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Industry 4.0: Challenges and opportunities for Kazakhstan SMEs

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Abstract

Industry 4.0 concept is one of the growing concepts worldwide for the last five years. It combines the physical and digital world, thus creating new capabilities which affect not only the manufacturing industry but to all other sectors and organizations. Furthermore, many experts worldwide declare that Industry 4.0 will have a substantially positive impact, especially in developing countries, where low-paid jobs are concentrated. After facing the social and economic effects of Coronavirus (Covid-19) global pandemic, the introduction of digitalization and moving toward Industry 4.0 has become not only emerging but essential for every industry, including SMEs. It is expected that it will help to improve the flexibility, productivity, and sustainability of the industries, to develop a knowledge-based economy and society, and, thus, enhance the quality of life. Therefore, this paper aims to analyze the emerging concept of Industry 4.0, impacts and applicability on SMEs, and, in particular, the readiness of SMEs in Kazakhstan to digitization and Industry 4.0. The gap in research, which exists currently about drivers, challenges, barriers, and opportunities specific for SMEs in Kazakhstan for moving towards Industry 4.0, will also be investigated.

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1. Introduction

Industry 4.0 as a part of the Fourth Industrial Revolution is a new era of industrial production, which includes the paradigm of self-controlling and self-optimizing processes that allow firms to offer a higher level of services and automating and digitizing processes in manufacturing with innovative business models [1-4]. Moreover, Industry 4.0 allows achieving a high level of flexibility in mass customization, which reproduces the time of craft manufacturing in terms of personalization of products. Customization of products impacts on value creation processes, however, it requires diversified product lines and changing production and manufacturing processes in an effective way. Additionally, it is important to note that digital transformation in small and medium-sized enterprises (SMEs) could make a substantial contribution to the implementation of contemporary production methods, including flexible mass

customization [2]. Industry 4.0 offers opportunities for SMEs, as the improved supply chains that involve efficient consumer response, better flexibility of small companies, etc. It is all said, the digitization concept and its potential effects on the competition are still unknown to many SMEs in both the developed and developing countries, including Kazakhstan. In the current state, Kazakhstan SMEs are being the governmental priority and potential economic driver of the country; however, there are some constraints towards Industry 4.0 implementation, which will be discussed in depth further.

The main aim of this paper is to analyse the current concepts of Industry 4.0 and based on the strengths-weaknesses-opportunities and threats (SWOT) analysis of SMEs in Kazakhstan towards this digital transformation. In particular, this study is designed to address the stakeholders' concerns about Industry 4.0 in the country, providing SMEs and governmental organizations with a helicopter view on the concept applied for Kazakhstan to produce specific

recommendations and reveal critical points for its implementation. The research objectives that were pursued include:

- **RO1:** To discuss the general implications of Industry 4.0 to SMEs;
- **RO2:** To research and assess the drivers, challenges and opportunities for Kazakhstan SMEs towards Industry 4.0;
- **RO3:** To present recommendations for the development of the Kazakhstan SMEs in the future towards Industry 4.0.

In order to address the research objectives, this article is structured as follows: Section 2 provides a literature review on Industry 4.0 for SMEs and concentrates on identifying the current situation of SMEs in Kazakhstan. Further, in Section 3, applying SWOT framework and in-depth analysis, drivers, challenges, and opportunities for Kazakhstan SMEs in the implementation of Industry 4.0 concept provided. Finally, in Section 4 recommendations based on the research and SWOT analysis, to improve and fasten the application process of Industry 4.0 by Kazakhstan SMEs, as well as the conclusion part presented.

2. Literature review

2.1. Industry 4.0 for SMEs

Industry 4.0 provides for digitization and the integration of technological, production, and business processes throughout the enterprise, from product development and procurement to production, logistics, and after-sale services. It is important that due to perfect cooperation, data processing, and other technologies implied, it becomes possible for SMEs to be able to tap into new market niches easier, reduce value creation costs and improve operational performance [3]. In addition, Industry 4.0 adoption is also driven by the impact of environmental factors such as external price pressure from clients/competitors, unexpected weather events, and changes in regulations [3]. For example, according to a survey study conducted by [4], one of the companies installed a tracking system for goods required by a new law that demands using advanced technologies, thereby leapfrogged barriers to its adoption and avoided penalties.

Although the literature sources agree that SMEs have more difficulties to adopt Industry 4.0 than multinational enterprises (MNEs) because of scarce resources and knowledge, they have great potential to rapidly achieve digital transformation. On the one hand, due to the proximity with employees the power of the leader in SMEs is immense and decisive [3]. On the other hand, the flat organizational structure of SMEs contributes to the smooth communication, close control inside the company, thus reducing the risk of failures [5]. Another strong point of SMEs towards digital transformation is high product specialization [6]. This refers to the capability of firms to focus on a certain number of products, gradually improving quality and manufacturing techniques. SMEs can efficiently use limited resources to create greater value, which is a good starting point for Industry 4.0. [7] in their research work argue that SMEs are the good learners, meaning that SMEs can explore and assimilate new innovation activities but struggle to exploit it to commercial use. This fact justifies the findings of [8], where the SMEs have maintained monitoring of production processes with Industry 4.0 technologies used for production

planning. As a result, both papers recognize that one of the main critical success factors for small firms is the upgrade of R&D level to meet new demands and offer additional value for users [7].

In order for SMEs to succeed in digital transformation, they need to have a continuous improvement strategy [3]. [9] supports it and indicates that companies must develop a robust strategy with a realistic business-oriented investment plan. This results from the negative side of the significant power of leaders, who if do not have a stake in Industry 4.0, focus on the daily operations, thereby contributing to the formulation of a short-term strategy that impedes its adoption [3]. Hence, the long-term strategy in pair with leadership support is necessary. Another crucial factor for digitalization is the competence of employees. Because Industry 4.0 entails the modifications of the skillsets of employees, they require constant support through training, which can be efficiently achieved with the limited hierarchy of SMEs that facilitates team-working and learning [10].

Successful implementations of Industry 4.0 by SMEs are not a general thing, therefore some examples of successful implementation are provided. [11] reports that the development of Manufacturing Execution System (MES) allowed the medium-firm to increase production efficiency by 12%, quality of the products by 40%, delivery of on-time data by 96%, and to reduce paperwork by 88%. Another example of successful implementation by SME is referred to by [12]. The authors state that smart manufacturing platforms were implemented by 3 SMEs and 2 start-ups and as a result, they have maintained resource scarcity issues, mass production and sales of the products to the market.

Industry 4.0 set completely new requirements for manufacturing systems and equipment for SMEs. To add to it, there are also various challenges associated with Industry 4.0 for SMEs. Besides the lack of expertise or short-term strategy, SMEs have to deal with high-level investments and fear of uncertainty among employees. Therefore, underlying affecting factors such as challenges and opportunities should be also considered in the first place.

2.2. Background of Kazakhstan SMEs

Since the outset, Kazakhstan's economy has been heavily dependent on extraction of natural resources, especially crude oil and gas exports. More than 50% of the cumulative exports stood for the oil and gas industry and accounted for 40% of the country's total revenue during the last decades. However, the sharp and steady decline in oil prices since 2014 led the country to significant investments in the trade and production industries and increased their shares in the country's economy [13].

The performance of SMEs plays a crucial role in the sustainable development of the country. Although there is no universal definitive differentiation among enterprises and it varies from case to case, SMEs in Kazakhstan are categorized in terms of staff headcount and annual turnover as shown in Table 1, which contains the key statistics of SMEs in Kazakhstan.

Supportive measures, which the government tries to undertake include the creation of the favorable business climate for the growth of SMEs. To date, Kazakhstan is ranked 55th in the Global Competitiveness Index (GCI), which

evaluates the global economies in terms of macroeconomic and business performance [15].

Table 1. Key statistics of SMEs in Kazakhstan [14].

Size/Criteria	Staff headcount	Annual turnover in KZT billion	Share from active entities
Medium-sized	>101 and <250	< or = 7.95	0.2%
Small	< 100	< 7.95	18.6%
Individual entrepreneurs	< 100	< 7.95	81.2%

Share of registered SMEs out of total - 96.3%. Share of active SMEs out of total - 28.4%. SMEs GDP contribution - 28.4%. Share in total employment – 38.1%. Number of workers in small businesses \approx number of individual entrepreneurs and comprise 80.5% of all occupied workers [15].

The country earned the highest score in shareholder governance, which indicates that the performance of the public sector is above the average among upper-middle-income countries. Meaning that the actions of the government of Kazakhstan are indeed effective. For example, one of the successful national programs dedicated for creating a supportive ecosystem for the growth of the SME sector and increasing the share of innovative activity among businesses is “Digital Kazakhstan” [16]. According to [17] under the scope of the program only in 2019, eight thousand new jobs were created, while the economic effect for two years 2018-2019 surpassed KZT 600 billion. One of the successful digitalization examples is based on the petrochemical plants, located in West and North Kazakhstan, where repair works and application of some tools helped to decrease the downtime and repair costs. As a result, better productivity was achieved, processing volume in both plants increased to 300 thousand tons in a year. Furthermore, remarkable outcomes were achieved in the training of digital literacy to citizens and employees. Over 2 years, the number of trained citizens exceeded 532 thousand [17].

However, to obtain a complete picture of the state of Industry 4.0 implementation in Kazakhstan this is not enough. Therefore, a more in-depth analysis of specific drivers, challenges and opportunities is provided in the next section.

3. Industry 4.0 Analysis of Kazakhstan SMEs: Drivers, Challenges, and Opportunities

The methodology that was used in this section is based on the literature review of Industry 4.0 in Kazakhstan. In this study, the stakeholders’ (SMEs) opinions were gathered through a series of interviews to validate and supplement the findings. This was used as the foundation for the SWOT analysis of Kazakhstan SMEs aimed at synthesizing recommendations for the managers and policymakers in Industry 4.0 implementation context.

Similar to others, Kazakhstan SMEs have their own forces that can create development opportunities. One of them includes *high product specialization*, which distinguishes them from larger competitors. According to [18], by 2019 in Kazakhstan there were launched several successful SMEs with high product specialization. Thereby, harnessing Industry 4.0 technologies for the increased productivity and quality will further enhance the competitiveness of

Kazakhstan SMEs on the local market.

Flat organizational structure and short hierarchical line of SMEs in Kazakhstan is also a favorable factor for Industry 4.0 adoption. According to [19], one of the main advantages of Kazakhstan SMEs compared with large corporations is increased creative initiative and independence in making major decisions, which facilitates the creation and implementation of innovations in that organization.

A *strong entrepreneurial spirit* in Kazakhstan is a supporting index for SMEs as well. Because it reflects the country’s citizens’ willingness to pursue entrepreneurship. 60% of the adult population in Kazakhstan see entrepreneurship as a real source of income and 46% of adults actually proceed from talk to action [20]. This phenomenon is related to the cultural perception of entrepreneurship in Kazakhstan that is viewed as a symbol of high status and also to the reduced fear of failure in recent years (from 40% in 2007 till 18% in 2017) [20]. Thus, it can be a reason for the growth of innovative activity and penetration of Industry 4.0 among SMEs.

Another strong aspect of SMEs towards Industry 4.0 adoption is *the expected positive impact on the company’s economic performance*. [17] puts main emphasis on the potential increase of profits of Kazakhstan enterprises by reducing costs and increasing labour productivity via Industry 4.0 implementation. Smart Factory launched in Kachary, Kazakhstan, utilizes modular automated systems integrated with Geographic Information System (GIS) and Enterprise Resource Planning (ERP) and as a result the costs were optimized, malfunctions of equipment were minimized and equipment productivity increased by 10% [17]. The same principle can be applied for SMEs with respective alterations, and by that to obtain economic incentives by the adoption of Industry 4.0.

The organizational nature of SMEs with proper digital technologies implemented would allow them to *expeditiously react to market changes*. [8] consider that vertical integration within an enterprise could facilitate the interoperability of enterprise systems and thereby obtain the ability to quickly respond to external factors. In that terms, [21] emphasizes that Kazakhstan SMEs provide the local market with necessary flexibility by promptly responding to changes in market conditions. Moreover, [22] points out the importance of SMEs in the context of introducing the flexibility to the economy by quickly adapting to the market fluctuations.

The lack of knowledge about Industry 4.0 and benefits of its appliances can be considered as one of the main barriers towards the adoption of Industry 4.0. [8] puts forward the claim that the research gap in knowledge about technologies and concepts of Industry 4.0 is a fundamental challenge for SMEs in their further transformation. In the context of Kazakhstan, [17] states that insufficient understanding of the economic benefits of digitalization in the business environment and how they can be utilized are found to be among major challenges on the path of digitalization of local organizations. According to the [23], majority of Kazakhstan enterprises lack the understanding of Industry 4.0 concepts and its potential benefits and thereby impedes the development of those organizations in that direction.

Another obstacle is the *shortage of financial resources*. Lack of proper financial resourcing decelerates the inner R&D activities of SMEs, which makes it impossible to create

the required technology in a timely manner. According to [21], the main challenge of Kazakhstan SMEs development is poor financial support from the government. This view is supported by [23], according to which the limited financial resources were identified as one of the main challenges towards the adoption of Industry 4.0 among Kazakhstan enterprises. Moreover, despite having numerous governmental programs for SME support, [21] emphasize that the majority of Kazakhstan SMEs do not use them or do not know about them due to the lack of promotion.

Lack of qualified personnel in SMEs is frequently mentioned in Industry 4.0 literature, while the qualification of the top management is not less relevant. According to [23], lack of qualified personnel was identified as one of the main barriers to adoption of Industry 4.0 among Kazakhstan enterprises. As well, since for Kazakhstan SMEs the most common hierarchy is top-down, all decision-making processes are highly centralized. Therefore, the lack of awareness of top management about Industry 4.0 and lack of knowledge about possible benefits negatively affects the overall qualification and knowledge level of employees in the organization [24].

Since Industry 4.0 is not only about digitization and technologies, a *lack of well-developed strategy* is also one of the major issues for SMEs [25]. According to [17], properly and thoroughly developed strategy and its stepwise implementation plays a crucial role in the transformation of Kazakhstan enterprises towards Industry 4.0. Moreover, [26] states that decentralization, which is one of the Industry 4.0 design principles, may play a role of additional support to top management and to make it easier for them to monitor/control the application of the strategy in Kazakhstan enterprises.

The governmental support, which includes financial and tax incentives, contributes decisively towards Industry 4.0 adoption among local SMEs and therefore considered to be a driving factor in that context. For example, The Third Modernization initiation, which was mentioned previously, aimed to train at least 10 thousand specialists for the key industries until 2025 throughout the whole country [17]. The "Business Connections" project, a part of the "Business Roadmap 2020" program, allowed the training of more than 3000 senior managers of SMEs. On top of that, under the same initiation, the project "Senior Senior" invited foreign experts to deliver the training and share their knowledge and advice [27]. Another governmental initiative Damu Entrepreneurship Development Fund JSC was established back in 1997 as a support for SMEs [27]. One of the projects of Damu is providing financing for SMEs.

The pervasive appliance of digital technologies and Industry 4.0 related concepts among economic units, including large companies and SMEs could facilitate the *increasing competitiveness* in the niche market. For that purpose, part of governmental programs was dedicated to increase investments into several specific areas such as innovations, diversification of produced national products, and increasing competitiveness on the international level, which certainly positively affects SMEs, providing them with opportunities to grow [27]. According to the meeting of the Kazakhstan Ministry in 2019, the results of the first modernization helped to launch a variety of new products in the local market [17]. In turn, these new products helped companies to increase competitiveness among others and to increase profit.

Another positive impact of Industry 4.0 for SMEs besides profits increase, is the *possibility to consolidate into the global value chain (GVC)* and extend the current market niche. According to OECD reviews, in 2013, the percentage of the direct export of manufacturing products within Kazakhstan firms consisted of only 2.4%, while in the neighbourhood countries the percentage was twice higher. The paper indicates that over 98% of Kazakhstan firms do business only on the domestic level [28]. Because of this limitation, SMEs heavily depend on the development of the national economy, as well as the income of the local community. Therefore, the inclusion of local SMEs towards GVC could potentially facilitate the knowledge sharing environment as well as the creation of new business models with globalized market focus, which in turn would impact the development of a healthy competitive environment.

Environmental issues such as climate change, floods, forest fires, and indeed, Covid-19, are just some examples which have shaken the world and changed the perception about fossil resources and their harsh usage. Industry 4.0 at this point will help to optimize usage of resources, decrease waste, and lead to a more sustainable approach. In the support of this point, [29] claims that optimization of processes and usage of smart systems in production will significantly reduce the energy consumption in the enterprise, thereby emphasizing and reducing greenhouse gas emissions. Kazakhstan enterprises such as Smart Factory in Kachary and gold mining plant in Aktogay have already implemented Industry 4.0 technologies and constituted an increase in productivity and optimization of energy consumption, which has a direct impact on the ecology of the environment [17].

The low integration level of the triangle "academia-industry-government", as well as the poor level of innovative activities in Kazakhstan, negatively affects SMEs *in terms of R&D level*. Currently, the share of innovative activity in the gross national product is 1,53%, and only 15,8% of the Kazakhstan organizations are engaged in innovations. To compare, in developed countries such as Switzerland, the share of enterprises that have any kind of innovative activity is 72,6%, Austria – 62%, Germany – 63,7% [30]. From the survey, the reasons for the low level of R&D within Kazakhstan SMEs were indicated as high economical risks (by 4% of the surveyed companies) and lack of demand for innovations (by over 34% of respondents) [36]. These reasons are obstacles for SMEs, while in case of successful application of innovations and as a result introducing the unique product, it can help to reinforce their positions on the domestic market.

The current ICT level and overall Kazakhstan's infrastructure level are also one of the obstacles for SMEs. Based on the [31], which aims to evaluate the factors, policies, and institutions that allow the country to utilize ICT, Kazakhstan holds 39th position out of 139 countries. In general, the country scored the above-average points among 10 assessment criteria but yet has to improve the quality of the products and services. Moreover, sharp disparities in the level of access to the internet between urban and rural areas decrease the readiness of Kazakhstan for Industry 4.0, as the adequate level of ICT infrastructure in a country is a key enabler of digital transformation [31]. Therefore, the current level of underdeveloped ICT infrastructure might impose a

real threat towards the adoption of Industry 4.0 among Kazakhstani SMEs.

Data security issues appeared almost with the boost of the Internet and still can be considered as a very significant [32]. According to [33] in 2017, Kazakhstan was positioned on an 83rd place for Global Cybersecurity Index, which puts him ahead only from a few former USSR countries. Moreover, taking into account a low level of Intellectual Property Rights (IPR) in the country and almost no legislation about online data property makes it one of the main reasons that disrupt the adoption of cloud technologies in companies.

Another threat in Kazakhstan was recognized as *corruption*. According to [34] more than 15 % of Kazakhstan SMEs reported that corruption is one of the main obstacles to run business. As well, corruption negatively affects the organization's reputation, damages morale of the employee, brings financial losses, and impacts the overall economic development of the country [34].

To sum up, Kazakhstan SMEs do possess some strong competencies towards the adoption of Industry 4.0, including high product specialization due to their narrowed focus on niche markets. Flat organization structure and short hierarchical line is also a great advantage of local SMEs which facilitates effective decision-making. In contrast, there are several internal weaknesses that are distinctive for Kazakhstan SMEs, which are lack of knowledge about Industry 4.0 and its benefits, lack of qualified personnel, absence of proper strategy, and shortage of financial resources. Moreover, Industry 4.0 provides Kazakhstan SMEs with opportunities such as increasing competitiveness through well-developed internal processes and stable supply chains, entering the GVC, and resolving environmental issues. Also, the low level of R&D development, inadequate ICT infrastructure, data security issues, and corruption are recognized as the major threats for Kazakhstan SMEs towards the transition to Industry 4.0.

Further, the presented findings of the research were classified into the strengths, weaknesses, opportunities, and threats related to Kazakhstan SMEs. The summary of the SWOT analysis is shown in Table 2 [35].

Table 2. SWOT analysis of SMEs in Kazakhstan in Industry 4.0 context.

Internal Factors	
Strengths (+)	Weaknesses (-)
High product specialization	Lack of knowledge about Industry 4.0 and its benefits
Flat organizational structure	Lack of qualified personnel
Strong entrepreneurial spirit	Absence of proper strategy
Expected positive impact on company's economic performance	Shortage of financial resources
Quick response to market changes	
External Factors	
Opportunities (+)	Threats (-)
Obtaining provisional support from the government	Low level of R&D
Increasing competitiveness	Inadequate ICT infrastructure
Entering the global value chain	Data security issues
Resolving environmental issues	Corruption
Analysis Summary	
More details of suggestion and summary presented further:	
<ul style="list-style-type: none"> • Modifications in state SMEs support programs; • Increase awareness of people about Industry 4.0; • Increase in digital literacy of employees required; • Exploit the strengths of SMEs and focus on customer satisfaction. 	

4. Conclusion and Managerial Implications

This work aimed to explore the correlation between two emerging topics: Industry 4.0 and industrial development of economies such as Kazakhstan. This paper combines the two topics and revolves around the argument that Industry 4.0 can boost industrial development of transitional economies. The main contributions of the following paper include:

- Discussion of the implications to SMEs caused by the emergence of Industry 4.0 based on the extensive literature review;
- Examination of the Kazakhstan SMEs development prehistory and their position in the economy of the country;
- Exploration of the main drivers, challenges, opportunities that propel and at the same time impede the Industry 4.0 transformation of SMEs in Kazakhstan;
- Providing recommendations for SMEs and governmental organizations to resolve challenges, barriers and facilitate the Industry 4.0 initiatives.

Based on the findings, as well as developed SWOT analysis, below listed some of the recommendations for the future development of the SMEs sector in Kazakhstan:

- It is important to add major modifications to the evaluation methods of the state programs. The lack of transparency and implementation of measures only "on paper" makes it even more challenging to make a clear assessment of the needs of SMEs and prevents their development;
- Using mass media, to change the cultural perception of people about digitalization, Industry 4.0 and increase their awareness;
- Increase of training programs to all levels of employees to improve their digital literacy is utmost importance;
- Taking into account the strengths of SMEs, increase customer orientation and adopt novel business strategies to further enhance interaction with customers;
- To reconsider micro-financing, tax incentives, and leasing mechanisms for SMEs in order to access technology and tools of industry 4.0 and, then, integrate the facilities to the digital chain.

Indeed, recommendations are not limited to the indicated above and could be extended by using other instruments. In conclusion, it could be stated that Industry 4.0 is already affecting businesses, including SMEs. Examining the current state of SMEs for their readiness to Industry 4.0 and understanding the essence of the challenges that hamper it in countries such as Kazakhstan will provide policymakers, SMEs' managers and researchers with valuable information for future SME 4.0 transformation projects.

According to the findings of this study, it is clear that more elaborate research is required to address unresolved questions, such as the current level of Kazakhstan SMEs related to Industry 4.0 and their future strategies towards it.

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