









“Digital transformation readiness of Kazakhstani enterprises: Mapping regional and sectoral capacities”

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DIGITAL TRANSFORMATION READINESS OF KAZAKHSTANI ENTERPRISES: MAPPING REGIONAL AND SECTORAL CAPACITIES

Abstract

Digital transformation is a key factor in the competitiveness of enterprises in the modern world. The study aims to analyze the readiness of enterprises in Kazakhstan for digital transformation at the regional and sectoral levels. The main research method was statistical analysis based on an index approach using data for 2023 from Kazakhstan's Bureau of National Statistics, reflecting the digital readiness and digital maturity of enterprises. According to the findings, in Kazakhstan, the level of readiness of enterprises for digital transformation is heterogeneous both in regional and sectoral terms. Kazakhstani enterprises are characterized by a high level of basic digital readiness (81.4% of enterprises had computers, 79.5% – Internet access), an unsatisfactory level of advanced digital readiness (5.6% of enterprises had IT-specialists, 1.1% – own data centers, 3.1% – implemented business processes innovations in information and communication systems), and digital maturity (26.5% of enterprises had Internet resources, electronic invoices – 79.1%, automated internal business processes – 16.7%, cloud computing – 11.0%, big data technologies – 1.9%, and RFID technologies – 1.1%). A digital gap in the readiness of enterprises for digital transformation was revealed between the leading (Almaty and Astana cities, Atyrau, and Karaganda regions) and lagging (Mangystau, Turkestan, and Kyzylorda regions) regions, and between the sectors, where enterprises in industry, trade, information and communication, hospitality and healthcare are significantly ahead of enterprises in agriculture, construction, and real estate. It is advisable to make more active use of innovation infrastructure facilities to increase the digital potential of enterprises.

Keywords

technologies, digital readiness, digital maturity, digital strategy, region, industry

JEL Classification

M15, O32

INTRODUCTION

Digital transformation is an inevitable stage in the development of modern society. Companies and states that actively implement information and communication technologies (ICT) and digital technologies gain a strategic advantage, increasing their competitiveness and efficiency. To survive in the digital economy, traditional companies have to transform themselves with the help of digital technologies (Ismail Abdelaal et al., 2017). For example, many well-known companies that have long served as a benchmark of quality and reliability, such as Nokia (cell phones), Blockbuster (movie distribution), and Kodak (photographic film), quickly lost their position in the market, unable to withstand new competitive conditions (Zettelmann & Cano, 2024). In this regard, digitalization of existing products and business models is a prerequisite not only for survival and maintaining an enterprise's current market position, but also for growth. In an increasingly competitive environment, enterprises must have digital competitive advantages that will accelerate routine processes and increase customer loyalty through convenience and efficiency (Bukanova et al., 2022). Important framework conditions for successful digital transfor-

mation of enterprises (regardless of size) are well-designed legal and regulatory frameworks and quality infrastructure: effective legal regulations can improve the quality and coverage of digital infrastructure, and properly functioning ICT infrastructure will ensure stable deployment of digital technologies in enterprises. At the same time, the adoption of digital technologies by enterprises is unthinkable without open competition in the telecommunications sector and unified government approaches to the development of digital infrastructure (OECD, 2023).

In Kazakhstan, government initiatives such as the State Program “Digital Kazakhstan” (Government Decree of RK, 2017), the Concept of Industrial and Innovative Development of the Republic of Kazakhstan for 2020-2025 (Government Decree of RK, 2021), the Concept of Digital Transformation, Development of the Information and Communication Technologies Industry and Cybersecurity for 2023-2029 (Government Decree of RK, 2023), and the Concept of Artificial Intelligence Development for 2024–2029 (Government Decree of RK, 2024), created the basic conditions for digitalization of the economy and laid the foundation for the development of the digital ecosystem, increasing the level of digital literacy of the population, introducing innovative technologies in enterprises and improving public administration. However, according to QazIndustry (2020), the majority of Kazakhstani enterprises did not have digitalization strategies or had only planned their development. It should be noted that the development of their own digital development strategies and the adaptation of international digital management models to national peculiarities requires an assessment of the readiness of enterprises for digital transformation.

1. LITERATURE REVIEW

In recent years, innovations in digital technology have emerged as a key catalyst for economic development (Fang & Liu, 2024). Amid the swift advancement of information technologies and the widespread adoption of the Internet, digital transformation has influenced all business sectors and has become an integral element of the strategic development of enterprises in various industries (Li et al., 2024; Paul et al., 2024). However, despite the widespread use of the term, there is no unified interpretation of “digital transformation” in the academic and applied literature (Ahlskog et al., 2022). Different researchers interpret it in different ways due to differences in research objectives, subject area, and scale of technology adoption.

Terminology related to digital change in enterprises, namely digitization, digitalization, and digital transformation, is often used synonymously, which causes confusion and requires systematization, although there are fundamental differences between these concepts. For example, digitization is the process of converting analog information into a digital format, while digitalization is a broader process of implementing digital technologies to optimize existing business processes and improve their efficiency, which is impossible

without the digitization of business operations. In contrast to these concepts, digital transformation encompasses fundamental changes in the logic of enterprise operation, including the transformation of business models, organizational culture, and ways of creating value for the customer, characterized by the use of digital technologies and the introduction of structural changes (Buganova et al., 2022). Currently, there are many terms that characterize digital change in enterprises and a variety of approaches to defining “digital transformation” (Table 1).

Digital transformation is not just the introduction of technology but a rethinking of business strategy, business models, business processes, organizational structure, corporate culture, and interactions with customers and competitors to improve operational efficiency, implement innovative business models and strengthen the company’s position in the market (Carvalho et al., 2021; Kaya & Bozbura, 2023; Chen & Shen, 2024). Thus, digital technologies, considered as combinations of information, computing, communication, and networking technologies, in many enterprises spanning different industries and sectors, are fundamentally transforming enterprise capabilities, their inter-firm relationships in extended business networks, their products and services, business

Table 1. Definitions of “digital transformation” in the enterprise context

No.	Author(s)	Definition
1	Liu et al. (2011)	“Integration of digital technologies into business processes”
2	Demirkan et al. (2016)	“Profound and accelerating transformation of business activities, processes, competencies, and models to fully leverage the changes and opportunities brought by digital technologies and their impact across society in a strategic and prioritized way”
3	Vial (2019)	1. “Process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” 2. “Process wherein organizations respond to changes taking place in their environment by using digital technologies to alter their value creation processes”
4	Tang (2021)	“Type of Business Transformation that is driven by emerging technologies (Social media, Mobility, Internet of things (IoT), Cybersecurity, Big data & Analytics, Cloud computing, Robotic process automation (RPA), Artificial intelligence (namely Machine Learning), Blockchain, and so forth)”
5	Lozić and Fotova Čiković (2024)	“A continuous process that leads to greater business efficiency using advanced IT technologies.”

strategies, and business processes (Bharadwaj et al., 2013). The use of such technologies along with changes in value creation, structural changes, and financial aspects are dimensions of digital transformation strategies as operational strategy (markets, products, processes) and functional strategy (human resources, finance, IT) (Matt et al., 2015). Developing a digital strategy is necessary for the successful digital transformation of an enterprise, which is a process with high uncertainty and risk for the enterprise (Gobble, 2018; Wu et al., 2024).

The concept of digital transformation is closely related to concepts such as digital readiness and digital maturity. In some studies, the concepts of “readiness” and “maturity” are considered equivalent. However, digital readiness and digital maturity are two related but different concepts used in assessing an enterprise’s digital transformation. Thus, digital readiness represents the ability of an enterprise to adopt and integrate digital technologies into its operations, strategies, and culture, while digital maturity refers to the current state of an enterprise, describing the extent to which digital technologies are integrated and optimized into its processes (Chounta et al., 2024). The difference between the two concepts is that readiness models clarify whether an enterprise is ready to start the development process or not, while maturity models show what level of maturity the enterprise is at (Akdil et al., 2017). It should be noted that large enterprises have a higher level of digital readiness and maturity than small and medium enterprises, while micro enterprises demonstrate a significant degree of digitalization. At the sectoral level, enterprises in sectors such as communications, engineering and architecture, manufacturing, energy,

retail, and finance have high levels of digitalization (Ribeiro-Navarrete et al., 2023). Therefore, enterprises need to assess their current level of digital readiness and digital maturity to effectively navigate digital transformation and develop an appropriate strategic roadmap (De Carolis et al., 2025).

Digital readiness indicates the state of an enterprise preparing for digitalization. It is considered under several concepts: information technology; technological, organizational, and environmental framework; operational technology; industrial internet of things; and unified theory of acceptance and use of technology. Critical success factors to assess the digital readiness of an enterprise include digital agents and skills, digital tools and applications, digital systems and infrastructure, and digital ecosystem and culture (Soomro et al., 2020). One classification of enterprises by levels of digital readiness includes “Outsiders” with no signs of digitalization, “Novice” with pilot projects, “Survival” with automation and plans for digitalization, and “Professionals” with integrated, intelligent solutions and high levels of digital maturity (Faisal et al., 2024).

Digital maturity reflects the level of development of digital processes, technologies, and organizational culture within enterprises, as well as the degree of integration of technology into business models and management processes, i.e., it represents the status of its digital transformation (Teichert, 2019). There are several levels of maturity, which can be categorized in different ways. For example, initial, managed, defined, quantitatively managed, and optimizing (Proença & Borbinha, 2016) or in-

Table 2. Comparative characterization of the concepts of “digital readiness” and “digital maturity”

Criteria	Digital readiness	Digital maturity
Focus	Preparation for digitalization, potential for digital change, and assessment of starting conditions.	Current level of technology adoption and use, level of digitalization, depth of technology adoption.
Purpose	Assessment of the entity’s readiness for digital transformation.	Assessment of the use of digital technologies.
Component	Availability of technologies, human resource competencies, regulatory framework, and financing.	Integration of digital processes, culture of innovation, and effectiveness of the use of digital solutions.
Stage of transformation	Initial stage – planning and preparation.	Advanced stage – implementation and continuous development of digital solutions.
Assessment metric	Internet access, digital literacy, and level of investment in ICT.	Automation of business processes, use of digital technologies, and degree of data integration.

complete, performed, managed, established, predictable, and optimizing (Haryanti et al., 2023). There are seven interrelated dimensions to determine the digital maturity of an enterprise: culture, customer, employee, organization structure, strategy, technology, and transformation process (Haryanti et al., 2023). Digital maturity can also be measured using various indicators, including digital skills and technology application, digital orientation, digital vision, digital management intensity, digital business process, digital innovation performance, environmental performance, digital management, and departmental agility (Ribeiro-Navarrete et al., 2023).

Based on the above, there are key parameters that distinguish digital readiness and digital maturity (Table 2).

Thus, based on the literature review, digital transformation is characterized by digital readiness and digital maturity. Digital readiness represents the initial stage of digital transformation, determining an enterprise’s potential for digital development, while digital maturity reflects the outcome of successful implementation of digital technologies. High digital maturity means that an entity is not only ready for change, but also successfully applies digital tools in its activities. In this regard, to identify the readiness of enterprises for digital transformation, indicators on the availability and use of various ICTs can be analyzed to reflect the level of digital readiness and digital maturity of the enterprise, respectively. The purpose of this study is to analyze the readiness of enterprises in Kazakhstan for digital transformation at the regional and sectoral levels. The following hypotheses were put forward:

H1. Kazakhstan has an average level of digital readiness of enterprises.

H2. Kazakhstan has a low level of digital maturity of enterprises.

2. METHOD

The main research method was statistical analysis based on the index approach with the use of secondary data reflecting digital readiness and digital maturity of enterprises. This study employs a two-stage approach to analyze distinguishes between digital readiness – the potential for digital development, and digital maturity – the use of digital technologies in enterprise operations:

- Stage 1 measures digital readiness in two tiers: basic readiness includes access to ICT infrastructure (computers, internet), and advanced readiness reflects the availability of other main resources (ICT specialists, innovations of business processes in ICT, expenditures on ICT).
- Stage 2 measures digital maturity based on the extent to which enterprises integrate ICTs into business processes (internet resource, automated internal business processes, RFID technologies, electronic invoices, cloud computing, big data analytics, e-commerce).

Calculations were performed at both the regional and sectoral levels, which also determines the novelty of this study. Together, these stages provide a comprehensive picture of the digital transformation landscape, helping to identify both leaders and lagging regions or sectors in Kazakhstan.

Indicators – indices – were calculated as a percentage ratio: the number of enterprises that have (internet, computers, etc.) or use relevant ICT (cloud technologies, big data, automation, etc.) was divided by the total number of reporting enterprises. These indices reflect the level of digital readiness and digital maturity, respectively, for identifying the levels of digital readiness and digital maturity of enterprises. The final value of this indicator, the index, is interpreted according to a letter and numerical scale (Table 3).

Table 3. Letter-based and numeric rating scale of index interpretation

Class	Value	Interpretation
A	From 70 to 100	High level
B	From 40 to 70	Medium level
C	From 10 to 40	Low level
D	From 0 to 10	Unsatisfactory level

The source base of the study was the bulletins of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan “On the use of information and communication technologies (ICT) in the enterprises of the Republic of Kazakhstan” (series 10 “Statistics of information and communication technologies and communications”) (BNS, 2024a) and “On innovation activity of enterprises in the Republic of Kazakhstan” (series 19 “Innovation Statistics”) (BNS, 2024b) for 2023. A limitation of the study was the unavailability of data for 2024, as well as the lack of disaggregation by enterprise size.

Cross-sectional data on the availability and use of ICT by enterprises were chosen for several reasons. Firstly, since 2022, data are no longer collected for activity 84 (public administration) according to the General Classifier of Economic Activities. Due to the reform in statistical reporting and accounting methodology, there has been a structural break and a loss of comparability across periods. Secondly, the analysis explicitly excludes public administration. Thirdly, the number of surveyed enterprises varies from year to year, indicating differences in the sampling structure across periods. In the tables, the conventional designation “-” shows that the phenomenon is absent, i.e., the value is zero, and “x” – the data are confidential. The data were analyzed through MS Excel software.

3. RESULTS

In 2023, among 152,658 reported enterprises, the majority, 81.4%, had computers, including 79.5% with access to the Internet. It should be noted that the enterprises of Astana city and Karaganda region have more than 90% of such enterprises. In contrast, in Abay, Kyzylorda, and West-Kazakhstan regions, such enterprises are slightly more than 60%. The number of computers available at the enterprises amounted to 1,116,642 units, of which 91.7% were connected to the Internet. These figures indicate a high level of basic digital readiness of Kazakhstani enterprises, as the availability of ICT infrastructure is one of the important conditions and factors for digital transformation. However, in the recalculation of the number of computers on average per enterprise, this indicator amounted to 7 units per enterprise, which is insufficient for the technological breakthrough of the enterprise. The situation is aggravated by the fact that only 5.6% of enterprises in Kazakhstan have ICT specialists, which indicates a shortage of specialists able to support and develop digital services in the field. The highest share of enterprises with ICT specialists is in Astana city (8.4%) and Atyrau region (7.6%), which is unsatisfactory. The lowest share is in Turkestan (2.2%), East Kazakhstan (2.5%) regions and Shymkent city (3.0%). It should be noted that in 14 out of 20 regions of the country, the value of this indicator is below the national average. Moreover, Kazakhstani enterprises practically do not have their own data centers. The percentage of enterprises that have implemented innovations in business processes in information and communication systems is very low – only 3.1%. The highest rate was recorded in Astana city – 11.1%. Despite a fairly high level of ICT costs at the enterprises of the republic in 918,349.9 million tenge, in recalculation per enterprise, they amounted to 6.016 million tenge, which is insignificant for technological and digital modernization of the enterprise. At the same time, 82.3% of these costs in the amount of 755,749.6 million tenge fall on the enterprises of three regions – Astana and Almaty cities, and Atyrau region (Table 4).

In the sectoral breakdown, three-quarters of ICT costs, amounting to 693,022.4 million tenge, were incurred in three areas: “Information and com-

Table 4. Indicators of digital readiness of enterprises of Kazakhstan by regions, 2023

Region	Number of reported enterprises, units	of them, %					Enterprises that have implemented innovations of business processes in information and communication systems, %	Expenditures on ICT, mln tenge		Availability of ICT facilities, units		
		using computers	having access to the Internet	having ICT specialists	having their own data centers	total		on average per one enterprise	number of computers	of them connected to the Internet, %	on average per one enterprise	
Kazakhstan	152,658	81.4	79.5	5.6	0.3	3.1	918,349.9	6.016	1116642	91.7	7	
Abay	2418	63.2	61.0	5.2	0.2	0.3	4,680.8	1.936	19,360	90.5	8	
Akmola	5,075	86.0	84.3	4.2	0.0	2.3	5,039.3	0.993	32,415	89.8	6	
Aktobe	6,005	69.6	67.0	4.6	0.1	0.7	11,084.6	1.846	38,379	85.1	6	
Almaty	5,247	70.1	69.1	3.4	0.1	3.4	12,464.0	2.375	34,370	94.9	7	
Atyrau	4,169	74.9	72.6	7.6	0.4	1.0	109,973.4	26.379	55,337	91.1	13	
West Kazakhstan	4,391	63.0	61.4	5.6	0.1	0.2	18,021.2	4.104	30,230	91.7	7	
Zhambyl	3,110	81.4	77.5	5.3	0.3	0.7	3,692.7	1.187	24,291	84.7	8	
Zhetysu	2,083	70.7	69.6	4.9	1.2	1.4	2,973.1	1.427	13,479	86.5	6	
Karaganda	8,706	93.6	93.1	5.5	0.0	3.5	17,173.0	1.973	72,340	89.9	8	
Kostanay	5,916	75.8	74.3	5.5	0.1	1.1	9,230.0	1.560	42,184	93.5	7	
Kyzylorda	2,621	66.1	60.7	5.8	0.3	0.3	4,520.9	1.725	21,274	88.6	8	
Mangystau	4,670	64.3	64.2	3.6	0.1	0.4	7,377.2	1.580	34,556	91.7	7	
Pavlodar	6,172	68.3	64.9	4.9	0.5	2.9	23,460.2	3.801	47,882	86.7	8	
North Kazakhstan	4,132	77.5	76.2	4.1	0.2	0.5	2,446.4	0.592	23,977	85.4	6	
Turkestan	4,457	86.4	85.4	2.2	-	1.1	5,255.6	1.179	27,067	93.9	6	
Ulytau	768	79.7	78.4	6.9	0.1	1.6	6,629.1	8.632	14,537	81.4	19	
East Kazakhstan	5,716	71.3	69.6	2.5	0.4	1.6	24,215.6	4.236	44,778	89.3	8	
Astana city	26,673	98.9	97.3	8.4	0.1	11.1	446,804.3	16.751	176,780	91.1	7	
Almaty city	43,316	81.5	79.6	5.9	0.6	1.8	198,971.9	4.593	321,372	95.7	7	
Shymkent city	7,013	80.5	77.3	3.0	0.1	4.3	4,336.6	0.618	42,034	91.9	6	

munication”, “Trade and repair of cars and motorcycles”, and “Mining and quarrying”. It should be noted that the highest ICT costs per enterprise on average were in the mining industry (74.406 million tenge) and information and communication (60.673 million tenge), the lowest – in the enterprises of pollution elimination (0.21 million tenge), agriculture, forestry and fisheries (0.342 million tenge), financial and insurance activities (0.548 million tenge) and real estate (0.552 million tenge). A high level of basic digital readiness was observed in the hotel sector (temporary accommodation services), 93.8% of enterprises have computers, and 92.6% of them have an Internet connection. The lowest indicator was observed in the enterprises of agriculture, forestry, and fishery (65.1% of enterprises have computers, of which 63.3% have Internet connection) and financial and insurance activities (60.0% and 52.0%, respectively). On average, these two sectors have 2 computers per enterprise, whereas there are 40 computers per enterprise in mining, 39 in electricity supply,

and 31 in health care. It should also be noted that only 1-2% of information and communication (1.6%), electricity supply (1.4%), and mining (1.1%) enterprises have their own data centers. In all other sectors, this indicator is below 1%, and in 7 out of 22 sectors of the economy, they are absent. In most sectors of the economy, the share of enterprises with ICT staff remains very low (between 0% to 14.5%), except for information and communication, where nearly half of the enterprises (47.9%) keep ICT specialists on staff. The lowest percentage of enterprises with ICT specialists is in the food and beverages (1.2%), agriculture, forestry and fisheries (1.3%), and real estate (1.4%) sectors (Table 5).

Only a little more than a quarter of enterprises in Kazakhstan (26.5%) have their own Internet resources. It should be noted that e-commerce is not widely developed and is mainly concentrated in enterprises located in metropolitan areas and the Atyrau region. At the same time, 10.7%

Table 5. Indicators of digital readiness of enterprises of Kazakhstan by type of activity, 2023

Type of economic activity	Number of reported enterprises, units	of them, %				Expenditures on ICT, mln tenge		Availability of ICT facilities, units		
		using computers	having access to the Internet	having ICT specialists	having their own data centers	total	on average per one enterprise	number of computers	of them connected to the Internet, %	on average per one enterprise
Total	152,658	81.4	79.5	5.6	0.3	918,349.9	6.016	1,116,642	91.7	7
Agriculture, forestry and fisheries	8,114	65.1	63.3	1.3	-	2,777.4	0.342	15,973	92.3	2
Mining and quarrying industry	1,613	81.3	78.7	12.1	1.1	120,017.5	74.406	64,510	89.4	40
Processing industry	10,256	86.8	84.6	6.4	0.5	74,964.2	7.309	123,804	89.5	12
Supply of electricity, gas, steam, hot water and conditioned air	834	89.8	88.8	14.5	1.4	13,938.9	16.713	32,938	81.6	39
Water collection, treatment and distribution	347	87.6	87.0	11.0	0.3	551.1	1.588	5,979	88.3	17
Wastewater collection and treatment	50	88.0	88.0	8.0	-	19.0	0.380	348	98.3	7
Waste collection, treatment and disposal; recycling/ recovery of materials	720	80.7	78.5	4.0	-	302.4	0.420	2,808	94.9	4
Pollution remediation	42	73.8	73.8	-	-	8.8	0.210	110	97.3	3
Construction	17,872	78.5	75.9	2.2	0.2	12,380.2	0.693	66,216	93.5	4
Trade and repair of automobiles and motorcycles	48,495	81.9	81.2	2.5	0.1	129,603.2	2.673	247,597	96.8	5
Transport and warehousing	8,201	83.1	80.7	4.7	0.4	36,540.9	4.456	92,392	77.1	11
Temporary accommodation services	779	93.8	92.6	6.2	0.6	1,058.3	1.359	5,871	96.0	8
Food and beverage services	3,255	80.7	78.4	1.2	0.1	5,422.2	1.666	9,631	93.4	3
Information and communication	7,308	88.2	86.8	47.9	1.6	443,401.7	60.673	93,623	92.8	13
Financial and insurance activities	25	60.0	52.0	-	-	13.7	0.548	54	87.0	2
Real estate transactions	10,282	73.3	70.7	1.4	0.1	5,672.7	0.552	22,775	94.3	2
Professional, scientific and technical activities	14,609	88.8	85.7	3.7	0.4	40,943.1	2.803	105,176	91.2	7
Administrative and support services	11,581	79.2	76.8	2.0	0.1	11,107.5	0.959	34,609	94.5	3
Health care	5,719	84.5	82.2	12.7	0.8	14,693.7	2.569	178,984	94.8	31
Sport	758	86.5	84.6	5.9	x	893.1	1.178	3,593	88.8	5
Recreation and entertainment	1,309	83.7	78.4	3.7	-	3,367.2	2.572	7,969	78.8	6
Repair of computers and communications equipment	489	88.5	86.1	12.5	-	673.2	1.377	1,682	97.5	3

Table 6. Indicators of digital maturity of enterprises in Kazakhstan by region, 2023

Region	Number of reported enterprises, units	of them having and/or using, %						of them trading via the Internet, %	
		Internet resource	automated internal business processes	RFID technologies	electronic invoices	cloud computing	big data analytics	receiving orders	ordering
Kazakhstan	152,658	26.5	16.7	1.1	79.1	11.0	1.9	10.7	12.9
Abay	2,418	20.3	9.6	0.8	65.4	4.8	1.4	2.6	1.7
Akmola	5,075	22.1	21.0	1.1	87.7	8.1	1.9	3.4	4.7
Aktobe	6,005	4.7	3.9	0.7	73.0	10.2	0.3	2.1	11.2
Almaty	5,247	5.7	4.6	0.8	68.5	3.7	0.5	1.2	1.4
Atyrau	4,169	16.0	23.0	2.0	74.8	10.5	2.0	13.0	11.8
West Kazakhstan	4,391	19.6	4.0	2.3	65.3	5.8	1.3	4.7	8.2
Zhambyl	3,110	10.5	16.6	1.5	80.8	4.6	0.7	1.0	3.8
Zhetysu	2,083	31.2	13.7	1.2	67.1	4.9	2.1	1.4	3.3
Karaganda	8,706	42.2	27.1	1.6	89.9	13.8	0.2	8.9	12.2
Kostanay	5,916	25.5	21.9	1.7	80.4	5.4	0.0	4.8	7.7
Kyzylorda	2,621	23.5	11.0	1.2	63.0	2.4	2.3	0.5	7.6
Mangystau	4,670	4.8	8.8	0.4	61.3	1.5	0.4	0.3	7.2
Pavlodar	6,172	27.9	17.4	0.9	70.4	7.1	2.5	8.0	9.2
North Kazakhstan	4,132	8.6	8.6	3.2	84.6	8.3	0.1	1.7	2.3
Turkestan	4,457	7.3	3.7	0.7	54.8	1.4	0.4	2.6	2.6
Ulytau	768	33.6	16.7	2.3	78.6	10.3	2.0	9.8	10.4
East Kazakhstan	5,716	30.5	2.9	0.8	78.6	10.7	0.4	4.3	12.7
Astana city	26,673	23.9	11.0	0.3	87.3	14.3	1.3	15.4	19.0
Almaty city	43,316	38.1	26.6	1.1	81.6	16.1	4.0	18.7	19.1
Shymkent city	7,013	33.6	14.8	1.2	80.9	6.4	2.2	10.4	8.7

of enterprises accept orders via the Internet, and 12.9% - order goods and services online, mainly enterprises of Almaty and Astana cities. The most common element of digitalization of Kazakhstani enterprises is electronic invoices. They are used by 79.1% of enterprises. However, only 16.7% of enterprises have automated internal business processes, and 11.0% use cloud computing. Critically low level of use of big data technologies (1.9%) and Radio Frequency Identification (RFID) (1.1%) (Table 6).

The level of utilization of electronic invoices in industrialized regions is between 80 and 90%. The lowest level of their use is in the Turkestan region (54.8%). The use of electronic invoices is one of the most “digitized” business processes. However, the automation of internal business processes and the introduction of more sophisticated technologies at Kazakhstani enterprises are at a low level. Thus, process automation reaches or exceeds 20% primarily in Akmola, Kostanay, Atyrau, Karaganda regions, and Almaty city. While at the enterprises of East Kazakhstan re-

gion, only 2.9% of enterprises have such automatization in place. Cloud services and big data analysis are mainly used by enterprises in large metropolitan areas and industrialized regions. In the southern and western regions of Kazakhstan (except Atyrau region), the penetration of these technologies remains in its infancy. It should be noted that RFID is a niche technology that is in demand in logistics, industry and large-scale retail. However, its use remains low, even at enterprises in leading regions.

The availability of their own Internet resource is significantly higher at the enterprises of industrially developed regions, as well as in cities of republican significance. However, the enterprises of Aktobe, Mangystau, Almaty, North-Kazakhstan, and Turkestan regions did not reach the national average. The availability of Internet resources directly influences the e-commerce capabilities of enterprises, especially in receiving orders for their goods and services. It should be noted that the percentage of enterprises ordering goods and services is higher

than the percentage of enterprises receiving them in almost all regions. High activity in online trade (both in sales and purchases) is characteristic of enterprises in metropolitan areas (Almaty and Astana cities) and some industrial regions (Karaganda, Atyrau, Ulytau, and East Kazakhstan regions). In a number of regions, the percentage of companies operating through online stores, platforms, and marketplaces remains extremely low.

Online sales and online purchases are most developed at enterprises in the sphere of temporary accommodation and food and beverage services, information and communication, health care, trade,

sports, processing industry and professional, scientific and technical activities. In contrast, traditional industries (agriculture, mining, utilities, real estate) are poorly involved in e-commerce and remain in the offline segment. It should be noted that the availability of Internet resources has the same sectoral pattern (Table 7).

A high level of business processes automation is observed in enterprises of information and communication, industry, trade, public utilities, as well as transport and warehousing. At the enterprises of agriculture, forestry and fishery, and organizations of financial and insurance activities, the lev-

Table 7. Indicators of digital maturity of enterprises in Kazakhstan by type of activity, 2023

Type of activity	Number of reported enterprises, units	of them having and/or using, %						of them trading via the Internet, %	
		Internet resource	automated internal business processes	RFID technologies	electronic invoices	cloud computing	big data analytics	receiving orders	ordering
Total	152,658	26.5	16.7	1.1	79.1	11.0	1.9	10.7	12.9
Agriculture, forestry and fisheries	8,114	9.1	5.6	0.8	56.7	3.4	0.4	0.8	2.0
Mining and quarrying industry	1,613	23.4	19.5	3.3	83.0	12.6	2.6	3.5	8.3
Processing industry	10,256	33.3	21.5	1.5	86.5	11.6	2.2	10.6	15.0
Supply of electricity, gas, steam, hot water and conditioned air	834	30.7	26.0	3.0	86.8	13.3	3.0	6.7	12.7
Water collection, treatment and distribution	347	24.8	13.8	2.9	81.6	11.8	2.6	4.6	7.5
Wastewater collection and treatment	50	16.0	20.0	-	100.0	14.0	8.0	8.0	12.0
Waste collection, treatment and disposal; recycling/recovery of materials	720	20.1	10.3	0.8	82.9	8.3	1.1	4.4	6.7
Pollution remediation	42	14.3	14.3	-	61.9	4.8	4.8	4.8	4.8
Construction	17,872	21.1	11.3	0.3	80.5	9.7	1.3	5.8	9.5
Trade and repair of automobiles and motorcycles	48,495	27.1	19.7	1.1	81.6	12.5	2.5	15.4	16.4
Transport and warehousing	8,201	27.4	19.9	1.6	83.6	13.1	2.8	9.8	13.0
Temporary accommodation services	779	36.1	15.4	1.9	89.9	7.4	2.4	28.9	19.5
Food and beverage services	3,255	24.5	12.6	-	72.0	10.0	0.3	13.8	11.7
Information and communication	7,308	37.7	26.3	1.8	83.8	20.9	4.3	12.8	17.9
Financial and insurance activities	25	4.0	8.0	-	48.0	4.0	-	-	-
Real estate transactions	10,282	22.2	10.8	0.7	68.0	4.8	0.4	4.6	8.1
Professional, scientific and technical activities	14,609	31.1	18.5	1.0	83.5	11.5	1.8	11.0	12.8
Administrative and support services	11,581	23.2	11.5	1.2	76.4	9.1	0.8	8.8	9.8
Health care	5,719	38.7	17.7	1.2	71.9	10.5	2.6	11.6	15.3
Sport	758	29.8	17.2	3.2	82.2	9.0	1.8	10.7	11.3
Recreation and entertainment	1,309	22.0	9.3	0.8	75.0	6.6	0.3	8.9	11.9
Repair of computers and communications equipment	489	26.2	11.7	0.8	88.8	12.1	-	14.5	24.7

el is much lower, which can be explained either by limited resources or lack of need for deep automation. Despite the widespread use of electronic invoices among Kazakhstani enterprises overall, the share remains moderate in certain sectors, namely, in the organizations of financial and insurance activity (48.0%) and enterprises of agriculture, forestry and fishery (56.7%), pollution elimination (61.9%), and real estate (68.0%).

RFID technology is more in demand by enterprises in mining and quarrying (3.3%), sports (3.2%), electricity, gas, steam, hot water and conditioned air supply (3.0%), water collection, treatment, and distribution (2.9%). In most other sectors, the share of enterprises using this technology does not exceed 1-2%, and in some sectors, it is absent altogether. The number of enterprises using cloud computing is much higher than the number of enterprises using big data analysis. The latter technologies are mainly used by enterprises of the information and communication sector and public utilities. Cloud solutions are also typical for these enterprises, as well as transportation and trade. The lowest level of use of both digital technologies is in the enterprises of agriculture, forestry and fisheries, and those related to recreation and entertainment.

It should be noted that, according to data for 793 large and medium-sized enterprises in the manufacturing sector, only 130 enterprises (16.4%) used digital technologies. The highest percentage of use of digital technologies was observed in the Atyrau

region, 33.3%, Astana city, 29.5%, and Aktobe region, 25.6%, the lowest ones are in Zhetysu, Turkestan, and North-Kazakhstan regions – 4.5%, 5.6%, and 9.1%, respectively (Figure 1).

The analysis of readiness of Kazakhstani enterprises for digital transformation revealed that Kazakhstani enterprises are characterized by a high level of basic digital readiness, i.e., the critical infrastructure (network and basic workplaces) is generally already formed. In contrast, the implementation of advanced digital solutions (ICT specialists, own data centers, business process innovation) is at a very low (unsatisfactory) level. The use of digital technologies in large and medium-sized manufacturing enterprises is also limited. Overall, the digital maturity of enterprises in Kazakhstan is characterized as low and unsatisfactory. The use of electronic invoices is widespread, but the introduction of advanced technologies is developing pointwise and heterogeneously. There are quite pronounced sectoral and regional disparities, indicating the presence of digital inequality. Readiness for digital transformation is higher at enterprises in cities of national significance and highly industrialized regions, as well as at enterprises operating in information and communication, industry, trade, and health care.

4. DISCUSSION

According to the findings, the enterprises of Kazakhstan have overcome the “threshold” of basic digital readiness and are characterized by

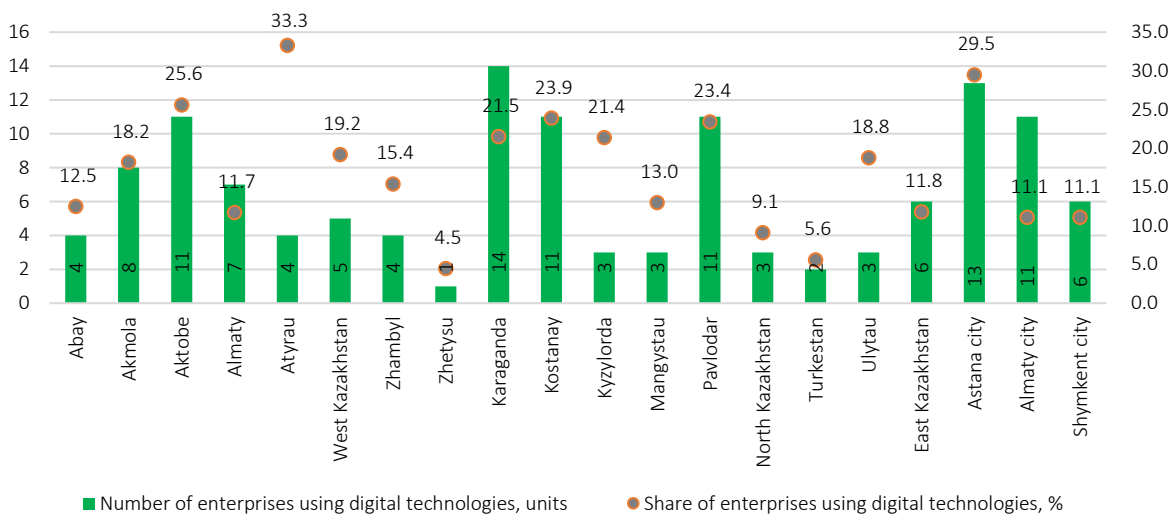


Figure 1. Indicators of large and medium-sized enterprises of Kazakhstan in the manufacturing industry on the use of digital technologies, 2023

a high level of their development. However, the level of advanced digital readiness, in terms of attracting competent specialists and the development of internal ICT infrastructure, remains extremely low outside a few of the most advanced regions and cities of republican significance. Digital transformation of the business processes of Kazakhstani enterprises remains at the initial stage. Kazakhstani enterprises face the challenge of transition from simply providing the “base” (computer and Internet) to a deeper digital transformation, requiring specialized personnel, sufficient funding, and systematic implementation of innovations and digital technologies, which affects the level of digital maturity of enterprises, which in Kazakhstan is characterized as low.

The results of the study are supported by earlier research findings. According to studies by Kazakhstani authors, most enterprises in various sectors of the economy face significant challenges in adopting digital technologies (Kazybayeva & Pak, 2021). The main barriers to the digital transformation of Kazakhstani enterprises, both large and small, primarily include limited understanding of its necessity, the absence of a digital strategy, as well as insufficient financial support, weak organizational culture, underdeveloped level of telecommunications infrastructure and technologies, a shortage of qualified specialists, and a low level of local competencies (Almasbekkyzy et al., 2021; Yezhebay et al., 2021). Computer literacy has a strong impact on multifactor productivity in Kazakhstani regions, except of Zhambyl, West Kazakhstan, and Kyzylorda regions (Kireyeva et al., 2022a), but enterprises in Kazakhstan, especially small and medium ones, face a lack of personnel with appropriate ICT skills and IT specialists, which negatively impacts businesses management and adoption of digital tools in their operations (Makasheva & Tussupova, 2021). The shortage of IT specialists in all Kazakhstani regions' enterprises is also confirmed by the findings of this study. Therefore, it is necessary to increase intellectual potential in the field of ICT through the development of domestic digital educational platforms, information systems for the ministries, and the establishment of digital situational centers to enhance ICT infrastructure (Kangalakova et al., 2023). One promising solution is the development of regional IT-hubs as an object of innovation infrastructure, in particular increasing access to their educational courses on various ICT and digi-

tal technologies for ICT learning of local population, especially in remote and rural regions, and specialists in traditional sectors of the economy (Huggins & Izushi, 2002), paying special attention to the training of the Chief Digital Officers (Furjan et al., 2020).

It should be noted that in the context of digital transformation, the modernization of existing infrastructure components of the national innovation system and the development of new ones are essential to support emerging industries and facilitate the transfer of advanced technology (Satpayeva, 2017), including information and communication and digital ones. An important source of knowledge spillovers and technology transfers for firms can be participation in international trade (Montalbano et al., 2016). So, it is important to develop internet resources (website, digital platform, etc.) and e-commerce for enterprises, and develop the technology transfer offices and international centers of technology transfer, especially ICT and digital technologies, for the government as a tool of business support in the context of digital transformation. In this regard, cloud technologies are an important area for technology transfer or their own development in the country, as the absence of their own data centers in Kazakhstan's enterprises may indicate that they prefer to either do without large data centers or use external cloud solutions.

The results of this study confirm the findings of Kireyeva et al. (2022b), namely that most ICT expenditures are concentrated in Astana and Almaty cities, which are characterized by advanced ICT infrastructure and full ICT ecosystems. Thus, the highest ICT costs are concentrated in Almaty and Astana cities, and the Atyrau region. At the same time, enterprises of the Atyrau region and Astana city invest many times more per enterprise than the enterprises of other regions, which can be associated with sectoral specifics (oil and gas industry, large corporations) and the administrative status of the capital. In a number of other regions, ICT expenditures per enterprise are extremely low, which hinders the development of more advanced forms of digitalization. A high level of ICT investment is observed in sectors that require sophisticated automation and data processing systems (mining, utilities, information and communication), while in traditional sectors (agriculture, real estate), ICT investment is low. To finance innovative ICT projects and the digitalization of traditional sec-

tors, it is essential to support the development of venture capital financing and the expansion of crowd-funding opportunities (Dos Santos et al., 2011; Štofa & Dráb, 2022; Girang Permata Gusti, 2023).

Digital transformation, namely the systematic introduction of digital innovations and digitalization of business processes, is a key strategic priority and important task not only for an individual enterprise, but also for enterprises in the country as a whole (Kraus et al., 2022), including taking into account regional and sectoral specificities. Thus, the enterprises of Almaty and Astana cities, as well as Atyrau and Karaganda regions, can be attributed to the number of regional leaders in terms of readiness for digital transformation, while the enterprises of Mangystau, Turkestan, and Kyzylorda regions – to the number of regional laggards. The sectoral leaders in Kazakhstan include enterprises in industry, trade, information and communication, and hospitality, which aligns with the results of the study by Ribeiro-Navarrete et al. (2023), and the sectoral outsiders include enterprises in agri-

culture, forestry and fisheries, construction, and real estate. Since innovation infrastructure is an important determinant of innovation in the ICT industry (Zhu et al., 2023), it is recommended to leverage the resources and capacities of existing innovation clusters to reduce regional and sectoral digital divides. This includes the “Alatau” Technological Innovation Park, regional IT hubs led by “Astana Hub”, venture funds, business incubators, accelerators, technology parks, industrial and special economic zones. Establishing new platforms and services focused on digital solutions in various regions of the country should be prioritized, particularly for industries with low levels of digital readiness and digital maturity.

Thus, the effective use of the innovation infrastructure provides a comprehensive solution aimed at bridging the digital divide between leading and lagging regions and industries, and provides foundations for sustainable growth of the digital potential of Kazakhstani enterprises and increasing their readiness for digital transformation.

CONCLUSION

The purpose of this study was to analyze the readiness of enterprises in Kazakhstan for digital transformation at the regional and sectoral levels. The analysis has shown that the level of enterprise readiness for digital transformation is heterogeneous both at the regional and sectoral levels. Kazakhstani enterprises have a low level of both digital readiness and digital maturity. Despite the availability of basic infrastructure and a high degree of penetration of information and communication technologies (computers and the Internet), key problems remain, such as the lack of qualified ICT specialists, limited investment in digitalization, and a low level of integration of digital solutions into business processes.

Against the background of low indicators of enterprises’ digital readiness and digital maturity at the regional and sectoral levels, the digital divide in enterprise readiness for digital transformation was revealed. Among regional leaders are the enterprises of Almaty and Astana cities, Atyrau and Karaganda regions, and among the regional outsiders are the enterprises of Mangystau, Turkestan, and Kyzylorda regions. The level of readiness for digital transformation is much higher at enterprises in industry, trade, information and communications, and hospitality than at enterprises in agriculture, forestry, fisheries, construction, and real estate. Reducing the digital divide and increasing the digital potential of Kazakhstani enterprises can be facilitated by utilizing the capacities of existing local innovation infrastructure facilities and creating new facilities for the development of emerging industries and new technologies.

Further research could adopt a mixed-method approach, integrating surveys and in-depth interviews with enterprise leaders to assess and evaluate digital readiness and digital maturity at the firm level. Such research could also examine the adoption of ICT and AI-driven solutions, evaluate organizational readiness for human-machine collaboration, incorporate cybersecurity and data ethics, and thus tailor digitalization strategy to each enterprise’s unique context and unique strategic requirements.

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REFERENCES

- Akdil, K. Y., Ustundag, A., & Cevikcan, E. (2017). A maturity and readiness model for Industry 4.0 Strategy. In *Springer Series in Advanced Manufacturing* (pp. 61-94). Cham: Springer. https://doi.org/10.1007/978-3-319-57870-5_4
- Ahlskog, M., Badasjane, V., Granlund, A., Bruch, J., & Sauter, B. (2022). Differing views of the meaning of digital transformation in manufacturing industry. *Proceedings of the 10th Swedish Production Symposium, 21*, 331-340. <https://doi.org/10.3233/ATDE220152>
- Almasbekkyzy, A., Abdikerim, D., Nabi, D., Abdallah, Y. O., & Shehab, E. (2021). Digital maturity and readiness model for multiple-case of Kazakhstan large companies,” *2021 IEEE International Conference on Smart Information Systems and Technologies (SIST)*, Nur-Sultan, Kazakhstan, 1-7. Retrieved from <https://ieeexplore.ieee.org/document/9465912>
- Bharadwaj, A., El Sawi, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly, 37*(2), 471-482. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2742300
- BNS. (2024a). *On the use of information and communication technologies (ICT) in the enterprises of the Republic of Kazakhstan*. Retrieved from <https://stat.gov.kz/api/iblock/element/158986/file/en/>
- BNS. (2024b). *On the innovative activity of enterprises in the Republic of Kazakhstan*. Retrieved from <https://stat.gov.kz/api/iblock/element/159628/file/en/>
- Buganova, A. A., Umirzakov, S. Y., & Nurpeisova, A. A. (2022). Digital economy and digital transformation in Kazakhstan. *Central Asian Economic Review, 146*(5), 155-168. <https://doi.org/10.52821/2789-4401-2022-5-155-168>
- Carvalho, R. B., Reis, A. M. P., Larieira, C. L. C., & Pinochet, L. H. C. (2021). Digital transformation: Construct definition challenges and scenarios for a research agenda. *RAM, 22*(6), eRAMD210400. <https://doi.org/10.1590/1678-6971/eRAMD210400>
- Chen, J., & Shen, L. (2024). A synthetic review on enterprise digital transformation: A bibliometric analysis. *Sustainability, 16*(5), e1836. <https://doi.org/10.3390/su16051836>
- Chounta, I.-A., Ortega-Arranz, A., Daskalaki, S., Dimitriadis, Y., & Avouris, N. (2024). Toward a data-informed framework for the assessment of digital readiness of higher education institutions. *International Journal of Educational*

- Technology in Higher Education*, 21, e59. <https://doi.org/10.1186/s41239-024-00491-0>
11. De Carolis, A., Sassanelli, C., Acerbi, F., Macchi, M., Terzi, S., & Taisch, M. (2025). The Digital REadiness Assessment Maturity (DREAMY) framework to guide manufacturing companies towards a digitalisation roadmap. *International Journal of Production Research*, 1-27. <https://doi.org/10.1080/00207543.2025.2455476>
 12. Demirkan, H., Spohrer, J., & Welser, J. (2016). Digital innovation and strategic transformation. *IT Professional*, 18(6), 14-18. Retrieved from <https://ieeexplore.ieee.org/document/7763741>
 13. Dos Santos, B., Patel, P., & D'Souza, R. (2011). Venture capital funding for information technology businesses. *Journal of the Association for Information Systems*, 12(1), 57-87. <https://doi.org/10.17705/1jais.00253>
 14. Faisal, S. M. F., Chandra Banik, S., & Sen Gupta, P. (2024). Development of a readiness model for Industry 4.0 using analytical hierarchy process and fuzzy inference system: Bangladesh perspective. *Heliyon*, 10(1), e23664. <https://doi.org/10.1016/j.heliyon.2023.e23664>
 15. Fang, X., & Liu, M. (2024). How does the digital transformation drive digital technology innovation of enterprises? Evidence from enterprise's digital patents. *Technological Forecasting and Social Change*, 204, e123428, <https://doi.org/10.1016/j.techfore.2024.123428>
 16. Furjan, M. T., Tomičić-Pupek, K., & Pihir, I. (2020). Understanding digital transformation initiatives: Case studies analysis. *Business Systems Research Journal*, 11(1), 125-141. <https://doi.org/10.2478/bsrj-2020-0009>
 17. Gobble, M. M. (2018). Digital strategy and digital transformation. *Research-Technology Management*, 61(5), 66-71. <https://doi.org/10.1080/08956308.2018.1495969>
 18. Girang Permata Gusti, H. (2023). The role of crowdfunding in supporting innovation and creative project development: A review of the crowdfunding phenomenon in the digital era. *Business, Organizations & Society*, 1(1), 22-25. Retrieved from <https://bosoc.com.my/archive/1bosoc2023/1bosoc2023-22-25.pdf>
 19. Haryanti, T., Rakhmawati, N. A., & Subriadi, A. P. (2023). The extended digital maturity model. *Big Data and Cognitive Computing*, 7(1), e17. <https://doi.org/10.3390/bdcc7010017>
 20. Huggins, R., & Izushi, H. (2002). The digital divide and ICT learning in rural communities: Examples of good practice service delivery. *Local Economy*, 17(2), 111-122. <https://doi.org/10.1080/02690940210129870>
 21. Ismail Abdelaal, M. H., Khater, M., & Zaki, M. (2017). Digital business transformation and strategy: What do we know so far? *Cambridge Service Alliance Working Paper*. Retrieved from https://cambridgeservicealliance.eng.cam.ac.uk/system/files/documents/2017NovPaper_Mariam.pdf
 22. Government Decree of RK. (2017). *On approval of the State Program "Digital Kazakhstan", No. 827, as of December 12, 2017*. Retrieved from <https://adilet.zan.kz/rus/docs/P1700000827>
 23. Government Decree of RK. (2021). *On Amendments and supplements to the Government decree of the Republic of Kazakhstan dated December 20, 2018, No. 846 "On Approval of the Concept of Industrial and Innovative Development of the Republic of Kazakhstan for 2020-2025", No. 965, as of December 30, 2021*. Retrieved from <https://adilet.zan.kz/rus/docs/P2100000965>
 24. Government Decree of RK. (2023). *On approval of the Concept of digital transformation, development of the information and communication technology industry and cybersecurity for 2023-2029, No. 269, as of March 28, 2023*. Retrieved from <https://adilet.zan.kz/rus/docs/P2300000269>
 25. Government Decree of RK. (2024). *On approval of the Concept for the development of artificial intelligence for 2024-2029, No. 592, as of July 24, 2024*. Retrieved from <https://adilet.zan.kz/rus/docs/P2400000592>
 26. Kangalakova, D., Dzhanegizova, A., Satpayeva, Z., Nurgaliyeva, K., & Kireyeva, A. (2023). Distribution of knowledge through online learning and its impact on the intellectual potential of Ph.D. Students. *Journal of Distribution Science*, 21(4), 47-56. <https://doi.org/10.15722/jds.21.04.202304.47>
 27. Kaya, Y., & Bozbura, F. T. (2023). Digital transformation: A cognitive study for organizations to shape their journeys. *International Journal of Professional Business Review*, 8(5), 1-27. <https://doi.org/10.26668/businessreview/2023.v8i5.1825>
 28. Kazybayeva, A., & Pak, E. (2021). Digitalization of business processes in Kazakhstani companies. *Eurasian Journal of Economic and Business Studies*, 61(3), 79-94. <https://doi.org/10.47703/ejeb.v3i61.57>
 29. Kireyeva, A. A., Kangalakova, D. M., Ainakul, N., & Tsoy, A. (2022a). Factors affecting the distribution of intellectual potential and returns in Kazakhstan. *Journal of Distribution Science*, 20(2), 55-64. <http://dx.doi.org/10.15722/jds.20.02.202202.55>
 30. Kireyeva, A. A., Satpayeva, Z. T., & Urdabayev, M. T. (2022b). Analysis of the digital readiness and the level of the ICT development in Kazakhstan's regions. *Economy of regions*, 18(2), 464-478. Retrieved from <https://www.economyofregions.org/ojs/index.php/er/article/view/27173>
 31. Kraus, S., Durst, S., Ferreira, J. J., Veiga, P., Kailer, N., & Weinmann, A. (2022). Digital transformation in business and management research: An overview of the current status quo. *International Journal of Information Management*, 63, e102466. <https://doi.org/10.1016/j.ijinfomgt.2021.102466>
 32. Li, Z., Gong, P., Wang, Y., & Qu, S. (2024). The impact of digital transformation on enterprise organizational structure. *Highlights in Business, Economics and Man-*

- agement, 41, 732-740. <https://doi.org/10.54097/qt9jer93>
33. Liu, D.-Y., Chen, S.-W., & Chou, T.-C. (2011). Resource fit in digital transformation: Lessons learned from the CBC Bank global e-banking project. *Management Decision*, 49(10), 1728-1742. <https://doi.org/10.1108/00251741111183852>
 34. Lozić, J., & Fotova Čiković, K. (2024). Digital transformation: The fundamental concept of transformation of business activities. In *107th International Scientific Conference on Economic and Social Development – Economic and Social Survival in Global Changes*. Zagreb, Hrvatska, 326-337. Retrieved from https://www.researchgate.net/publication/379257824_DIGITAL_TRANSFORMATION_THE_FUNDAMENTAL_CONCEPT_OF_TRANSFORMATION_OF_BUSINESS_ACTIVITIES
 35. Makasheva, R. S., & Tussupova, L. A. (2021). Digital factors influencing small and medium-sized businesses in the context of Covid. *Economy: strategy and practice*, 16(4), 6-17. <https://doi.org/10.51176/1997-9967-2021-4-6-17>
 36. Matt, C., Hess, T., & Benlian, A. (2015). Digital transformation strategies. *Business & Information Systems Engineering*, 57, 339-343. <https://doi.org/10.1007/s12599-015-0401-5>
 37. Montalbano, P., Nenci, S., & Pietrobelli, C. (2016). International linkages, value-added trade, and firm productivity in Latin America and the Caribbean. In Grazi, M. & Pietrobelli, C. (Eds), *Firm innovation and productivity in Latin America and the Caribbean* (pp. 285-316). New York: Palgrave Macmillan. https://doi.org/10.1057/978-1-349-58151-1_9
 38. OECD. (2023). *Improving framework conditions for the digital transformation of businesses in Kazakhstan*. Paris: OECD Publishing. <https://doi.org/10.1787/368d4d01-en>
 39. Paul, J., Ueno, A., Dennis, C., Alamanos, E., Curtis, L., Foroudi, P., Kacprzak, A., Kunz, W. H., Liu, J., Marvi, R., Nair, S. L. S., Ozdemir, O., Pantano, E., Papadopoulos, T., Petit, O., Tyagi, S., & Wirtz, J. (2024). Digital transformation: A multidisciplinary perspective and future research agenda. *International Journal of Consumer Studies*, 48(2), e13015. <https://doi.org/10.1111/ijcs.13015>
 40. Proença, D., & Borbinha, J. (2016). Maturity models for information systems - A state of the art. *Procedia Computer Science*, 100, 1042-1049. <https://doi.org/10.1016/j.procs.2016.09.279>
 41. QazIndustry, (2020). *Recommendations for solving problems using digital projects (solutions) and increasing the efficiency of enterprises*. Retrieved from <https://qazindustry.gov.kz/docs/otchety/1597038508.pdf>
 42. Ribeiro-Navarrete, B., Martín, J. M. M., Guaita-Martínez, J. M., & Simón-Moya, V. (2023). Analysing cooperatives' digital maturity using a synthetic indicator. *International Journal of Information Management*, 72, e102678. <https://doi.org/10.1016/j.ijinfomgt.2023.102678>
 43. Satpayeva, Z. T. (2017). State and prospects of development of Kazakhstan innovative infrastructure. *European Research Studies Journal*, 20(2), 123-148. Retrieved from <https://ersj.eu/journal/670#>
 44. Soomro, M. A., Hizam-Hanafiah, M. & Abdullah, N. L. (2020). Readiness models: A systematic literature review. *COMPUSOFT, An International Journal of Advanced Computer Technology*, 9(3), 3596-3605. Retrieved from <https://ijact.in/index.php/j/article/view/558>
 45. Štofa, T., & Dráb, R. (2022). Success factors of crowdfunding of innovative projects. *International Journal of Management and Enterprise Development*, 21(3), e227. <https://doi.org/10.1504/IJMED.2022.125774>
 46. Tang, D. (2021). What is digital transformation? *EDPACS*, 64(1), 9-13. Retrieved from <https://www.tandfonline.com/doi/full/10.1080/07366981.2020.1847813>
 47. Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 67(6), 1673-1687. <https://doi.org/10.11118/actaun201967061673>
 48. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, 28(2), 118-144. <https://doi.org/10.1016/j.jsis.2019.01.003>
 49. Wu, C.-H., Chou, C.-W., Chien, C.-F., & Lin, Y.-S. (2024). Digital transformation in manufacturing industries: Effects of firm size, product innovation, and production type. *Technological Forecasting and Social Change*, 207, e123624. <https://doi.org/10.1016/j.techfore.2024.123624>
 50. Yezhebay, A., Sengirova, V., Igali, D., Abdallah, Y., & Shehab, E. (2021). Digital maturity and readiness model for Kazakhstan SMEs. *2021 IEEE International Conference on Smart Information Systems and Technologies (SIST)*, Nur-Sultan, Kazakhstan, 1-6. Retrieved from <https://ieeexplore.ieee.org/document/9465890>
 51. Zettelman, A., & Cano, J. A. (2024). The high cost of complacency: Lessons from Kodak, Blockbuster, and Nokia. *Health Management*, 24(3), 181-183. Retrieved from <https://healthmanagement.org/pdf/article-download/the-high-cost-of-complacency-lessons-from-kodak-blockbuster-and-nokia/hm3-v24-mostregrettablebusinessdecision-printoptimised-the-highcostofcomplacency.pdf>
 52. Zhu, Z.-Y., Xie, H.-M., & Chen, L. (2023). ICT industry innovation: Knowledge structure and research agenda. *Technological Forecasting and Social Change*, 189, e122361. <https://doi.org/10.1016/j.techfore.2023.122361>