Digital transformation of the Bulgarian industry

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Abstract. Information and communication technologies are the major driving force of the digital revolution in Europe and the bedrock underpinning the construction of a competitive knowledge-based economy. As a Member State of the EU, Bulgaria is pursuing a policy on the preparation and development of human, institutional and organisational capacity necessary to obtain societal and economic advancement. Adopting such a perspective, the paper aims to explore the nature of the digital economy in the context of Industry 4.0. To that end, the paper further examines the state of utilization of digital technologies in the Bulgarian industrial enterprises, which provided the basis for specific set of recommendations to be made on improving the process of digital transformation of the Bulgarian industry.

1. Introduction
The development of digital technologies is a leading factor and a solid basis for building a competitive national economy in the coming decades. At the global and European level, the advent of digital technologies and their effects on the manufacturing sector in particular, is considered one of the main strategic priorities [9,11]. As part of the European space, digital transformation in Bulgaria is driven primarily by the rapid growth of new technologies leading to unprecedented automation and digitisation of the existent manufacturing and business processes and provision of brand new opportunities for the creation of value added business relationships [2,7,9,11]. The preparation and development of human, institutional and organisational capacity necessary to obtain societal and economic advancement prove undoubtedly a decisive factor in the planning and management of such a kind of complex technological, economic and social process called digital transformation.

2. Industry 4.0 within the framework of digitisation of the economy
The concept of “Digital Economy” refers to a wide range of digital technologies and their application in different social spheres, which calls for more detailed coordination between strategic and reference policies [8,9,11]. Global digital economy evolves dynamically and represents an important means of propelling new innovation activities to induce competitiveness and promote productivity and economic growth, to encourage entrepreneurship and ensure full-scale industrial development. There are numerous activities, business models and technological solutions that fall within the scope digital economy. On the one hand, these are the gradual advancement of electronic business and e-commerce, automated industrial production and smart manufacturing enterprises, intelligent transport systems and autonomous vehicles, intelligent energy systems and others. Cloud technologies, Internet technologies, including the Internet of things, Big Data technologies, industrial and service robotics along with the artificial intelligence development are thought to be the vital technological prerequisites for the explosive growth of digital economy. Just as important are also public sectors such as e-government,
e-health, e-education and the development of smart and technology-connected sustainable cities are a natural trial run of the products and services created by the digitally-enhanced economy. Integrating research and technology development into active plans of actions for implementing such policies and models that would enable and support the continued expansion of the digital economy are of utmost importance considering their strong impact on all aspects of economic and public life [2,7,9,11].

The fourth industrial transformation (Industry 4.0) is a genuine continuation of the digitisation and automation of the manufacturing sector and relates to a set of connected digital technology solutions that sustain the growth of automation, integration and real-time exchange of data in a process-based manufacturing. It is an intrinsic manifestation of the industrial and technological transformation process which follows necessarily from the development of scientific and best manufacturing practices. Closer analysis of the specific Industry 4.0 characteristic features groups them in the following directions:

- **Optimisation of decision-making.** Decision making is becoming a key factor in the global competitive environment. Capitalizing on the capabilities allowing for real-time analytics and handling large datasets helps businesses to make real-time decisions. This, in terms of manufacturing, implies more flexibility in responding to unforeseen events such as breakdowns or malfunctions as well as optimisation beyond the boundaries of the enterprise.

- **Resource productivity and resource efficiency.** Industry 4.0 retains the existing strategic objectives that have been ranked first in the strategic planning process of the manufacturing industry: producing the most output possible with the available resources (resource productivity) at the lowest possible resource cost for available production quantities (resource efficiency). Cyber-physical systems, thus, are ready to optimise production processes throughout the value chain. Moreover, in order to achieve maximum efficiency in the cost of the resources and energy or (carbon) emission reduction, certain systems can be optimised and continually adapted over the entire process of manufacturing it self.

- **Individual approach to every customer.** Industry 4.0 makes provisions for any individual and customer-specific requirements to be fulfilled as regards a specific design, configuration, order, planning, production and operation, including the requisite for changes to be introduced at fairly short notice. With Industry 4.0 even the production of individual items (batch of a single product) may well yield substantial profit.

- **Flexibility.** Cyber-physical system (CPS)-based network favours dynamically organized business processes in multiple dimensions: quality, time, risk, sustainability, cost, environmental impact, etc. Thus, materials and logistics chains are invariably kept in a fine balance. Accordingly, design processes can be immediately organized, production operations can be easily modified and compensations can be granted for short-term disruptions (e.g. caused by suppliers), or the volume of supplies can be substantially increased within a short period of time.

- **Potential for creating (added) value by offering new services.** Industry 4.0 facilitates the creation and implementation of new forms of value added and employment, for example through the provision of (supply) chain services. Through the application of intelligent algorithms, the vast amount of data collected on a large scale by means of smart devices can be used for proposition of innovative services. Within the framework of Industry 4.0, this would enable the companies to exploit the potential of Business-to-Business (B2B) services designed specifically for small, medium and startup businesses.

The impact of the new digital industrial technology, known as Industry 4.0 upon the manufacturing and business processes can be broadly grouped in the following directions:

- Engineering brand new products and services with integrated intelligence, innovative business models and opportunities for personalisation and customization to fulfil individual customer’s needs;

- Full digitization of the entire process of manufacturing, accelerating research development through digital prototyping and virtual production, flexible organisation of the production process.
3. Digital transformation of the Bulgarian industry
The digital transformation of the Bulgarian industry (Industry 4.0) is closely linked to the development of the digital economy, which implies vast/unprecedented expansion and widespread use of digital technologies in the social and economic life. From this perspective, the government primary economic objectives are aimed at creating prerequisites for the modernization, automation and competitive medium to long term positioning of the Bulgarian economy.

The 2017 rating of Digital Economy and Society Index (DESI) reveals that Bulgaria performs well below the EU average for the implementation of digital technologies by the respective enterprises [1, 2, 3]. Observed in the country is a widespread use of radio frequency identification (RFID) technology, and yet, Bulgarian enterprises are falling behind the rest of EU in the digital transformation of their business activities despite the slight improvements in their usage of social media, electronic invoices and cloud computing paradigm for managing and delivering services over the internet. More specifically, as illustrated by the trends in the field of e-commerce, SMEs are turning away from online trading - only 5 % of SMEs are currently conducting their business electronically, which accounts for the low rate of online sales turnover - only 1,7 % of the total turnover. The slow development of e-business is due to the small number of active e-shoppers purchasing goods and services online (an average of 9% for the country as a whole, with a higher share in densely populated areas — 14%), the low level of technological input by some of the enterprises and the inadequate supply of online public services [3].

The 2017 analysis of the statistical data provided by the National Statistical Institute (NSI) showed a considerable slowdown on the part of SMEs with regard to the implementation and extensive utilisation of digital technologies comparable to that of the larger companies [10]. Practical application of digital technologies is prevalent in industrial enterprises with economic activities such as: Manufacture of chemical and pharmaceutical products (70,67%), Manufacture of wearing apparel, incl. that of leather as well as leather and fur processing (65,34%), manufacture of beverages (65%), Manufacture of radio, television broadcasting and communications equipment (49,67%), Manufacture of fabricated metal products (47,67%) and manufacture of non-metallic mineral products (43,34%) (figure1). With SMEs, a major part of digital technologies are mostly concentrated within the beverage manufacturing sector - 45%, followed by the manufacturing of chemical and pharmaceutical products-38% and manufacture of wearing apparel, incl. leather and fur processing– 34%.

The great majority of the industrial enterprises in Bulgaria believe that their employees are well qualified (80%), and that their employees are fully aware of the best practices in the sector (81%). The adoption of a human resources strategy proves to be pivotal for the sustainable development of enterprises over shorter and longer periods of time. The requirements of the modern global market impose new competences and skills that are likely to be gradually incorporated into our internal domestic market as well. The new set of essential knowledge and competence framework can only be constructed through a deliberate policy towards improving staff qualifications and skills (figure2). Training programmes to enhance the digital literacy of the employees have been carried out in the following areas: social media, resource planning systems, security skills, IT architecture, creating web pages and developing web applications, creating and building mobile applications, applying cloud computing technology and bigdata/data analytics.
Figure 1. Utilization of digital technologies in Bulgarian industrial enterprises by economic activities [4,5,6,10]

Data indicates that all large-sized industrial enterprises have invested in the development of their employees’ skills in encouraging wider use of the resource planning systems (100%). 97% of the employees have undergone training in the area of (digital) security skills, 93% - IT architecture, platform architecture, and 83% - creating and building mobile applications. 81% of the enterprises
have provided training programmes in Cloudcomputing and virtualisation, 78% in Big data analytics technologies and tools.

As for medium-sized industrial enterprises, it is reported that 68% of the employees have been given training in the use of ERP systems, 65% - in the area of security skills, and 51% - in IT architecture. Only 24% of the employees have been offered job-related training in Cloud computing and virtualization.

Small-sized industrial enterprises were more inclined to offer their employees adequate training mostly in the area of ERP systems (21%), creating web pages and developing web tools (18%) and social media (13%).

Formulating and pursuing effective market-driven strategies is of utmost importance for the enterprise to be commercially successful and profitable in the context of digital transformation of the European and global industries. Currently, as a result of the improved extended access to digital technologies and increased market pressure, activities such as planning, marketing research, internal and external market expansion strategies, that were once uniquely specific to large-sized companies, are increasingly becoming relevant to the very functioning of modern SMEs. 55% of the industrial enterprises are cited as having adopted process-based management systems, 33% - supplier relationship management systems, and 21% - customer relationship management systems. 27% of the enterprises in Bulgaria have implemented another types of process management systems.

4. Conclusions
Considered, in line with the analysis presented so far in the present paper, might be the following set of recommendations in support of the current digital transformation of the Bulgarian industry:

a. Taking decisive steps to secure a steady improvement in the overall business environment and a more targeted investment in the human capital in order to attract foreign direct investments in Bulgaria and future technology transfer
b. Making the best use of the existing information and communication technologies (ICT) to propel the growth in the industry, to boost exports, to raise the value of R&D staff and capacity utilization
c. Specifying the optimum prerequisites for the formation of ICT industrial clusters across the country
d. Establishing Digital Innovation Centres
e. Popularizing the existing standards guiding the field of Industry 4.0.
f. Deepening the relationship and building successful partnerships between science and industry in Bulgaria and accelerating the process of integration of Bulgaria into European and international programmes, initiatives and networks related to the advancement and implementation of Industry 4.0.
g. Technological renovation of the Bulgarian economy through: implementation of adequate standards, procurement of proper infrastructure, provision of concrete mechanisms for fostering the development of technological innovations and their successful market introduction (new products, services and process-based manufacturing) through the deployment of Industry 4.0 technologies.

h. Building the human, scientific, organisational and institutional resources for development of Industry 4.0 in Bulgaria.

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