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Analysis of Textile Manufacturing SMEs in Kazakhstan for Industry 4.0

Dinara Dikhanbayeva[a], Malika Aitzhanova[a], Essam Shehab[a], Ali Turkyilmaz [a,*]

[a]School of Engineering and Digital Sciences, Nazarbayev University, 53 Kabanbay Batyr Ave, Nur-Sultan 010000, Kazakhstan

* Corresponding author. *E-mail address:* ali.turkyilmaz@nu.edu.kz

Abstract

Industry 4.0 is a concept which majorly changes the industries, enterprises, the whole way of doing traditional business by transforming existing business models. However, not all developing countries are keeping up with the time, therefore many industries may leave behind. This research aims to study one of the promising but not investigated sectors of Kazakhstan as textile. Textile took the main share (60%) in Kazakhstan's light industry and is considered one of the well-growing sectors, which can become one of the major contributors to the Kazakhstan economy. The main focus of the study will be oriented to SMEs in that sector, as SMEs present almost 97% of all businesses in the country. The goal of the study is to analyze the current status of industry companies via the developed maturity assessment model. As well, to investigate their digitization state; identify common strengths and weaknesses; draw out the possibilities that digital technologies may bring to the sector, and conclude by recommendations to improve the sector. The findings during this study can be useful for researchers, governmental organizations and policymakers, and all other interested parties.

Keywords: Industry 4.0; Manufacturing SMEs; Kazakhstan; Textile and apparel industry, Maturity assessment.

1. Introduction

Industry 4.0 (I4.0) is a new booster of the economic development of countries around the world [1]. With the help of digital technologies, I4.0 changes the operational performance of companies by reducing set-up and processing time and increasing productivity [2]. These new industrial changes are allowing to effectively respond to the customers' changing demand and affecting competition levels in the market [3].

The light industries, such as the textile, play an important role, especially for the largest producers such as India, where nearly 45 million people are employed in this sector, or China, which accounts for producing cotton production for 40% in the world and 50% of the world's clothing. In the overall world GDP, the textile industry's share is only around 3%, while this number increases to 10% in certain countries [4]. In the existing studies, researchers from different countries investigate the state of the industry, analyze their strong and weak sides, and provide some solutions for the adaptation of textile industry to digital transformation. For example, in [5] it was stated that advanced technologies and innovative products offer new possibilities to smart factories in the fashion industry. The study conducted in Turkey [6] investigates "Apparel 4.0" and resulted in the main benefits of it such as better agility, transparency, increased quality, productivity and customer satisfaction, reduced operational cost and delivery time, however, there are still some challenges such as financial, technical and social. Despite the availability of various similar studies around the world, the textile sector in the Kazakhstan case still remains undisclosed. While in the last 10 years the light industry sector has grown by 1.5 times. Specifically, the textile industry showed growth to 3.3 times increasing production from 41 million USD to more than 137 million USD. Despite the effect of Covid-19, the index of physical volume in the light industry in the first half of 2020 increased to 108% compared with 2019 [4].

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Small and medium enterprises (SMEs) are one of the main economic drivers of developed and developing countries. I4.0 gives various opportunities for SMEs, such as better flexibility, increased production efficiency, and improved customer services. However, SMEs face many difficulties while implementing and adapting to I4.0 and new technologies into their business models [7]. Therefore, in order to create correct long-term strategic plan towards I4.0, it is critical for them to identify their current position by utilizing systematic and reliable approaches.

Summarizing all points mentioned above and taking into account the research gaps, the research objectives of this study are:

RO1: To analyze the I4.0 readiness of the selected SMEs in the textile sector of Kazakhstan through a developed comprehensive maturity assessment model (COMMA 4.0);

RO2: Investigation of digitization state, strengths and weaknesses, similarities and common patterns of SMEs in textile;

RO3: Provide improvement recommendations towards I4.0 to managers, researchers, governmental authorities, and all other interested parties.

2. Literature review

2.1. Industry 4.0 and Readiness Assessment

I4.0 is transforming manufacturing into a new smart and autonomous industry by providing better flexibility, efficiency, and increasing the quality of the offered products and services [8]. I4.0 technologies or so-called pillars include artificial intelligence (AI), the internet of things (IoT), smart technologies, big data, cyber-physical systems (CPS), etc. [9]. Implementation of these technologies into manufacturing firms enables them to support the big amount of data, decentralize the decision-making process, assist employees, and connect humans and technologies by generating and sharing real-time data [10]. However, there are studies such as Modrak et al. [11] which described a self-assessment method and roadmap model in implementing I4.0 technologies in smart logistics and smart production for SMEs, most companies claim that I4.0 implementation has drawbacks such as the absence of a clear roadmap or a guideline, financial uncertainties, a lack of knowledge about new concept, and lack of skilled employees [12].

In order to solve one of the issues such as a lack of a clear roadmap or easily accessible guideline, maturity models were developed to assess the readiness of firms towards I4.0. Maturity models are commonly presented in the form of a survey, assessing the company from several perspectives and resulting in a certain score [13]. I4.0 readiness assessment tools or maturity models help companies to understand their position in regard to I4.0, reveal their weak and strong sides, and set future targets and strategies. Several existing maturity models that are the most cited can be mentioned, as Impuls [13], Digital operations self-assessment [14], Singapore Smart Industry Readiness Index (SIRI) [15], Reference Architecture Model for the Industry 4.0 (RAMI4.0) [16] and etc. On average, each maturity level has from three to nine main dimensions such as Strategy, Processes, Technologies, and etc. Also, despite various techniques used for calculation and weighting allocation to the questions, the maturity stages range between three to six, while the most common is five. However, many studies about existing maturity models by different researchers around the world identify the following gaps in those models [17, 18, 19, 20]:

- Lack of full description of maturity dimensions and levels for most of the models, which makes it difficult for companies to use the tool;
- Models might be too scientific, using a lot of terms, which makes it difficult to understand;
- Very few existing maturity models are applicable or dedicated to SMEs;
- Lack of full coverage of the main design principles of I4.0;
- Limited practical guidelines for different maturity levels;
- Many maturity models are not designed as a self-assessment tool, which assumes companies need additional help to use the model;
- Absence of recommendations/suggestions or actions to take after receiving the result as the maturity level/score, which decreases the value for companies;
- Some models can be used only on a payment basis;
- Lack of empirical studies validating the model.

2.2. Textile sector in Kazakhstan

The development of SMEs is the basis of the economy of any country and one of the main factors that influence a macroeconomic situation [21]. The worldwide statistics reveal that the light industry is one of the leading industries due to growing demand. Within it, particularly the share of the textile sector is high [22]. It is expected that the global textile market size will reach nearly 1413 billion USD in the next seven years. Also, the compound annual growth rate (CAGR) is prognosed to be 4.4% from 2021 to 2028. Covid-19 and the following boost of e-commerce worked as drivers of this increase [23]. In the Kazakhstan case, the share of textile manufacturing in the light industry is also high, more than 60%, while the number of produced textile products in 2017 reached 272.6 million USD [24]. This sector is considered promising because it currently covers only 10% of the local market, importing the rest 90% [24]. Additionally, SMEs are essential in the textile sector of Kazakhstan as it consists of 94.3% of small enterprises, 3.7% medium, and 2% large enterprises [25]. The topic of maturity readiness of the textile sector to I4.0 is interesting to many researchers as many works and studies are conducted in different countries [5-6-26-27]. However, this topic is still left behind in the Kazakhstan case. Many researchers claim that existing sources do not analyze the readiness level of Kazakhstan manufacturing companies, including the textile sector. For example, [28] in their studies concluded that the light industry services are undeveloped therefore there is a need to analyze the present stage in more detail. Pazilov et al. [22] claim that domestic textile enterprises need to pay attention to the latest innovations and developments to increase their competitiveness. Daribay et al. [29] show that Kazakhstan needs to adopt digitization perspectives to target the global community.

Concluding it, in order to obtain a complete picture of the readiness of textile manufacturing companies in Kazakhstan for the implementation of I4.0, a more in-depth analysis of specific challenges and opportunities of I4.0 to the textile industry in Kazakhstan and recommendations for this

implementation is needed. Thus, to fill this gap this study was conducted.

3. Methodology

3.1. The Model

In order to analyse the readiness of the textile manufacturing SMEs, COMMA 4.0 was utilized in this research [30]. The COMMA 4.0 is a research model developed for the analysis of the manufacturing enterprises in developing economies and takes into account the characteristics of SMEs. The model includes the following five main dimensions chosen based on an extensive literature study and analysis of local manufacturing industries: Strategy and Organization, Workforce Development, Smart Factory, Smart Processes, and Smart Products and Services. The model assesses the enterprises based on five maturity stages starting from level 1 (Entrant) to level 5 (Expert). In order to identify the weights of the developed model dimensions and indicators, the Analytic Hierarchy Processes (AHP) method was employed [31]. AHP is a structured technique allowed to identify the weights of dimensions and maturity items using eigenvectors with a panel of researchers and interviewed practitioners [31]. Each of the respondents compares the relative importance of each pair of items using a specially designed questionnaire. In addition, one of the main values of the model is that it is equipped with an expert system, which automatically estimates the level of maturity of the company, identifies drivers and weaknesses and generates certain recommendations upon the received score. The model is empirically grounded and validated by pilot tests conducted by developers. The model was checked and approved by Institutional Research Ethics Committee (IREC).

3.2. Data collection

The sample data for this study were chosen within the textile sector companies located in 14 different cities of Kazakhstan. Also, the companies operating in the sector for more than two years were selected in order to be sure about established systems and processes within the firm.

During this study, the data was collected using the CATI (Computer-assisted telephone interviewing) survey method [32], and the respondents' replies were recorded by a team member. As a result, from 105 shortlisted firms, 27 responses were collected.

4. Results and Analysis

The size characteristics of the sample along with their received maturity level are presented in Table 1. All participated companies represent SMEs, and the average maturity level received equals to 2.3, which corresponds to a beginner level.

Table 1. Size characteristics of the sample.

Size	Count	Percentage	Maturity level (out of 5)
Employees: 1-10	5	19%	2,3
Employees: 10-50	15	56%	2,2
Employees: 50-200	7	25%	2,3

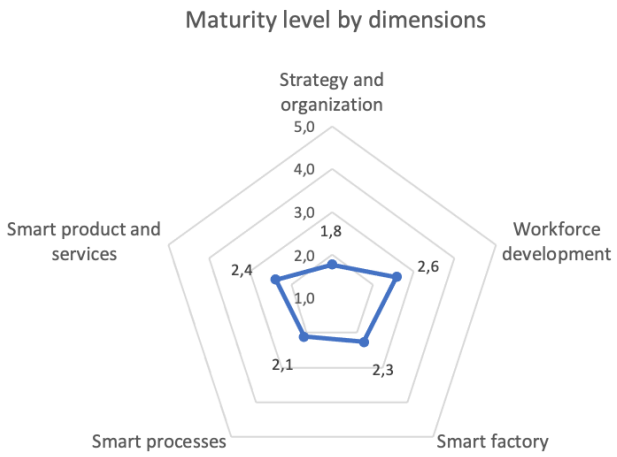

Fig. 1. Maturity levels of textile companies by dimensions.

Fig. 1 represents the average maturity level for each main dimension of all companies in the sample size. All of the main dimensions show that companies are in a beginner level (scoring from 2 to 3 out of 5) except for the strategy and organization dimension which score is 1.8 and corresponds to an entrant level. In opposite, the highest result within all dimensions was received by the workforce development (2.6/5). The results are consistent with manufacturing industry of Kazakhstan when considered as a whole, having a very slight difference (all dimensions score a beginner level, ranging from 2.15 to 2.94). Similarly, a recent study by Rahmadi [33] on Indonesian textile industry, where authors used the specially designed I4.0 readiness framework with over 33 elements grouped in 8 determinants has scored as "potentialists", which corresponds to level 2.

In order to identify the strengths and weaknesses of each main dimension in more detail, further analysis is conducted.

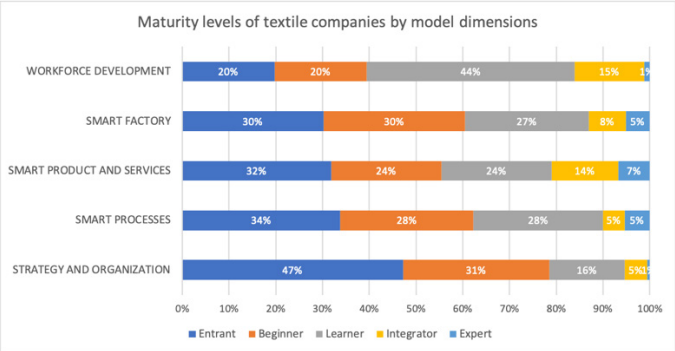

Fig. 2. Maturity level of textile companies by model dimension.

Fig. 2 presents the maturity levels of textile companies by model dimensions. It can be stated that in terms of strategy and organization prospect within the textile industry of Kazakhstan there exists an understanding of the need to transform to I4.0, however, no proactive steps are taken as 47% of firms correspond to an entrant and 31% to a beginner levels. Further, Fig. 3 shows the maturity levels for all model components grouped in colour by main dimensions. In relation to leadership support and I4.0 strategy implementation, 56% of companies indicated that top management is still not aware of I4.0 and its potential benefits, and almost half of them do not have any I4.0 strategies in place. Nonetheless, more than one-third of

companies (37%) have their I4.0 strategies at a development stage. In addition, around 50% of the companies indicated that collaboration with stakeholders about I4.0 to some extent is present. In terms of state of ICT function, the assessed companies also face challenges. Almost 41% of the firms don't have any structured ICT within their organization. Concerning ICT systems budget management, 59% of companies indicated that they do not have any budget planned for ICT systems.

A higher maturity level for the workforce development dimension can be explained by a high acceptance level of changes within employees which corresponds to almost a learner level, which is level 3 (Fig. 2). 44% of firms fall into learner maturity level. It also correlates with the overall digital competency of the workforce. However, the weakest part is top management support for employees' professional development and the absence of budget planned for such activities (Fig. 3). Only 4% of companies have planned and scheduled budget for personnel development programs (e.g., training, courses, etc.).

Components of smart factory dimension show results stretched onto three levels of maturity, i.e., entrant (30%), beginner (30%), and learner (27%) maturity levels (Fig. 2). It was identified that only a small portion of the equipment is upgradable at the enterprise and this sub-dimension resulted in a beginner level (Fig. 3). Production can be observed at a machine level and production system is automated to a lesser extent. In most companies (67%) digitization of enterprise data is mostly done in spreadsheets or similar programs without any use of isolated ICT. ICT architecture is present and centralized, however it does not possess any features of interconnectivity and network. Similarly, machine-to-machine communication is present at a low level. Since low data amounts are digitized, cloud services are utilized only for basic storage with no purpose of data analytics in 19% of the companies. Moreover, half of the companies do not use any cloud services at all.

In smart processes dimension, textile companies on average are also in an entrant (34%), beginner (28%) and learner (28%) stages (Fig. 2). As it can be seen from Fig. 3 and dimensions components, data-driven decision-making has the highest score of 2.56 which means that companies understand the need to collect and use data for further decision-making processes in the company, however do not use it to a full extent. In addition, it can be observed that basic steps towards establishment of standardized business processes and quality control are taken. However, almost half of the companies (48%) utilize only corrective maintenance approach. i.e. maintenance is done only at the time of occurrence. Use of business information systems is another weakness, as only 38% of companies' processes are semi-automated with some basic IT systems.

In the smart products and services case, results mostly belong to entrant level (32%), then equally to beginner (24%) and learner (24%) (Fig. 2). The strongest sub-dimension of customer data utilization (Fig. 3) shows that 33% of companies utilize the customer information at a high level, 4% at an advanced level, 44% at the middle level, 15% at a low level, and only 4% do not use any customer data. Due to this fact, the maturity level for frequency of product or service upgrades is also found at a higher level in comparison with other sub-dimensions. Digital products resulted at entrant level meaning that at this stage products have no digital features embedded, and 21% of the companies answered that implementation of digital features is irrelevant for their firms. Examples of such features can be unique identification of products, possibility of products to store and manage data or real-time monitoring of products along their life-cycle. In addition, in firms, services such as proper online ordering and payment services are also not available. However, according to the results, companies are eager to incorporate digital features (43%) or already in a design stage of implementing such features (16%). Furthermore, 31% of respondents indicated that they use various types of the sales channels, including digital ones.

However, the majority (38%) still use only traditional and physical sales channels. Product customization degree also corresponds to a beginner level where only slight customization is possible at final stages of production for one-third of the companies, while for another third of respondents no customization is possible.

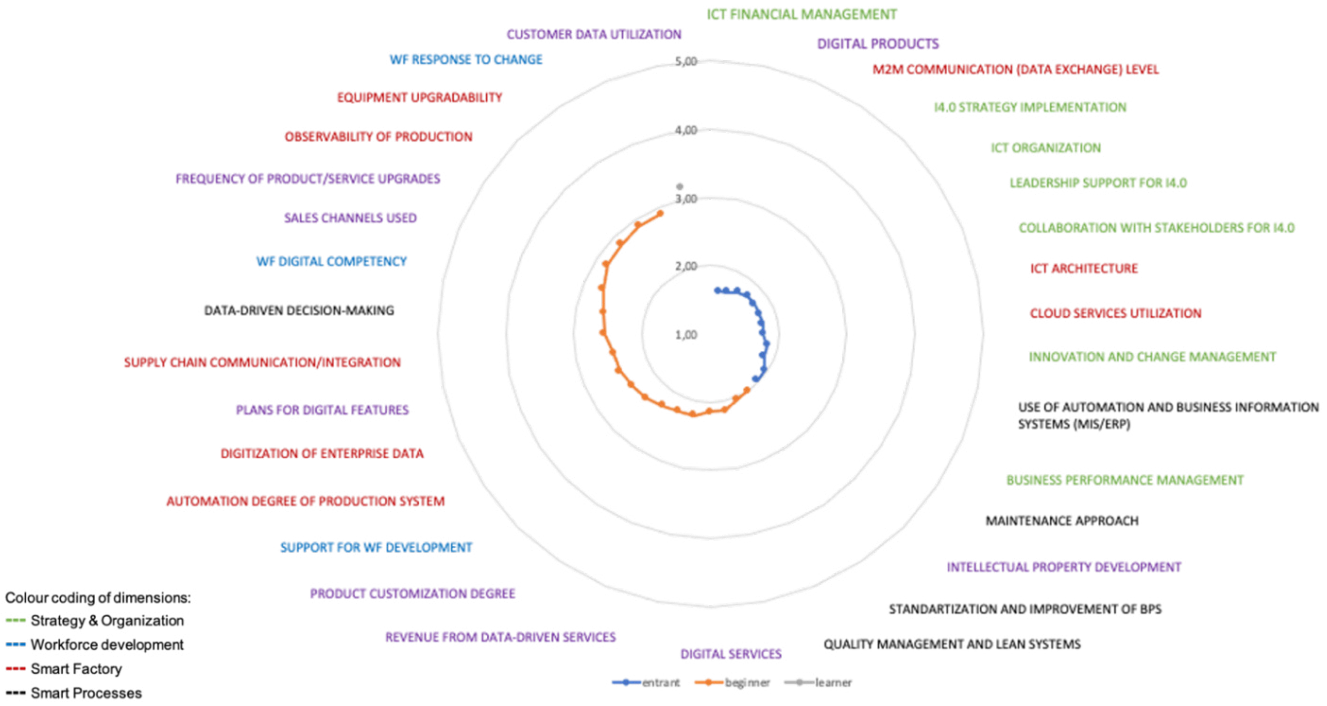

Fig. 3. Maturity levels for all model components.

Fig. 3 presents all model components on a single radar chart. Summarizing all points, the textile industry can firmly be described as a beginner in the I4.0 journey since the maturity level for almost 60% of components is located between 2 and 3. Nonetheless, lack of digital features in product and/or services, machine-to-machine communication, appropriate strategies towards I4.0 and its implementation plan, and poor ICT systems budget management are the weaknesses that put off I4.0 improvement in the textile industry of Kazakhstan. On the other hand, it has been identified that customer data is utilized at a middle level and employees have a relatively good level of change acceptance (59% - moderate degree, 19% - high (positive attitude towards changes) degree. In addition, present equipment can be enhanced and upgraded to satisfy I4.0 needs. These strengths should be used to promote and implement I4.0 further.

5. Conclusion and Implications

This study was dedicated to investigating the current state of the selected manufacturing firms operating in the textile sector in Kazakhstan. Given that only 10% of the local market is covered by domestic companies, and with the availability of raw materials in Kazakhstan and its efficient location, it is clear that there is a great potential for these companies to grow. The weaknesses identified in the analysis of textile companies of Kazakhstan should be given foremost attention when further steps towards I4.0 are taken. Companies should aim both at improving their automation and digitization level, such as introduction of digital features into products and services, increase in data exchange level, cloud services utilization and financial management of ICT and ICT organization. As well, to establish proper strategy management including innovation management, leadership support as well as better collaboration amongst all stakeholders. Certainly, the help of governmental authorities is required, in order to create the correct innovative environment, where companies will be given opportunities, such as required infrastructure for companies to smooth the transition to I4.0. This can be done through disseminating information about the governmental initiatives of I4.0, holding of special workshops and provision of training on digitization and I4.0 basics for employees.

To sum up, it is obvious that in order to increase the competitiveness of the local firms and access to the global value chain the acceleration of I4.0 and its tools in the current world is a necessity. Based on the study above and taking into account challenges and drivers, the following suggestions to the companies, governmental organizations, investors, and all other interested parties are developed:

- Increase the awareness about I4.0 and its benefits, explaining the importance not only of technologies but the right strategy;
- It was clearly seen from the results that employees are ready for the changes, however, firms are lacking budget. At this point, governmentally supported development programs may fill this need;
- Internal and external collaborations, as the location of Kazakhstan (in the heart of Eurasia) gives a great opportunity to play a major role in logistics and supply chain; at the same time cooperation can be regarding joint enterprises as Kazakhstan have plenty of raw materials available;
- Despite the available online sales channels in more than 30% of the firms, the percentage of the offered digital services along with the customization level is low; additionally, the strategy was found as the lowest within all other dimensions. Thus the strategy of the organizations needs reconsideration. The term "Textile 4.0" is getting more widely used, which can be a guideline for domestic firms. Strategy oriented to innovations and new marketing approaches is of utmost importance if the organization planned to succeed in the market;
- Investments in digitization can solve issues with the limited financial resources, while they can be attracted from abroad, or can be found within local entrepreneurs, to whom will be given legal benefits and exemptions from taxes and others.

The study has limitations as the absence of the possibility to visit factories, as well as the small sample size due to the low level of willingness from organizations to cooperate. Future research can include bigger sample size, and in-depth interviews along with the surveys, in order to have a better understanding of the situation of the industry.

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