Fundamental steps towards digitalisation of construction supplying SMEs in Bulgaria

Author: Vencislava Toteva
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands

ABSTRACT,

The Fourth Industrial Revolution or Industry 4.0 has already begun to transform the world around us. Yet, it is still in the developing stage and it has not reached its full potential. The large companies are grasping onto the new trends of smart technologies, while most of the Small-Medium Sized Enterprises (SME) are lagging behind the change. As a consequence of the lack of a functioning digital strategy and scarcity of tangible and intangible resources, they miss on the key benefits of the Smart Industry such as increased productivity and improved market competitiveness. Further, Bulgaria has been ranked as the last country of the European Union, in terms of overall business digitalisation. Thus, the purpose of this research is to identify the fundamental steps towards digitalisation for Bulgarian SMEs which operate as construction suppliers. The objective is to provide theoretical and practical insights to these organisations on how to anticipate Industry 4.0. The paper is constructed as a case study of two Bulgarian companies which manufacture and deliver steel constructions. Their current levels of digitalisation have been measured by the Smart Industry Maturity Scan. In this way, potential barriers which influence the speed and success of the implementation of Industry 4.0 have been detected. Moreover, suitable smart technologies have been proposed as a practical insight. The paper's contribution to the existing literature relies on the view of defining digitalisation as an organisational change. Also, it fills the gap of research for Bulgarian SMEs in the context of the Fourth Industrial Revolution.

Graduation Committee members:

First supervisor: Dr. R. P. A. Loohuis
Second supervisor: Drs. P. Bliek

Keywords
SMEs, Industry 4.0, construction suppliers, digitalisation, organisational change, Smart Maturity Scan, case stud

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1. INTRODUCTION

1.1 Situation and complication

Due to the COVID-19 pandemic acting as a slowdown for the global economy, many businesses started struggling to maintain their activities because of financial issues (OECD, 2020). Therefore, SMEs must enforce their competitive advantage, while stabilizing their market position. Industry 4.0 aims to unite production, information and communication technologies, and the Internet, while providing opportunities for highly efficient, flexible, and automated mass production processes (Matt et al., 2020). Thus, it can serve as a gate to achieve the objective of the SMEs by adopting smart innovations which facilitate their business operations.

While technology is an essential tool for market competitiveness, SMEs hardly adapt to this environment due to their lower levels of technological and financial resources (Das et al, 2020). Furthermore, implementation of digital solutions is limited due to knowledge gaps of the SMEs regarding awareness and capabilities (European Investment Bank, 2019). Hence, they miss out on opportunities to scale up their business by implementing innovations, potentially leading to organisational change and prosperity.

1.2 Relevance

In the context of research, many papers do not focus on small enterprises which usually have limited capital resources, managerial capacity, and lack of human resources and knowledge management (Klein & Todesco, 2021, p.1). According to the European Commission (2017), there are high costs of investments involved, while adopting advanced manufacturing products. Therefore, some innovations from Industry 4.0 can be considered as relatively high-costly investments for an SME with limited resources. As a consequence, a gap is created regarding the feasibility of their solutions, applied on a smaller scale. For instance, replacing the current machinery to achieve digitalisation can be considered a high-costly investment, compared to upgrading them (The Cost-Effective Path to Industry 4.0, 2020).

In addition to this, Bulgaria is lagging with business digitalisation (European Commission, 2020). Thus, providing the essential information regarding coping with Industry 4.0 could be beneficial for Bulgarian SMEs. Adaptation towards the new challenges is needed so that they can survive on the market while facilitating their operational processes.

1.3 Research objective

The research aims to determine the opportunities and constraints of construction supplying SMEs in Bulgaria regarding their development towards digitalisation. This case study analyzes two Bulgarian companies which operate in the construction and steel industries, as they supply mainly metal enforcement to building facilities. Firstly, the research will examine their current situation of implementation of smart solutions within their business by analysing their smart industry maturity level via the Smart Industry Maturity Scan, provided by IXIA Smart Insights. In this way, a clear overview will be presented, regarding the level of digital development of the companies, participating in the case study. After collecting the data from the analysis, additional research will be done to suggest possible technologies that could benefit their operational processes. Thus, it will examine the opportunities for adaptation to the Fourth Industrial Revolution. Furthermore, it will guide through the fundamental steps needed to start the integration of smart solutions to achieve organisational change. Therefore, the paper will describe how

Bulgarian SMEs, can benefit from the implementation of Industry 4.0 technologies.

1.4 Research question

The research question is formulated as follows: How can construction supplying SMEs, located in Bulgaria, achieve organisational change through the implementation of Industry 4.0 technologies within their business?

Further, the sub-questions of the research question are determined as follows:

- What is the current smart maturity level of the analysed SMEs?
- What are the opportunities and benefits of the implementation of smart technologies for construction suppliers, located in Bulgaria?
- What are the constraints of the implementation of smart technologies for construction suppliers, located in Bulgaria?
- What are the steps towards organisational change, while implementing new technologies within SMEs?

1.5 Structure

This research is formulated out of seven sections, excluding the references and the appendix that can be found at the end of the paper. The first section serves as an introduction to the problem by describing the current situation and complication, and the relevance, while it outlines the research questions. Further, the theoretical framework explores the implementation of Industry 4.0 in Bulgaria, as well as, the opportunities, benefits, and constraints coming with it. In addition to this, a science-based tool, measuring the level of smart maturity of companies, is introduced. Also, the process of digitalisation is represented as an organisational change. After, the methodology of this research is discussed, namely, how descriptive and empirical data is gathered to answer the research question. The further section will examine the results from the implementation of the science-based Maturity tool within two Bulgarian companies. Additionally, the theoretical and practical implications are discussed, as well as, the limitations and possibilities for further research. Finally, a conclusion is drawn, followed by acknowledgments, references, and the appendix.

2. THEORETICAL FRAMEWORK

In this section, the key concepts of Industry 4.0 are reviewed and put into the context of the construction and steel industries, while describing the opportunities, benefits, and constraints of its integration. Also, the characteristics of the Fourth Industrial Revolution are determined. Further, the current level of digitalisation of Bulgarian SMEs is examined. Additionally, the nature of an SME is defined, as well as their opportunities and constraints, regarding the adaptation towards Smart Industry. To identify the fundamental steps towards digitalisation, the concept has been presented as an organisational change. Finally, the SIMS scan is introduced as a science-based tool that is applied in this research to explore the level of smart maturity of Bulgarian construction suppliers.

2.1 The Fourth Industrial Revolution

2.1.1 Key concepts

The Fourth Industrial Revolution, or Industry 4.0, or Smart Industry can be outlined as the integration of Information and Communication Technologies (ICT) within the production (Matt et al, 2020). Moreover, digitalisation is described by Miśkiewicz and Wolniak (2020) as "restructuring of all the social and business processes around digital communication". According to the European Parliamentary Research Service (2015), Industry 4.0 covers a few technological developments. These include:

- **ICT** to digitize data and integrate systems at all business processes, both inside companies and across borders.
- **Cyber-physical Systems (CPS)** using ICTs to monitor and control physical processes and systems. These include embedded sensors, intelligent robots, or additive manufacturing devices, such as 3D printers.
- **Network communications** including wireless and internet technologies that link machines, systems, work products, and people, both within the manufacturing plant and with suppliers and distributors.
- **Simulation, modeling, and virtualization** in the design of products and the establishment of manufacturing processes.
- **Big data analytics** and exploitation, either immediately on the factory floor, or through cloud computing.
- **Digital assistance systems** for human workers, including robots, augmented reality (AR), and intelligent aid systems.

Furthermore, in the research of Roblek et al. (2016) Industry 4.0 consists of four key components that include the Internet of Things (IoT), the Internet of Services (IoS), cyber-physical systems (CPS), and the smart factory. The IoT represents a global network of machines and devices that can interact with each other within a complete system (Lee & Lee, 2015). The IoS is a combination of Web 2.0 applications and Service Oriented Architecture (Reis, & Gonçalves, 2018). It represents the implementation of interactivity, social networks, tagging, or web services to improve the capability of companies to communicate with key stakeholders, such as suppliers and customers. Further, CPS is the connection between the real and virtual world (Roblek et al., 2016). Lastly, the objective of the smart factory is to involve smart devices with strategic decision making which requires a connection with Manufacturing Execution Systems (MES) and Enterprise Resource Planning (ERP) systems (Roblek et al., 2016; Govender et al, 2019). Therefore, Industry 4.0 not only represents the implementation of smart technologies, but also the industrial processes of knowledge management and value-adding activities (Lu, 2017). Furthermore, it can be divided into three integration layers. According to Govender et al. (2019), these include:

- **Vertical integration:** Enables information flow from the MES system to the ERP system.
- **End-to-end integration:** Maintains and manages data flow during the product life cycle management.
- **Horizontal integration:** Enables sharing data between the organisation supply chain.

It is essential to cover all of these three layers to reach a complete integration of Industry 4.0 within a company.

2.1.2 Characteristics of Industry 4.0

The characteristics of the Fourth Industrial Revolution determine the guidelines of what a company needs to achieve a high level of smart maturity. Veleva (2020) defines these characteristics as follows:

- **Decision-making optimization**: Flexible decisions are feasible through Big Data analysis.
- **Resource Productivity and Resource Efficiency**: It enables setting up essential strategic goals, for instance, producing the most output based on the available resources at the lowest possible cost. Thus,

optimization of production processes in a sustainable way becomes possible.

- **Client feedback**: It is used for improving the offerings to suit the customer demands.
- **Dynamic organisation of production processes** in terms of time, quality, price, risk, sustainability, resources, suppliers, customers, and more.

2.1.3 Key technologies for the construction industry

On-site construction processes can be a subject of high variability and unpredictability which results in a high level of intermediate buffers and long lead-times for the construction supply chain (Dallasega, 2018). Currently, the most popular smart technologies within the Construction Supply Chain industry include Cloud-based platforms, Web services, M-Internet, Geographic Information System (GIS), and Radio-Frequency Identification (RFID), and Building Information Modelling (BIM) (Dallasega, 2018).

Firstly, the Cloud-based systems and Web services technology allows sharing of real-time data about construction materials status (Gong and Azambuja, 2012). In terms of M-internet, personal digital assistants (PDA) can be enhanced via global positioning systems (GPS) and RFID technologies to increase on-site materials control (Shi et al., 2016). Moreover, GIS has been integrated to automatically track and localize materials (Dallasega, 2018). Lastly, the BIM supremacy relies on a digital building model which offers data about time, cost, energy efficiency components, and field verified component on-site installation (Dallasega, 2018). Irizarry et al. (2013) discovered that the combination between BIM, GIS, and mobile devices improves the material and information flow between the complete Construction Supply Chain.

2.1.4 Key technologies for the steel industry

Since the analyzed companies operate within the construction and steel industries, the smart opportunities of both should be examined to provide a better understanding and guidance on the anticipation of Industry 4.0. According to Govender et al. (2019), the digitalisation of the steel industry demands "a fully-integrated manufacturing system for real-time decision making". Furthermore, the companies in this sector require data from operational processes such as lead time and machine health to improve quality management. The Internet of Things (IoT) is the fundamental technology to produce real-time data flow (Govender et al., 2019). Combined with cloud computing, the approach solves one of the biggest challenges within the sector, namely the desynchronization between the MES and the ERP systems. Furthermore, alerts and notifications that serve as a decision-making basis can be received via the CPS system which collects the data from the IoT (Govender et al., 2019). To conclude, a combination of IoT and cloud computing within one CPS system enables the successful integration of steel manufacturers into the Fourth Industrial Revolution. This approach can be considered as a fundamental step towards lean digitized manufacturing.

2.2 Bulgarian SMEs and Industry 4.0

2.2.1 Industry 4.0 in Bulgaria

The Digital Economy and Society Index examines "the relevant indicators on Europe's digital performance and tracks the evolution of EU Member States in digital competitiveness" (The Digital Economy and Society Index (DESI), 2020). According to it, Bulgaria ranks in the last position within the European Union (see Figure 1). The results show that the country drops back significantly by scoring less than 20 points on the integration of digital technology, which positions it in the last place of the ranking list (see Figure 1). Therefore, Bulgaria is not only lagging with the implementation of Industry 4.0 but also with the overall business digitalisation.

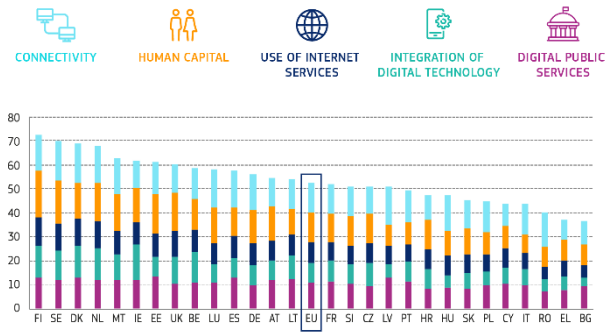

Figure 1. The Digital Economy and Society Index (2020). Retrieved from https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi

One of the challenges for Bulgarian SMEs is providing higher wages and career development potential for ICT professionals (Gigova et al., 2019). The experts prefer to work for international companies which can satisfy their requirements and the smaller firms are left out with less competent employees. However, due to the development of cloud technologies, the need for ICT professionals has decreased. Also, many SMEs are implementing ICT infrastructure management, platforms, and services that do not require expertise (Gigova et al., 2019).

Further, the utilization of digital technologies in Bulgarian manufacturers of fabricated metal products is 35% for medium-sized enterprises, and 21% for small ones (Ahmedova, 2020). While the digital technologies of the large-sized businesses are identified to be 87% (see Figure 2). Since these SMEs have implemented less than half of what the large ones did, it can be concluded that the smaller businesses are not a significant competition due to falling behind with the lack of advanced technical solutions. To conclude, the findings of Ahmedova (2020) show that more than 70% of Bulgarian SMEs are not using digital technologies.

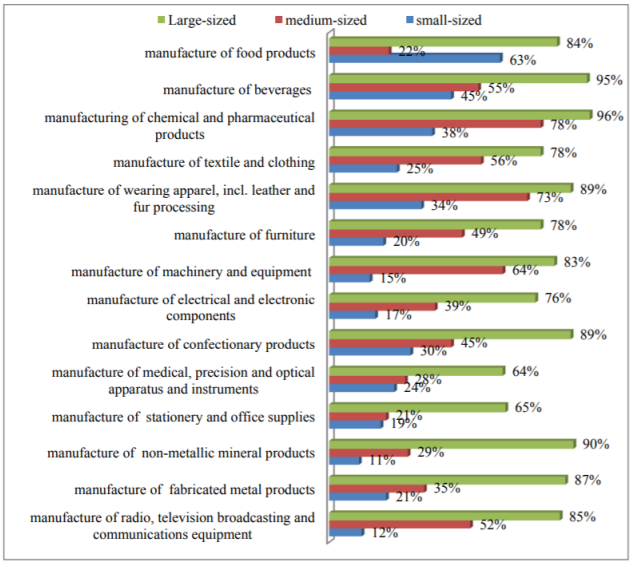

Figure 2. Utilization of digital technologies in Bulgarian industrial enterprises by economic activities. (Ahmedova, 2020)

According to Ghobakhlo & Fathi (2019, p.1), the transition towards Industry 4.0 necessitates an integration of IT-based modern technologies within the organisations. Considering the low scores of digital performance of Bulgarian enterprises in the index, the implementation of IT tools as a foundation base is crucial for adapting to the Fourth Industrial Revolution. Generic IT-based resources such as industrial controllers and sensors can be transformed into IT-enabled capabilities which increase the business value (Ghobakhlo & Fathi, 2019, p. 6). Therefore, they can serve as a cost-efficient solution towards the adaptation to the Fourth Industrial Revolution.

2.2.2 Definition of an SME

It is important to note that 99% of the registered businesses within the European Union are classified as Small and Medium-sized Enterprises (European Commission, 2017). Thus, they take a big part in the economy of Europe. The two main criteria to be identified as an SME are the number of employees and the value of the annual turnover or the total amount of the balance sheet (European Commission, 2017). Depending on that data, each company can be defined as a micro, small, or medium-sized one (see Table 1).

Table 1. SME criteria. (European Commission, 2017).

Category	Number of employees	Annual turnover	Balance sheet total
Micro	< 10	≤ € 2 million	≤ € 2 million
Small	< 50	≤ € 10 million	≤ € 10 million
Medium-sized	< 250	≤ € 50 million	≤ € 43 million

2.2.3 Benefits and opportunities for SMEs

In general, investing in new technologies leads to improved productivity, quality, and flexibility, as well as reduced costs (Raymond, 2005). Further, the implementation of IoT tools optimizes the logistic processes and systems by facilitating the storage, process, and transmission of more sophisticated data (Gerhäuser et al., 2008). According to Moeuf et al. (2017), technologies from Industry 4.0 enable opportunities such as synchronizing workflows, achieving autonomous processes, customizing products, and connecting to partners. Therefore, the objective of Industry 4.0 technologies is to improve the operational efficiency and productivity of companies and to increase the level of automatisation (Lu, 2017). Usually, this is done by speeding up the process from the development of the product to its delivery to the customer (Vuksanović et al., 2016). Higher productivity leads to better operational quality, as well as flexibility and less costs (Miśkiewicz and Wolniak, 2020).

SMEs tend to utilize low-cost solutions such as simulation and cloud computing. Meanwhile, breakthrough technologies that allow thorough business transformations such as CPS, big data, or Machine-to-Machine are being forsaken by SMEs (Moeuf et al., 2017). Cloud computing has a proven positive impact on operational performance and it is an innovation that requires less investment and expertise (Radziwon et al., 2014). Generally, Industry 4.0 facilitates the anticipation, identification, and solving of potential issues (Miśkiewicz and Wolniak, 2020). Therefore, the business opportunities that the Smart Industry provides are faster decision-making processes, increased productivity, and a better market position as an innovation leader.

2.2.4 Constraints for SMEs

Even if the number of new technologies within Industry 4.0 increases, SMEs still lag behind these innovations due to ignorance and under-exploitation of the tools (Moeuf et al., 2017). Besides technological hurdles, digitalisation creates challenges for the operational, organisational, and managerial levels of the companies (Cimini et al., 2020). Constraints that SMEs encounter are scarcity of resources to invest in research and development (R&D) activities, difficulties during the management of complex solutions, and the lack of experts who are not only focused on the production process (Moeuf et al., 2016). Also, business process transformations, organisational impacts, and employee skills could become a barrier to the implementation of Industry 4.0 (Cimini et al., 2017). Further, Raj et al. (2020) identify the absence of digital strategy alongside resource scarcity as the main constraint for adapting to new technologies in both developed and developing countries.

In addition to this, the challenges, regarding the operational, organisational, and managerial levels can be overcome by the implementation of a clear change management process. Therefore, digitalisation is presented as an organisational change, while utilizing the eight-step approach (see Figure 3) by Kotter (1996). Furthermore, to stimulate it, staff competencies should combine practical technical skills with soft skills (Rehman et al., 2014). The required soft skills for coping with Industry 4.0 are critical thinking, change adaptability, analytical thinking, initiative, effective communication, cognitive flexibility, curiosity, resilience to pressure, emotional intelligence, and time management (Sky 4.0, 2020). Lastly, the biggest barriers to the anticipation of the Smart Industry within the SMEs are the lack of digital culture and training (Hossain and Nadeem, 2019).

2.3 Digitalisation as an organisational change

Industry 4.0 increases the business opportunities for manufacturers while expanding the complexity and need for new management and organisational strategies (Cimini et al., 2020). The process of implementation of new technologies requires to be reviewed as an organisational change ("Organisational Change", 2010; Miśkiewicz and Wolniak, 2020). Society for Human Resource Management (SHRM) conducted a survey in 2007 which revealed that resistance to change and communication breakdown are the main reasons why companies fail to implement changes. Some of the possible factors behind the resistance to change include feelings of uncertainty, fear of failure, personality types, and the scale and scope of the required changes ("Organisational Change", 2010). To anticipate these obstacles, identifying the fundamental steps towards technology innovation is required. Developing such a framework would bring clarity to the process while facilitating the comprehension and communication of the new concepts by a company's staff.

Depending on the scale and scope of the required changes, they can be distinguished into two types – adaptive or transformational changes (Stobierski, 2020). The first ones represent minor adjustments within the business's operation. While transformative changes cover extensive shifts within the strategy, structure, or processes of a company. Considering the scope of Industry 4.0 projects, the implementation of one would classify as a transformational change for the business. Therefore, organisational change can be identified as one of the fundamental steps towards adopting the Smart Industry.

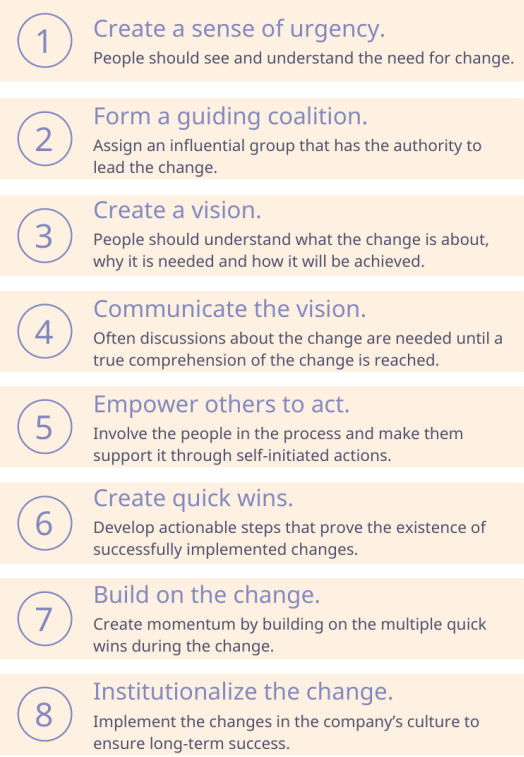

Figure 3. Kotter's eight-step model towards organisational change.

One of the most significant contributions to change management is the book Leading change (Kotter, 1996). According to Appelbaum et al. (2012), the bestseller has become an instant success for its author and it still serves as a key reference for change management even more than 15 years later. Kotter's eight-step process represents a systematic approach to successfully implementing a change within an organisation. The eight steps, leading to an organisational transformation are shown in Figure 3. Since the approach has proven itself to be effective in leading change management, the framework of this research is based upon it.

2.4 Smart Industry Maturity Scan

To estimate the current smart industry maturity of Bulgarian construction suppliers, the case study represents a comparison between 2 companies, located in different cities. They will be examined via the Smart Industry Maturity Scan (SIMS), provided by IXIA Smart Insights. It evaluates 7 main aspects of digitalisation of a business (IXIA smart insights, 2021). Further, the possible maturity levels are ad-hoc, starter, intermediate, advanced, and proficient (IXIA smart insights, 2021). By utilizing this scan, the research can identify the current status of digitalisation within the construction suppliers in Bulgaria. Additionally, it offers great insights regarding the current maturity level of the companies, including their strengths and weaknesses. In this way, the scan serves as a guide that points out where is the biggest need for improvement within the presented aspects.

3. METHODOLOGY

In this section, the research design is presented in terms of the research setting and research method. Further, the data collection and analysis methods have been identified. The study is split into two parts – theoretical and empirical. The first one examines concepts, opportunities, benefits, and constraints related to Industry 4.0, smart technologies, and their implementation into SMEs. Further, the empirical research is focused on analysing the current smart maturity level of two Bulgarian construction suppliers. The main objective is to develop a framework regarding the fundamental steps of SMEs towards digitalisation, based on the findings of this study.

3.1 Research design

3.1.1 Research setting

The research can be identified as a case study that is based on a literature review and empirical data. According to Lewis (1998), field-based research, such as this case study, is suitable for getting through changes in technology and managerial methods. Combining qualitative and quantitative data enriches the information and brings more clarity to the investigated phenomena (Santos et al., 2017, p.7). Therefore, to enhance the quality and validity of the paper, the case study examines the topic by implementing the two research approaches. In this way, the research can be classified as a triangulation, or a hybrid study (Santos et al., 2017, p.2).

Firstly, extended literature research has been done to identify the key concepts of Industry 4.0, as well as, the main opportunities and constraints for SMEs to implement it. Also, touchpoints of the digitalisation as an organisational change have been determined, so that the essential steps towards change could be identified.

Furthermore, the empirical data is gathered via a science-based tool, the SIMS scan (Ungerer, 2019). By combining both methods of research, the paper becomes more explicit towards understanding the current situation of Bulgarian SMEs in the construction supplying industry and their level of implementation of Industry 4.0 practices. In this way, the hybrid study can propose more specific and practical solutions that will lead to digitalisation as an organisational change.

3.1.2 Research methods

Since the research represents data as a snapshot of time and it was not conducted repetitively in time, the paper can be recognized as a cross-sectional study (Wang and Cheng, 2020). For the quantitative part, each company has one representative that will fill out the needed data for the SIMS scan. An overview of the complete process can be described as:

(1) Find at least two Bulgarian SMEs willing to participate in research, regarding Industry 4.0.
(2) Contact the company's representatives to inform them about the nature and objective of the research.
(3) To eliminate a potential language barrier, turn the scan into a questionnaire in Bulgarian.
(4) Send out the questionnaire to the representatives of the companies.
(5) Analyze the current smart maturity level of the companies via implementing the data in the scan.
(6) Use the results to answer the research question: "How can construction supplying SMEs, located in Bulgaria, achieve organisational change through the implementation of new technologies within their business?"
(7) Define a step-by-step framework for the implementation of digitalisation as an organisational change within SMEs.
(8) Share the results and the framework with the participating companies online.

3.2 Data collection

The empirical data has been collected via a questionnaire, provided by IXIA Smart Insights. To eliminate the possible language barrier, the survey has been translated into Bulgarian. However, it contains the same questions used in the SIMS scan. Each company has agreed upon providing only one respondent due to the high workload within their business. In addition to this, the researcher has added notes for clarifying concepts that could be unknown or unclear to the representatives of the companies. This has been done for the convenience of the participants, as well as to minimize possible inconsistencies or mistakes within the results. Afterward, the questionnaire has been sent out to the respondents via email.

The survey focuses on 7 business aspects, which are evaluated by 48 questions in total. Three out of those questions are related to general information about the company, such as yearly revenue, and the number of employees, while the rest focus on evaluating the smart maturity level of the firm. These questions can be responded on a scale of 1 to 5, where one is the lowest score and 5 is the highest one.

3.3 Data analysis

The analyzed dimensions by the SIMS scan are Strategy and Organisation, People and Organisational Culture, Products and Customer Services, Customer Interface, Value Chain, Technology and IT Management, and Institutional Awareness. The result consists of a mean score per dimension, and an overall score of the current smart maturity level of a company. Since the scan is based on an evaluation scale of 1 to 5, the results are also provided in this range. Additionally, the outcome is defined in 5 different maturity levels, regarding the smart industry implementation (see Table 2).

Table 2. Maturity levels. Retrieved from IXIA tool.

Level	Score	Smart Industry Implementation
Level 1	(1 – 1,49)	Ad-hoc
Level 2	(1,5 – 2,49)	Starter
Level 3	(2,5 – 3,49)	Intermediate
Level 4	(3,5 – 4,49)	Advanced
Level 5	(4,5 – 5)	Proficient

After the results have been analyzed, they are presented to the two companies in two separate online sessions. In this way, a more personalized approach can be applied for each firm, so that any specific questions can be answered without the presence of any competitor. The questions from the online sessions can be seen in Appendix B. Additionally, the companies receive the SIMS analysis and the complete research via email, so they can reflect further on it and have it as a reference when the digitalisation begins.

4. RESULTS

This section describes the companies, covers the outcome of the SIMS analysis, and outlines the framework of the five fundamental steps towards digitalisation. The results of the scan have been described in a summary and different sub-sections per company. A more detailed overview of the radar charts, used in the scan can be seen in Appendix A. Further, the steps towards digitalisation as an organisational change have been identified by combining theoretical and practical insights into a complete framework.

4.1 Description of the companies

The participants of the study are two Bulgarian SMEs, operating in the B2B sector. Company A is located in the capital, Sofia, and it offers all types of construction materials such as bricks, paints, and small ironmongery, as well as the production of reinforcement constructions. Thus, the firm can be identified as an all-around construction supplier. However, their main income stream comes from manufacturing and delivering steel constructions to building sites. The company has an annual revenue of fewer than 5 million euros and it employs between 15 and 20 people. As facilities, they have a store where they sell the smaller materials and take orders for executing bigger projects. Further, they have a separate building where they cut the metal products to complete the ongoing projects. Additionally, they offer transport services to their customers.

Company B is located in Varna. The firm provides only metal cutting and transporting services to their customers. Therefore, their main activity is producing reinforcement constructions for other firms. The organisation has an annual revenue of between 5 and 10 million euros and it employs less than 25 people.

4.2 Maturity assessment

The results of the maturity assessment revealed that both Company A and Company B can be identified as “Intermediate”, in terms of Smart Maturity Implementation. The level has been evaluated, with regards to the developed matrix (see Table 2) by Ungerer (2019). The average score of Company A, namely 3,0, is slightly higher than the one of Company B which resulted in 2,7. A summary of the average results per aspect and per company is shown in Table 3.

According to the analysis, the lowest-performing aspects for Company A and B are A1. and A2 (see Table 3). Both of the businesses scored 2,2 on the section of Strategy and organisation. Company B has the same score of 2,2 on A2 and A3, while the results of Company A are higher with 0,6 and 0,8 points respectively. The best performing aspects for Company A are Customer interfaces (3,4) and Technology and IT Management (3,4), while for Company B it is Institutional awareness (3,8).

Table 3. Summary of average results per aspect per company.

Aspect	Company A	Company B
A1. Strategy and organisation	2,2	2,2
A2. People and organisational culture	2,8	2,2
A3. Products and customer services	3	2,2
A4. Customer interfaces	3,4	2,6
A5. Value Chain	3	2,8
A6. Technology and IT Management	3,4	3,2
A7. Institutional awareness	3,2	3,8
TOTAL average of all aspects	**3**	**2,7**

4.3 Results of Company A

Since A1, namely Strategy and organisation, is the worst-performing aspect for Company A, research into the specific results per question is needed. Each question is evaluated on a system between 1 (not at all) to 5 (to a very high extent). In A1, most of the questions have received a 2 as a grade, besides the one which has been evaluated with a 3 (see Figure 1, Appendix A). The results state that Company A has implemented Industry 4.0 and innovation as a strategy within their business to a small extent. However, digital functions, products, and services enhance the organisational value, even if not so much data is collected during the process.

Unfortunately, the firm does not create an environment to discuss regularly the opportunities of smart technologies between the employees. Neither the management is focused on the implementation of Industry 4.0 within their products or operations. As a consequence, the staff is not being trained to adopt the new technologies. Therefore, digitalisation is not one of the top priorities of the participant, since it has not been integrated within their environment.

Further, the highest average score, namely a 3,4, for Company A has been achieved both in the fourth and the sixth aspect. These cover Customer interfaces and Technology and IT Management. A finding of the questionnaire is that customers are often using the Internet to contact them. Also, sufficient IT security measures have been taken to protect the data of the company and its clients.

During the online session which took place after the results of the SIMS scan, Company A admitted that most of their enquiries come from their website or returning clients. Besides this, they shared that recently they have upgraded their machinery by building a second warehouse and installing brand new machines Moreover, these technologies have been equipped with smart sensors to track the production. However, they have not been integrated within their ERP system. Thus, a connection between the MES and ERP systems is needed to keep the management updated simultaneously for the processes within the warehouses. Besides this, financial struggles have appeared after the investment into the new warehouse, thus, additional smart innovations cannot be added at the moment.

To conclude, even though Company A has begun the integration of smart technologies, it has not reached complete digitalisation. In addition to this, the firm owns a reliable and secure IT system which facilitates communication with their customers. However, their employees are not easily adaptive towards new knowledge or technologies due to the lack of an innovative environment.

4.4 Results of Company B

Company B scores 2,2 on three aspects, namely A1, A2, and A3. Thus, their Strategy and organisation, People and organisational culture, and Products and customer services have reached to a small extent the smart maturity. According to their answers, Industry 4.0 does not participate in their business strategy nor their operations or products. Also, its opportunities are not being discussed in the work environment. However, Company B states that its employees adapt easily to changes and are willing to apply new knowledge.

Their highest score, namely 3,8 has been achieved on the seventh aspect, Institutional awareness since almost all of the questions received a score of 4 (see Figure 7, Appendix A). From the results, it can be assumed that the organisation is conscious of the implications of Industry 4.0, in terms of laws, regulations, and taxes. Thus, they have implemented a good system for processing their customers' data under the GDPR regulations.

Unfortunately, an online session with Company B could not take place, however, the respondent managed to answer some of the follow-up questions via email (see Appendix B). According to the answers, Company B do not even have a website. Moreover, their sales come from recurring clients or through the word-of-mouth approach. However, due to the COVID-19 pandemic, the business have fewer sales than usual, thus, they experience slight financial problems at the moment. Even though they have implemented an ERP system, they do not use any smart technologies within their production processes. However, the respondent made sure to specify that the staff is adaptive towards new changes and they look forward to integrating concepts of Industry 4.0, once the economy recovers.

In conclusion, Company B have not started the digitalisation process yet, even if their employees can cope easily with modifications. At least, the firm is aware of the legal consequences of integrating smart technologies within their business. Therefore, adapting to the Smart Industry could become a reality, once the idea of it has started spreading more within the work environment.

4.5 The steps towards digitalisation as an organisational change

In research from Cimini et al. (2020), it is identified that the technological investments in Industry 4.0 should be co-developed for the organisation, while involvement and support from the operational roles are applied. Further, the implementation requires understanding the complete process and clarifying its expectations, while reserving a place for testing and adaptation. Thus, experimentation is needed on both technological and organisational levels (Cimini et al., 2020). As a conclusion from the research of Cimini et al. (2020) can be drawn that testing and adaptation are essential for the implementation of Industry 4.0. Another insight from their study is that digitalisation can be split into two sections, namely technological and organisational.

Considering the eight-step approach by Kotter (1997) as an established framework for adopting a change, it should be applied within the transition towards Industry 4.0 (see Figure 3). To make a change, the idea of it has to be sparked first. This process includes creating a vision and setting up an innovative environment. Further, one of the priority tasks is to appoint a leader of the implementation to ensure the success of the organisational change. For instance, a Project Manager to develop and implement a digital strategy, including technical requirements and concepts. Therefore, one of the requirements for the job position should be to have deep technological competencies with a focus on smart developments. Besides this, they should be able to inspire and create an innovative and learning environment within the company by communicating the vision of the project. Additionally, creating quick wins and building upon the change is needed to validate the concept before proceeding with institutionalizing it as a final step.

To answer the research question, a few conclusions have been made and combined in one framework (see Table 4). Firstly, digital strategy is the core of the path towards Industry 4.0. However, many SMEs are lacking the details behind it, or do not have one at all. Secondly, digitalisation can be reviewed in two levels which are running parallel. These sections are namely technology and organisational change. Lastly, the employees need to acquire new skills of operating with smart technology. As a consequence, they also have to adapt to it to complete the process of integration of Industry 4.0. The overview of the path towards digitalisation can be seen in Table 4. The concept has been developed based on Kotter's eight-step approach of organisational change, as well as other insights, mentioned in the previous sections of this paper. Further, the findings from the case study have been taken into consideration and applied as the

last step of the framework. For instance, improving the technical skills of the staff. Additionally, key concepts of IT Project Management, namely conceptualization and technical requirements, have been integrated within the approach to give more insights on the technology level.

Table 4. The five fundamental steps towards digitalisation.

Steps	Organisational change	Technology
1. Spark the idea	- Create a vision - Set up an environment	Develop a technological concept
2. Refine the idea	Appoint a leader	Develop technical requirements
3. Implement the idea	- Empower others to act - Create quick wins	Implement the needed technologies to test the concept
4. Validate the idea	Build on the change	Implement the recommendations from the testing period
5. Institutionalize the idea	Adaptation of the staff	Improve the technical skills of the staff

Since the exact needed technologies depend on the nature of the business, specific types have not been mentioned in this framework. However, suitable technologies for the construction and steel industry can be found in the theoretical framework of this paper. Also, a specific recommendation has been given within the practical implications and the conclusion of the study.

5. DISCUSSION

5.1 Theoretical implications

The key objective of this paper was to propose a step-by-step framework to Bulgarian SMEs on how they can achieve organisational change through the implementation of Industry 4.0 technologies. Besides practical insights, the research was focused on providing theoretical ones as well. To answer the research question, an overview of the key concepts, characteristics, and technologies of Industry 4.0, the current level of digitalisation of Bulgarian SMEs, and the path towards organisational change was presented in the theoretical framework. These insights will be used to validate the findings of the maturity scan by Ungerer (2019).

The main challenge of the participating companies is the lack of a work environment that promotes innovation and integration of smart technologies. While the employees of Company B easily adapt to changes, the ones of Company A do not experience it in the same way, even if both companies regularly train their staff to a certain extent. Also, both scores show a poor implementation of Industry 4.0 within their operations or products. Therefore, an innovative change for both businesses is needed which will increase their operational efficiency and productivity (Lu, 2017). In this way, the firms will be able to sustain and improve their market competitiveness, even as SMEs.

Cimini et al. (2020) identify the integration of smart technologies as a challenge for the operational, organisational, and managerial levels of SMEs. After reviewing the results, it can be stated that the management of Company B does not focus on the opportunities of Industry 4.0. Further, this can be seen from the lack of discussions about it within their work environment. Therefore, the theories of Cimini et al. (2020) can be confirmed via this case study.

Considering that both scores for A1 from the scan, namely Strategy and organisation are the lowest for each firm, it can be stated that both companies are lacking a complete digital strategy. These results are in line with the findings of Raj et al. (2020) and Hossain and Nadeem (2019). Thus, the absence of a clear digital strategy is crucial for the beginning of the successful integration of Industry 4.0 developments and innovations. Taking into account the characteristics of the smart industry, developed by Veleva (2020), a digital strategy should cover decision-making optimization, resource productivity and efficiency, client feedback, and the ability to cope with the dynamic organisation of production processes. Luckily, the five-step framework from this paper can serve as a baseline for developing a digital strategy within SMEs.

Additionally, the employees' skills are one of the common obstacles to the integration of smart technologies (Cimini et al., 2017). Besides an unclear digital strategy, Raj et al. (2020) define resource scarcity as a potential barrier towards the integration of Industry 4.0. In this research, Company A clearly expresses the lack of skilled workers to manage and apply the new concepts. Also, they struggle with financial stability, after the development of the new warehouse. Moreover, Company B shared that their sales have decreased due to the COVID-19 pandemic. Thus, the findings of this paper are aligned with the research of Cimini et al. (2017) and Raj et al. (2020).

5.2 Practical implications

In terms of types of technologies, a BIM system are great for tracking data about time, cost, energy efficiency components, and on-site installation (Dallasega, 2018). In addition to this, GIS can be integrated to track and localize the materials. Moreover, Dallasega (2018) defined the action points for fostering construction supply chain management with Industry 4.0 (see Figure 4). These should be taken into consideration while building the digital strategy and system of the SMEs. However, the models by Dallasega (2018) have been built for the whole Construction Supply Chain, thus, they would be more useful to construction companies, rather than suppliers. Even though, it would be beneficial if the construction company has the system integrated and allows access to their suppliers for inputting data.

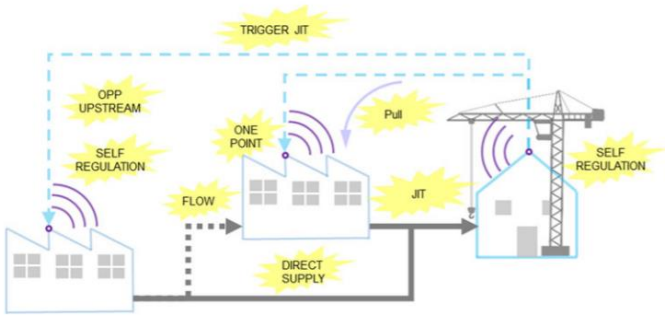

Figure 4. Action points for fostering Construction Supply Chain management with Industry 4.0 (Dallasega, 2018)

Furthermore, significant results in terms of productivity and energy efficiency have been made by Miśkiewicz and Wolniak (2020). The principle of their case study relies on the integration of IoT devices and cloud computing systems within the organisation of a steel manufacturer. The developed solution is split into three segments, namely Vizum Workforce (for staff

monitoring), Vizum Vehicles (for delivery monitoring), and Vizum Tools (for tools supervision). The complete system makes use of the Internet, GPS, mobile devices, beacon Bluetooth, and beacon UWB (ultrawideband technology). Therefore, the anticipation of Industry 4.0 can be achieved through the implementation of IoT devices and cloud computing within a complete system, specifically a Cyber-Physical one. It requires ICTs such as embedded sensors, intelligent robots, or 3D printers to monitor and control the physical processes. Moreover, this solution should be integrated with the Enterprise Resource Planning (ERP) of the company to create a better synchronization between the business management and the operational processes.

Further, the research of Cimini et al. (2020) identifies that organisations often underestimate the costs and challenges while implementing new technologies within an existing system. Therefore, financial scarcity may turn out as a challenge to SMEs during the adaptation to Industry 4.0. To overcome it, certain components that transform the current machinery into a smart one should be integrated. For instance, adopting smart sensors, industrial converter models, Power over Ethernet (PoE), or communication cards (The Cost-effective Path to Industry 4.0, 2020). By implementing these technologies, a CPS system can be built to facilitate production. While upgrading their current technologies, the SMEs save on costs during the transition to Industry 4.0, as they are not obliged to buy completely new machines.

Once the companies have decided to join the Smart Industry, they should follow the fundamental steps towards digitalisation (see Table 4). Since it gives insights on both levels, technological and organisational, the framework brings more clarity to the digital strategy. Besides that, it serves as a guide through the process of digitalisation.

To conclude, construction supplying SMEs have two options to implement Industry 4.0. One of them relies on developing a BIM system, in combination with a GIS one. The other alternative, presented by Miśkiewicz and Wolniak (2020) is to integrate a complete CPS system, constituted from several sub-systems, depending on their departments. If their findings are combined with more cost-efficient approaches such as transforming their current machinery into a smart one, it would be a great way to cope with Industry 4.0. Yet, it is important to keep in mind the three integration layers of digitalisation, defined by Govender et al. (2019), namely vertical, end-to-end, and horizontal. Therefore, to be part of the Smart Industry, the companies should integrate a complete system, connected to their ERP, sharing data through the product life cycle, and between the supply chain. The most suitable solution is to combine the approach of Miśkiewicz and Wolniak (2020), namely the development of one system, composed of a few sub-systems by the department with upgrading the current machinery to save on costs. Also, the CPS and the ERP systems should be connected.

5.3 Limitations and further research

A limitation of this research is the explicit focus on Bulgarian companies. Therefore, some of the results may be biased by geographical, political, or cultural characteristics. Furthermore, it is focused solely on firms whose main objective is supplying metal constructions for buildings and roads. Therefore, the research does not cover other construction materials such as concrete or paints. Additionally, the sample size of this research only consists of two cases. Thus, some of the insights provided may not be enough to create a general insight of the Bulgarian construction suppliers on the path towards Industry 4.0. In addition to this, the size of both companies is rather micro to small than medium. Considering this, further research into medium-sized enterprises is needed to generalize the concept of the fundamental steps towards digitalisation.

Moreover, the quality of communication between RFID tags and readers can decrease due to the presence of steel objects and moisture, thus, it is not a suitable technology for suppliers of steel constructions (Sardroud & Limbachiya, 2010). Therefore, they have not been examined in this research. Also, Web services, M-Internet, and Geographic Information System (GIS) have not been exploited yet in the Construction Supply Chain industry (Dallasega, 2018). Thus, further research into these technologies and their effect on the industry is needed. Besides this, since SMEs lack financial resources, more cost-effective options should be discovered and compared to the existing ones.

6. CONCLUSION

The purpose of this research was to identify the fundamental steps towards digitalisation as an organizational change for Bulgarian construction suppliers which are defined as SMEs. Moreover, the study gives theoretical and practical insights regarding the adoption of smart technologies and overcoming the main challenges during the process. To define the current maturity level of Bulgarian SMEs in the targeted sector, the SIMS scan of IXIA Smart Insights has been applied. The outcome of the evaluation positioned both companies as “Intermediate” in terms of anticipation of the smart industry. Besides this, the analysis provided guidance about the strengths and weaknesses of the participating companies towards their adaptation to the Fourth Industrial Revolution.

The main obstacles for Bulgarian SMEs to become part of Industry 4.0 are the lack of digital strategy and a work environment, in which the topic is discussed often. Another challenge forms due to the scarcity of financial resources and skilled workers, in terms of innovation and technology. As a consequence of these barriers, the companies cannot benefit from opportunities such as an increase in operational efficiency and productivity. To overcome these obstacles, the SMEs should introduce an open work environment that stimulates sharing innovative ideas and encourages often experimentation of new concepts. In this way, the presence of a strong and supportive organisational culture will drive the organisational change through the adaptation of a novel vision that aspires the employees to be part of it.

Since the introduction of new technologies within a company can be defined as an organisational change, the eight-step approach by Kotter (1996) has been used to define how to achieve digitalisation. Further, the characteristics of Industry 4.0 by Veleva (2020) are serving as the fundamental guidelines on what types of systems make an organisation reach a high level of smart maturity. The smart maturity evaluation identified that both companies need to put more emphasis on resource productivity and efficiency, and dynamic organisation of production processes to improve their productivity and market competitiveness.

A final recommendation to Company A is to invest more into educating their staff in the concepts of Industry 4.0. Also, they should work on the integration between their CPS and ERP systems, as well as their overall digital strategy. For Company B, the road towards digitalisation seems longer since they have not implemented any smart technologies. However, Table 4 provides them the baseline to build their digital strategy to become more productive and innovative.

To conclude, organisational change is essential for achieving smart maturity within SMEs. The path towards Industry 4.0 includes a strong digital strategy, skilled employees, and a work environment that inspires innovations through technology.

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APPENDIX

Appendix A: Results of SIMS scan

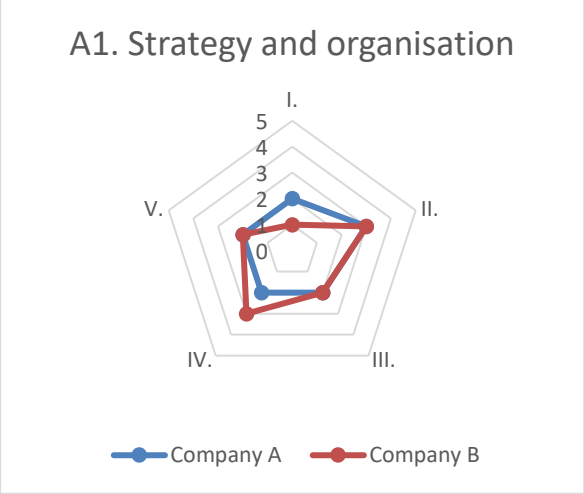

Figure 1. A1 – Strategy and organisation

Average score:
Company A = 2,2
Company B = 2,2

Figure 2. A2 – People and organisational culture

Average score:
Company A = 2,8
Company B = 2,2

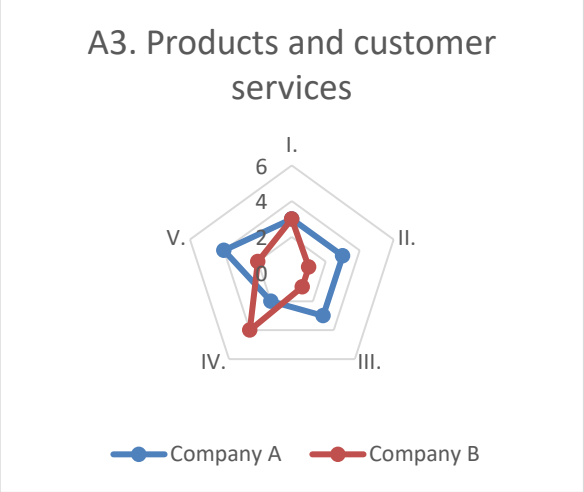

Figure 3. A3 – Products and customer services

Average score:
Company A = 3,0
Company B = 2,2

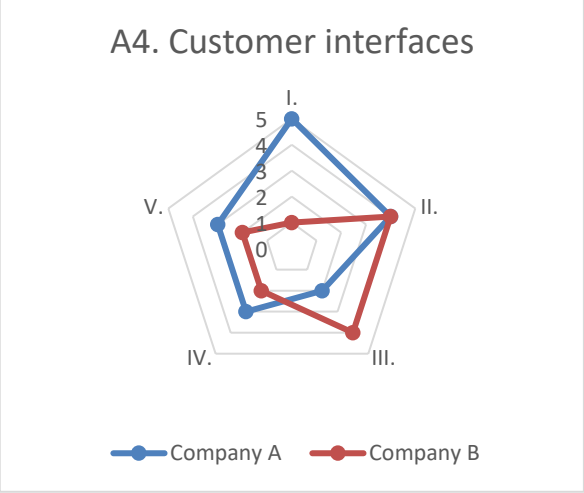

Figure 4. A4 – Customer interfaces

Average score:
Company A = 3,4
Company B = 2,6

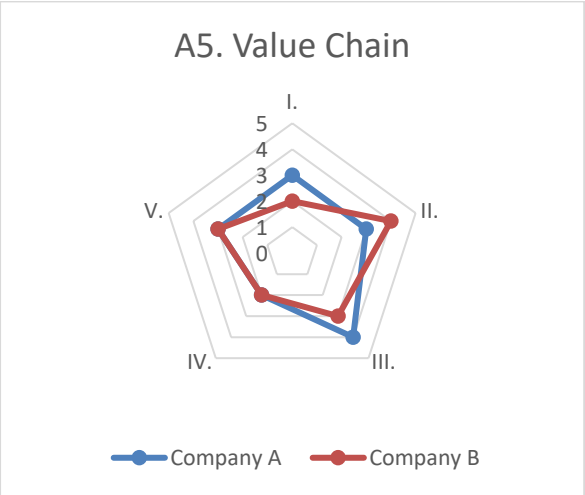

Figure 5. A5 – Value Chain

Average score:
Company A = 3
Company B = 2,8

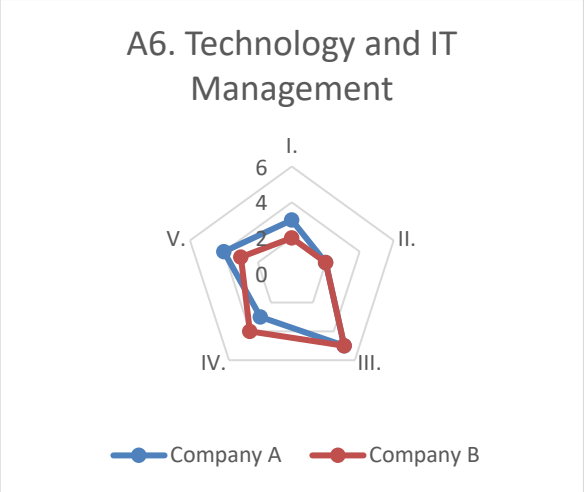

Figure 6. A6 – Technology and IT Management

Average score:
Company A = 3,4
Company B = 3,2

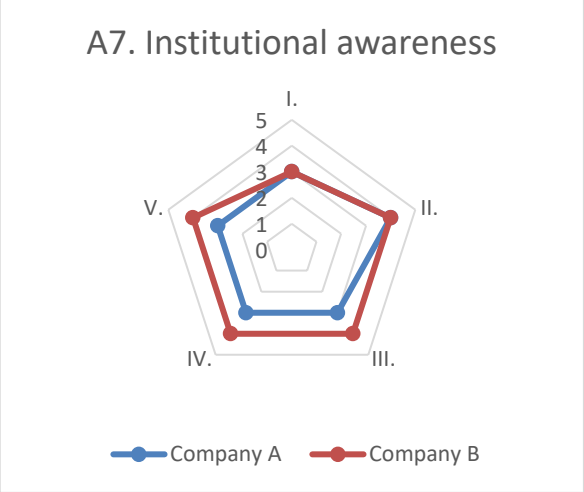

Figure 7. A7 – Institutional awareness

Average score:
Company A = 3,2
Company B = 3,8

Appendix B: Questions for online sessions

1. Which is your main revenue stream?
2. How do you find new clients?
3. Have you integrated any smart technologies within your business?
4. Do you have enough financial resources to cope with Industry 4.0?
5. Do you have enough human resources to cope with Industry 4.0?
6. What online systems do you support? (e.g. website, social media channels)