Research paper / Оригинальная статья
https://doi.org/10.51176/1997-9967-2025-1-6-18
МРНТИ 06.52.17
JEL: J24, O11, O33

The Impact of Digital Literacy on Kazakhstan's Employment Structure in the Context of Technological Change

Aidarbek T. Gyiazov[a]*

[a]*Batken State University, 21 I. Zhussupov Str., Batken, Kyrgyzstan*

For citation: Gyiazov, A.T. (2025). The Impact of Digital Literacy on Kazakhstan's Employment Structure in the Context of Technological Change. Economy: the strategy and practice, 20(1), 6-18, https://doi.org/10.51176/1997-9967-2025-1-6-18

ABSTRACT

Today, digital transformation has a significant impact on the labor market, changing the employment structure and forming new requirements for the qualifications of employees. The purpose of the study is to analyze the impact of digital literacy on the employment status of the population of the Republic of Kazakhstan in the context of rapid technological changes and the consequences of the COVID-19 pandemic. Research methods include correlation analysis to identify the relationship between the level of digital literacy and employment structure, as well as a comparative method to assess the dynamics of changes in the labor market. The empirical base of the study is based on statistical data for 2010-2022 collected from official statistical collections of Kazakhstan and reports of the International Labor Organization (ILO). The results of the study show that an increase in the level of digital literacy leads to a decrease in the proportion of employees and the self-employed, which is associated with automation, the development of digital platforms and changing forms of employment. Correlation analysis revealed a significant negative relationship between the level of digital literacy and the proportion of employees (r = -0.75), as well as a strong positive relationship with the number of pensioners (r = 0.75) and dependents (r = 0.94). The results obtained confirm the trend towards the transition to remote forms of work and the use of digital technologies in everyday life. Future research may focus on developing strategies to increase digital literacy among the population for balanced labor market development and reduce the digital divide, especially in rural areas.

KEYWORDS: Digital Literacy, Digital Economy, Employment, Employment Strategy, Labor Market, Technological Breakthrough, Flexible Forms of Work

CONFLICT OF INTEREST: the author declares no conflict of interest.

FINANCIAL SUPPORT: this research has been funded by grant No. AP23488981.

Article history:
Received 10 November 2024
Accepted 18 March 2025
Published 30 March 2025

*** Corresponding author: Gyiazov A.T.** – Doc. Sc. (Econ.), Professor, Batken State University, 21 I. Zhussupov Str., Batken, Kyrgyzstan, email: aziret-81@mail.ru

Влияние цифровой грамотности на структуру занятости Казахстана в контексте технологических изменений

Гыязов А.Т.[a]*

[a]*Баткенский государственный университет, ул. И. Жусупова 21, Баткен, Кыргызстан*

Для цитирования: Гыязов А.Т. (2025). Влияние цифровой грамотности на структуру занятости Казахстана в контексте технологических изменений. Экономика: стратегия и практика, 20(1), 6-18, https://doi.org/10.51176/1997-9967-2025-1-6-18

АННОТАЦИЯ

Сегодня цифровая трансформация оказывает значительное влияние на рынок труда, изменяя структуру занятости и формируя новые требования к квалификации работников. Цель исследования провести анализ влияния цифровой грамотности на статус занятости населения Республики Казахстан в условиях быстрых технологических изменений и последствий пандемии COVID-19. Методы исследования включают корреляционный анализ для выявления взаимосвязи между уровнем цифровой грамотности и структурой занятости, а также сравнительный метод для оценки динамики изменений на рынке труда. Эмпирическая база исследования основана на статистических данных за 2010–2022 гг., собранных из официальных статистических сборников Казахстана и отчетов Международной организации труда (МОТ). Результаты исследования показывают, что повышение уровня цифровой грамотности приводит к снижению доли наемных работников и самозанятых, что связано с автоматизацией, развитием цифровых платформ и изменением форм занятости. Корреляционный анализ выявил значительную отрицательную связь между уровнем цифровой грамотности и долей наемных работников (r = -0,75), а также сильную положительную связь с числом пенсионеров (r = 0,75) и иждивенцев (r = 0,94). Полученные результаты подтверждает тенденцию к переходу на дистанционные формы работы и использования цифровых технологий в повседневной жизни. Будущие исследования могут быть направлены на разработку стратегий повышения цифровой грамотности среди населения для сбалансированного развития рынка труда и сокращения цифрового разрыва, особенно в сельских районах.

КЛЮЧЕВЫЕ СЛОВА: цифровая грамотность, цифровая экономика, занятость, стратегия трудоустройства, технологический прорыв, гибкие формы труда

КОНФЛИКТ ИНТЕРЕСОВ: автор заявляет об отсутствии конфликта интересов

ФИНАНСИРОВАНИЕ: данное исследование финансировалось по гранту №AP23488981.

История статьи:
Получено 10 ноября 2024
Принято 17 марта 2025
Опубликовано 30 марта 2025

* **Корреспондирующий автор: Гыязов А.Т.** – д.э.н., профессор, Баткенский государственный университет, ул. И. Жусупова 21, Баткен, Кыргызстан, email: aziret-81@mail.ru

INTRODUCTION

The aim is to measure the impact of digital literacy on the employment status of the population of Kazakhstan. The labor market is a key element that affects citizens' economic development and social well-being. In technological breakthrough times, the indicator of the population's digital literacy plays an important role. Digital literacy has different indications for different ages and employment of the population. Over the centuries, technological, social, and political changes have shaped the economy and ways of earning money, influencing the structure and functioning of the labor market (Ferilli et al., 2024).

Today, technological breakthroughs and political situations dictate their own rules to the world. As demand and technology needs developed systematically, but with the advent of the pandemic, the development of technological processes increased, new innovative technologies appeared, and personnel management and workflow were also transformed into a different format. Digitalization has helped mitigate the negative effects of the pandemic (Uctu et al., 2024a). Employees with intellectual workloads or office managers have switched to remote, online work. The issues of safety, productivity, and the possibility of outsourcing remote work are noted: when you do not spend time on the road and are not in a specific building, there are fewer risks in the workplace, and the use of new technologies increases productivity (Nazarova et al., 2024).

At the beginning of the COVID-19 pandemic, this gap among urban residents increased in regions with high levels of financial and technological illiteracy, especially in rural districts (Wang et al., 2024). The COVID-19 pandemic has significantly impacted the global labor market, particularly in developing countries. In 2020, according to the International Labor Organization (ILO), 114 million fewer jobs were recorded compared to 2019.

Between the differences between developed and developing countries, it is necessary to consider the differences in the level of training and infrastructure (Ren et al., 2023). There is a significant gap in financial literacy between developed and developing countries, making it difficult to access financial resources and innovation (Sarabdeen & Alofaysan, 2023). There are fewer barriers to adapting innovations in developed countries than in developing countries. The modern industrial revolution is characterized by digitalization, network technologies, and intelligent systems, where artificial intelligence (AI) is driving progress (Komp-Leukkunen, 2024).

As the largest developing country with the most significant labor force, China faces serious employment problems, especially among the rural population, which accounts for 491 million people, or more than 35% of the country's total population. Over the past 40 years, excess rural labor has shifted from low-productivity agriculture to urban non-agricultural industries, underscoring the importance of addressing rural employment issues (Nguyen et al., 2024)crowdfunding, and AI literacy. For example, small businesses like batik firms face challenges such as limited access to finance and low levels of financial literacy, making it difficult for them to grow and develop. Small and medium-sized firms may have these barriers (Lin et al., 2023).

Thus, modern digital transformation significantly impacts the labor market, changing the employment structure and forming new requirements for the qualifications of employees. Technological changes contribute to the transition to flexible forms of employment, process automation, and digital entrepreneurship. Digital literacy plays a particularly significant role in the context of the COVID-19 pandemic, which has accelerated the introduction of remote work and digital tools into professional activities. The purpose of the study is to analyze the impact of digital literacy on the employment status of the population of Kazakhstan in the context of rapid technological changes and the consequences of the COVID-19 pandemic.

LITERATURE REVIEW

The study of the impact of digital literacy on the labor market is widely represented in the scientific literature. Research confirms that digitalization generates both new employment opportunities and serious challenges related to automation, the digital divide, and changes in traditional forms of employment. They cover practices such as the verification, exchange, and standardization of data, as well as the training, repair, and control of laboratory robots (Begen & Atasoy, 2024). Therefore, it is important to rethink educational programs and skills for successful work in a rapidly changing economy, using new technologies and artificial intelligence (Nicol et al., 2022). In a rapidly changing labor market, knowledge and practical experience working with new technologies are becoming critical for a successful career, and digital literacy is an important factor that can improve graduate employment (Awodele et al., 2024).

Differences in education (general or professional) affect graduates' quality of employment and income. This is especially relevant in developing

countries, where educational systems often face problems of quality and accessibility (Beissenova et al., 2013). In a rapidly changing labor market and the growth of digital technologies, online learning is becoming a key tool for increasing employee competitiveness (Andabayeva et al., 2024).

The development of technologies such as telepresence and robotics allows workers to perform their duties from remote locations. AI represents the sixth wave of technological change, significantly affecting various industries and economic models (Kemper & Renold, 2024). AI highlights how new technologies can displace outdated methods and business models. These technologies increase productivity and change employment patterns, creating new opportunities and challenges for the workforce.

Despite the substitution of some professions, the introduction of new technologies also leads to the creation of new jobs, especially in high-tech industries such as software development, data management, and research of new technologies in engineering and mathematics (Ferilli et al., 2024; Komp-Leukkunen, 2024; Al-shami et al., 2024; Ribeiro et al., 2023). These positive changes illustrate how technological advancements transform employment and economic growth (see Figure 1).

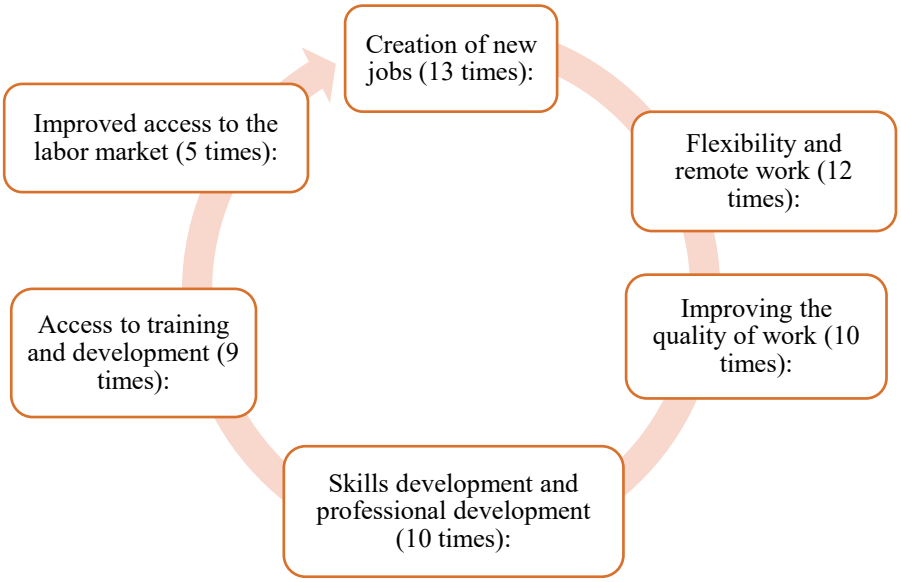

Figure 1. Positive consequences of the technological process

New forms of employment, such as freelancing and remote work, provide workers with greater flexibility in managing their time and work conditions, which can improve work-life balance (Komp-Leukkunen, 2024). Automating routine tasks frees workers to perform more complex and creative tasks, improving the quality of work and employee satisfaction (Komp-Leukkunen, 2024). Strategic technology adoption can improve the quality of work, increase productivity, and create new opportunities for the workforce (Jahan & Zhou, 2023). Introducing new technologies creates a demand for training and development, contributing to employees' professional development and adaptation to the changing demands of the labor market (Komp-Leukkunen, 2024).

As digital transformation reshapes employment, it also influences the education sector by expanding opportunities for professional growth and skill development. Technology opens up new opportunities for online learning and development, which allows young professionals to access educational resources and programs necessary for their professional growth, improving the overall level of qualifications in the industry (Dabić et al., 2023; Kemper & Renold, 2024). New technologies such as online learning provide educational and professional skills opportunities for a broader range of people, including those who face constraints due to work, family responsibilities, or geographical location (Awodele et al., 2024; Donald et al., 2023)known as Railway 4.0, that is revolutionizing operations, infrastructure, and transportation systems. However, developing countries face challenges in keeping pace with these technological advancements. With limited research on Railway 4.0 adoption in developing

countries, this study was motivated to investigate the awareness, readiness, and challenges faced by railway professionals towards implementing Railway 4.0 technologies. The aim was to assess the level of awareness and preparedness and identify the key challenges influencing Railway 4.0 adoption in Nigeria's railway construction industry. A questionnaire survey (was distributed to professionals in the railway construction sector to gather their perspectives on awareness of, preparation for, and challenges associated with the use of Railway 4.0 technologies. The results revealed that awareness of Railway 4.0 technologies was moderate, while readiness was low among the professionals. Using exploratory factor analysis, 10 underlying challenge constructs were identified including lack of technical know-how, resistance to change, infrastructure limitations, and uncertainty about benefits, amongst others. Partial Least Square Structural Equation Modelling (PLS-SEM).

Beyond transforming traditional jobs, technology also changes recruitment processes, making hiring more inclusive and global. Technology allows organizations to conduct virtual events and recruitment campaigns, which makes it possible to attract candidates from different regions and countries, increasing the pool of potential employees. Introducing AI can lead to new professions and roles, such as query engineers, which opens up new career paths for specialists (Andabayeva et al., 2024). Digitalization opens access to global markets, allowing companies to expand their business opportunities and create new jobs. Digital financial inclusion improves access to financial services for rural residents and small and medium-sized enterprises (SMEs), making it easier for them to obtain loans and other financial resources (Nazarova et al., 2024).

Among all jobs, the increase in unemployment and job cuts are mentioned the most numerous times (15 times). Automation and the introduction of artificial intelligence replace routine and low-skilled jobs, especially in traditional sectors, which leads to mass layoffs. This phenomenon is called technological unemployment (Bekzhanova et al., 2023; Ren et al., 2023). There is concern that automation and AI, including ChatGPT, could lead to job cuts for programmers, especially those who perform routine tasks.

Figure 2 describes the negative consequences of the technological process.

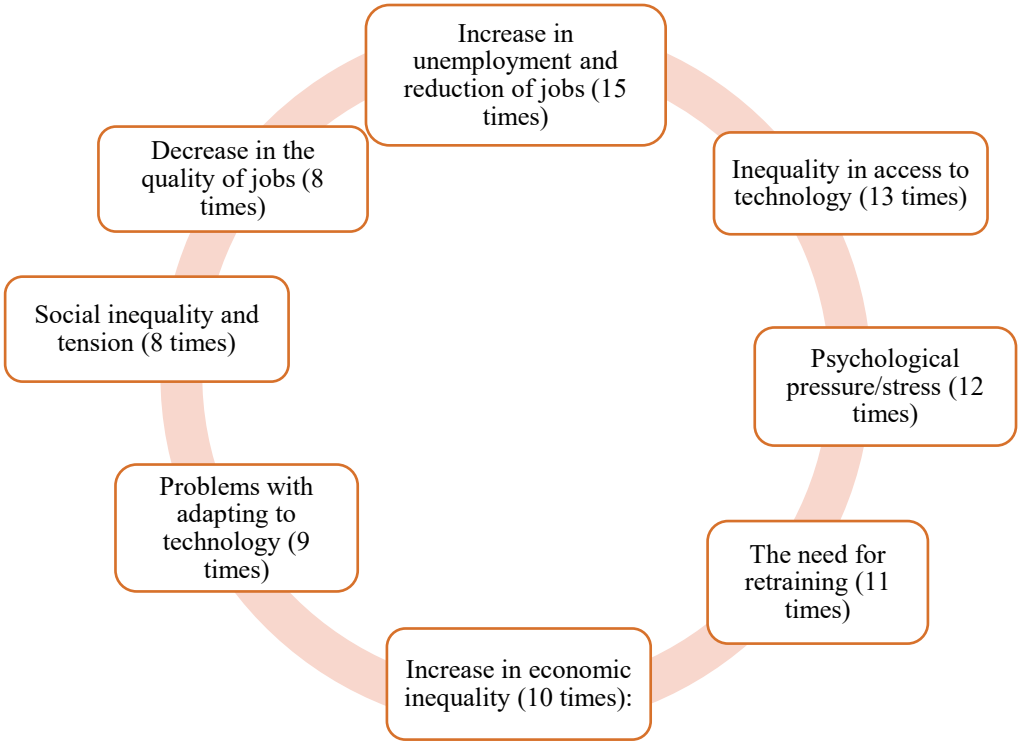

Figure 2. Negative consequences of the technological process

Inequality in access to technology is second (mentioned 13 times). Not all workers have equal access to new technologies and training, which can exacerbate existing social and economic inequalities. This is especially true for low-income people in remote or rural areas, who may face restrictions in access to digital resources and education (Nguyen et al., 2024; Uctu et al., 2024)crowdfunding, and AI literacy.

Psychological pressure and stress are mentioned 12 times. Rapid changes in work processes, the need for constant retraining and adaptation, increased productivity requirements, and the continuous use of technology for monitoring are causing stress and burnout among employees (Kemper & Renold, 2024; Ribeiro et al., 2023). Some employees reported feeling helpless during the transition to an online work format. Job cuts and the need to adapt to new conditions can lead to stress, anxiety, and other psychological problems, negatively affecting overall well-being (Bekzhanova et al., 2023; Ren et al., 2023).

The need for retraining (mentioned 11 times). Employees whose skills have become outdated due to the introduction of new technologies may face difficulties finding a job, which requires additional efforts to retrain and train (Bekzhanova et al., 2023; Kurt, 2019). Increasing economic inequality (mentioned 10 times): The technologization of the economy contributes to higher wages for highly skilled professionals, while low-skilled workers face falling incomes (Ferilli et al., 2024; Ren et al., 2023). Furthermore, problems with adapting to technology (mentioned 9 times). Not all employees were ready for a rapid transition to new technologies, which led to lower productivity and increased work errors (Nicol et al., 2022; Urekeshova et al., 2023).

Social inequality and tension (mentioned 8 times). New forms of employment, such as freelancing and outsourcing, often do not provide workers with sufficient social protection, making them vulnerable to economic shocks and instability (Ferilli et al., 2024; Uctu et al., 2024). Finally, job quality reduction (mentioned 8 times). New technologies can create new jobs, but they can also lead to temporary or unstable positions, such as the "gig economy" (for example, working as couriers or taxi drivers), which can negatively affect employment stability and the income level of employees. Technology cannot completely replace the human factor, especially in creative and complex tasks, and therefore, it is not necessary to rely on them entirely (Ribeiro et al., 2023; Awodele et al., 2024).

As a result of technological changes, the labor market is polarized, and the number of highly skilled jobs is increasing. At the same time, the number of medium-skilled and low-skilled is decreasing. This widens the gap between highly skilled and low-skilled workers (Adegbite, 2024; Beissenova et al., 2013).

An analysis of the literature has shown that digital transformation significantly impacts the labor market, contributing to a change in the employment structure and creating both new opportunities and threats for workers. The literature highlights that digitalization exacerbates socio-economic inequality: access to technology and digital skills is unevenly distributed, which creates barriers to employment among low-income groups, especially in rural areas. In addition, the high rate of technological change requires constant retraining of employees, but not all employees have equal opportunities for professional development. This, in turn, creates additional pressure on employees and can cause stress and burnout.

RESEARCH METHODS

The paper is based on an extensive literature review that includes research and data on the impact of digitalization, automation, and remote employment on the labor market. Various types of employment, such as freelancing, self-employment, and temporary work, are considered, as well as their relationship to new technologies. Statistical data obtained from international organizations such as the International Labour Organization (ILO) and national statistical agencies are analyzed in dynamics for the period 2010-2022.

The methodological basis of the study was used:

(1) The correlation analysis was carried out to identify the relationship between the population's digital literacy level and key employment indicators: the proportion of employees, the self-employed, the unemployed, students, pensioners, and dependents.

(2) The comparative analysis is based on ILO data, including differences in adaptation to digitalization between developed and developing countries. The indicators of workplace automation, the level of digital technology penetration, and the dynamics of traditional and flexible forms of employment were considered.

(3) The impact of new technologies, such as artificial intelligence and automation, was assessed regarding their impact on labor productivity, job quality, and economic inequality.

Figure 3 below shows a diagram of the research steps as a sequential process.

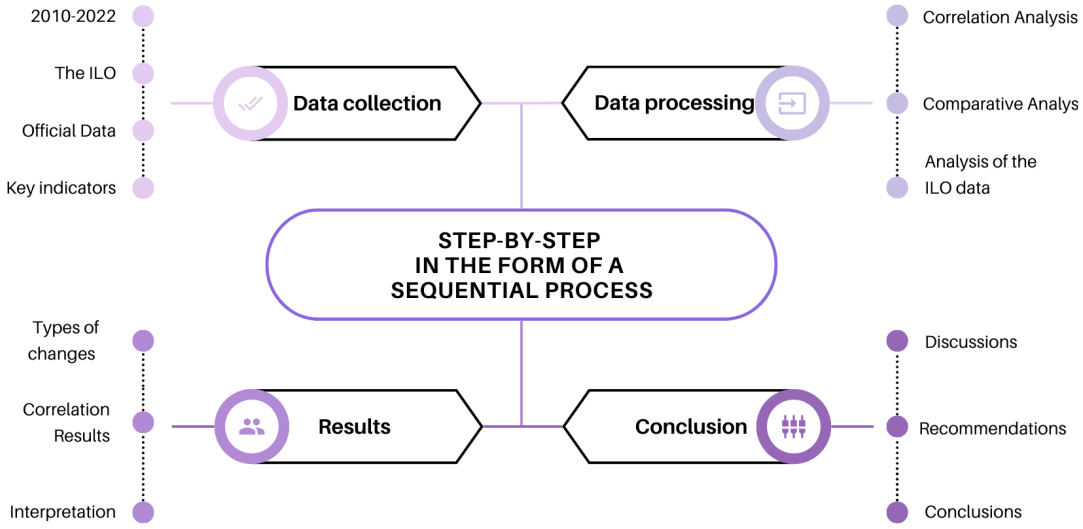

Figure 3. Diagram of the research steps as a sequential process

This paper considers the methods in more detail based on the above scheme.

Correlation analysis was used to identify statistical relationships between the population's digital literacy level and indicators of the employment structure of the population. This method made it possible to quantify the degree of relationship between variables. In our case, there is a difference between the indicator of digital literacy (the proportion of the population with essential digital skills) and the proportions of the population belonging to various employment categories (employees, self-employed, unemployed, students, pensioners, dependents, and others). The nature of the data justified the choice of the correlation coefficient: the Pearson coefficient was used since the analyzed indicators are quantitative fractions (in percentages) and are distributed over a time interval with presumably linear dependence.

The study analyzed paired correlation coefficients between the level of digital literacy of the population (X1) and various components of the employment structure, including the proportion of employees (X2), the self-employed (X3), the unemployed (X4), students (X5), pensioners (X6), dependents (X7) and other categories (X8). This analysis made it possible to identify key relationships between digital literacy and changes in the employment structure, as well as to assess which categories of the population are most susceptible to the transformational processes caused by the digitalization of the economy.

Comparative analysis was used to identify the dynamics of the employment structure over time. This approach involves comparing indicators for different periods to identify trends and structural shifts. The work identified two key chronological stages: 2010-2015 and 2016-2022. This division of the study period is due to changes in government policy and the technological environment (for example, the active phase of the economic digitalization program occurred in the mid-2010s).

The comparison criterion was the absolute changes in shares (in percentage points) and the growth/decrease rates of these shares relative to the beginning of the period. For example, for each indicator, the change in its value in 2016-2022 compared to 2010-2015 was determined, as well as the overall shift from 2010 to 2022. This approach made it possible to identify which employment categories show growth or decline in different phases of the digital transformation of the economy. These changes were interpreted considering socio-economic factors (automation, flexible forms of employment, demographic shifts, etc.).

Analysis of the ILO data was additionally carried out based on secondary data, which served as an important addition to the national statistics. The choice of ILO data is based on its reliability, international comparability, and relevance to understanding global labor market trends. In particular, we used aggregated indicators of the global labor market and data on groups of countries (developed and developing economies) in recent years, including the global crisis caused by the COVID-19 pandemic. For example, ILO data on global employment dynamics was used, according to which 114 million fewer jobs were created in 2020 than in 2019, indicating

an unprecedented decline in employment during the pandemic. The conclusions obtained from the analysis of the ILO data reasonably complement the results of the correlation and comparative analysis, confirming that increasing the population's digital literacy is an important factor in the sustainability and adaptability of the employment structure in the face of technological shifts.

RESULTS

An analysis of changes in the employment structure shows that digital transformation affects the demand for various professions and forms of employment. With the development of technology, there has been a reduction in traditional jobs, especially those related to routine tasks, and an increasing demand for specialists in the fields of IT, data analytics, cybersecurity, and artificial intelligence. Data scientists, software developers, cybersecurity experts, and artificial intelligence specialists have become in demand in the labor market. The demand for highly qualified personnel with knowledge of information technology, data analysis, and programming has increased significantly. The increased demand for retraining and advanced training courses affects educational institutions and the labor market. In addition, automation and digitalization contribute to changing the role of employees, transforming professional responsibilities, and creating interdisciplinary professions. Moreover, technological changes have contributed to the growth of the digital economy, which has led to an increase in the number of jobs in sectors related to e-commerce, online services, and digital platforms. This creates new employment opportunities, especially for young people and people who are ready to adapt to new conditions.

Table 1 shows the dynamics of key changes in the employment structure caused by technological progress.

Table 1. Types of changes over time of technological progress

Change	Interpretation
Changing roles and responsibilities	As a result of the introduction of technology, the roles of employees may change. For example, researchers can focus more on interpreting data and developing new hypotheses, while automated systems will perform routine tasks.
Uneven distribution of influence	Technological changes can lead to uneven benefits and losses among workers. Some professions may disappear, while others may become more in demand, which creates challenges for workers who cannot adapt to new conditions.
Interdisciplinary professions	Technological changes are contributing to the emergence of interdisciplinary professions that require a combination of knowledge from different fields. For example, data scientists can combine programming, statistics, and business analysis skills. Workers with knowledge in several fields, such as technology, business, and social sciences or technology and business become more competitive in the labor market.
Increasing the importance of soft skills	In the context of technological change, the importance of soft skills such as communication, creativity, and teamwork is increasing. These skills are becoming important for successful work in a new environment where technology plays a key role .
Human-machine cooperation	In the new working conditions, there is a tendency for man and machine to work together. Jobs that were previously performed exclusively by humans can now be performed using robots and automated systems, which changes the nature of work and requires new skills from employees.
Increasing the importance of digital skills	In the context of digitalization and automation, the importance of digital skills is increasing. Employees must be able to work with new technologies, which makes digital literacy an important requirement for most professions.

Note: compiled based on Donald et al., 2023; Andabayeva et al., 2024; Begen & Atasoy, 2024; Wang et al., 2024; Adegbite, 2024.

An analysis of the data from Table 1 shows that technological progress significantly transforms the labor market. The introduction of new technologies is changing the roles and responsibilities of employees, reducing the need for routine tasks, and increasing the demand for analytical and creative competencies. However, the impact of digitalization on employment turns out to be uneven. While tech-

nology creates new jobs in some areas, in others, it leads to automation and a reduction in traditional professions. Employees can now compete locally and internationally, requiring them to improve their skills and adapt to new conditions continuously.

Based on the literature review conducted, we wanted to analyze the impact of the level of digital literacy on the employment status of the population. The indicators were collected from 2010 to 2022. The population's employment types include employees, self-employed workers, the unemployed, students, pensioners, dependents, and others.

The frequency of the indicators was divided into two stages. From 2010 to 2015 for interim analysis from 2016 to 2022, and the total from 2010 to 2022. The level of digital literacy has increased significantly since 2010-2015 (+30.5%) due to the increased government policy of digitalization and the availability of technology and Internet services (see Table 2).

Table 2. Dynamics of indicators from 2010 to 2015

Indicator	2010	2011	2012	2013	2014	2015	2010-2015, %
The level of digital literacy of the population	43,7	51,3	62,6	63,2	64,1	74,2	30,5
An employee (paid)	51,3	49,9	57,0	56,7	55,4	40,4	-10,9
Self-employed employee	16,1	16,4	19,7	20,7	22,5	18,6	2,5
Unemployed	3,8	5,0	3,9	4,7	4,4	5,8	2
Student	16,0	15,2	9,8	12,0	11,2	6,2	-9,8
Retired people	6,0	8,4	6,7	3,3	4,0	10,8	4,8
Dependent						15,6	15,6
Others	6,8	5,1	2,8	2,6	2,7	2,6	-4,2

Note: compiled by authors

In 2016-2022, the growth rate slowed down (+12.1%), which may indicate that the basic needs for digital skills have reached saturation. During 2010-2022, it grew from 43.7% to 88.31%, an increase of 44.6%. It should be noted that digitalization and technological progress are gaining momentum both in the international market and the country (see Table 3).

Table 3. Dynamics of indicators from 2016 to 2022

Indicator	2016	2017	2018	2019	2020	2021	2022	2016-2022, %	2010-2022, %
The level of digital literacy of the population	76,2	78,2	79,6	82,1	84,1	87,3	88,31	12,1	44,6
An employee (paid)	40,8	41,9	42,0	42,0	41,4	41,0	40,9	0,09	-10,41
Self-employed employee	18,5	16,7	15,9	16,1	15,2	14,7	7,8	-10,69	-8,29
Unemployed	4,1	3,4	3,1	3,0	3,0	3,6	4,4	0,29	0,59
Student	6,8	6,0	5,7	5,4	6,1	5,3	6,2	-0,62	-9,82
Retired people	9,9	10,9	10,8	10,8	10,9	11,2	13,6	3,7	7,6
Dependent	17,9	19,7	21,1	21,0	22,3	22,9	23,5	5,57	7,9
Others	2,0	1,3	1,3	1,6	1,1	1,4	3,7	1,65	-3,15

Note: compiled by authors

A strong decrease in the share of employees was observed from 2010 to 2015, by -10.9%, followed by a stabilization of the indicator from 2016 to 2022 (about 41%). This reflects structural changes in the labor market, such as automation and the transition to flexible forms of employment. The share of the self-employed increased by +2.5% until 2015, but from 2016 to 2022 decreased by -10.69%, reaching 7.8%. The total charge is -8.29%. The reason for this may be competition with digital platforms. The unemployment rate remained relatively stable, increasing by 0.59% over the entire period (2010-2022), indicating an overall balance between job creation and job loss.

A significant decrease in the proportion of students was observed from 2010 to 2015, at 9.8%. Further, from 2016 to 2022, a decline of -0.62%. In total, there has been a steady decline of 9.82% over 13 years. This is due to the earlier entry of young people into the labor market. With the development of technological innovations, new professions have emerged such as blogging, SMM marketers that do not require a diploma. They get special training certificates. The share of pensioners has steadily increased from 2010 to 2015, +4.8%, and from 2016 to 2022, +3.7% for a total of +7.6%. This is due to the demographic aging of the population. Dependents also show a steady increase from 15.6% to 23.5% (+7.9%), which may be due to an increase in the proportion of the economically inactive population. Other indicators show a decrease from 6.8% to 3.7% (-3.15%), which indicates a decrease in the proportion of unaccounted-for forms of activity.

Digitalization contributes to an increase in the share of qualified specialists, which requires increased digital literacy. The decrease in the share of self-employed and salaried workers follows the automation of routine processes. The decrease in students indicates a decrease in the proportion of young people in the employment structure. The population's digital literacy is a key driver of labor market transformation.

A multidimensional correlation analysis was carried out to determine the impact of the digital literacy level of the population on employment. Among them are self-employed, unemployed, student, retired, dependent, and others.

Since the correlation of variables was studied, all X factors were determined (see Table 4).

Table 4. Analysis of the correlation of the level of digital literacy of the population with employment indicators

Variable	X1	X2	X3	X4	X5	X6	X7	X8
Digital literacy	1							
Employee	-0,75	1						
Self-employed worker	-0,47	0,60	1					
Unemployed	-0,37	0,25	0,24	1				
Student	-0,95	0,76	0,33	0,37	1			
Retired	0,75	-0,92	-0,77	-0,26	-0,74	1		
Dependent	0,95	0,36	-0,77	-0,63	-0,49	0,59	1	
Other	-0,80	0,44	-0,09	0,42	0,84	-0,36	-0,06	1

Note: compiled by authors

Correlation analysis revealed significant correlations between the level of digital literacy and various employment categories. In particular, a negative correlation has been established between digital literacy and the proportion of employees (r = -0.75), indicating a decrease in the number of traditional jobs in digitalization. There is also a negative relationship between digital literacy and the level of self-employment (r = -0.47), which may be due to the competition of digital platforms and the transition of workers to more flexible forms of employment. The share of students in the employment structure decreased by 9.82% in 2010-2022, indicating the transition of young people to alternative forms of education and employment. Technological progress requires adapting professional skills, increasing the demand for IT specialists, data analysts, and artificial intelligence experts. In general, digitalization stimulates changes in the labor market, creating new opportunities, but it also requires active adaptation on the part of workers and the education system.

There is a strong positive correlation (0.75) between digital literacy and retirees. This indicates that an increase in the level of digital literacy in society has a positive effect on the involvement of pensioners in the use of digital technologies. After retirement, residents undergo retraining through online programs, and they can work remotely, which is

very convenient for the population at this age. There is a very strong positive correlation between the digital literacy of the population and dependents (0.95). Dependents, young people, or people who depend on relatives are more likely to use digital technologies for leisure, education, or communication. This group is more receptive to digital innovation.

The growth of digital literacy in the population is leading to the transformation of traditional forms of employment. The strong adaptation of pensioners and dependents to digital technologies confirms the need for further development of digital education programs and the availability of technology for these groups. At the same time, a decrease in the proportion of students and employees with a high level of digital literacy indicates a shift towards flexible and modern forms of employment, such as self-employment, freelancing and project work. A decrease in the correlation with wage labor also confirms this.

The rapid development of technology requires regular updating of knowledge, which underlines the importance of retraining and advanced training programs, which means the need for special courses and updating the curriculum at universities. New technologies increase the need for specialists with modern technical and analytical skills, which requires constant training and adaptation. In order to ensure the development of highly qualified personnel, it is necessary to invest in education and professional training.

CONCLUSIONS

The purpose of the study is to analyze the impact of digital literacy on the employment status of the population of Kazakhstan in the context of rapid technological changes and the consequences of the COVID-19 pandemic. The results confirm that the growth of digital literacy contributes to the transformation of the labor market, increasing the share of flexible forms of employment, remote work, and self-employment, but also creating new challenges, such as the reduction of traditional jobs and the need for continuous professional development. Another important aspect is the need to increase rural residents' digital literacy and financial knowledge to use the opportunities provided by digital financial inclusion effectively. The lack of practical training and internships in training programs related to automation and analytical skills reduces its effectiveness, emphasizing the need to introduce more practice-oriented approaches to learning. Technology promotes the development of flexible forms of employment, such as remote work, which can lead to instability and a lack of social guarantees for workers.

The impact of AI on employment can vary by region, which requires consideration of local conditions and needs when developing policies and strategies. The impact of digital financial inclusion on employment is more pronounced in certain groups, such as unmarried men and residents of the eastern regions, which indicates the need to take regional specifics into account when developing policies. When introducing innovative technologies into the workforce, it is necessary to consider the population's cultural and regional differences. For the effective use of digital financial services, it is essential to improve the digital infrastructure in rural areas, which will help reduce credit restrictions and increase the availability of financial resources for the local population.

Like all developing countries, Kazakhstan is implementing innovative technologies to promote its economic situation in the world. The country's workforce management is consistently changing, with many specialists working remotely using new technologies. Improving the country's Internet coverage, training the population in digital literacy, and introducing advanced technologies into industry, especially in rural areas, is necessary to maintain competitiveness in this area.

The study highlights the importance of active government intervention in regulating the labor market, which can help create new jobs and maintain economic stability. Despite the market-based nature of the gig economy, active government involvement is required to develop an effective management system that supports workers' rights and ensures their well-being. This means that it is necessary to develop and implement measures to support innovation, reduce the cost of entrepreneurship, and create a favorable environment for developing the digital economy, especially in rural areas. The labor market development must take place within the framework of sustainable development, which includes social inclusion, environmental sustainability, and economic efficiency. Technological changes should affect the social aspects of employment, including occupational safety, working conditions, and job accessibility for various population groups.

Future research may focus on developing strategies to increase digital literacy among the population, which will balance the development of the labor market and reduce the digital divide, especially in rural areas. This includes studying the most effective educational programs and initiatives aimed at developing key digital skills among the population in demand in the modern economy.

AUTHOR CONTRIBUTIONS

Conceptualization and theory: AG; research design: AG; data collection: AG; analysis and interpretation: AG; writing draft preparation: AG; supervision: AG; correction of article: AG; proofread and final approval of article: AG. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Adegbite, W. M. (2024). Unpacking mediation and moderating effect of digital literacy and life-career knowledge in the relationship between work-integrated learning and graduate employability. *Social Sciences & Humanities Open*, *10*, 101161. https://doi.org/10.1016/j.ssaho.2024.101161

Al-shami, S. A., Damayanti, R., Adil, H., Farhi, F., & Al Mamun, A. (2024). Financial and digital financial literacy through social media use towards financial inclusion among batik small enterprises in Indonesia. *Heliyon*, *10*(15), e34902. https://doi.org/10.1016/j.heliyon.2024.e34902

Andabayeva, G., Movchun, V., Dubovik, M., Kurpebayeva, G., & Cai, X. (2024). Labor market dynamics in developing countries: Analysis of employment transformation at the macro-level. *Journal of Innovation and Entrepreneurship*, *13*(1), 65. https://doi.org/10.1186/s13731-024-00417-0

Awodele, I. A., Mewomo, M. C., Municio, A. M. G., Chan, A. P. C., Darko, A., Taiwo, R., Olatunde, N. A., Eze, E. C., & Awodele, O. A. (2024). Awareness, adoption readiness and challenges of railway 4.0 technologies in a developing economy. *Heliyon*, *10*(4), e25934. https://doi.org/10.1016/j.heliyon.2024.e25934

Begen, N., & Atasoy, H. (2024). Technological literacy and employment: An inquiry into the adoption of learning technologies. *Telecommunications Policy*, *48*(10), 102864. https://doi.org/10.1016/j.telpol.2024.102864

Beissenova, A., Nurbekova, Zh., Zhanazarova, Z., Dzyurenich, Y., & Turebayeva, A. (2013). Labour Conflicts in Kazakhstan: A Specific Character of their Solution. *Procedia - Social and Behavioral Sciences*, *82*, 877–881. https://doi.org/10.1016/j.sbspro.2013.06.364

Bekzhanova, T., Aliyev, M., Tussibayeva, G., Altynbekov, M., & Akhmetova, A. (2023). The Development of Small and Medium-sized Businesses and its Impact on the Trend of Unemployment in Kazakhstan. *Australasian Business, Accounting and Finance Journal*, *17*(4), 73–99. https://doi.org/10.14453/aabfj.v17i4.06

Dabić, M., Maley, J. F., Švarc, J., & Poček, J. (2023). Future of digital work: Challenges for sustainable human resources management. *Journal of Innovation & Knowledge*, *8*(2), 100353. https://doi.org/10.1016/j.jik.2023.100353

Donald, W. E., Baruch, Y., & Ashleigh, M. J. (2023). Technological transformation and human resource development of early career talent: Insights from accounting, banking, and finance. *Human Resource Development Quarterly*, *34*(3), 329–348. https://doi.org/10.1002/hrdq.21491

Ferilli, G. B., Palmieri, E., Miani, S., & Stefanelli, V. (2024). The impact of FinTech innovation on digital financial literacy in Europe: Insights from the banking industry. *Research in International Business and Finance*, *69*, 102218. https://doi.org/10.1016/j.ribaf.2024.102218

Jahan, N., & Zhou, Y. (2023). Covid-19 and digital inclusion: Impact on employment. *Journal of Digital Economy*, *2*, 190–203. https://doi.org/10.1016/j.jdec.2024.01.003

Kemper, J., & Renold, U. (2024). Evaluating the impact of general versus vocational education on labor market outcomes in Egypt by means of a regression discontinuity design. *Journal of Development Economics*, *166*, 103172. https://doi.org/10.1016/j.jdeveco.2023.103172

Komp-Leukkunen, K. (2024). How ChatGPT shapes the future labour market situation of software engineers: A Finnish Delphi study. *Futures*, *160*, 103382. https://doi.org/10.1016/j.futures.2024.103382

Kurt, R. (2019). Industry 4.0 in Terms of Industrial Relations and Its Impacts on Labour Life. *Procedia Computer Science*, *158*, 590–601. https://doi.org/10.1016/j.procs.2019.09.093

Lin, P. M. C., Peng, K.-L., Wilson Au, W. C., & Baum, T. (2023). Labor market transformation in the hospitality gig economy in a post pandemic era: Impacts of institutional governance. *International Journal of Contemporary Hospitality Management*, *35*(4), 1490–1510. https://doi.org/10.1108/IJCHM-12-2021-1531

Nazarova, G., Honcharova, S., Achkasova, O., Nazarov, N., Semenchenko, A., & Khomenko, P. (2024). The impact of digitalization on labor market transformation: opportunities and challenges. *Financial and Credit Activity Problems of Theory and Practice*, *3*(56), 459–473. https://doi.org/10.55643/fcaptp.3.56.2024.4391

Nguyen, T. T., Dao, T. T., Tran, T. B., Nguyen, H. T. T., Le, L. T. N., & Pham, N. T. T. (2024). Fintech literacy and digital entrepreneurial intention: Mediator and Moderator Effect. *International Journal of Information Management Data Insights*, *4*(1), 100222. https://doi.org/10.1016/j.jjimei.2024.100222

Nicol, M., Lu, L., & Wang, C. (2022). A Survey Study on the Technology and Public Acceptance of Remote Labor*. *IFAC-PapersOnLine*, *55*(27), 416-423. https://doi.org/10.1016/j.ifacol.2022.10.548

Ren, J., Gao, T., Shi, X., Chen, X., & Mu, K. (2023). The impact and heterogeneity analysis of digital financial inclusion on non-farm employment of rural labor. *Chinese Journal of Population, Resources and Environment*, *21*(2), 103–110. https://doi.org/10.1016/j.cjpre.2023.06.006

Ribeiro, B., Meckin, R., Balmer, A., & Shapira, P. (2023). The digitalisation paradox of everyday scientific

labour: How mundane knowledge work is amplified and diversified in the biosciences. *Research Policy*, *52*(1), 104607. https://doi.org/10.1016/j.respol.2022.104607

Sarabdeen, M., & Alofaysan, H. (2023). Investigating the Impact of Digital Transformation on the Labor Market in the Era of Changing Digital Transformation Dynamics in Saudi Arabia. *Economies*, *11*(1), 12. https://doi.org/10.3390/economies11010012

Uctu, R., Tuluce, N. S. H., & Aykac, M. (2024). Creative destruction and artificial intelligence: The transformation of industries during the sixth wave. *Journal of Economy and Technology*, *2*, 296–309. https://doi.org/10.1016/j.ject.2024.09.004

Urekeshova, A., Rakhmetulina, Z., Dubina, I., Barykin, S., & Mottaeva, A. (2023). Development of the Labor Market in the Context of Kazakhstan's Digital Economy and the Concept of Sustainable Development. *Journal of Law and Sustainable Development*, *11*(11), e1842. https://doi.org/10.55908/sdgs.v11i11.1842

Wang, X., Chen, M., & Chen, N. (2024). How artificial intelligence affects the labour force employment structure from the perspective of industrial structure optimisation. *Heliyon*, *10*(5), e26686. https://doi.org/10.1016/j.heliyon.2024.e26686

Information about the author

***Aidarbek T. Gyiazov** – Doc.Sc. (Econ.), Professor, Batken State University, Batken, Kyrgyzstan, email: aziret-81@mail.ru, ORCID ID: https://orcid.org/0000-0002-8200-7438

Автор туралы мәліметтер

***Гыязов А.Т.** – э.ғ.д., профессор, Баткенский государственный университет, Баткен, Кыргызстан, email: aziret-81@mail.ru, ORCID ID: https://orcid.org/0000-0002-8200-7438

Сведения об авторе

***Гыязов А.Т.** – д.э.н., профессор, Баткенский государственный университет, Баткен, Кыргызстан, email: aziret-81@mail.ru, ORCID ID: https://orcid.org/0000-0002-8200-7438