

MAIN PILLARS BUILDING UP THE RISK FRAME OF INDUSTRY 4.0 IMPLEMENTATION IN THE ENTERPRISES IN BULGARIA²

Development of the technologies is a part of the modern world and modern business. The realization of extended changes, that have been imposed by Industry 4.0, is a very serious challenge for enterprises and in most cases have a high-risk ratio. The goal of this article is to define the main risk components forming the risk frame of Industry 4.0 implementation in enterprises in Bulgaria. In this relation, research has been made, giving the opportunity for a definition of the already mentioned components of the risk frame.

The research has been made on the basis of a questionnaire survey, covering 91 enterprises in Bulgaria. On this basis, eight main components are defined, which mainly determine the risk framework for the implementation of Industry 4.0 in enterprises in Bulgaria. A number of weaknesses and omissions have been outlined, which confront the realization of Industry 4.0 in Bulgarian enterprises. The risk variation in these components has also been studied, covering six risk areas identified as key risks in the researched enterprises. All this determines the current level of a significant part of enterprises in Bulgaria in the field of implementation of Industry 4.0 and also provides guidelines for taking measures to limit the impact of risk.

Keywords: Industry 4.0; Risk; Risk frame; Enterprises in Bulgaria

JEL: M15; O14; O33; O38

1. Introduction

In the last years, Industry 4.0 has turned into one of the main subjects. It is related to digitalization and new business models, with positives and challenges for the enterprises.

Digitization goes back quite a long way, since the second half of the 20th century. The digital changes have started with technological innovations, the introduction of hardware and software that has led to the intensification of production, changes in the quantity and efficiency of manufactured goods, changes in production technologies, including the

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production of new digital products that start changing the nature of the work (Bulkina, et. al., 2022).

According to Borissova (2021), the definition of digitalisation contains certain technical parameters describing the specificity of the carried actions in this process of transformation. This is a process of conversion, i.e. transformation of an analogue medium, as text, sound, video, signal, telephone impulse in a digital form through digital devices by information scanning method.

According to Chudaeva (2019), Digitalization leads to the emergence of such an opportunity as management of the organization in "real time" (Real Time Enterprise, RTE), which allows to receive information without delay, in the mode close to "real time". The combination of fast accumulation of knowledge, the dominant culture focused on changes and flexible forms of organization reduces the time (and, therefore, reduces the costs of the enterprise) and improves the quality of decision-making process at all levels of business management.

Heeding to digitalization, we can't miss a term like digital competitiveness of enterprises. According to Markova (2022), ICT-based innovations optimize business processes, increase efficiency and improve business decision-making. ICT-based innovation is a necessity in the present and a good investment in the future for the business and the environment, for consumers and for society as a whole. Nowadays, the business discusses and plans its digital competitiveness as an actual business tool.

Dutton (2014), relates Industry 4.0 to the so-called "smart factory".

Hozdic (2015), defines Industry 4.0 as the horizontal integration of data flow between partners, suppliers and customers as well as vertical integration within the organizational frames – from the growth to the final product. The result is a fully integrated system of processes – an informational system in a real-time frame.

According to Cordeiro, Ordonez and Ferro (2019) to implement the Industry 4.0 structure, it will be necessary a business model to be structured, which is in line with the operation of the cyber-physical systems, which will connect and share data in the whole chain in real time.

Deliotte (2014) introduces the huge capacity that the industry and traditional manufacturing have to change: Virtual networking of smart production systems; Horizontal integration via a new generation of global value chain networks; Through-engineering across the entire value chain; Acceleration through exponential technologies.

According to Senvar, Erkut Akkartal (2018) Industry 4.0 has a positive impact on meeting individual customer requirements, manufacturing suppleness, optimization, effectiveness, productivity and efficiency, value creation opportunities through new services and so on.

According to Sinay, Kotianová, Glatz (2018) Industry 4.0 can be defined as a philosophy that defines the methods and methods of managing technologies that are already used in some areas of industrial production where machines, machinery and products communicate with each other and organize themselves individually in the production process.

Global Industry 4.0 Survey (2016) Industry 4.0 is driven by: Digitisation and integration of vertical and horizontal value chains; Digitisation of product and service supply; Digital business models and customer access.

Ibarraa, Ganzaraina, Igartuaa (2017) identify Industry 4.0 as a transformation. This transformation represents an incremental innovation that optimizes the actual business without involving big changes. The new technologies such as Big Data, Cloud Computing, Collaborative Robots, Additive Manufacturing, Artificial Vision or Augmented Reality are introduced just to optimize the value creation architecture (key resources and activities) due to increasing efficiency and improving performance (reducing costs, time and failures, employee training, etc.). This could be the first step for traditional manufacturing companies to embrace Industry 4.0 without addressing high risks).

The upper definitions, concepts and opinions show the necessary changes in the enterprises, including their structures, processes and business models.

The pre-process business planning of the enterprises in the digital transformation part of the processes and data transfer are in the base of Industry 4.0. It is a change, directed to the creation of the so-called “smart factories” through building up overall cyber-physic systems and it is going to set deep wide-range changes in the processes of the industrial enterprises.

These changes will be relevant to a change in the way of interaction between processes, people and systems, committing real manufacture to the digital world of informational technologies. This change is a topic of the day for many enterprises in the world (Nikolov, 2019; Tsochev et al., 2019, etc).

Elkaseer, Salama, Ali and Scholz (2018) have presented practical approaches to implant Industry 4.0 in the additive manufacturing process to increase the flexibility, competitiveness and profitability of the manufacturing systems – Native design approach and Plug and Play approach.

Nowadays the changes in the business environment have a huge influence on the business. Their complexity, dynamics and intricacy turn into an obstacle for the enterprises very often. All of those changes lead to the necessity of quick and adequate reaction of the enterprises.

The conceptual base of Industry 4.0 throughout the possibilities of digitalization is namely to reach much better possibilities for reaction, adaptation, economic growth, competitiveness and better positioning of the enterprises in the dynamic business environment.

The organizations that adopt Industry 4.0 can expect to significantly improve their present competitive position, increasing value creation and minimizing risks. The adoption of more efficient and faster production systems and of innovative technologies will allow shorter operations, delivery times and faster time to market of new products and services (Fonseca, 2018).

2. Digital Transformation (Industry 4.0)

According to Industry 4.0 Research (2019-2023), the Transformation in Industry 4.0 is going to change the long-term dynamics in the trade and the global economic balance of the forces. The prognosis of Industry 4.0 market Research is that the Market will go through a significant transformation during 2019-2023 – changes in the market, expected to reach USD 1 Trillion till the beginning of 2030; growth of the global competition, possibilities with no precedence for optimization of the manufacturing processes; high economical expense of government work and private sector and in the same time growth of the industrial base and many others.

Trstenjak and Cosic (2017) make reference to the importance and the necessity of the realization of Industry 4.0. Very soon big international companies that use concepts of continuous improvement and have high standards for research and development will accept the concept of Industry 4.0 and make themselves even more competitive on the market. SMEs with a lower state of development will be left even more behind and couldn't keep up with the changes and demands of the market. That is why it is very important for them to develop their own strategy for Industry 4.0 implementation on time.

According to Fitsilis and Tsoutsas and Gerogiannis (2018), Industry 4.0 is not only technology and transformation of the production line. It includes as well the digital transformation of the whole business. This means that we have to reconsider a) the digitization and integration of vertical and horizontal value chains and b) the business model in general by optimizing customer interaction and access.

According to Ghanbari et al. (2017) When discussing business opportunities in the IoT, companies need to collaborate and be aware of novel network-centric business models. In this process, the key concern is how each company can be positioned within the business network in a way that it guarantees its profitability as part of a larger group; not only a single company. The challenge is that companies need to accept these new market rules where they individually will perceive less control over the final customers and the entire value proposition.

Bulgaria and Bulgarian businesses are part of this global world and for sure the new realities will exert influence on the business and the business development. That's why the attention needs to be focused in this direction – acceptance and application of these modern technological realities as Industry 4.0.

In this relation, the accepted National Strategic Document “Digital Transformation of Bulgaria for the period 2020-2030” lays down the principles of digital change in the main spheres of economic life (Ministry of Transport and Communications, 2020).

Despite that, the change coming for the enterprises in Bulgaria about implementing Industry 4.0, causes many questions and ambiguities. Some of them are: Are the enterprises in Bulgaria ready for such changes? Who and how will make these changes possible? What's the capacity for such a change? What are the risks connected with the implementation of Industry 4.0? How the enterprises will cope with them?

The enterprises in Bulgaria put efforts to be up to date with the modern tendencies including digital technologies. Despite that, Bulgarian enterprises have been defined as modest

innovators and taking one of the last places in Europe (European and Regional Innovation Scoreboards, 2019). The difficulties they meet have different character and nature. Here we can mention difficulties when participating in activities related to technological transfers, innovations and so on. The lack of experience and traditions additionally impedes their development of innovative potential, financial possibilities and so on (Nikolov, 2019). All that is one of the main premises for low results and shows the difficulties that the enterprises in Bulgaria have and will continue having in the future.

Siemens Bulgaria and German-Bulgaria Industrial Trading Association conducted research in 2018 showing some of the weaknesses and one of them is the lack of overall digital strategy of the enterprises. This article shows and confirms it. It shows that the enterprises in Bulgaria still have no real vision and no expectancies regarding the changes they follow. It also outlines the readiness for implementing Industry 4.0 in the enterprises in Bulgaria. A big part of enterprises are not ready for such changes, in spite of the fact they realize the role of the new technologies, the new models of functioning and digitalization. This is one of the main risk key factors related to Industry 4.0 implementation.

All these statements have been confirmed by the report of the European Commission regarding the penetration of digital technologies in Economics and society DESI, 2020 (The Digital Economy and Society Index). The DESI 2020 reports are based on 2019 data and they show that Bulgaria takes the last 29th place. Bulgaria, Greece, Romania and Italy have the lowest scores on the index (DESI, 2020).

New research of Siemens and the Bulgarian-German industrial trade chamber in 2021 (2021) shows the conditions, the obstacles and the perspectives in digitalization in Bulgaria. According to this research, more than 1/3rd from the questioned people, admit that they don't have an overall digital strategy. Our business has no high expectations for profit growth and reducing the ecological print in result of the digitalization. The business in Bulgaria doesn't expect any serious stress and loss of working positions because of digitalization. In the meantime – the companies have a clear vision of the type of employees they will need in this sphere for the next years. The qualification of the employees and the size of the investments are the main obstacle for the Bulgarian business regarding the future implementation of digital technologies and processes. This opinion has been shared among half of the people who took part in the questionnaire.

According to Veleva (2020), the enterprises have four barrier groups:

- Related to policy – One of the most important barriers facing industrial organizations is the need for long-term and sustainable national and international policies that have to ensure the development of smart innovation and sustainable change;
- Related to new technologies – in this group, the main barrier is that enterprises must be uncompromisingly quickly ready to apply and use new technologies, creating innovation;
- Related to R&D – Research and development (R&D) needs adequate financial support, both from the EU and from a national perspective.
- Related to qualification – the shortage of highly qualified personnel also influences the issue of introducing and embarking on the Fourth Technological Revolution.

All of the above information necessitates the attention and efforts to be directed to risk management connected to Industry 4.0 implementation.

The risk management is a key factor for every sphere and area in the dynamics of the modern business environment. In the conditions of realization of radical changes related to the way of interaction between processes, people and systems, the risk management attains even bigger significance and effect.

For essence, according to Snieška et al. (2020; Ghanbari et al., (2017), the potential risks of Industry 4.0, are one of the main reasons that impede or doubt the Industry 4.0 implementation. From an economic point of view – the loss of competitive advantage by reduction of the business models leads to a decrease in profits and even translocation of manufacturing. This is as a result of Industry 4.0 implementation.

Prinsloo et al. (2019), Radanliev et al. (2019) put an accent on the risks for cyber-security. This security aspect is often overlooked, particularly by promising new start-ups and parties that are not too familiar with the risks involved in not having proper cyber-security measures in place.

Birke et al. (2019) research exact risks, including economical, ecological, social, technical risks, IT-related risks and law risks.

Pusztai et al. (2023) present a possible method of implementation of a risk-adjusted production schedule in a data-rich environment. The framework is based on production datasets of multiple workshops, which is followed by statistical analysis, and its results are used in stochastic network models

Tupa et al. (2017) give a presentation of a design of framework to implement risk management for the Industry 4.0 concept, that includes a few aspects – Risk identification, Design of framework, Integration of performance and risk management.

Szlávika (2021) is concerned with the so-called “strongest sustainability indicators“ of Industry 4.0, applying a sustainability assessment model, concluding that a comprehensive preliminary sustainability analysis is essential to minimize the negative impacts of Industry 4.0.

Soitovski et al. (2021) discovered 28 risks on the basis of a literature survey, forming four groups – “Economic Risks“, “Social Risks“, “Environmental Risks“, and “Technological Risks“.

Sanchez (2019), puts an accent on the unemployment risks, generated by the implementation of new technologies and the vulnerability of the data due to the manipulation and the interconnection of the devices.

Not a small part of those studies is focused on a specific type of risk related to Industry 4.0, such as cyber risk and its impact, cyber security, sustainability risks, project risk, etc. There is no doubt that these risks are extremely important, but only affecting a specific type of risk leads to a certain limitation related to the realization of Industry 4.0. Another important fact is that each country has different progress in the field of implementation of Industry 4.0 and the risks have different impacts and importance.

In this relation, research has been made in Bulgarian enterprises and its goal is to define and outline the main risk components forming the main pillars in the risk frame for implementation of Industry 4.0 in the enterprises in Bulgaria (Figure 1).

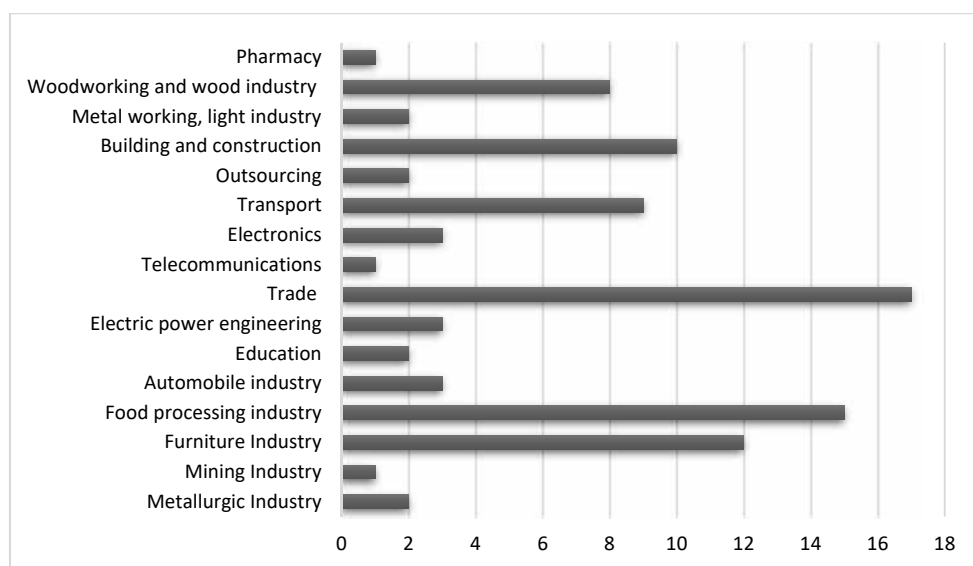
3. Profile of the examined enterprises

The research has been made on the basis of a questionnaire survey in July 2022 and includes 91 enterprises with different activities, fields and industries (Figure 1).

The surveyed enterprises are Joint-stock Companies, Limited Liability Companies and Limited Liability Private Companies. Company managers, as well as leading managers in the field of production and information technology, who have built or are currently building digital business processes in their enterprises and are familiar with the importance of Industry 4.0, have been selected as respondents.

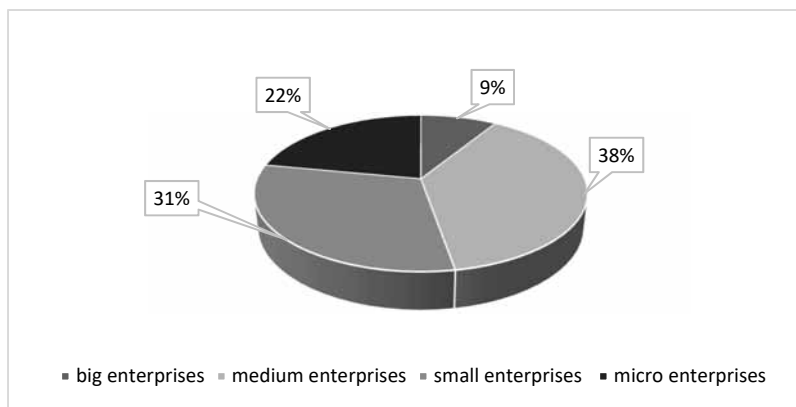
The research does not examine or evaluate specific types of risks that have or could have a relation to Industry 4.0, as it has been done in a large part of the research. The research carried out in this article aims to show precisely those risks that the managers of the organizations define as the most significant at the moment and which can be defined as the main pillars in the risk framework for the implementation of Industry 4.0 in Bulgarian enterprises.

Figure 1. Areas of activity, industries and fields



9% are big enterprises, 38% – medium enterprises, 31% – small enterprises and 22% – micro enterprises (Figure 2).

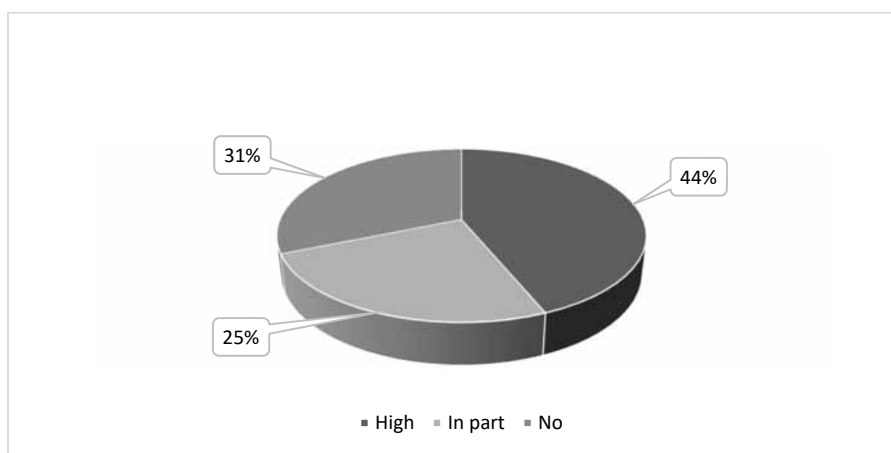
Figure 2. Structure of the size of the enterprises



The questions from the research include a wide circle of themes related to Risk Management, Industry 4.0 and Innovational Competency.

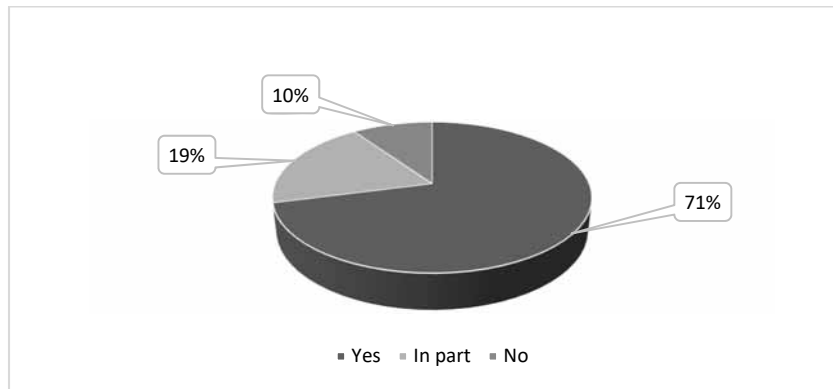
First of all, the participants in the research were asked to present how much and to what extent they are familiar with the nature of Industry 4.0 (Figure 3). Since the Industry 4.0 implementation process is related to a high level of knowledge, it is also one of the first and important key aspects of this process. The conducted research shows that 44% of the respondents are highly familiar with the essence of Industry 4.0, as well as what it requires and enforces its implementation. 25% of the respondents answered that they are partially aware, and 31% answered that they are not aware. The data presented at the moment shows a relatively low level of knowledge about Industry 4.0 in some of the Bulgarian enterprises. This is a serious risk factor that will have a negative effect on the realization of the stages of this process

Figure 3 Knowing the essence of Industry 4.0



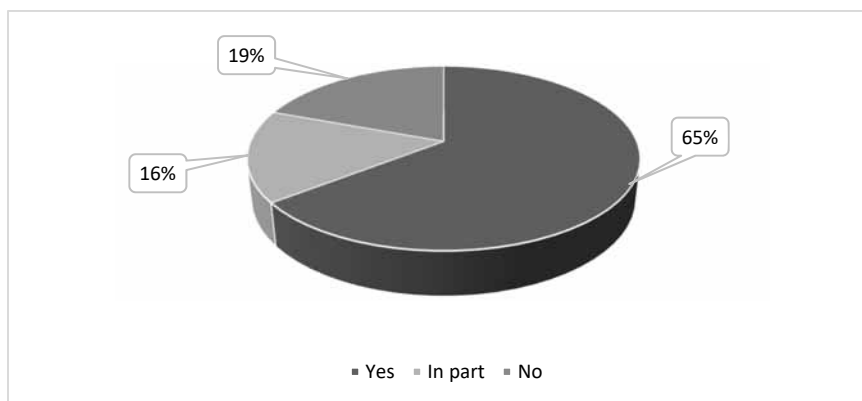
In the second place, research has been made about the use of modern information technologies and platforms in organizations (Figure 4). The research shows that 71% of the respondents use different IT platforms in the management of their business processes, including financial and accounting, warehouse, production, logistics, customer relations management, etc. Partially answered 19% and those who do not use any IT platforms are 10%. It can be seen that the percentage of those who use the possibilities of modern information technologies in their activities is relatively high, but the share of those who do not use the technologies can't be neglected. This creates certain difficulties for the business and its functions. Adapting enterprise processes to modern realities will also be extremely difficult.

Figure 4. Use of modern information technologies and systems in your organization



In the third place, the participants in the research were asked whether they intended to digitize their processes for the creation of goods and services in the future and to what extent (Figure 5).

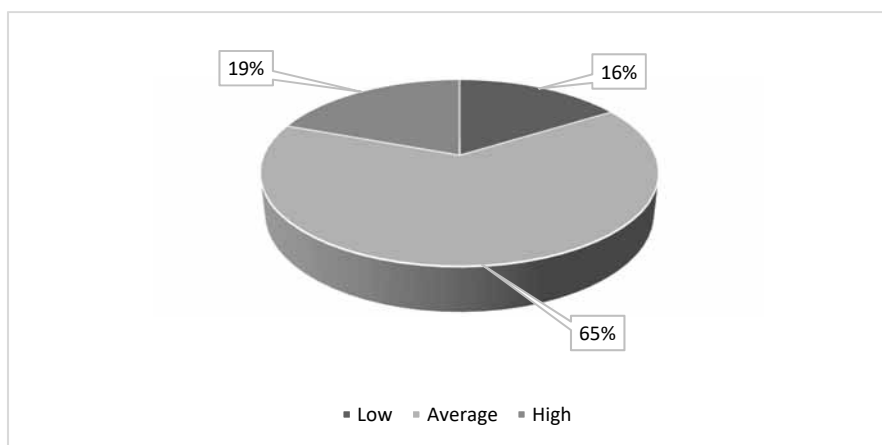
Figure 5. Linking the creation of goods, services and processes with digital technologies



65% of the respondents answered that they intend to digitize their processes for the creation of goods and services to a high degree. 16% partially answered and 19% are those who do not intend to. Although the share of those who answered positively is higher, the share of those who partially intend and those who do not intend to use the possibilities of digital technologies, can't be ignored as well and it is 35%.

In the fourth place, the participants in the research were asked to evaluate the possibilities of company management and applied business management models for reformatting and adapting to new technological realities (Figure 6).

Figure 6. Possibilities of company management regarding applied business management models for reformatting and adapting to new technological realities



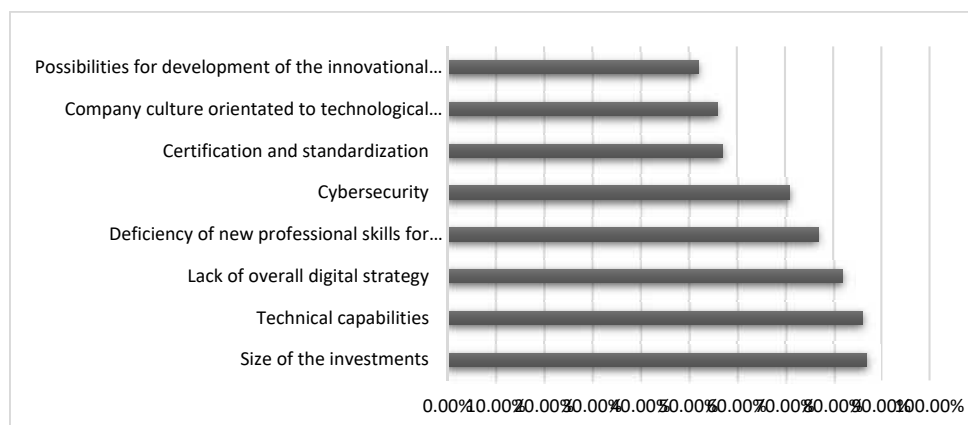
65% of the respondents answered that the possibilities of company management and applied business management models for reformatting and adapting to new technological realities are high. 16% answered that they are medium and 19% that they are low.

Despite the high percentage of those who answered positively, it can be seen that there is a problem in the company management and still a considerable part of the enterprises will encounter difficulties in terms of the digitization of their processes.

In the fifth place, the participants in the research were asked to identify the risk areas in their company that are related to the Industry 4.0 implementation.

This research gives us the possibility to outline the following risk areas and risk components related to building the risk frame when implementing Industry 4.0 in enterprises in Bulgaria. They have key and critical significance in the most cases (Figure 7).

Figure 7. Main risk components



- 1) 87% point the size of the investments needed for the realization of Industry 4.0 like a main risk component – the size of the investments for most of the enterprises is “unclear” but they have big expectations. Even a big part of small and medium enterprises in Bulgaria are not ready for such investments and the digitalization of their business processes and systems is difficult to be implemented at that point.
- 2) 86% define the technical possibilities they have. They have concerns about the technical possibilities they have at the moment and probably in the near future for Industry 4.0 realization.
- 3) 82% point the lack of overall strategy for Industry 4.0 implementation – this shows that at that point many of them are not ready for Industry 4.0 implementation.
- 4) 77% point the deficiency of new professional skills for participation in the transformational processes in Industry 4.0 – this component will have a significant influence on the realization of the digitalization of the business processes as well as the work afterwards and the necessity of qualified employees.
- 5) 71% point the cybersecurity – the implementation of internet-based devices will increase the risk of cyberattacks. In this relation, the data security will be threatened and the apprehensions are related to the overall management including their gathering, storage and exchange.
- 6) 57% point the problem with certification and standardization – lack of distinctness regarding the rules, requirements, certificates and standards followed by vagueness regarding the possibilities for building up effective systems preventing abuses in cyberspace.
- 7) 56% point the lack of company culture orientated to technological innovations (which Industry 4.0 is based on). The lack of culture orientated to innovations practically means rejection and difficult acceptance of the novelties and their necessity. This will also be

related to the possibilities for the development of the innovational potential and development of the enterprises.

- 8) 52% point missing possibilities for development of the innovational capacity of the enterprise – many of the enterprises consider that they are not looking for enough possibilities for development of their innovational capacity. It is a precondition for the standstill of the enterprises, impossibility for their development and better positioning in the business environment and it is also a precondition that will exert influence when implementing Industry 4.0.

Next, research has been made on how the risk level has been changed compared to the components identified. It covers six risk areas that have key role in the examined enterprises; business processes, technologies, technical and technological resolutions, financial factor, reliability and information security, IT systems (Table 1).

Three-dimensional scale for risk assessment has been used, including the “Low Risk” levels (0-2.99), “Medium Risk” (3-5.99) and “High Risk” (6-9) (Figure 8).

Rating scale for consequences of risk even occurring:

- 1 – Low possibility
- 2 – Medium possibility
- 3 – High possibility

Rating scale for risk event occurring possibility:

- 1 – Low influence
- 2 – Medium influence
- 3 – High influence

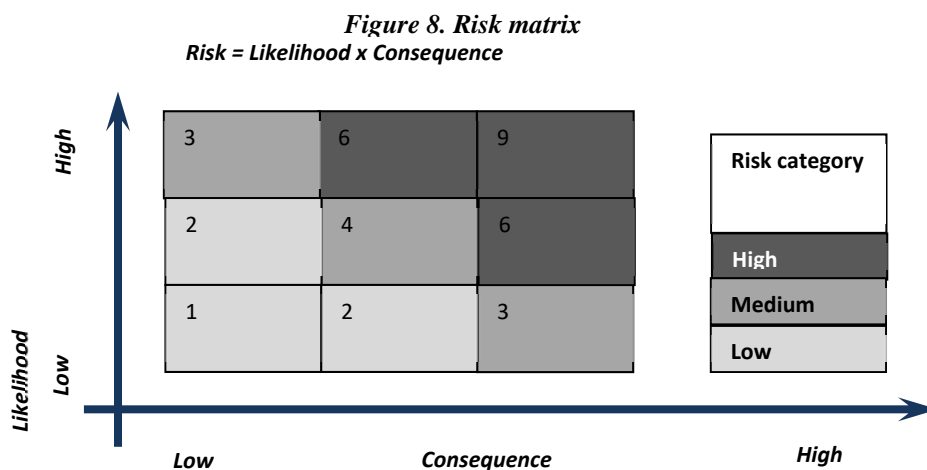
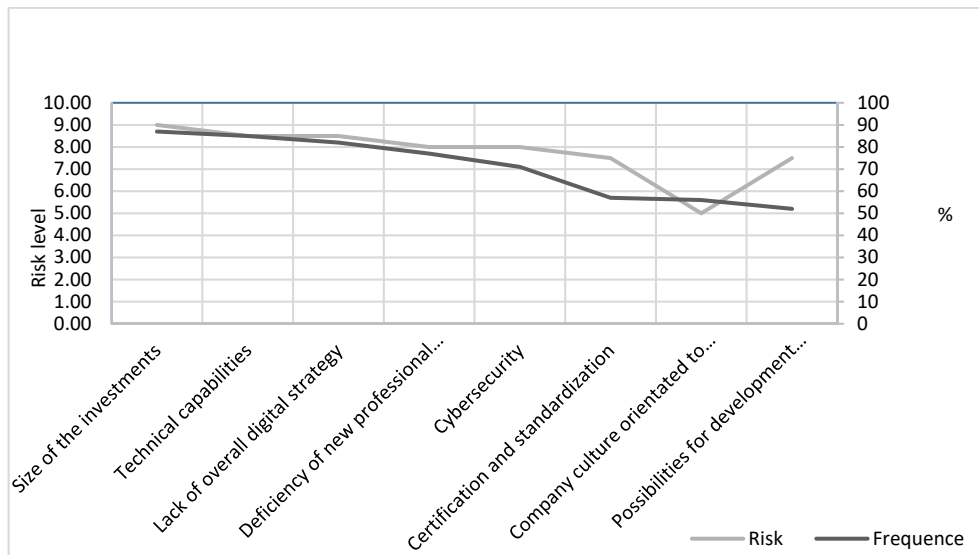


Table 1. Change in risk versus risk components

Risk components	Frequency (%)	Risk Level
Size of the investments	87	9,00
Technical capabilities	85	8,50
Lack of overall digital strategy	82	8,50
Deficiency of new professional skills for participation in transformation processes that Industry 4.0 is going to implement	77	8,00
Cybersecurity	71	8,00
Certification and standardization	57	7,50
Company culture orientated to technological innovations	56	5,00
Possibilities for development of the innovational potential	52	7,50

The highest risk level has the size of the investments (Figure 9). It is at 1st place with a value of 9 (high risk). At 2nd place with a value of 8.50 (high risk) are the technical possibilities of the enterprises and the lack of overall strategy for implementing of Industry 4.0. At 3rd place with value 8 (high risk) is the lack of new professional skills for participation in the transformational process that Industry 4.0 will impose and the cyber security. At 4th place with a value of 7.5 (high risk) is the certification and standardization and missing opportunities for the development of the innovational capacity of the enterprises. At 5th place with value 5 (medium risk) is the lack of company culture directed to technological innovations.

Figure 9. Risk variation



The researches show opportunity for analysis in different aspects and they have a key role in Industry 4.0 application in Bulgarian enterprises. The arrangement of the risk components is

not much different than the risk variation in them. The data shows a row of weaknesses and omissions as well as the readiness of the Bulgarian enterprises for Industry 4.0 realization. At this stage, their readiness is extremely low and the risks they need to overcome are extremely high. This identifies the difficulties for Industry 4.0 realization in them. Bulgaria is far behind Industry 4.0 realization. The lack of strategy for Industry 4.0 is also one of the main omissions in this part. The state needs to give assistance to the efforts that the business is making. Digitalization, new technologies, transfer of technologies, etc... do not take a foremost and central place. This means that all processes that are about to be performed, will be performed extremely difficult and some of them will not be performed at all at this stage.

Measures need to be taken that will direct the efforts of the state to help overcoming these difficulties.

Conclusion

Nowadays the development of modern business models is more related to the development of digital technologies. The tendency towards higher productivity, higher additional value and higher accelerated rates of economic development are invariable part of modern business strategies.

This research gave us a possibility to define 8 business components forming a main part of the risk frame for the implementation of Industry 4.0 in the enterprises in Bulgaria.

A number of weaknesses and omissions were laid down. That will hinder the realization of Industry 4.0 in Bulgarian enterprises, including: weaknesses in knowing the essence of Industry 4.0; weaknesses in the application and use of modern information technologies and platforms; weaknesses in the direction of digitization of processes; weaknesses of company management regarding the applied business management models directed to reformatting and adapting the new technological realities.

All of the above as well as the components identified help us define the following future directions for taking actions towards accepting the measures for limiting the risk influence.

These 8 components will play a big role and will have a determinant and key role for Industry 4.0 implementation in the enterprises in Bulgaria.

The variation of the risk, examined in these components, shows the direction that particular actions need to be taken from the side of the state and the enterprises in Bulgaria.

It needs to be remarked that the variation of the risk may be examined in other risk areas, showing specifications and other essential elements in the enterprises.

In this relation, the Industry 4.0 implementation will be a serious challenge for the enterprises in Bulgaria. It is related to high expectations and at the same time has many risks. We also need to highlight the limited possibilities for many of the enterprises at the moment – many of them are not ready for Industry 4.0 implementation. In most cases, they have limited possibilities in the already mentioned risk components.

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