Introduction of Industry 4.0 in Industrial Enterprises: Problems and Challenges

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Abstract: *This publication analyzes the opportunities, problems and challenges associated with the implementation of Industry 4.0 in Bulgarian industrial enterprises in condition of a dynamic changing competitive environment and extending digitalization. An analysis is made on the base of the four fundamental principles that are used for application of solutions related to the implementation of Industry 4.0 and that influence on the organizational activities in all functional areas in the industrial enterprise. Various industrial sectors are analyzed to identify the trends, problems and challenges of the introduction of Industry 4.0 in manufacturing activities. Opportunities for improving their competitiveness are identified by means of using the principles and advantages of the modern digitalization. Up-to-date statistics and various methods for analyzing of the existing information are used. The specifics of development of the leading sectors in Bulgarian economy are identified. The results show that there is a growing number of Bulgarian industrial enterprises focused on deploying Industry 4.0 to reach new higher levels of productivity, quality and efficiency. This is a new approach in seeking favorable opportunities for their further sustainable development and competitiveness. Some fundamental problems, challenges and barriers in industrial enterprises, in the process of introduction of digitalization in the industry are discussed, which hinder the fast pace of their development. As a result of this analysis are presented some appropriate solutions.*
Keywords*: INDUSTRIAL PRODUCTION, INDUSTRY 4.0, DIGITALIZATION, CHALLENGES, SUSTAINABLE DEVELOPMENT.*

1. Въведение

In the modern world, it is increasingly being talked about the enormous impact that digitalization is developing at an extraordinary rate, its advantages and challenges. The process itself may be called "megatrend", which causes the world to look toward new, more sophisticated levels of productivity. More and more organizations are redirecting and refining their strategies and goals toward the introduction of new generations of digital technology. Aiming at building competitiveness, today every industrial enterprise is concentrating its efforts and resources on the development and improvement of digital technologies through the implementation of Industry 4.0. The aim is to achieve higher levels of productivity, quality, efficiency, search for favorable opportunities for their further sustainable development and competitiveness.

2. Industry 4.0 - essence and characteristics

Industry 4.0 is a modern phenomenon that has many advantages but also has negative impacts. There is no one specific answer for the name "For" or "Against" Industry 4.0. Prior the introduction of Industry 4.0, every industrial enterprise must clarify the specific nature and specific characteristics contained in the concept of digitalization through its prism of reality. According to the concept of digital transformation of Bulgarian industry, "... the importance of new technologies for society and economy is determined by the definition of the term "Fourth Industrial Revolution"[2]. Based on the detailed literature review, could be done the conclusion about the majority of the Fourth Industrial Revolution. These conclusions may be presented by summaries of researchers in this field (Industry 4.0) (Table 1):

The Fourth Industrial Revolution is developing on the base of modern digitalization, combining different technologies, methods and digital solutions, which lead to significant changes in the market environment, business and society.

Table 1: Key summaries concerning the essence of the Fourth Industrial Revolution (Industry 4.0).

	The Fourth Industrial Revolution (Industry 4.0) - The Essence
Federal Government of Germany, 2011 (High-Tech Strategy for Germany 2020)	„High-tech strategy for the development of the German industry in 2011“ [3]
According to the Concept for Digital Transformation of Bulgarian Industry [2017]	"Industry 4.0. is defined as part of the application of new digital technologies in the manufacturing sector and includes a wide range of technological solutions and business models that contribute to qualitatively new forms of economic activity. "[2]
Corresponding Member MD Svetozar Margenov Director of the Institute of Information and Communication Technologies - BAS (IICT - BAS),	"Digitization in industry: ecosystem for sustainable innovative growth "[5]
Prof. Dr. J. Ovcharova (Head of the Institute of Information Technology Management (IMI))	„The term Industry 4.0 is a word game consisting of 3 parts - first "industry" means that this initiative is aimed at the industry; second, "0" is a reference to Internet technologies; and third "4" marks the fourth industrial revolution and aims to reach a new level of industrial value ... " [6]

The need to understand, use and fully implement the concept of Industry 4.0 is primarily due to the fast development of new technologies leading to the automation, modernization, refinement and digitization of the real production and business processes. In this way, each organization (industrial enterprise) manages to achieve sustainable development and growth and high levels of competitiveness.

According to the Concept for Digital Transformation of Bulgarian Industry from 2017 digitalization of the economy "..... it is developing dynamically and is an important driver of innovation, competitiveness and growth ....". The Fourth Industrial Revolution is based on four basic principles that are used to implement decisions related to its implementation and that affect organizational activities in all functional areas of an industrial enterprise. These are: [2]

1. **Interoperability** - the ability and need of a system or product to work with other systems or products without the need for additional user action. This principle is implemented through the Internet of Things (IoT) or Internet of People (IoP);

2. **Transparency** – it is realized by the ability of new generations of information systems to calculate and store data in the so-called cloud structures.

3. **Structuring and visualizing information** in a new, comprehensible way that helps managers to make decisions about pressing issues.

4. **Autonomy** - technological innovations are not universally applicable, but they must be tailored to the specific functional areas of the industrial enterprise.

Applying and complying these 4 fundamental principles is a key factor in achieving the competitiveness, development, productivity and survival of any organization in today's competitive environment. [10]

Industry 4.0 is a set of various activities, business models, technological and strategic decisions. E-commerce, intelligent manufacturing enterprises, cloud technologies, internet technologies, artificial intelligence, 3D printing, robotics, smart cities, smart factories are only a small part of the development of automation and real-time data exchange in manufacturing processes.

The characteristics of the Fourth Technological Revolution may be summarized as follows:

- Decision-making optimization - Big Data analysis and processing facilitates more flexible decisions when urgent problems arise;
- Resource Productivity and Resource Efficiency - The pursuit of basic strategic goals, namely producing the most output based on available resources at the lowest possible cost. In this way, optimization of production processes, reduction of costs, better use of resources and energy, reduction of harmful emissions from production and environmental protection are achieved.
- Customer/customer feedback regarding ordering, planning, manufacturing, design regarding the production of a product or service.
- Dynamic organization of production processes according to time, quality, price, risk, sustainability, resources, suppliers, customers and more.

3. Introducing Industry 4.0 into Industrial Enterprises - Essence, Problems, and Challenges

"The Industry 4.0 platform is a response to the changes in modern technology that have led to the fourth industrial revolution since the introduction of machines, production lines and IT." [1]

The introduction and implementation of this platform is not an easy process for any industrial enterprise, which is developing in the current competitive environment. In an extremely fast-paced, dynamic business environment, it is clear that there is no one-size-fits-all solution or sequence that can be applied to digitalization, both for large, small, and medium-sized industrial enterprises. Each organization is unique and each decision must be strictly individual. The desire to achieve pragmatism and adaptability on the part of enterprises is increasingly being sought, trying to achieve maximum results with limited resources and opportunities.

One of the main keys to the introduction of Industry 4.0 is the promotion of human-machine collaboration. The pace of introduction of new technologies, resources and staff qualification are also among the key factors for transition to the Fourth Industrial Revolution.

According to the Strategy for Bulgaria's Participation in the Fourth Industrial Revolution. (Industry 4.0) – 2018, [9] 4 basic strategic tasks for the introduction of Industry 4.0 can be identified and practically implemented as they are listed:

- Institutional support for the development of Industry 4.0 - identification of specific strategies, policies, programs, procedures, mechanisms and tools to support the development of Industry 4.0 in relation to the peculiarities of Bulgarian organizations and market conditions;
- Creating synergies between existing policies, programs, procedures, strategies and support mechanisms;
- Development of educational and scientific initiatives to build institutional and organizational capacity for acceptance and compliance with the requirements and prerequisites of Industry 4.0;
- Creating preliminary projects and demonstration models for visualization, analysis and implementation;

Digital education, qualifications and training in the range of the work process can be cited as major problems with implementation. Their solutions lie in providing accessible tools for employees that are used in different departments of industrial enterprises. In this way, by sharing experience and information, organizations can achieve their ultimate goals faster, pragmatically, by joining forces to implement complex solutions.

The key to the introduction of Industry 4.0 is based on the seamlessly digital knowledge transformation into everyday skills and professional qualifications - fast, pragmatic and more active. [10]

The significant role of innovation must also be noted here. To realize an innovative idea, several components are needed: creativity, entrepreneurship, freedom. [1]

In the classification of the main challenges and obstacles to the introduction of Industry 4.0 Industrial enterprises can be identified the following risks and barriers:

- Unclear economic benefits;
- Investment amount;
- Qualification and training of employees;
- Insufficient standardization and certification;
- Unclear economic conditions;
- Data security;
- Strong competition;
- Insufficient stimulation of digitalization by the state;
- Adaptation of legislation;

Some of the major benefits that any industrial enterprise could benefit after deciding to introduce and use the latest generation digital platform are:

- Increasing efficiency;
- Optimization of planning and management processes;
- Achieving resource efficiency and resource productivity;
- Maintaining competitors advantages and competitiveness in the market;
- Collection and analysis of large amounts of data through information systems;
- Cost reduction;
- Increase in turnover;
- Achieving sustainable development and growth;
- Employee-user feedback;

According to the National Statistical Institute (NSI) the results of the conducted in 2019 a survey of enterprises with 10 or more employees show that 95.7% of them use computers, and for large enterprises with 250 and more employees the relative share is 100.0%. High-speed, reliable and uninterrupted Internet access is a fundamental necessity for businesses and 93.7% of them have permanent access to the global network. To connect with Internet companies, they mainly use DSL or other fixed technology (80.5%), with 64.8% of them having the fastest fixed connection speed exceeding 30 Mbps. [11]

From the Fig. 1, it is clear that more and more organizations are using the Internet, which is directly dependent on the development and implementation of Industry 4.0 in the Bulgarian market economy. [9]

Another important factor concerning the essence of the introduction of Industry 4.0 is the provision, deployment and use of information and communication technology (ICT) in an industrial enterprise. [8]

According to NSI data, in 2019 one of five enterprises (20.1%) has employees whose primary job is to develop, manage or maintain ICT systems or software applications. In the previous 2018 10.0% of enterprises have employed or have tried to employ ICT specialists, as 41.6% of them have experienced difficulties in finding suitable staff. 10.1% of employers provide ICT training to improve the skills of their staff. Fig. 2 presents the relative share of

enterprises that employ ICT professionals and provide training in the field of ICT by enterprise size in 2019. [11]

Share of enterprises with internet access by size class and economic activity in 2019

(Per cent)

	Internet	Fixed connection	From them: with speed ≥ 30Mbps
Total	**93.7**	**80.5**	**64.8**
By size class			
10 - 49 persons employed	92.5	78.3	62.3
50 - 249 persons employed	98.8	89.7	73.8
250 or more persons employed	100.0	97.5	81.8
By economic activity			
Manufacturing	94.1	81.7	59.5
Electricity, gas and steam, water supply, sewerage and waste management	98.9	84.7	69.0
Construction	95.2	78.1	66.6
Wholesale and retail trade; repair of motor vehicles and motorcycles	93.8	80.7	59.7
Transportation and storage	95.6	78.2	58.8
Accommodation and food service activities	85.4	70.1	67.0
Information and communication	100.0	96.0	93.8
Real estate activities	97.5	87.1	75.6
Professional, scientific and technical activities	99.7	94.0	79.6
Administrative and support activities	87.3	73.7	71.1

Fig. 1 Relative share of enterprises with Internet access of enterprises economic activities in 2019 by size according to NSI [11]

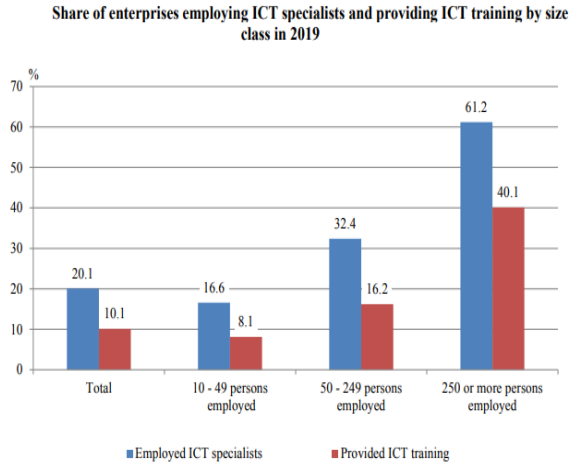

Fig. 2 Share of enterprises employing ICT specialists and providing ICT training by size class in 2019 accordin to NSI [11]

More and more Bulgarian industrial enterprises are focusing on the implementation of Industry 4.0 to achieve higher levels of productivity, quality and efficiency. This is a new, modern approach to seeking opportunities for their further sustainable development and competitiveness. [4], [7].

4. Barriers to industrial enterprises in the process of introduction of digitalization in industry and appropriate solutions.

The barriers defined by the analysis of existing information facing industrial enterprises determined to introduce and use new generations of technology can be classified into several major 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. Flexibility of the organization regarding to this barrier is crucial in achieving competitive positions in the face of new market conditions.
- 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.

5. Conclusion.

Achieving resource productivity (producing as much output as possible from available resources) and resource efficiency (at the lowest possible consumption of resources for available quantities of output), individual approach to the consumer, flexibility and potential for value creation by offering new services and products, summarizes and presents how important and necessary the process of deploying Industry 4.0 in an industrial enterprise is. In this way, the key advantages considered are the challenges and benefits of implementing digitalization, defining Industry 4.0 as a powerful tool for achieving high efficiency and competitiveness of industrial enterprises in a highly competitive environment.

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