

Digital Maturity and Readiness Model for Multiple-Case of Kazakhstan Large Companies

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Abstract—With the evolving of Industry 4.0 in the 21st century, digitalization gains popularity in companies, because it is a need that makes the company competitive and optimizes the work. Many factors influence the company and its transformation, especially in large companies, for example, financial situation, organizational culture, employees and their skills and talents, technology, and strategy. Based on these factors, models are developed to assess the digital readiness and maturity of the company. As a result of a comprehensive review of different models and current situations in large Kazakhstani companies, the model was developed and described together with the results of the model which was applied in different companies.

Keywords—Industry 4.0, digitalization, digital maturity, digital readiness

I. INTRODUCTION

Industry 4.0 changes the reality of managing the business and triggers a more significant step towards technologies at the micro-level. Thus, pushing organizations and companies to go through the process of digital transformation will not end up with success for all of them. Following these massive changes, Kazakhstan initiated the program "Digital Kazakhstan". It is a sophisticated program that aims to increase the living standards of people using digital transformation. Successful digital transformation is the result of implementing the digital maturity model correctly.

Digital readiness is the preparedness and comfortability of people and organizations to use new technologies [7]. There are three main elements of digital readiness: digital skills, trust to the online information and use, where use shows the level of digital tools usability [7]. Machado [2] stated that "readiness should be used for assessment before engaging in the maturing process, whereas maturity aims to assess the as-it-is situation while the maturing process".

This paper aims to design the digital maturity and readiness model for large Kazakhstani companies through analyzing the current situation in the country and models for companies abroad.

II. LITERATURE REVIEW

A. McKinsey's 7S framework

Assessment methods and tools differ from organization to organization. One way of assessing maturity in the technology business is McKinsey's 7S framework [5]. The model was introduced in the 1980s by the consultants of the McKinsey company, and this model is still used and considered to be the most popular strategic planning tool. The 7S framework consists of seven different factors and divided into two groups hard and soft. Hard group's factors are strategy, structure, and systems, while soft group factors are skills, staff, style, and shared values [5]. This model is used to check the organizational design and its effectiveness; therefore, it also fits to assess the digital maturity of the organization [9]. According to Ravanfar [9], five steps need to be followed to apply this tool:

1. Identify the wrong targets.
2. Establish the most suitable organization design.
3. Determine types of modifications and where they should be applied.
4. Apply these modifications.
5. Continuously repeat these steps of the 7s framework.

In the article by Demir [5] the case of a consulting company in the IT-sphere, that was on the process of digital transformation for three years and continuing to transform regarding Industry 4.0. Together with three experts of this company McKinsey's 7s framework was applied, for each 7S digital transformation sub-criteria were developed and using analytic hierarchy process defined its weights, as a result of the six-week job done the company's current performance was equal to 78% [5]. Listing from the weight with highest to lowest, "Strategy", "Shared Values", "Structure", "Skills", "Style", "Systems", and "Staff". This analysis showed which criteria performance is weak and where additional improvements are needed.

B. Deloitte digital maturity model

One of the things that discourage the development of digital transformation is a lack of good strategy and specified knowledge and roadmap for applying this strategy. The Deloitte digital maturity model covers five principal dimensions of the business; they are customer, strategy, technology, operations, organization, and culture [15]. The resulting digital maturity model avoids the usage of multiple tools to assess the readiness level of the organization and cuts the costs [15]. To broaden them and to facilitate the process of grading each dimension they were divided into 179 individual subdimensions such as customer engagement, delivery governance, network, security, technology architecture, change management, workforce enablement, organizational design and others [15]. Thus, dimensions build the model of digital maturity for any applied organization.

C. Pacchini's Industry 4.0 model focused on technological development

Regarding Industry 4.0 as digital technology, Pacchini [1] proposed a model based on the Society of Automotive Engineers standard J400 to measure readiness and maturity level of the manufacturing company. This standard is developed to measure lean manufacturing implementation, and its principles were adopted by the authors for measuring readiness level regarding Industry 4.0 implementation. During the approach established, the first step was to identify the technologies that enable proper Industry 4.0 implementation. The identified "enablers" were IoT, Big Data, Cloud technology, Cyber system, Autonomous robot, Additive manufacturing, AR and then extended with AI. Then, for each enabler, six prerequisites were identified. For example, for the enabler Big Data six prerequisites for a company were: a) availability of infrastructure for digital systems, b) information has to be organized and maintained in protected digital systems, c) availability of data communication network, d) availability of staff to collect data, e) treatment of big data at a strategic way, f) knowing the problems that to be solved with acquired data. For each prerequisite four possible levels of answers were used L0, L1, L2, L3. Which correspond to "No", "Small", "Medium" and "Complete infrastructure" with respective points assigned to each level.

Similarly, applying such an approach for other prerequisites, the next formula (1) is used to measure the degree of readiness with regards to technology enabler:

$$g_n = \frac{\sum \text{points obtained as a result of evaluation of components of elements } e}{\text{Maximum points possible}} \quad (1)$$

However, to assess the company's readiness degree, it needs to be determined readiness degree regarding all the technology enablers using the formula:

$$D_R = \frac{g_1 + g_2 + g_3 + \dots + g_n}{n} = \frac{\sum_{i=1}^n g_m}{n} \quad (2)$$

Where $g_1, g_2, \dots, g_n$ - degree of readiness of enabling technologies 1, 2...n, respectively. Where $g_1, g_2, \dots, g_n$ -

degree of readiness of enabling technologies 1, 2...n, respectively; n - number of enabling technologies and, D_R - readiness degree of a company towards Industry 4.0. Table I below presents the readiness degree status.

TABLE I. READINESS DEGREE STATUS [1]

Degree of Readiness (D_R) - %	Status	Characteristics of the company
$0 \leq D_R \leq 10$	Embryonic	Some superficial knowledge
$10 \leq D_R \leq 25$	Initial	Some knowledge of some technologies but may not know all of them
$25 \leq D_R \leq 50$	Primary	A good knowledge of all technologies, only some was adopted
$50 \leq D_R \leq 75$	Intermediate	Full knowledge of all technologies and begun to be adopted
$75 \leq D_R \leq 90$	Advanced	Full knowledge of all technologies and have a high degree of adoption
$90 \leq D_R \leq 100$	Ready	Practically all the enabling technologies in full degree of maximum adoption

D. The Acatech Industrie 4.0 Maturity Index framework focused on data analytics

Gürdür [4] in their study employed the Acatech Industrie 4.0 Maturity Index framework to assess Sweden industry. The model focuses on four capabilities: resources, information systems, culture, and organizational structure.

Authors designed the questionnaire which contained 22 questions from Q1 to Q22. The answers for the questions were constructed based on fully agree, agree, neutral, disagree and fully disagree, and some answers based on "yes/no" format. Afterwards, the average of the answers was calculated to assess the readiness level, according to Table II.

This framework is useful for assessing a company's current Industry 4.0 maturity level and identifying measures to achieve a higher maturity level. However, it was used for data analytics of the company.

TABLE II. SCORING RULE [4]

Average Score	Alignment Assessment	Readiness level
0%-20%	Very Low	1
21%-40%	Low	2
41%-60%	Medium	3
61%-80%	High	4
81%-100%	Very High	5

E. Digital transformation of large Kazakhstani organizations

In January of 2017 there was announced the "Digital Kazakhstan" program. This strategic document includes

five directions: digitalization of industries, a transition to a digital state, implementation of digital silk way, creating an innovation ecosystem [16]. Before starting the implementation of the program Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan with the help of foreign experts investigated the current state of the industrial enterprises. As results showed, most of them do not have sufficient technological basis to complete digital transformation [11]. Moreover, it was found out that 60% of mining and 80% of manufacturing companies were at the industry 2.0 level or on the process of automation. In addition, the following main challenges and barriers were identified:

- lack of top management support
- lack of qualified specialists
- lack of financial support enough for digital transformation
- low level of development of telecommunication infrastructure
- lack of understanding the whole benefits of digital transformation
- low level of development of local competencies and technologies [12].

According to the Prime-minister's official website, 13 large mining enterprises planned to implement 58 big projects with 315.4 billion tenge investments. Currently, 20 projects with 88.7 billion investments have already been implemented. Since the project started, the companies have already implemented 14 projects with 7.5 billion tenge investments. As a result, the enterprises receive benefits such as reduction of equipment downtime and resources loss, cutting the costs [11]. Moreover, the government is expecting 2-10% annual productivity, 2,5-5% agricultural and 3% production growth as a result of digital transformation work [14].

The main thing to highlight is that every time the government wanted to assess the current condition of enterprises, they invited experts from foreign institutes such as Fraunhofer ISI (Germany) which is one of the leading companies in the implementation of applied technologies [6]. It is reasonable because there were no companies specialized in the digital transformation of large enterprises. Moreover, still, there are no digital transformation models adapted for local culture and conditions. Additionally, only a few academic works of literature have been published concerning the digital transformation of the economy of the Republic of Kazakhstan. That is why there is an acute need for research in the field.

III. METHODOLOGY

Reviewing different models to identify the digital maturity and readiness of large companies in Kazakhstan, taking into consideration mentality, skills, economy and other factors, it was identified that the model is close to the model developed by Deloitte. The main criteria that model includes are four: strategy, organization and culture,

technology, and operations. Each of them is also divided into sub-criteria presented in Table III. To choose all main and sub-criteria attribute testing method was used.

TABLE III. MODEL CRITERIA

Strategy	Technology	Operations	Organization & Culture
Strategic Management	Network	Business Process management	Culture
Stakeholder Management	Standards automation	Data and Analytics	Digital and Leadership skills
Finance	Technology governance	Resource management	Governance
			Talent Management

The strategy is crucial because it focuses on the changes and modifications of the business to increase its competitiveness, to go through transformations successfully, primarily digital.

The next key factor is technology. It is responsible for doing the business, in this case, more digital to create, develop, process/serve, analyze, and perform at lower expenses for the company to satisfy stakeholders, shareholders and customers

Operations perform business processes and develop it further by applying digital technologies to make business efficient, effective, and successful, through operations, the strategy of business becomes a reality.

Finally, organization and culture play a huge role in the company, because, without the support of the people in the organization and understanding and aspiration of a common goal, the transformation could fail or pass through many challenges. Relying on Table II, the level of readiness can be assessed, giving tangible values.

To assess each factor and its sub-criteria group of questions related to each criterion were developed, and the scale for the answers in the form of from zero to five, some questions contain multiple-choice where scale is absent, depending on the importance of each choice the percentage was assigned. The equations 1 and 2 presented by Pacchini [1] was used to calculate the total value for each question, sub criterion and criterion.

IV. PROBLEM IDENTIFICATION

Digital transformation spans more and more companies in different areas in the world. It aims to use digital technologies and approaches for the essential increase of productivity and worthiness of organizations. The organization's maturity level and readiness model regarding digitalization is a vital aspect to implement a successful digital transformation, and it can differ related to the company size. According to OECD [10], types of

enterprises differ related to the criteria of employee number and financial ceiling; the numbers are presented in Table IV. These numbers play a huge role in the digital transformation process of the company, which was mentioned above in section Methodology. If companies adequately respond to the environment and surrounding changes, they will achieve a higher maturity level, which in turn is a potential to increase capabilities and to improve business processes [2]. Several factors define whether a company is ready for a digital change. The most important are organizational structure, employees' skills and talent, corporate culture, and the digital environment. Therefore, assessment of an organization for digital readiness enables to reveal whether an organization will be successful or not in the result of digital transformation. To identify it, the model described above in the methodology part was developed.

TABLE IV. ENTERPRISE DIFFERENTIATION BY FACTORS [10]

Criteria	SMALL	MEDIUM	LARGE
Employee number	10 – 49	50 – 249	above 250
Financial ceiling (euro)	2 – 10 mln	10 – 50 mln	above 50 mln

V. RESULTS

A. Multiple-case large enterprises

To assess the digital transformation readiness level, a survey was conducted among four large enterprises from aerospace, consultancy, and construction sectors. The European Commission grouped enterprises [10] and large companies are those which have more than 250 employees. The names of the enterprises remain undisclosed; therefore, pseudonyms are used. For the first two companies in aerospace industry A and B, for the audit company C, and construction company D letters are assigned. Two aerospace companies differ in that one is the production and the second is a service company.

B. Company A: Aerospace production enterprise

Activities of the company A include research, design, creation and testing of sophisticated spacecraft, software and space technology. Fig. 1 presents the survey results by four dimensions: Business processes, technology, organization and culture, and strategy.

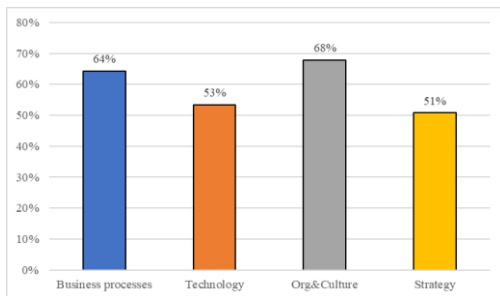


Figure 1. Survey results for Company A by four dimensions

As can be seen from Fig. 1, the company pays more attention to business processes and culture rather than strategy and technology. Each dimension will be discussed in more details.

Business processes. The company has already implemented an ERP system. However, the system is not utilized in its full potential because some data is still collected and stored manually in Excel files. Besides, manufacturing processes are automated at a low level. As a result, high human involvement was observed. Moreover, the main processes are not fully automated.

Technology. The company is using essential technologies such as social networks, web, and mobile apps, chatbots. Surprisingly, there is no unified portal for business units. Moreover, the company does not use technology to increase employee effectiveness. As a result, the survey shows that company A is not well developed in terms of technology.

Organization and culture. The company mostly has an open collective culture. Consequently, employees communicate effectively, externally, and internally. Also, employees have appropriate levels of digital skills. Nevertheless, people are not so open to changes. It might be the consequences of that the company does not coordinate a portfolio of initiatives.

Strategy. The company well understands the need for digital transformation. However, it does not have enough resources, including finance and technology, to perform a digital transformation. Also, it was found out that the company did not share the digital transformation strategy plan with partners and employees in order to revise it according to their feedback. Additionally, the company does not have partners in industry 4.0. All these factors affected the company to be behind the schedule of digital transformation.

Considering all problems and barriers, the company was evaluated as 59% ready for digital transformation.

C. Company B: Aerospace service enterprise

The company B focuses on several services such as providing access to Earth sounding images database and geographic information data, cartography, space monitoring of forest resources, photogrammetry, high precision positioning etc.

As can be seen from Fig. 2, the company mostly focuses on digital transformation strategy and culture rather than technology and business processes.

Business processes. Business processes are the weakest among four dimensions. Even though the company has an ERP system, most of the central business processes are not automated, and high human involvement is observed. Moreover, the current supply chain is poorly integrated because the company communicates with the suppliers and customers only if necessary.

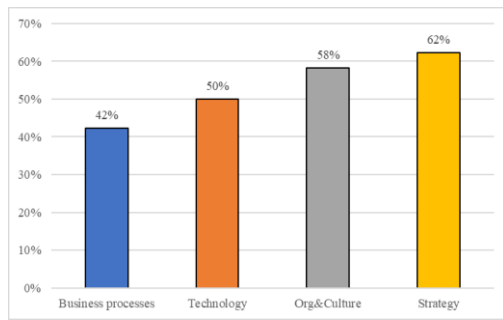


Figure 2. Survey results for Company B by four dimensions

Technology. Regarding technology, the company has the latest technology. However, the employees do not utilize them. Survey results show that the company does not work concerning the use of new technologies to achieve business goals which in turn does not lead to increased productivity and lowering the costs. It might be the consequence of the fact that technology in the aerospace industry is very complicated.

Organization and culture. The culture in the company is not fully open and collective. The current organization model slows down cross-functional collaboration which in turn led to the fact that the employees do not adequately communicate inside and outside of the company.

Strategy. Even though the strategy received the highest grade among other dimensions, it has several problems.

Until the company solves the problems, it will stay at an overall 53% level.

D. Company C: An audit company

The company C provides consultancy services in financial, energy, consumer and industrial goods, telecommunication sectors. The survey results for this company are presented in Fig. 3.

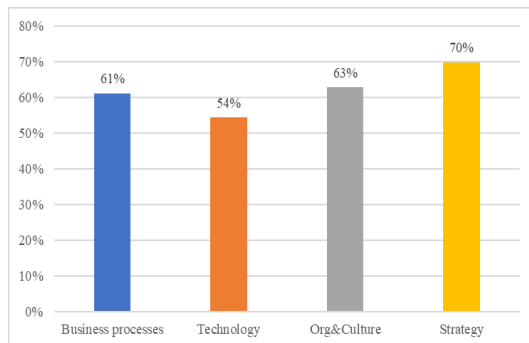


Figure 3. Survey results for Company C by four dimensions

Business processes. The company utilizes an ERP system. However, some data is still collected and stored in Excel files. Moreover, this collected data only used only for quality management. In the whole value chain, high human participation is observed. That is why the traceability of the operations is still at a low level of only 20%. Besides, the main business processes are not fully automated and receive only 47%.

Technology. The state of technology needs to be improved because the employees use only basic things such as social networks, mobile apps, portals and sometimes BI data analytic tools. As stated above, only a few business processes are automated; that is why it does not lead to labor productivity. Moreover, the resistance of employees to new technologies is observed. Also, employees position the company as not innovative.

Organization and culture. The survey results show that the company should work to have an open and collective culture because employees come to the company only for work purposes and do not communicate effectively outside. Moreover, the company should put effort to train employees to use new technology as most of the employees are open to changes.

Strategy. The company well understands the necessity of digital transformation and has all financial and technical resources. However, there is a lack of leadership skills to manage the digital transformation appropriately. Moreover, the digital transformation strategy should be revised based on employees, customers, and feedback from suppliers. All the facts lead the company to be behind schedule.

The company should focus on new technologies to move further. However, according to this framework, the current state of digital transformation is 62%.

E. Company D: A construction company

The company is one of the significant holdings in Kazakhstan employing more than 8000 people. The company builds houses of all levels and bridges, driveways, roads of republican and regional significance, implements complex projects for oil and gas companies. The survey results show the highest level of maturity among all companies (see Fig. 4).

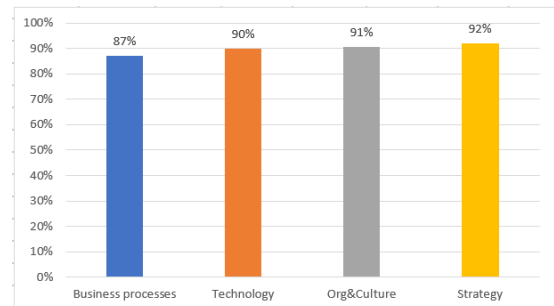


Figure 4. Survey results for Company D by four dimensions

Business processes. The company has all technology to automate business processes and collect data such as enterprise resource planning (ERP), supply chain management (SCM), product data management (PDM), machine data collection (MDC) etc. then data was collected mostly used for forecasting and quality management. The main processes are fully automated except production, which is in the process of transformation.

Technology. The company utilizes all the necessary technologies, including BI and data analytics, cloud computing etc. as well as all business units, are connected via digital platforms. Moreover, the results show that the company is innovative enough to assess and apply new technologies.

Organization and culture. The company has an open and collective culture, so the employees effectively communicate inside and outside of the company. Also, the employees have all the necessary skills to perform a digital transformation. Nevertheless, the company should prioritize customer desires over functional silos.

Strategy. The company has all the necessary resources for digital transformation such as finance, technology, and leadership skills. However, the strategic plan of digital transformation should be given to the employees, clients, and partners to revise it based on their feedback.

Company D showed the highest level of digital maturity with a score of 89%, which indicates that it is ahead of schedule.

VI. CONCLUSION

The project aims to identify the digital readiness levels of Kazakhstan Large companies. The development of the maturity model is based on the literature review, from academic research papers, maturity models developed by world-leading consulting companies such as McKinsey and Deloitte were also considered. To assess the digital readiness of Kazakhstan large four companies were chosen for the survey. Two companies are from the aerospace industry (Companies A and B), one is an audit company (Company C), and the last one is a construction company (Company D).

Through the surveying the employees of the presented companies, it can be concluded that in average large enterprises are on a medium and high levels of digital maturity.

Overall, among the four companies, the Company D showed the highest result that differs a lot as an outlier—considering, Companies A, B, and C the readiness level of Business processes and technology among large companies in a medium level, Organization and Culture and Strategy at a high level. However, these data are not enough to draw the whole picture of the country.

VII. FUTURE RESEARCH

To assess readiness level more accurately, further investigation of readiness of Kazakhstan large companies for digitalization should include the following activities:

1. Carrying out surveying as many companies as possible.
2. Broaden the assessment criteria.
3. Developing the model, respectively, the specification of the company.
4. Developing an action plan for further development on digitalization.

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