PREPARING FOR INDUSTRY 4.0 AND DIGITAL TRANSFORMATIONS IN SMEs. EUROPEAN AND NATIONAL ASPECTS

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Introduction

Industry 4.0 is a dynamically developing technological, economic and social trend marking the rise and broader implementation of sophisticated technology solutions that allow for the merger of the physical and information space. Taking into account the business and social impact of Industry 4.0, the present study aims to outline the main European and national initiatives behind the digital transformation processes and the readiness of SMEs.

The wide implementation of Industry 4.0 and smart factories technologies started to transform the European manufacturing landscape and to push for further digitalization of the economy. Industry 4.0 is a new paradigm shift toward next-level automation models, based on a cluster of technologies such as cyber-physical systems, Internet of Things, Additive manufacturing (3D printing), robots/cobots, artificial intelligence, bid data, cloud computing and others. Recognizing the need to sustain the EU primary position and industry leadership, the European Commission launched several key initiatives in order to upgrade national efforts, to encourage industry modernization with private and public investments and to promote joint cooperation activities among country members. In order to stimulate further collaboration among the key players in the field during the last few years there have been adopted several initiatives. Coordinating and orchestrating the efforts of technology leaders, research community and public administrations to develop new supporting infrastructure, connected platforms and complex services, the EU policy makers are opening the floor of next rounds of negotiations for standardization and unification. Therefore, the EU initiatives in the field of Industry 4.0 are directed not just to encourage

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technology innovations and digitalization in specific economic sectors but aim to create appropriate settings and impetus to nurture future European leadership in the field. Providing mechanisms to fund research organizations and industry innovations, the EU framework programs, such as Horizon 2020 and Erasmus +, enable EU research and business organizations to develop, share and mobilize key expertise in new technologies. But in the same time, it is important to ensure a smooth economy transition in many regions and companies, and especially in SMEs that still lag behind. That is why the EU institutions look to deliver instruments and mechanisms to integrate the efforts of the country members for wider promotion and implementation of Industry 4.0 and smart factories models. Investment opportunities in transnational cooperation and collaboration along with knowledge sharing and best practices dissemination are among the drivers of the next waves of economic development in European context. Now it is the time to define the next models of technology infrastructure, standards, business models and value chains that will nurture the new organizations, supporting platforms and complex economic networks. Thus, in the present research we explore Industry 4.0 and intelligent manufacturing as the basis for the next round of EU policy initiatives for supporting economy's digital transition. Furthermore, the impact of Industry 4.0 exceeds the transformation of the manufacturing sector to dynamic and self-organizing production networks. It is widely expected that Industry 4.0 is a paradigm shift, imposing a new frame of thought that will become the cornerstone for the EU's digital transformation.

Considering the European and national aspects of the current digitalization and technology negotiations processes within EU, the present paper aims to explore how these trends directly affect small companies and businesses. More specifically, the present research tries to identify the companies' perceptions, readiness and attitudes toward mass digitalization. Thus, the main concepts behind the new institutional mechanisms and instruments to support the organizations by implementing the models of Industry 4.0 are outlined, and the EU policy initiatives concerning the digital transformation are explored.

The paper aims to propose a structured review of the main ideas, dimensions and approaches behind the new Industry 4.0 paradigm shift. It will allow for the analysis of the paradigm shift precipitated by the challenges of an industry revolution. Therefore, the main aspects and characteristics of industrial revolutions and their impact on companies and SMEs are examined in order to identify the possible scenarios and elements stemming from the digital transformation. The major factors and aspects of the local ecosystem are also explored. The paper then presents the approach of the DIGITRANS project, funded by the Interreg program of the European Commission. It outlines the factors and ideas behind organizational changes and business model transformation. Finally, empirical data from qualitative research among several Bulgarian SMEs are presented and

discussed. The last part of the paper highlights the main messages of "Industry 4.0" and how it is reflected in a wider environment of paradigm change.

Theoretical research – Defining digital transformation, Industry 4.0 technologies and the new technology paradigm

Digital transformation and economy digitization in a broader societal context can be defined as an economic and social transformation triggered by the massive adoption of digital technologies that generate, process, share and transact information (Katz et al., 2014). It is difficult to provide a single definition of the Industry 4.0 technologies as they can be recognized as a cluster of general purpose technologies, used as "door-opening" versus "gaps-filling". The term "Industrie 4.0" was coined in the political program of the German government in 2011 to encourage efforts and investments in the next-level manufacturing industry technologies. In parallel to the term "Industrie 4.0" there emerged other concepts such as Industrial Internet, Advanced manufacturing, Smart Industry, Smart Manufacturing and Smart factory (Hermann et al., 2016). Thus, among the main characteristics of Industry 4.0 technologies are their impact and ability to transform and manipulate both the physical world and the virtual reality, by combining real-time data processing with interconnected machines along with devices, smart fabrics and complex solutions, artificial intelligence and people. Almada-Lobo (2016) defines Industry 4.0 manufacturing transformation based on Cyber-Physical Systems (CPS) and Cyber Physical Production Systems (CPPS) toward mass customized, decentralized, vertically integrated industries, connected and mobile, using cloud computing and advanced data analysis approach. As Rüβmann et al. (2015) focus on, Industry 4.0 stays for the rise of nine specific digital industrial technology that has the potential to lead the next industry growth and transformation. Further, the Industry 4.0 is defined as a new platform model of value chain organization and complex management system along the lifecycle of products (Gawer & Cusumano, 2014). As they represent reliable, interoperable solutions that integrate the production facilities with the environment, they cover elements such as integration of data, cyber-security, integration of legacy systems, and Big Data. The effects of the industry digitalization is expected to substantially increase operational effectiveness, to develop entirely new business models, new services, and new products (Hermann et al., 2016).

Although the purpose of the present study is not to discuss whether Industry 4.0 stands for the next Fourth Industrial revolution, many researchers as Schwab (2015) and the researchers of MIT (Brynjolfsson E., McAfee A., Jurvetson S., et al., 2015) open the discussion that social challenges and economic impact of new technologies implementation will be substantial. Thus, our main goal is to

identify how new digital transformation identified as Industry 4.0 technologies will challenge the existing arrangements within companies and organizations. Therefore, in the following paragraph we will focus on some of the basic findings for Industrial revolutions in order to recognize its main patterns and characteristics. For example Mokyr (2017) underline that among the key factors triggering the first three Industrial revolutions in Europe is the significant shift of the values, putting science and technologies high in the hierarchy of social prestige in the centuries before and during the industrial revolutions. Thus, even if Industrial revolutions are not made by "superstars", Mokyr (2017) identifies the importance of small groups of savants who define the new theoretical concepts and knowledge and then the role of the larger group of fabricants, who adopt them and through incremental modifications and innovations replicate them in a larger scale. Further by outlining the main characteristics of the industrial revolutions, Mokyr (1988) mentioned that formation of knowledge and institutional arrangements (such as shared concepts and beliefs), play a significant role in the emergence of new technologies and the subsequent economic growth.

In table 1 an overview of the theoretical findings out of the previous industrial revolutions is presented. There we outline how the trends of Industry 4.0 surpass the level of simple technology innovations and form a new step towards more important transformational processes. Even if the historical analogies with the past may be misleading and dangerous, our approach aims to highlight the manifestation of social changes. Thus, the factors that define an industrial revolution, are explored by the model of Mokyr (1988).

Table 1. Analysis of the characteristics of Industry revolutions based on Mokyr (1988) and adopting the model to Industry 4.0

Characteristics of an Industry revolution	Industry 4.0
The progress is not limited to a single sector, but it is omnipresent	The new coming digital innovations disrupt all sectors such as manufacturing, transportations, city development, utilities, power generation, agriculture, logistics, healthcare and many others
General purpose technologies (GPT)	New technologies under the Industry 4.0 can be classified as GPT as they become universally adopted as new technology backbone
Emergence of new organizations and company forms	Emerging platform-based organizations outperform and challenge the process-based organizations, requiring new organizational forms

Networks and standardization	Innovations become a larger coordination game, depending on networks and standardization effects within innovation ecosystems
Knowledge formation	Considerable accumulation of new empirical knowledge is expected, based on the data provided by sensors; AI and machine learning will further contribute for the emerging data models and others
Skills, human capital and income distribution, technology employment	Increasing global inequality rates, raising debates about technology unemployment, raising needs for new digital skills and human capital up-grading
Globalization effect	Communication and information flows along with intensified movements of humans, capital and goods along the stage of industrial revolutions

Source: The authors

Table 1 shows that the impact of the new technologies is more substantial in a larger scale. Moreover, the new technologies are leading to substantial organizational and institutional changes, as they open the door to new forms of network organizations, collaboration mechanisms for open innovations and inter-organizational synergies extending the value chains. However, the main question is whether these technologies will have the potential to create shocks that can disturb the rate of growth of the production outputs.

Furthermore, it is important to stress that the new technologies and innovations are not "neutral" as they create path dependences and lock-in factors. Thus, standardization and technology adoption determine further the power distribution within a society and the dominance of specific ideology mindset. Therefore, network dependences and standardizations make the innovations in Industry 4.0 a complex coordination game (Mokyr, 1988), as new technologies and innovations have to fit the existing technology framework.

The European and national perspectives of digital transformation

Based on the long-term efforts of Horizon 2020 strategy to ensure inclusive and intelligent growth, the European commission launched several initiatives in order to further encourage the digitalization of the European industry. Its first goal is to focus on the activities of the companies, researchers and citizens to "invent" the digital transition processes by developing and implementing key technology innovations, standards and scientific evidence that will further ensure its leading position as an "Innovation Union". Its second objective is to attract more public and private investments and projects to support the smooth transition and digital

transformation within all member states. As stated in the recent report of the EU barometer [1], the impact on digital technologies increased considerably during the last years and most of the EU citizens are positive about the coming digital transformation processes.

Thus, additional resources on European scale have been mobilized, in addition to the traditional programs for research, education and development such as Horizon 2020 and the Erasmus+ Program. Among the key initiatives directly addressing digitalization of the economy and the society the following can be identified: The Digital Single Market Strategy, the EU strategy on cooperative, connected and automated mobility, the EuroHPC – the strategy for supercomputer infrastructure, the digital skills and jobs coalition, the European Interoperability Framework and others. More recently joint initiatives in the field of cybersecurity, free-flow of non-personal data and others have been adopted as well.

The "European platform of national initiatives" is among the main policy instruments designed to facilitate and further encourage the digital transformation of the European industry. It was launched in 2016 with the goal to become a common platform and stimulate the sharing of best practices, to trigger collaboration and joint investments, to explore common approaches to regulatory problems, and reinforce the re-skilling of the workforce. In 2018, 15 countries among the EU members states already started digital transformation initiatives such as Industry 4.0 or smart manufacturing policies (Tables 2 and 3).

Table 2. European platform of national initiatives on digitizing industry – National financial measures

		Austria	Belgium	Czech Republic	Germany	Denmark	Spain	France	Hungary	Italy	Latvia	Luxemburg	Netherlands	Poland	Portugal	Sweden
Incentives to invest in R&D&I	Innovation vouchers		X	X	X			X	X		X			X	X	
	Amortization schemes					X		X		X						
	Foreign direct investment measures	X		X											X	X
	Tax relief	X	X			X	X	X		X	X		X	X		X

Access to Finance	Guarantee/ Loan fund						X	X	X	X			X	X	X	
	National Innovation Fund		X	X	X	X		X				X	X	X		X
	Venture capital Start-ups support	X			X	X	X	X		X			X	X		X
Patents & Intellectual Property Rights Incentives		X	X		X					X	X	X		X		

Source: European Commission, 2018

Table 3. European platform of national initiatives on digitising industry – National actions along the Digitalizing European Industry (DEI) strategy

		Austria	Belgium	Czech Republic	Germany	Denmark	Spain	France	Hungary	Italy	Latvia	Luxemburg	Netherlands	**Poland**	**Portugal**	**Sweden**
Digital Innovations for all	Test-beds				X			X	X		X	X	X	X	X	X
	R&I infrastructure	X	X		X		X	X	X	X				X	X	X
	Digital Innovation Hubs	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Clusters		X		X	X	X	X		X	X	X	X		X	
R&D&I Programs	Basic technology research	X	X			X		X	X	X			X	X	X	
	Industrial/Applied research	X	X	X	X	X	X	X					X	X		X
	Pilot & Demonstrators	X	X		X	X			X					X	X	X
	Standardization	X			X		X	X		X	X	X	X	X	X	
	International cooperation	X	X	X	X			X	X	X	X	X				X
	R&I PPPs					X				X			X			X
	Regional level		X		X	X	X	X					X			X
Regulation			X	X	X	X	X	X	X		X	X	X	X	X	X
Digital skills		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Source: European Commission, 2018

However, many other member states still lag behind in the adoption of digital transformation policy measures. Recognizing the fact that the manufacturing sector plays a crucial role in Europe, different approaches aiming to foster integration of the digital technologies and extending the industry value chain have been implemented. As different technologies are rarely used in isolation, the policies further encourage a mixture of technologies to be implemented in products and services.

On European level, by the end of 2017, three main working groups within the European Commission have been formed, providing further strategies, policy measures and digital transformation frameworks for fostering the industry's digitalization.

- WG1: Digital innovation hubs, Investments and skills [2] – it aims to engage Digital Innovation Hubs to support a broad range of SMEs, develop sustainable models for services and collaboration through the network of Digital Innovation Hubs, and help businesses with training and skills development activities. It includes a reflection on an investment programme supporting all businesses, notably SMEs, to invest in their digitization.
- WG2: Public-private partnerships – it reflects on future partnerships for research and innovation as a means for strategic programming at the EU level across European, national and regional programmes and as a vehicle for critical co-investments on Europe's key digital innovation challenges.
- WG3: Digital Industrial Platforms and standardization – strengthening leadership in digital technologies and in digital industrial platforms across value chains in all sectors of the economy. The DEI – Digitizing European industries is based on platforms, standards, pilots and ecosystems [3]. Three subgroups developing detailed policy measures were identified: IoT, Industrial Data Platforms, Connected Smart Factory, Digital Transformation of Health and Care and Smart Agriculture.

A goal of the Digitising European Industry strategy is to have a Digital Innovation Hub in every European region by 2020, but many of them are still not covered (Fig. 1).

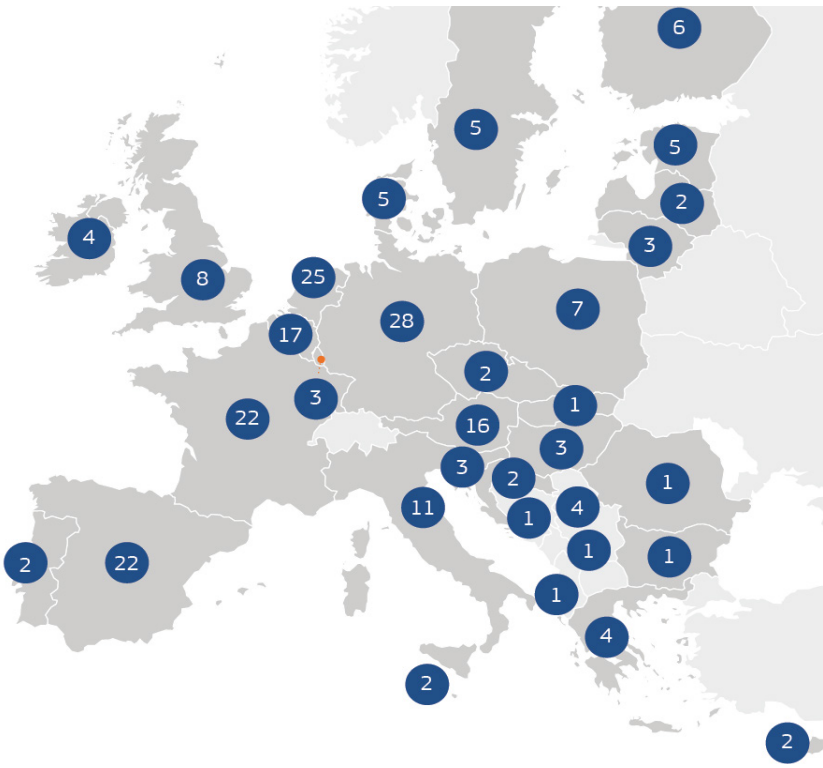

Fig. 1. European Catalogue of Digital Innovation Hubs in 2018

Source: European Commission, 2018

To support them, the European Commission has launched coaching and training programs for new DIHs. Under the I4MS initiative, 29 new DIHs received support from the existing network of hubs on how to develop a business plan, identify the needs of industry in their regions and operate their services. With €2 million support by the European Parliament, the European Commission has also started a similar program that will give training to 34 new DIHs across 13 countries in Central and Eastern Europe (European Commission, 2018).

In the Bulgarian context, the processes for accelerating industry digitalization attracts further efforts on business, sectoral and policy level. Several policy initiatives for economy digitalization have been implemented on national level. A national concept for digital transformation of the industry or "Industry 4.0" strategic policy document was approved in the summer of 2017 as a basis for the development of a more detailed digital transformation strategy. In the framework of the Presidency of the Council of the EU in the first part of 2018, Bulgaria

highlighted multiple initiatives on the EU roadmap of digital transformation. On the other hand, there are activities for preparing a next level of documents and strategy initiatives for stimulating digitalization processes on national and regional level such as e-government, extension of open data implementation, adoption of projects and working groups for preparing national policy documents in the field of e-Health, Strategy for Industry 4.0, Strategy for digital transformation in Tourism and others. Furthermore, several efforts are made to connect these initiatives to the National Strategy for Smart Specialisation, bringing additional resources, instruments and mechanisms within the framework of a future roadmap.

Bulgaria still lags behind in most of the rankings for mass digitalization. The country is traditionally ranked among the last ones in different studies such as DESI [4], EU barometer and others. However, there are good chances for Industry 4.0 adoption and digital transformation, based on the country's experience, long-term specialization in the field of ICT, the flourishing start-up ecosystem and the good national branding. This creates good perspectives to open the floor for more initiatives for the country's industrial digitalization. According to the recent report [5], the ICT sector contributes to almost 3,5% of the country's GDP and the turnover of the SMEs in the sector is above 1 billion EUR for 2016, while the forecasts till 2020 is to double. About 70% of the ICT companies are export-oriented, highly competitive on the international market, and with good international exposure. Bulgaria ranks high for Cloud computing and cloud services, AI implementation, BPO outsourcing, AR/VR and gaming technologies and others. Further success stories can be found as well in FinTech, Big Data and Open Data analysis, IoT and robotics and Industry 4.0 implementations. The activities are highly concentrated in Sofia, with 82.1% of those employed in industrial enterprises and 83.6% of those employed in Services operate in the capital.

Table 4. Bulgaria's digital readiness based on the SWOT analysis for Industry 4.0

Strengths	Weaknesses
• Well performing, competitive and fast-growing ICT sector, acknowledged on the international market • Good pool of expertise in the fields of ICT and advanced manufacturing, engineering and ICT traditions • Big international manufacturing companies as source of know-how • National policy initiatives for adopting Industry 4.0 in Bulgaria, corresponding to the EU Digital transformation initiatives • Well-developed start-up ecosystem and established interest from different stakeholders, especially in the field of ICT and growing Industry 4.0 sub-domains – IoT, Big Data, AI, VR and others • Country's smart specialization strategy in the field of ICT and Mechatronics, giving the floor for further public and private funds and cooperation projects in the field of research and innovations	• Lack of enough qualified technology experts especially in the field of Digital transformation and new advanced models of manufacturing; • Need to further improve the coordination of the Industry needs and the educational system • Lack of effective LLL programs focused on-the job training and digital skills improvement among the Advanced manufacturing companies' professionals • Lack of resources and administrative capacity to support SMEs digital transformation – financial, human, knowledge, R&D • Lack of R&D funds and research capacity in the field of Advanced manufacturing
Opportunities	**Threats**
• Growing international market for manufacturing products, solutions and technologies; • EU initiatives for Digital transformation and advanced manufacturing • Development of e-Government solutions based on advanced manufacturing – Open data, Smart city, Smart governance and other advanced products and services • Competitive business environment, good administrative and legal framework, tax system, regulations, access to public and private funds for innovations • Growing bottom-up ecosystem supporting the digital economy	• The manufacturing sector is highly competitive on international level and many competitors can take a market share • The lack of highly-skilled professionals can threat both national as well as EU perspectives in the manufacturing sector • The traditional industry sectors lag behind the digital trends

Source: The authors, based on the SWOT analysis in the Innovation Strategy for Smart Specialisation of the Republic of Bulgaria, 2014.

The SWOT analysis presented in Table 4 identifies the main factors that influence the wider implementation of the Industry 4.0 solutions in the Bulgarian economy.

The DIGITRANS Project approach

Responding to the needs of member states to encourage further collaboration across companies, organizations and researchers in order to boost the next level of digitalization in SMEs, the European Commission funded the Interreg project DIGITRANS. The main aim of the project is to enhance SMEs to reconsider their business models and to encourage them to adopt more digitally-enabled, open to innovations and customers-oriented business models. Therefore, DIGITRANS aims to develop an appropriate innovation methodology and training materials for SMEs, enabling them to create competitive digital business models within a specifically setup incubator space. Within its implementation, 17 project partners from the Danube region will develop and adapt different instruments to encourage innovations, simulations and risk-taking by adopting new innovative methods such as design thinking, blue ocean strategy and modelling digital services and platforms.

During the first stage of the DIGITRANS project implementation, the project partners undertook several studies of the SMEs digital readiness across partners' countries. Summarizing the results from the in-depth interviews made in May 2017 across 10 Bulgarian SMEs in the sectors of advanced manufacturing, healthcare and creative industries, along with discussion with consultants and IT professionals, we can outline the following status-quo general findings. Although the empirical data are not representative, the good practices of industry leaders can be identified in different sectors, and the results will help us to identify the dominant mindset and preparation for the digital transformation of SMEs.

- Technologies: adopting systems for data analysis and reporting still remain the main focus of the Bulgarian SMEs, interested more in sector specific technologies (for example in healthcare) but not in wider Industry 4.0 implementations such as IoT, cyber-physical systems and robotized systems.
- Business models: the traditional companies are still not ready to disrupt and digitize their business. IT consultants confirm that the readiness of their traditional clients for company digitalization is very low. Still many of the companies put as focus of their strategy to automate key business processes and operations but do not consider overall product/service digitization, customer orientation or other extension of the Long-tail business models.
- Knowledge: SMEs do not have competences and knowledge for digital transformation, and usually rely on external sources of information (f.e.

consultant companies). It is highlighted that in general in Bulgaria there is a lack of informational sources providing good practices and lessons learned for Industry 4.0 implementation, as well as best practices and case studies. The main sources of knowledge remain specialized IT events, technology exhibitions and conferences.

- The challenges and motivations behind Industry 4.0 include the company culture (the mind-set of the clients and the resistance to change), visualization of the benefits and ROI from digital transformation processes, the lack of finances for investments in digitalization, lack of critical mass of experts that can catalyse and support the digitalization of the local SMEs, lack of clear understanding about the fundamental changes coming with the new technology paradigm shift.

Based on the obtained empirical results, the most important actions for promoting Industry 4.0 is to raise awareness and publicly discuss the benefits of the digital transformation for companies and for the society in general. When people gain better understanding of the digital transformation processes, best practices, lessons learned and good examples, they will be more motivated to make the change. Furthermore, if companies become more aware of the technology trends (like Big data, Machine learning, IoT), as well as if they study real examples for technology-driven transformation and new business creation, they will be able to relate this to their business and understand better the challenges and opportunities of the digitalization.

Discussion – digital transformation processes in Bulgaria

Based on the analysis above, combining both the theoretical insights, political analysis and empirical data, we can make the following conclusions.

First, analysing the readiness of the digital transformation of Bulgarian SMEs we can conclude that the sources of knowledge for Industry 4.0 are still scarce. Thus, despite the fast- developing ICT sector, the vertical integration among industries is low and there is a lack of collaboration models among industries. Furthermore, a large part of ICT businesses is export-oriented (about 70%)[v], limiting the options of local businesses to benefit from their world-level expertise. Moreover, the regional aspects are important as well as digital companies are highly concentrated in a few locations, while the rest of the country lacks human capital and infrastructure to boost digitalization. The lack of practical knowledge about digitalisation and digital business models is the main constraint for SMEs' managers to understand the opportunities for digital transformation. Furthermore, in general they miss an open mind-set (openness towards new digital technologies, culture, working styles, methods, competences, open network exchange), needed to implement new digitalization processes.

Secondly, as the CEOs or SMEs owners do not play a leading role in initiating a new digital strategy, it is more often outsourced to external consultants or to

younger employees with limited role for decision-making. Bulgarian SMEs and small businesses rarely have a direct contact with the end-customers, limiting their options for obtaining data for customer analysis and encouraging innovations. But more importantly, the companies' management still does not see the competitive advantages of the digital transformation due to the constant profit margins and the lack of strong market pressure. An appropriate ecosystem and common culture encouraging digital transformation, knowledge formation and knowledge sharing is still missing in Bulgaria. Thus, the general readiness in SMEs to adopt Industry 4.0 and digital business models is low. More importantly, the practical knowledge of the digitalization projects is scarce and not freely shared. Moreover, the main sources of knowledge and good practices still remain the foreign companies.

Thirdly, Industry 4.0 can become a vision for further development only if specific culture for encouraging innovations and science is put in place. In Bulgaria key sectors and employment fields such as education, science and research, along with engineering and STEM disciplines do not attract enough young professionals. Moreover, the persistent trend during the last decades among young people in the country is to continue their studies abroad or to graduate business disciplines or economics (confirmed by the statistics of the National Statistical Institute, 2017). This comes to show that a potential to develop enough competent human capital is missing and the up-grading of the workforce skills to adopt digital transformation processes would be difficult.

Furthermore, traditional business leaders and owners demonstrate the lack of understanding of the new digital processes that will further enhance companies. In the case of new technologies, most of the companies consider them as end-users and not as developers or value co-creators. This makes integration among sectors in the country particularly complex in the field of Industry 4.0.

Finally, Industry 4.0 is not just about business automation and technologies adoption, as it can open the floor to new more dynamic value formation models, network business models and future path dependences. This means that if local businesses such as SMEs and more importantly the society as a whole miss the moment to adapt to the new waves of digital transformation, we can further expect waves of "conservative revival", as shown in the model of Iyigun & Rubin (2017

Conclusion

The present research identified the current processes for adoption of Industry 4.0 as a paradigm shift on European and national level. More specifically, data obtained during the interviews with experts were analysed that revealed some interesting conclusions about the current situation in Bulgaria and the local SMEs' readiness and awareness of business models' digitalization. Based on the analysis made, we can conclude that the dominant culture lacks behind the

current European digitalization processes. This means that more efforts should be made to further investigate how to integrate and up-grade company digitalization models on national level.

First, the Bulgarian SMEs need relevant and practical information how to digitalize their business models and what their main benefits could be. Secondly, best practices and lessons learnt should be publicly available in order to create meaningful environments and good directions for company managers. Thirdly, digital start-ups and digital ecosystem should be recognized as a leading partner of the traditional companies' transformation and thus, they can be more directly involved in the initiatives for Industry 4.0 further implementation. Last but not least, more efforts should be made in order to stimulate the companies and research community to actively take part in knowledge exchange programs of the leading European initiatives, encouraging know-how, expertise creation, knowledge sharing programs and further digital awareness programs.

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Notes:

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PREPARING FOR INDUSTRY 4.0 AND DIGITAL TRANSFORMATIONS IN SMEs. EUROPEAN AND NATIONAL ASPECTS

Abstract

The objectives of the research are to explore the new technological, organizational and institutional changes leading to the implementation of models of Industry 4.0 into SMEs. The methodology includes a theoretical investigation of the industrial revolutions and current digital transformation processes, comparative studies of the EU policy efforts and national initiatives, as well as empirical research – in-depth interviews with companies in Bulgaria. The results include conclusions based on empirical data gathered within the DIGITRANS INTERREG project concerning the digital readiness of the Bulgarian SMEs.

Key words: Industry 4.0, technologies, digital transformation, SMEs.

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