of the Uploading And Handling System Software*

Table2: *Description of Symbols Contacts and Comments for Uploading and Handling System*

Symbol	Address	Comment
Malzeme_Al_Bitti	M14.0	Internal Contact to take material
Malzeme_Al_Ok	M14.1	It is set when the material-taking process is completed
Malzeme_Bırak_Bitti	M16.0	Internal contact used to drop material
Malzeme_Bırak_Ok	M16.1	It is set when the material-dropping process is completed.
Malzeme_Sür_Bitti	M12.0	Internal contact discharging material
Malzeme_Sür_Ok	M12.1	It is set when the material-discharging process is completed.
Sistem_Hazırla_Bitti	M10.0	The contact used to enable the system to switch to its initial setup
Sistem_Hazırla_Ok	M10.1	When the system is ready it is set.
Start_Bit	M0.4	Contact uses in software
System_On_Off	M0.0	System On-off initial contact
Sürme_Peryodu	VW100	Timer variable for the material feeding period

4. Conclusion

The PLC-based unloading and handling system which is used actively in Trakya University Mechanical Theory and Dynamics Laboratory was experimentally run with the students, thus providing to develop their talents and gained experience in system parameters and PLC program before being applied to the industry.

Students got to know the system and programmed the system with different approaches and possibilities, and by developing codes based on feedback, they achieved the same results. Thus, it will open a door for them to solve problems related to the difficulties they realized to encounter and may face in the future.

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Evaluation of the learning success in the implementation phase of Extended Reality

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Abstract: *Extended Reality (XR) stands as a hypernym for Augmented Reality (AR), Mixed Reality (MR) and Virtual Reality (VR) technologies and represents an increasingly important Industry 4.0 technology rank. XR technologies are enriching or replacing the environment with digital information. This introduces new possibilities for learning, collaboration, product presentation or other fields of application in companies. Various meta- and individual studies prove a positive influence of XR elements on learning success. However, the appraisal of results must be made with caution since no standard is currently available to measure learning success. This paper contributes to this situation by providing a framework to perform a generic measurement of learning success when using XR. The developed framework follows the 4-level evaluation model according to Kirckpatrick focussing on response, learn, apply, and benefit to the organization and is further developed meeting the specific requirements of XR training. The developed framework adresses two dimensions: the evaluation of the short term as well as the long-term training success. Furthermore, the paper gives insights in the practical validation of the framework done by an industrial company using a VR Training within the onboarding process. The framework is intended to help organizations to systematically assess the learning success of XR-supported training compared to traditional paper-based training.*
Keywords*: LEARNING SUCCESS, EXTENDED REALITY, XR, TRAINING, EVALUATION*

Introduction

The terms ‘digital transformation’ and ‘Industry 4.0’ (I4.0) describe the progressive automation and interconnectedness of things into self-controlled intelligent systems [1]. The technology streams encompassed are complex and can be grouped into nine enabler technologies as of 2022. One of them are Extended Reality (XR) technologies: From Augmented to Mixed to Virtual Reality. [2, 3, 4]

Current trend studies confirm the potential and relevance of immersive XR technologies [5, 6]. A survey conducted by Bitkom Research in 2021 shows that this potential is still far from being exploited by companies. According to this survey, more than half of the industrial companies surveyed classify themselves as Industry 4.0 laggards [7]. The Association of German Chambers of Industry and Commerce e. V. confirms this situation. Of nearly 4,300 companies surveyed in Germany in 2020, less than 10% use XR technologies. For almost 2/3 of the respondents, a deployment is currently not planned [8]. The reasons for this situation are complex: A lack of resources, a lack of expertise in this area, or existing restrictions such as IT security or data protection inhibit an implementation [7, 8].

Nevertheless, several XR use cases have already been established within companies. One of them is the support of work-based learning respectively XR-supported training [9]. The technology enables a high degree of flexibility not only in terms of space and time, but also in terms of the information consumed. Thus, XR-supported training can be used to retrieve individually required information exactly where and when it is needed. This means that learning is no longer separated, but takes place directly on demand at the respective workplace [10, 11] .

Regarding to that, the question now arises as to whether this new form of training and learning offers a measurable advantage compared to traditional learning methods. This is the subject of research in many studies, although no measurement standard has yet been established for evaluating XR-supported training [12, 13]. However, this would help companies to determine the company-specific added value of XR-supported training for different training scenarios. This paper addresses this initial situation. It presents a methodology to measure the learning success of XR in a training context in a standardized way. Based on established measurement methods, a multidimensional evaluation tool was developed and validated. The result serves companies to evaluate the efficiency and effectiveness of XR-supported training and thus to support the decision regarding the implementation of XR for training purposes.

Extended Reality as a learning media

Step by step, technological progress is innovating all areas of life. Training and further education as well as the didactical methods used there are affected by this [14]. New forms of e-learning, blended learning concepts and the integration of digital methods and digital media are becoming increasingly important [15]. The COVID-19 pandemic has reinforced this broad impact [16, 17]: The necessity to work virtually and remotely forced many companies to engage with digital collaboration and communication platforms and to use smart devices such as smart phones, tablets or data glasses. This led to increased security of use regarding those devices, which in turn also positively influenced the willingness to use them also for working and learning.

Learning methods, whether classic or digital, always make use of a method and a medium. In the case of XR, the hardware with its respective technical functionalities represents the medium. By enriching reality with information or creating virtual spaces, XR offers great potential for learning occasions [10]. Here are a few examples [18]:

1. On-demand training by displaying instructions for action or additional information directly at the workplace or machine.
2. Additional practice of activities on virtual machines and digital systems enables higher training intensity and thus increased behavioral safety.
3. Independent learning of standard procedures in the course of onboarding, both in terms of location and time.

But XR does not replace classical training approaches, it is just another learning medium [15]. Through increased interaction with virtual objects, additional training repetitions can be implemented independent of location and time and without the use of real resources. In addition, by linking the employee's workplace and level of knowledge, a higher degree of individualization can be achieved in the design of the training. This flexibility makes the use of XR-supported learning methods appealing [18].

As shown, there are many possible applications, but the cost-benefit ratio does not always favor the use of XR for training purposes [19]. In order to measure this, the learning success when using XR compared to classical methods is an essential key figure [20].

Evaluation of training focussing learning effect

Altough no standard for measuring XR-based training has yet been derived, the Kirkpatrick 4-stage model counts as the most widely utilized framework for evaluating training [21]. Therefore, this framework is explained in this chapter.

According to Kirkpatrick, evaluation of training adds value when all 4 stages, reaction, learning, behaviour, and impact on the organisation, are evaluated [22]. This paper follows this approach and evaluates training in the implementation of XR applications on a meta-level, regarding all 4 stages, but with a focus on assessing the learning effect.

Kirkpatrick developed the 4-step model in 1959 [22] and it is still the most widely used model for evaluating training and development programmes [23, 24, 25]. The model has been revised several times since its creation, but the biggest change was made in 2010 [26]. This paper is oriented to both models. The original model is shown first in Figure 1 and the revised model in Figure 2.

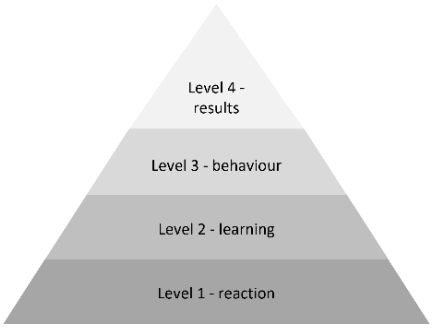


Figure 1: Kirkpatrick's 4-level model developed in 1959.

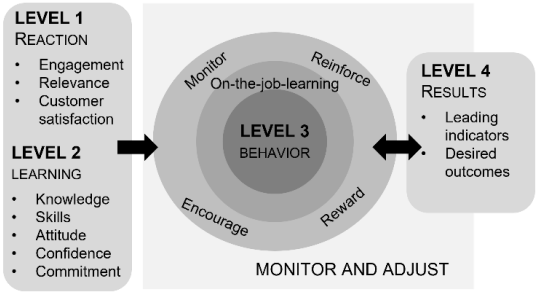


Figure 2: Kirkpatrick's 4-level model developed in 2010.

According to Kirkpatrick, the level of response is characterised by "the participant's reaction to a training event. It's basically a measure of (internal) customer satisfaction." [22]. The author adds at this point that a positive reaction is a basic prerequisite for successful learning.

Within the second level "learning", Kirkpatrick differentiates in terms of evaluation of knowledge, skills and change in attitudes. The author also notes at this point that the measurement of learning success is significant because the achievement of one or more learning goals is a prerequisite for behaviour change, that refers to level 3 [27]. In this paper, on the one hand, the objective learning success in the sense of a declarative increase in knowledge is assessed. On the other hand, the change in attitudes is recorded in the form of subjective learning success. In addition, Kirkpatrick recommends conducting an achievement test to determine the learning success regarding certain skills [27, 28].

Kirkpatrick describes the third stage as the occurrence of a change in behaviour on the job as a result of the training. It is crucial to consider the challenge that teachers often think their job is done with the completion of the training. Supervisors, on the opposite, focus on the level 4, results, and refer to the origin of the training in case of problems in the application of the training content. As a result, the importance of level 3 is forgotten from time to time. Nevertheless, the evaluation of behaviour change is important because the evaluation of the reaction and the learning success provide too little value for the company. Only when a change in behaviour occurs the organisation does benefit from the completion of the training. If problems occur at level 4 (Results), an additional evaluation of the behavioural change is necessary. Thus, it can be questioned at which level there is potential for improvement [27].

The evaluation of the perceived results for the organisation starts with the definition of the learning objectives to be addressed in the training. After determining the learning objectives, metrics can be derived that evaluate training-specific results for the organisation. In this sense Kirkpatrick mentions the "Return on Expectations". This metric measures the extent to which learning objectives have been achieved in terms of organisational benefit [27].

Methodology

Based on the already mentioned 4-step model according to Kirkpatrick, this chapter shows the possibilities of evaluation. This chapter serves as a basis for the results in the following section "Results of the discussion". Thus, the individual stages of the model are mentioned once again and possibilities for evaluation are shown. This paper mentions evaluation opportunities and does not list all the questions formulated but refers to the original sources. However, the approach to measuring learning success is shown in detail.

Level 1 – Reaction

As noted earlier, evaluating learner response allows an inference to be made about internal customer satisfaction, as learners in this case are customers. Kirkpatrick assesses in this stage the reaction of the learners to the content as well as the learning environment. The points to be assessed are therefore subject matters per se, facilities, schedule, and quality of the instructor. But this paper does not specialise in the evaluation of traditional training, but in the evaluation of XR-based training. Therefore, ways to capture participants' response to immersive learning environments are now identified. To evaluate the users' reaction to the XR-based training, the three measurement dimensions of perceived workload, usability and user acceptance are used. For all three dimensions, measurement standards are already established in practice and shown in Table 1.

Dimension	Measurment
Percieved workload	NASA-TLX
User-Acceptance	TAM
Usability	SUS

Table 1: Measurements to determine Level 1 - Reaction

Percieved workload (NASA-TLX)

When using the NASA-TLX, a total of six questions are asked to address six levels. These levels are Mental Demand, Physical Demand, Temporal Demand, Performance, Effort and Frustration. Even though Kirkpatrick proposes a rating scale with five characteristics, only four characteristics are recommended to avoid a tendency towards the middle [29].

User Acceptance (TAM)

The Technology Acceptance Model was developed by Davis in 1989 and postulates that Attutude Toward Using depends on two variables. These variables are Perceived Usefulness and Perceived Ease of Use. The model has been revised several times by the author, but the first model is most respected for its simplicity [30].

Usability (SUS)

The System Usability Scale (SUS) is a simple method of evaluating subjective usability using a Likert scale as a rating. It asks 10 questions to evaluate usability, which include content such as goal achievement (can users successfully achieve their objectives), efficiency (how much effort and resource is expended in achieving those objectives) and satisfaction (was the experience satisfactory) [31].

Level 2 – Learning

This passage is considered in detail because this paper deals with the evaluation of XR-based training with a focus on the measurement of learning outcomes. Therefore, approaches are given that indicate measurements of objective and subjective learning success, as well as in the short- and long-term time horizons.

Subjective learning success

The term subjective learning success is defined differently for each person, as learning success is subjectively interpreted dissimilarly by different people. In context of subjective learning the author Holzkamp mentioned the four levels "object insight", "expansion of availability", "quality of life" and "social conflict avoidance" in the context of subjective learning success [28, 32]. Since this paper focuses on the evaluation of learning success in immersive learning settings, the two meta-levels "media exposure" and "threat avoidance" were added. The definitions of these meta-levels can be found in Table 2.

Term	Definition
Object insight	This level is characterised by the acquisition of understanding and the assessment of knowledge about the subject matter.
Expansion of availability	The stage is achieved when professional prospects have improved and/or new perspectives have been gained.
Quality of life	This meta-level is defined by satisfaction through increased knowledge, a more elevated linguistic expression, as well as the feeling of a reorientation in the world of life due to learning.
Social conflict avoidance	Social conflict avoidance refers to avoiding being perceived negatively in social situations such as group discussions or presentations. Furthermore, this level includes the recognition of people who are important to the individual.
Media handling	This term represents the successful use of new technologies, especially the proficient use of XR technologies. Without an understanding of how to use this technology, no learning success can be achieved.
Threat prevention	This level was added to record whether the learner can see a purely external purpose in the training and only completes it based on a mandatory instruction from the employer.

Table 2: Metalevels of subjective learning success

The authors Holzkamp and Hemming defined suitable questions based on their four meta-levels, which guarantee an evaluation of the individual levels [28, 32]. Questions on measuring media use and threat avoidance can easily be formulated with the help of the literature cited. Furthermore, in the sense of subjectivity, a weighting of the levels is carried out through the pairwise comparison [33].

Objective learning success

In this context, it is noted that the measurement of objective learning success refers purely to declarative knowledge growth and refers to the knowledge of facts and definitions.

If an organisation identifies a training need, the first step is to define learning objectives that characterise the specific need. Based on these learning objectives, questions can be formulated that test the achievement of these objectives. Since learning objectives are formulated based on a use case, there are no generally valid questions that are used to measure objective learning success [34, 35].

Short- and long-term learning success

The short-term learning success represents the storage of the learning content in the working memory, in which the memory span is limited to 7 (+/- 2) units. To record "short-term" learning success in terms of declarative knowledge gain the measurement takes place directly after the training stimulus [36].

Long-term learning success is related to the storage of learning content in long-term memory. Stable storage of newly learned content takes place in the form of synapse formation through repetition, application in practice or through a greater depth of processing during initial learning [36]. If what is learned is not repeated or applied within 1 week, only a quarter of the learning content is remembered [37]. In this paper, long-term learning success is associated with the occurrence of behavioural change induced by learning, which leads us to the third stage of Kirkpatrick's 4-step model.

Level 3 – Behavior

Behavioural changes in daily businesses are measured which can be traced back to the completion of the training. Kirkpatrick emphasises that, on the one site, a certain amount of time must be allowed for the learner to apply what he or she has learned. Contrary to that, the author emphasises the balance between support and accountability. Showing best practices and the results that followed is one of the most effective methods to demonstrate support. Accountability means that managers must set a good example for people to follow. We cannot reasonably expect others to behave in a new way that does not reflect our own behaviour. Secondly, holding ourselves accountable for new actions will lead to the fruitful results we seek [38]. Following instruments for data collection are mentioned in this context:

- Surveys and Questionnaires
- Observations and Checklists
- Work review
- Interviews [39]

It is crucial to collect as many perspectives as possible, as the change in behaviour can be classified differently by a self report than filled out by superiors, customers, work colleagues or subordinates [27]. As an example, 360-degree feedback is mentioned because it requests feedback from different perspectives. The research design can take the format of a post-only measurement, pre- and post-multiplies or non-equivalent comparison group [39].

Level 4 – Results

This level aims to link training results to organisational goals. Therefore, level 4 outcomes are seen as linking learners, their needs, and their learning in the workplace, which is facilitated by their supervisors. The recommantation is to start with the end in mind. Therefore, relevant stakeholders should define their expectations in terms of learning objectives. Based on this, adequate metrics can be defined, which Kirkpatrick calls "Return on Expectations" (ROE). Thus, level 4 Results shows Key Performance Indicators (KPIs) which represent the training objectives and make these goals measurable [38].

To support accountability, the literature references the use of a Balanced Scorecard (BSC). The recommendation of a BSC also emphasizes the interdependence of the individual levels in the 4-level model. In addition, creating a BSC provides a meta-level visualization of the impact of the training on the organization. Thus, the interaction of the individual levels is comprehensible for third parties [38]. The use of a BSC is briefly addressed again in the next chapter.

Results of discussion

The research paper offers insights into the practical testing of the prior derived framework by an industrial organization implementing VR training as support for the onboarding process. The approach is designed to assist organizations in methodically evaluating the effectiveness of training with a focus on learning success. Finally, the previously discussed four levels are linked to a BSC to illustrate the importance of learning success for the achievement of company goals.

Validation of the framework in pratice

The validation of the frameworks for measuring the first level "Reaction", the second level "Learning" and the third level "Behaviour", was carried out with an industrial company. This

enterprise plans to introduce VR-based training to support the onboarding process of new staff. For this purpose, a total of 45 new employees were invited to complete this onboarding training. The term "new employees" define workers who have been with the company for less than three months. The study group was divided into an experimental group and a control group. The experimental group consisted of 24 people who completed the onboarding training in a virtual environment. A further 21 people were members of the control group and received the content, which was as identical as possible, in a face-to-face lecture. The learning objectives of this onboarding process included topics such as general product knowledge, market knowledge and branch knowledge about specific products. At this point, it must be added that the XR application was rated as Technology Readiness Level 7 (TRL 7), what describes a prototype application testing in a real environment.

The measurement of level 1 response was conducted using the NASA-TLX to determine perceived workload, the SUS to identify ease of use and the TAM to measure user acceptance. The three measures were collected once directly after the training.

The measurement of level 2, learning, was conducted in the form of subjective as well as objective learning success, assesing both short and long-term time evaluation. The survey of subjective learning success takes place once directly after the scheduling of the training and uses the framework described in the Methodology chapter. The measurement of objective learning success takes place three times in total: Prior to the training due to the reduction of the influencing variable "prior knowledge", immediately after the training for measuring the short-term objective learning success and at least one week after the training to evaluate the long-term learning success. The learning objectives were checked in the form of a knowledge test in which content about products, their markets and segments as well as the ranking of the regions with the highest turnover were asked.

The application of knowledge in practice by the learner represents the consolidation of level 3 behaviour. As shown in the methodology chapter, a view from multiple perspectives is advisable, as colleagues, superiors and own employees assess the behaviour differently than the person him-/herself. On the one hand, due to time limitations on the part of the company, and on the other hand, due to rather declarative learning objectives whose applicability in practice is limited only the subjective assessment of the employee him-/herself was collected in this case study. In addition, confounding variables, such as repetition through review or application, were asked. The reason for this was to check whether behavioural change occurs faster or slower through learning in immersive environments compared to traditional learning settings.

The testing of this framework is currently taking place. The results of this testing will be published in a further publication.

A positive evaluation of level 1-3 according to Kirkpatrick can support the achievement of a company's BSC goals. The mentioned metrics can be linked to KPIs of the BSC. This guarantees a meta-level evaluation and shows an outlook for the measurement of level 4 results. The practical connection of a change in the KPIs in a BSC caused by positive changes in the first three stages is therefore mentioned now.

Balanced Scorecard

Kaplan and Norten highlight the influence of KPIs in a company on the behaviour of its employees with the statement "What you measure is what you get [40]." For this reason, the two authors designed a BSC that complements the, at this time established in practice, monetary metrics with three additional perspectives: customer-, process-, as well as innovation and learning perspective. The benefit of a BSC is illustrated by an example: A pilot needs detailed information about the aircraft to be able to guarantee a safe flight. The analogy to the manager is that he/she, needs to take a bird's eye view, what can be supported with the use of a BSC [40].

Subsecently, the link to the 4-step model to the four perspectives of a BSC is drawn. These connections are illustrated in Figure 3 at the beginning. Then the Reaction, Learning and Behaviour levels of Kirkpatrick's levels are listed as well as their influence on the organisational goals is derived. Thus, the last level 4 of Kirkpatrick's model, the results are defined. The BSC follows the objective of introducing an XR-based onboarding process and is only an example how it could look like.

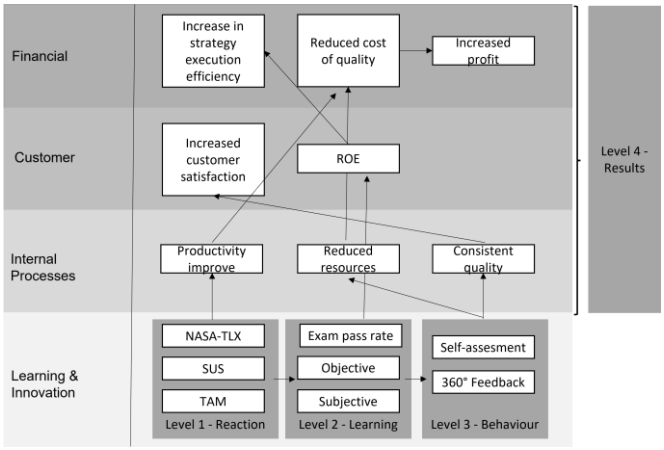


Figure 3: Linking the 4-level-model and the BSC.

Level 1 – Reaction: On the one hand, reduced perceived workload, increased usability and user acceptance make learning easier and support the internal perspective such as an increased productivity.

Level 2 – Learning: The exam pass rate can be measured before and after the training. This means that the declarative knowledge gain can be directly attributed to the completion of the training. Successful learning promotes behavioural change in practice, which defines long-term learning success in this paper. As one requirement of the XR-based application of the company was increased learning success, this defines a part of the ROE.

Level 3 – Behavior: A change in behaviour in the professional environment injected by the training leads to guaranteeing a consistent quality of the onboarding process. Furthermore, by holding the training in a VR world, the time of the instructor is saved. In addition, participants do not have to plan for travel time, as the training can be conducted regardless of location.

Level 4 – Results: Increased productivity, reduced resources and consistent quality reflect the goals of the internal process perspective. These in turn influence goals in terms of the customer and financial perspective. Increased productivity and reduced resources positively influence reduced training costs. Reduced training costs favour increased profit. Consistent quality increases customer satisfaction, whereby internal customers (=learners) are meant. Increased ROE leads to an increase in strategy execution efficiency if the original strategy includes the implementation of XR technologies.

Conclusion

A change in the fourth level of Kirkpatrick's model has a direct influence on the company's success. Nevertheless, the premise here is a positive assessment of the underlying levels, reaction, learning and behaviour. A positive evaluation of the first three levels supports a positive benefit for the organisation. The mutual influence of Kirkpatrick's levels and their ultimate impact on corporate goals can be supported by the preparation of a BSC.

Current publications, such as Ahrendt et al (2021), prove that these investigations are very topical. Due to the finding that employees and their competencies are becoming increasingly

important for companies, the focus is on "systematic competence management." However, the identification and control of personal and social competences poses a great challenge to those responsible compared to professional competence, since it goes beyond the conscious interrogation of knowledge. Controlling social competencies thus becomes the bottleneck factor of competence management [41].

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Evaluation of the screen time children spend daily for using digital technology

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Abstract: *The survey "Evaluation of the screen time our children spend daily for using digital technology" was conducted as part of a master thesis in Social Entrepreneurship at the American University in Bulgaria in March 2023. Analysis of the data for "time spent" by children on interacting with electronic devices is increasing alongside with the grow of the child and is directly influenced by entering formal education system. Acceptable "time spent" for the majority of parents is 1-2 hours in age group 5 to 9 (pre- and primary school) and 3-5 hours for 10 and above (when children enter the phase of adolescence). The parental that digital technologies are having positive impact over children (educational, social and digital skills development) is growing with the child growing up, and for the age group 10 -14 (secondary school) and 14 and above (gymnasium) it is dominating among parents.*
KEYWORDS*: ELECTRONIC DEVICES, DIGITAL TECHNOLOGIES, TIME SPENT, EDUCATION, CHILDREN*

1. Introduction

The accelerated implementation of information and communication technologies in all areas of public development requires in-depth studies of its effects at both national and global level. As education is one of the sectors most influenced by these trends, the need for systematic research on the application of digital technologies in the educational process is becoming increasingly apparent nowadays, [1]. Over the last years the usage of mobile devices has increased among the population. The trends 2016-2021 from the National Statistical Institute in Bulgaria show significant growth of mobile (smart) phones as a preferred device for internet access, growing from 42.1% to 71.8%, [2]. Among the most important triggers in the usage of mobile devices was the COVID-19 pandemic, which caused a full closure of schools in 2020 (second semester). Moving to online education forced students in all Bulgarian schools to use an electronic device, connected to the internet, to be able to participate in the educational process. According to a survey, conducted in a partnership between Deloitte and IPSOS, on behalf of the European Commission almost 90% of students in Bulgarian schools have access to a device – either laptop, tablet, or smart phone. [3]. And while this research is measuring usage at least once per week, during the lockdown 90% of students were engaged 5 days per week in the online learning process, without measuring the time spent for homework preparation as per Ministry of Education report. [4]. Still there are not many studies conducted to measure the impact of mass technology on daily use of students and how the habits are evolving from using connected devices for learning purposes to using them for entertainment purposes and what is the impact. Research, aiming to disclose parents' view on electronic time spent by their kids was conducted as part of a master thesis in Social Entrepreneurship at the American University in Bulgaria in 2023 and some key findings are presented.

2. The Research Backgrounds

The impact of digital media usage and its impact on development of young people is a topic, becoming more and more in focus for many researchers in the past 10 years, marking the "explosion" of social media, interactive communication platforms, and electronic games. Focus is primarily on adolescence, which is defined as the transition period between childhood and adulthood (approximately ages 10–22 years), where parental influence decreases and peers become more important. Extensive overview of research documents on adolescence neural systems confirms they are still underdeveloped and undergoing significant changes while growing up, and may contribute to sensitivity to online rejection, acceptance, peer influence, and emotion-loaded interactions in media-environments. [5]

Recently published paper examined the associations between adolescent digital media use and mental health by comparing adolescents enrolled in 8th, 10th, and 12th grade in the United States in 2018 (pre-pandemic) and adolescents in 2020 (during COVID-19). The data comparison shows that there were significant differences by year in adolescent hopelessness, with adolescents reporting less hopelessness in 2020 than in 2018. And there are no significant differences between adolescent happiness and loneliness. Adolescents in 2020 spent significantly more time watching movies and video chatting, but less time texting and on social media than adolescents in 2018. In practice results of the survey did not confirm the initial hypothesis of the researchers: adolescents in 2020 will have significantly worse mental health (lower happiness, higher hopelessness, and loneliness) than adolescents in 2018. [6]

Recent survey, conducted in Latvia among basic schools and secondary schools finds out that screen time during COVID-19 pandemic crisis has increased. Together with the online formal learning process, implemented due to lockdown and schools' closure, the time spent online increased with homework preparation, totally 46,2% of students report they spent an additional 3-4 hours. There is no big change observed in the physical activities' times spent during pandemic. Still the majority of students in Latvia prefer to study on-line instead of face-to-face learning, although well-being for many students during COVID-19 pandemic crisis has decreased. It seems that in future on-line studies will become more popular in comparison to face-to-face studies is the conclusion of the survey. [7]

More and more researchers are focusing on different approaches to overcome the negative implications of electronic screen syndrome among teenagers. A recent study, implemented in two governmental schools in Cairo, Egypt among 13-15 years aged students. Specially designed digital detox program with four sessions was applied to the focus group of students in their schools in separate classes. The results before and after the program implementation show that the percentage of students with high and moderate electronic screen addiction has decreased, while the percentage of students with low electronic screen addiction has increased. The main outcome of the study is that preventative programs must be developed for high school students, and awareness should be raised about electronic screen addictions and their negative consequences. [8]

A cross-sectional study among students in Saudi Arabia Universities assess the online learning experiences and how it is related to headaches associated with screen exposure time spent. Results show that students faced many challenges with online learning that affected their communication efficiency as well as high prevalence of headache (65.72%) and a high screen exposure time among the studied students (52.69%). Increased screen time exposure is linked with increased headache and migraine reporting among students. [9]

3. Data and Methodology

The survey "Evaluation of the screen time our children spend daily for using digital technology" was implemented in March 2023 among parents of children and school students by using an online survey platform (n=304).

Four age groups of surveyed students were outlined, based on learning levels of Bulgarian education system: 1-4 (kindergarten), 5-9 (pre- and primary school), 10-14 (secondary school), above 14 (gymnasium). The goal of the survey is to understand the third party (parents) evaluation of screen time spent of their children and the respective implications further. For the questionary was used an online survey platform and the results were analyzed using SPSS (Statistical Package for the Social Sciences) software for statistical analysis.

4. Results and Discussion

Table 1 presents the data for daily interaction of the children with electronic devices (computer, mobile phone, tablet, console or other) – per hours and per age group, (Cramer's V = 0,371, Approximate Sig.= 0,009).

Table 1 *How much time does your child spend in front of a computer, mobile phone, tablet, console or other electronic device per day by age?*

	I can't say	spends no time	1	1-2	3-5	above 5
1-4		28.6%	**37.1%**	22.9%	11.4%	0,0%
5-9	6.9%	4.6%	20.7%	**44.8%**	19.5%	3.4%
10-14	0.7%	0.7%	6.7%	31.9%	**45.2%**	14.8%
above 14	6.3%	0.0%	6.3%	16.7%	**41.7%**	29.2%
Total	3.3%	*4.9%*	14.1%	32.1%	**33.4%**	12.1%

Only 3.3% of the survey adults cannot provide answers about the time spent on interaction with electronic devices of their kids. It is clear that adults have a very good understanding and visibility on the daily e-activities of children. The time spent in front of the screen depends to a very large extent on the age group in which the children are. And while for children between 1 and 4 years the largest group is the one that spends up to 1 hour per day (37.1%), followed by the one that includes children who have no interaction with digital screens at all, for children in the next age group - from 5 to 9 years, already the largest group spends in front of a digital screen between 1 and 2 hours (44.8%). This change has a logical explanation: in the age group 5-9 children are part of the formal education system and digital technologies are implemented in the learning process.

As children grow up - the time spent in front of digital screens increases. For age groups10 to 14 almost half are spending 3 to 5 hours (45.2%) and results are pretty much close to the age group 14 and above. If we apply the standard 24-hours' time split: 8 hours of sleeping and 6 hours engaged in formal education in schools, more than one third of remaining time (10 hours) is spent in front of electronic devices. For age group 14 and above almost one third of children (29.2%) spent more than 5 hours, or at least half of the "free" time during the day. In total the biggest group is 3-5 hours spent per day (34.8%), . Results show the logical trend – as a child is growing up the time spent interacting with electronic devices is growing, (Cramer's V = 0,371, Approximate Sig.= 0,009). It is important to understand how parental engagement facilitates this trend.

Table 2 represents the results showing the effect of using screen time control software and/or the availability of formal rules for using electronic devices. Results are presented by time spent for all children, and not by age group. Table 2 combines answers given by parents to the following questions: "*Do you have usage and screen time family policies to regulate the amount of time and content your child has access to and are they being followed?"* and "*Do you use parental control software on your child's most used electronic devices?"*, (Cramer's V = 0,345, Approximate Sig.= 0,009).

Table 2 *Effect of using screen time control software and/or the availability of formal rules for using electronic devices.*

software	rules	I can't say	spends no time	1	1-2	3-5	above 5
Yes	strict	2,9%	2,9%	25,7%	42,9%	25,6%	0.0%
No	**strict**	**4,5%**	**22,7%**	**50,0%**	**18,2%**	**2,3%**	**2,3%**
Yes	semi-strict	1,6%	0.0%	11,3%	35,5%	38,7%	12,9%
No	**semi-strict**	**2,5%**	**2,5%**	**10,0%**	**52,5%**	**22,5%**	**10,0%**
Yes	non-strict	0.0%	0.0%	0.0%	12,0%	68,0%	20,0%
No	non-strict	**0.0%**	**0.0%**	**0.0%**	**37,1%**	**34,3%**	**28,6%**
Yes	no rules	20,0%	0.0%	0.0%	30,0%	40,0%	10,0%
No	**no rules**	**6,1%**	**2,0%**	**2,0%**	**26,5%**	**53,1%**	**10,2%**
Yes	total	3,0%	0,8%	12,1%	32,6%	40,9%	10,6%
No	**total**	**3,5%**	**8,1%**	**15,6%**	**31,8%**	**27,7%**	**13,3%**

68% of children spend 3-5 hours interacting with electronic screens in families that have implemented parental control software, and at the same time there are no strict rules to regulate the screen time spent. More than half of students (53.1%) are in families where parents neither implement any software control, nor there are any rules. Looking at the result for children, spending between 1 and 2 hours 52.5% are in families, where there is no software control and rules are semi-strict. While in the scenario where there is software control and strict rules in families, 42.9% of children interact with electronic screens. Comparing those results with the total results for software control availability in families shows that as the time spent is growing, the percentage of parents, implementing such measures is also growing. So, the importance of rules available is the key factor to control the time spent. As for example having software control implemented, but not strict rules most probably means the capacity of software is not used. It is confirmed also by the results in the group of parents, reporting they can't say how much time their kids spent with electronic screens, while at the same time there is a software control implemented and no rules available (20%): most probably software is available, but never used or monitored. Strict rules are most important for the group of children, spending up to 1 hour interacting with electronic devices, and this group is dominated by children up to 9 years old. While children from families with no strict rules are the biggest portion of the group, defined as spending more than 5 hours daily (20% and 28.6%). Those results are also connected with the analysis of parents' knowledge about the effects of screen time exposure of children.

Table 3 shows the results of the answers to the question: *"As a parent, do you have enough information about the effects of "Screen Time" - the benefits and disadvantages?"* in relation to the total time spent in front of electronic devices, (Cramer's V = 0,243, Approximate Sig.= 0**,**000).

Table 3 *As a parent, do you have enough information about the effects of "Screen Time" - the benefits and disadvantages?*

	I can't say	spends no time	1	1-2	3-5	above 5
No	0.0%	3,6%	0.0%	25,0%	**60,7%**	10,7%
Maybe	1,2%	2,4%	2,4%	**40,2%**	**40,2%**	13,4%
Yes	4,6%	6,2%	21,0%	**29,7%**	26,7%	11,8%
Total	3,3%	4,9%	14,1%	32,1%	33,4%	12,1%

The biggest portion of children (60.7%) spend 3 to 5 hours daily and live in families, where parents confirm they don't have enough information, while in the same group twice less (26.7%) are the ones whose parents report they have enough information. In the group of children spending between 1 and 2 hours daily 40.2% and 29.7% are from families, where parents consider they are maybe or fully aware about the effects of "screen time". If those results are compared with the above-mentioned data from Table 2, we see the direct link between the growth of age, the growth of "time spent" and the level of parents' confidence in their knowledge. One of the

possible explanations is that as kids grow up more and more digital tools are deployed in their hands – from using parents device in early age (1-4), having own mobile phone (5-9), adding tablet computer (10-14) and in 14+ group exposure to gaming (through gaming device). And as parents usually don't use some of those technological devices at all or use them in a different way than youngsters, it is difficult to stay informed up to date.

Table 4 presents the data from a closed question to parents: "*Do you think that the excessive use of electronic devices and increased time in the digital space?*" and 4 optional answers, (Cramer's V = 0,167, Approximate Sig.= 0,042).

Table 4 *How the excessive use of electronic devices and increased time in the digital space impact a child?*

	I can't say	spends no time	1	1-2	3-5	above 5
Harm the child	3.3%	7.8%	18.3 %	**30.6%**	28.3%	11.7%
Neither harmful nor beneficial	0.0%	1.6%	4.8%	**41.9%**	**40.3%**	11.3%
Benefit the learning process and social skills	3.8%	0.0%	7.7%	26.9%	**46.2%**	15.4%
Useful for the development of digital skills	8.1%	0.0%	13.5 %	27.0%	**37.8%**	13.5%
Total	3.3%	4.9%	14.1 %	32.1%	33.4%	12.1%

It is not strange that 0% of parents, whose children are not spending time with electronic devices, consider there is no benefit, as the majority of kids in this group are 1 to 4 years old (28.6%). With the increase of time spent and kids growing more and more parents consider excessive use of devices harmful, with peak (30.6) in the group of 1-2 hours spent. Also peak in this group are parents of 41.9% of children, who do not have neither positive, nor negative opinion. And we see that for approximately the same number of parents in this group benefits are related to learning process and social skills (26.9%) or development of digital skills (27%). This could be explained with the level of exposure of children to digital technologies when they enter the educational system, and start using electronic devices not just for entertainment, but also for learning. This conclusion is supported by data from the next group: spending 3-5 hours daily, dominated by children in age groups 10-14 and 14 and above. The % of parents without positive or negative opinion is at the same level as previous group (40.3%), but the % of parents with positive opinion is increasing significantly, with peak of all surveyed groups: 46.2% of children are coming from families, where parents think the excessive use of electronic devices and increased time in the digital space is beneficial for learning process and social skills, as well another 37.8% of children live in families, considering it is it is useful for development of their digital skills. So, if we connect results of those cross-section data with the ones presented in Table 2 – the control over "time spent" either thru special software implementation or formal rules in place is not of importance for parents as majority believe time spent with technologies is overall beneficial for their children.

5. Conclusion

There are few important conclusions made from the data analysis:

- "Time spent" by children on interacting with electronic devices is increasing alongside with the grow of the child and is directly influenced by entering formal education system;
- What the majority of parents consider as "acceptable time spent" is 1-2 hours in age group 5 to 9 (pre- and primary school), 3-5 hours for 10 and above (when children enter the phase of adolescence) while the bigger number of parents, participated the research consider the kids spend too much time
- The parental belief that digital technologies have positive impact on children (educational, social, and digital skills development) is growing with the child growing up, and for the age group 10 -14 (secondary school) and 14 and above (gymnasium) it is dominating among parents.

Data collected in the survey "Evaluation of the screen time our children spend daily for using digital technology" are not sufficient to differentiate how electronic devices are used and in what proportion between serving educational needs and entertainment needs. This is how the research could be extended further, adding detailed data and analysis.

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