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Wages and working conditions in the context of digitalization

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Abstract

Artificial intelligence is transforming our way of life and work, and its impact on the future of work is the subject of numerous discussions. The development of AI technologies is reshaping the labor market and the skills that employers value in their employees. Today, the digital transformation of the economy has become a major trend that provides significant support for the sustainable development of our economy, improves quality and efficiency, and has a profound impact on employment. The article examines the impact of workplace digitalization on pay equity and working conditions. The study revealed that improving the quality of workplace digitalization creates new opportunities and presents new challenges for the labor market. Enhancing the digitalization process of workplaces has led to an increase in average wages. The level of wages provides vulnerable groups such as women, the elderly, and individuals with low levels of education with the opportunity to earn equal pay and has a positive impact on the protection of fundamental rights and interests, greater flexibility in employment, and increased job satisfaction. On the other hand, workplace digitalization also exacerbates wage inequality. Self-employed workers face heavier workloads and longer overtime hours. Voluntary, unpaid overtime work undermines the rights and interests of workers.

Keywords: Digital transformation, Job satisfaction, Labor market, Labor rights protection, Risks of labor digitalization, Wage distribution.

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1. Introduction

The technological revolution is fundamentally transforming the world of work, and this trend is expected to continue at a rapid pace. In fact, the COVID-19 pandemic has significantly accelerated the growth of the digital economy. Digital measures are essential for timely crisis response, mitigating the impact of future epidemics, and implementing business recovery strategies.

The digital transformation of the economy has a dual impact on overall employment: it not only contributes to the creation of new jobs but has also led to the reduction of certain jobs in traditional industries. However, overall, the digital transformation of the economy has opened up new opportunities for workers to increase their employment and income, playing an important role in promoting employment, stabilizing the labor market, and expanding job opportunities for the population. On the one hand, artificial intelligence technology can automate routine tasks, allowing employees to focus on more complex, creative, and fulfilling work. AI may replace workers in specific fields, such as manufacturing, where machines can perform tasks more efficiently and accurately than humans. In such cases, employees will need to undergo retraining to adapt to new jobs that require different skill sets.

The imbalance of regional development in Kazakhstan's labor market is becoming increasingly pronounced. Issues of regional development are among the key challenges of the global labor market. There are differences in the industrial structure across various regions some regions are based on the energy sector, while others rely on manufacturing and the service sector.

These differences lead to varying rates of growth and job creation opportunities across regions. Moreover, insufficient infrastructure such as transportation, communication, and education, hinders investment and job creation in certain areas. In recent years, the influence of political factors on economic activity has become increasingly evident, while tax, investment, and trade policies have further exacerbated regional development disparities, which in turn affect employment.

In the course of the study, the authors aimed to identify differences in the perception of digital changes in the workplace among employees aged 20 to 60 in Astana and Atyrau. The degree of use of information technologies in the workplace was selected as the variable of the research. The objective of this study is to determine the impact of digital technologies on the labor market and to assess employees' attitudes toward such changes. The article explores whether vulnerable population groups can equally benefit from the advantages brought about by the growing digitalization of work.

1.1. To Achieve the Stated Objective, The Following Tasks Were Set in the Article

(1) To study the main factors influencing changes in the labor market;
(2) To examine the wages of vulnerable population groups, wage distribution, and working conditions;
(3) To determine a regression model for the impact of workplace digitalization on wages;
(4) To identify differences in how people perceive digital changes in the workplace in Astana and Atyrau through a survey;
(5) To analyze the relationships between the variables.

2. Literature Review

The rapid development of artificial intelligence and automation technologies is transforming entire industries, which may lead to the disappearance of certain jobs and the creation of new ones. AI technology may place administrative workers at a higher risk of unemployment, as such roles are more likely to be replaced by automation. Technological changes require the workforce to possess new skills and knowledge, potentially leading to a skills mismatch, where the existing workforce lacks the necessary competencies to adapt to new technologies. These changes may exacerbate labor market inequality and hinder workforce mobility and career advancement.

Compared to the traditional offline office, the opportunities and benefits of remote work can be divided into three levels. The first, at the micro level, includes increased individual work efficiency, reduced travel expenses, and similar advantages. The second, at the meso level, involves lower costs for office rental and equipment maintenance for companies. Third, at the macro level, remote work helps address issues such as high real estate prices, traffic congestion, and environmental pollution in large cities. These advantages stem from the separation of employees' workplaces from their everyday living spaces.

The greatest challenge of remote work lies in transforming socially active office employees into isolated individuals within their own homes. This physical isolation intensifies disconnection among employees and hinders interpersonal communication [1].

Blocked communication also disrupts the personal network that could have been formed in the office. A study conducted by the Massachusetts Institute of Technology revealed that since the shift to remote work, the formation of "weak ties" between people in a social sense has decreased by nearly 40%. In collaborative work, people are not as tightly connected as parts of a machine system they are independent and require a multitude of personal relationships to function effectively.

On the one hand, such weak ties can foster a positive atmosphere in the workplace and strengthen employees' sense of belonging and loyalty to the organization. On the other hand, these weak ties are also an important source of creativity at work. Informal conversations during daily work often give rise to a large number of innovative ideas.

The results of numerous studies are summarized in the articles (Table 1), in which the authors present an analysis of various models of the impact of the digital economy on socio-economic development.

Table 1.
Analysis of the Impact of the Digital Economy on Socio-Economic Development.

Authors of the Study	Dependent Variable	Factor Properties
Choi, et al. [2]; Stavropoulos and Mourtzis [3] and Matthess and Kunkel [4]	Internet Access	ICT development strategy, investment in information and communication technologies, development of communication infrastructure, development of digital ecosystems, digital policy and regulation, information security and cybersecurity
Babich and Hilary [5]; Bodkhe, et al. [6] and Pradhan, et al. [7]	Use of personal computer, internet access	Willingness to change, ability to adapt to innovation, openness to technological changes, receptiveness to innovation, knowledge and innovation economy
Bergvall-Kåreborn and Howcroft [8]; Turner and Oyekan [9] and Haftu [10]	Dissemination of the Internet and computers	Human capital development, competencies and skills, intellectual capital, labor resources, knowledge economy, Human Development Index (HDI), social resilience, health and longevity, environmental well-being, urban living comfort, sustainable societal development, competencies and skills
Hur [11]; Bergvall-Kåreborn and Howcroft [8]; Ciucu-Durnoi, et al. [12] and Myovella, et al. [13]	Gross Domestic Product (GDP)	Investment in information and communication technologies, technological development, development of telecommunications infrastructure, emerging professions, and digital competencies
Frey and Osborne [14]; Kerr, et al. [15]; Pellegrino, et al. [16]; Li, et al. [17]	Gross Regional Product, unemployment rate, investment in fixed capital	Digital education, lifelong learning, information technology infrastructure, digital transformation, knowledge base, scientific and technological progress, adoption of new technologies, digital transformation, research and development, digital competencies, emerging professions
Zhang, et al. [18]; San [19]; Capone, et al. [20]; Dosi and Mohnen [21]; Li and Xu [22]; Hu, et al. [23] and Legris, et al. [24]	ICT and Productivity	Process automation, remote work and flexibility, access to information and knowledge, employee training and development, improvement of quality and services, cost reduction

2.1. Key Factors Influencing Changes in the Labor Market Situation

The key factors influencing changes in today's labor market are presented in Figure 1:

- *Economic globalization* is the process of deepening economic ties and interdependence among countries around the world, increasing the alignment of national economic regulations between countries, and enhancing the role of international economic coordination mechanisms. Economic globalization promotes a deeper international division of labor, the expansion of the global market, and the accelerated dissemination of technologies.;
- *Technological progress*, particularly the rapid development of automation and artificial intelligence, has had and will continue to have a profound impact on the labor market. Automation can increase productivity, but it can also lead to the elimination of certain jobs.;
- *Flexibility of employment forms* – Four years after the pandemic, remote work remains a highly popular concept and is even considered a key direction for the future of work. Many people have responded positively to its benefits, and both large and small enterprises, domestically and internationally, have adopted corresponding practices.
- *Changing skill requirements* – refers to a comprehensive set of skills and cultural literacy that enable individuals to quickly and effectively identify and obtain information, evaluate it, integrate it, and communicate it using specific information technology methods in a digital environment.
- *Changes in labor legislation and regulation* – Government policies and legal frameworks have a direct impact on the labor market. Low wage standards, revisions to labor laws, and changes in tax policy all influence human resource management within enterprises.
- *Demographic shifts* – Changes in population structure, particularly aging and declining birth rates, have a profound impact on labor market demand and supply.

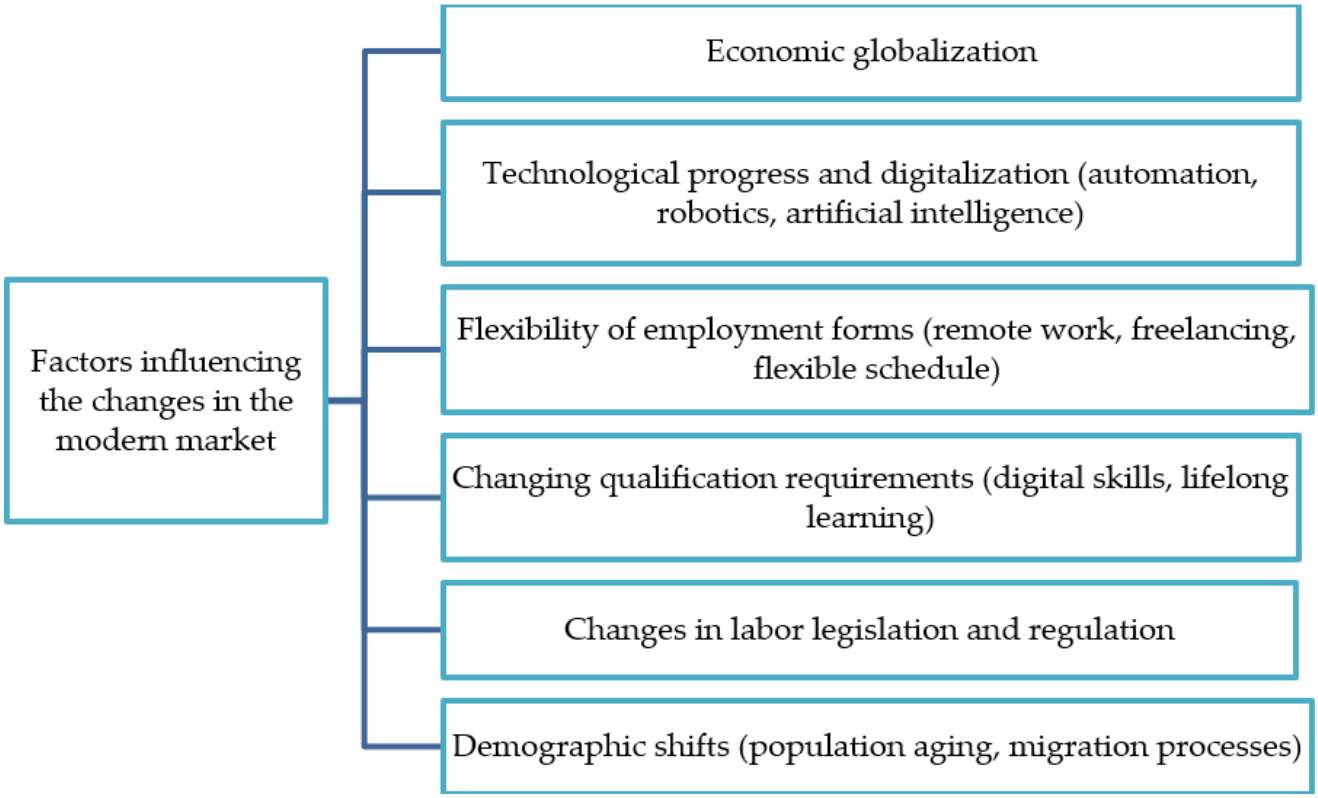

Figure 1.
Factors Influencing Changes in the Modern Labor Market.

2.2. Wage Parameters

There is a wide range of literature on the impact of workplace digitalization on wages. Much of the international literature focuses on exploring the potential for increasing average wages through digital applications. An increasing number of companies are incorporating the Internet into their daily operations, which enhances production efficiency and overall work performance. In this context, wage planning is also taken into account [25, 26]. The Internet provides employees with greater opportunities for learning. This enables them to be more satisfied with their jobs and eventually transition to more responsible positions [27].

2.3. Wages of Vulnerable Population Groups

The question of whether vulnerable groups can equally benefit from workplace digitalization remains highly relevant. Some studies have shown that in sectors where digital technologies are rapidly adopted, the number of women in full-time employment has decreased. At the same time, there has been a relative increase in non-traditional analytical tasks and interactive tasks. This shift has played a significant role in reducing the gender pay gap. However, there are also studies indicating that fields utilizing digital technologies are currently male-dominated, and women often face discrimination in hiring processes [28].

Information technologies have increased the productivity of highly skilled employees and boosted demand for non-traditional jobs in the labor market. Wages in highly skilled and non-traditional positions are higher than those in low-skilled jobs [29]. Empirical data have shown that university graduates have an advantage in the labor market. There is a growing body of research literature, and in addition, individuals with lower levels of education are also benefiting from the opportunities created by workplace digitalization, which is grounded in the theory of technological progress [30].

2.4. Wage Distribution and Working Conditions

Wage distribution can better reflect overall changes in the labor market. While the growing digitalization of workplaces contributes to improved job quality and working conditions, it also introduces challenges such as irregular schedules and overtime work. Special attention should be given to protecting the rights and interests of employees. Additionally, workers may experience "technostress" due to their inability to adapt to digital changes. Some manifestations include excessive workload, a constant sense of urgency caused by fragmented tasks, and anxiety stemming from doubts about their own capabilities [31].

Workplace ecology, overtime work, and mental health at work are valuable additions to the existing qualitative analytical literature from the perspective of ergonomics. The authors note that the digitalization of opportunities for vulnerable population groups and the growth in the number of jobs may affect the overall wage distribution in the labor market.

2.5. Regression Model of the Impact of Workplace Digitalization on Wages

The regression model of the impact of workplace digitalization on wages is considered as follows.:

$$\ln(S) = \beta \cdot C_i + X_i \cdot \rho = \beta \cdot C_i + \gamma \cdot I_i + \delta \cdot D_i + \varphi_1 \cdot Z_i + \cdots \varphi_n \cdot Z_n + \varepsilon \quad (1)$$

In Equation 1 $\ln(S) -$ is the dependent variable, representing the logarithm of wages in the workplace. $C_i -$ the level of workplace digitalization is a continuous and independent variable. X_i - Variables related to digital life. $I_i -$ internet usage, $D_i -$Digital life skills. $Z_i, \dots, Z_n -$other control variables, including individual characteristics such as work experience, education, age, and other factors affecting wages.

$\beta, \rho, \gamma, \delta, \varphi_1, \dots \varphi_n -$ are regression coefficients that indicate the influence of the corresponding variables on wages. $\varepsilon -$ represents the random error term of the model.

In this model, the coefficient β reflects the impact of workplace digitalization on wages. If the value of β is positive and statistically significant, indicating that an increase in digitalization is associated with an increase in wages.

To study the contribution of digitalization to the gender pay gap, the choice in favor of significance estimates is not entirely straightforward. Therefore, in the main part of the study [32], the author used a more balanced indicator that takes into account both the level and importance of digital knowledge and skills.

Let us consider the basic Digitalization Index, or Digitalization Index (DI), which takes into account the level and importance of digital knowledge and skills, and is calculated using the following formula:

$$DI = \frac{\sqrt{K_{LV} \cdot K_{IM}} + \sqrt{U_{LV} \cdot U_{IM}}}{2} \quad (2)$$

In Equation 2, each indicator has two properties: level (LV) and importance (IM).

K_{LV}, K_{IM} – represent the level and importance, respectively, of knowledge in electronic and computer hardware, software, and programming;

U_{LV}, U_{IM} –represent the level and importance, respectively, of the degree of use of computers and computer systems for programming, configuring functions, data entry, or information processing.

3. Materials and Methods

In the course of the study, we attempted to identify differences in the perception of digital changes in the workplace among residents of Astana and Atyrau. The research was conducted in two cities of Kazakhstan Astana (with over 1.5 million residents) and Atyrau (with over 407 thousand residents), which were selected as the study areas. Random respondents were selected, including an equal number of participants from each city. For this study, a sample of 1,024 respondents from each selected city was chosen, with an equal number of participants from both locations. A structured questionnaire was developed to collect responses, which was administered via a Google Form. A link was sent to the respondents, and they completed the survey at their convenience. Respondents were divided into three categories: employees, employers, and self-employed individuals (full-time workers aged 20 to 60). Self-employed respondents who did not intend to use the Internet at work were excluded from the study. The respondents are employees of government institutions and private companies. The sectors include agriculture, industry, services, and education. Nearly half of the respondents were men, with an average age of 36. The respondents who participated in the selection process hold higher education degrees: 64.37% in Astana and 64.95% in Atyrau. The remaining 4.68% in Astana and 11.81% in Atyrau completed secondary school, while 30.95% in Astana and 23.24% in Atyrau have incomplete higher education (Table 2).

Table 2.
Characteristics of the respondents.

Parameters		**Astana**		**Atyrau**	
		Repeatability	**Percentage (%)**	**Repeatability**	**Percentage (%)**
Gender	Male	671	65.52	652	63.67
	Female	353	34.48	372	36.33
Age	from 20 to 30 years old	147	14.40	216	21.08
	from 31 to 40 years old	394	38.45	401	39.12
	from 41 to 50 years old	420	41.05	348	34.00
	from 51 to 60 years old	63	6.10	59	5.80
The level of education	Middle school	48	4.68	121	11.81
	Incomplete higher education	317	30.95	238	23.24
	Higher education	659	64.37	665	64.95

The survey was conducted using a Likert scale (a 5-point scale ranging from "strongly disagree" to "strongly agree"). This article examines respondents' perceptions of digital changes and their impact on professional development, productivity, and the work environment. The assessment is based on seven aspects: labor market digitalization, competencies and skills, flexibility of employment forms, risks of digitalization, work environment and conditions, work-life balance, and the impact of digital technologies on working conditions.

3.1. Frequency Analysis

The aim of this study is to determine the impact of digital technologies on the labor market and to assess employees' attitudes toward such changes.

Table 3.
Frequency Analysis of Respondents.

Parameters	Statement	Astana					Atyrau				
		V.D	D	N	S	V.S	V.D	D	N	S	V.S
Digitalization of the Labor Market	The transition to digital technologies is contributing to a reduction in the number of traditional jobs in my industry.	61 (6)	123 (12)	0 (0)	665 (65)	175 (17)	133 (13)	204 (20)	0 (0)	564 (55)	123 (12)
	The transition to digital technologies increases the skill requirements for employees.	92 (9)	154 (15)	31 (3)	614 (60)	133 (13)	61 (6)	175 (17)	92 (9)	461 (45)	235 (23)
	The automation of work processes has a positive impact on the quality of tasks performed.	82 (8)	389 (38)	41 (4)	410 (40)	102 (10)	82 (8)	410 (40)	20 (2)	440 (43)	72 (7)
	Remote work using digital tools has become much easier.	72 (7)	225 (22)	0 (0)	645 (63)	82 (8)	92 (9)	717 (70)	0 (0)	195 (19)	20 (2)
	The implementation of digital technologies would create new jobs in my industry.	82 (8)	410 (40)	20 (2)	451 (44)	61 (6)	51 (5)	563 (55)	102 (10)	226 (22)	82 (8)
Competencies and Skills	To have a successful career, an employee must possess digital skills.	10 (1)	154 (15)	41 (4)	727 (71)	92 (9)	72 (7)	236 (23)	51 (5)	614 (60)	51 (5)
	My organization offers digital skills training programs.	102 (10)	697 (68)	20 (2)	154 (15)	51 (5)	20 (2)	727 (71)	72 (7)	113 (11)	92 (9)
	I regularly study new digital technologies related to my profession.	61 (6)	779 (76)	82 (8)	82 (8)	20 (2)	51 (5)	819 (80)	72 (7)	72 (7)	10 (1)
Flexibility of employment forms	In recent years, remote work has become increasingly popular in my field.	41 (4)	420 (41)	10 (1)	512 (50)	41 (4)	41 (4)	307 (30)	154 (15)	461 (45)	61 (6)
	A flexible work schedule has a positive impact on my productivity.	41 (4)	420 (41)	10 (1)	522 (51)	31 (3)	51 (5)	307 (30)	51 (5)	553 (54)	61 (6)
	I feel that remote work reduces team spirit and makes it harder to interact with colleagues.	82 (8)	481 (47)	31 (3)	410 (40)	20 (2)	51 (5)	522 (51)	41 (4)	348 (34)	61 (6)
Risks of digitalization	The implementation of digital technologies increases the risk of losing personal data.	41 (4)	204 (20)	0 (0)	728 (71)	51 (5)	51 (5)	216 (21)	41 (4)	665 (65)	51 (5)
	Digital transformation increases the workload on employees due to the need for continuous learning.	41 (4)	204 (20)	0 (0)	697 (68)	82 (8)	72 (7)	266 (26)	31 (3)	614 (60)	41 (4)
	Automation and artificial intelligence can lead to job loss.	51 (5)	256 (25)	0 (0)	697 (68)	20 (2)	41 (4)	256 (25)	0 (0)	707 (69)	20 (2)
Work environment and labor conditions	I have all the digital tools necessary for effective work.	51 (5)	512 (50)	0 (0)	389 (38)	72 (7)	61 (6)	461 (45)	0 (0)	461 (45)	41 (4)
Work-life balance	A flexible work schedule is encouraged in my organization.	112 (11)	410 (40)	0 (0)	461 (45)	41 (4)	92 (9)	615 (60)	0 (0)	307 (30)	10 (1)

The impact of digital technologies on working conditions	The transition to digital technologies has improved working conditions in my field.	51 (5)	461 (45)	0 (0)	512 (50)	0 (0)	51 (5)	461 (45)	0 (0)	502 (49)	10 (1)
	Digital technologies allow me to work more efficiently.	20 (2)	205 (20)	0 (0)	779 (76)	20 (2)	51 (5)	461 (45)	0 (0)	461 (45)	51 (5)

Note: V.D.-Very Discontent, D.- Discontent, N.-Neutral, S.- Satisfied, V.S.-Very Satisfied.

Table 3 presents an analysis of the entire questionnaire in the form of a comparison of the responses received from both parties.

The statement "Digital transformation affects the reduction of traditional jobs in my region" was positively received by the majority of respondents: in the city of Astana, 65% agreed and 17% strongly agreed, while 12% disagreed; in the city of Atyrau, 55% agreed and 12% strongly agreed, while 20% disagreed. This confirms the trend of decreasing jobs that do not require digital literacy.

The high level of approval (Astana – 73%; Atyrau – 68%) indicates that "The transition to digital technologies increases the qualification requirements for employees." This highlights the need for additional training and retraining of personnel.

Half of the respondents (Astana – 50%, Atyrau – 50%) believe that "The automation of work processes positively affects the quality of work performed." This indicates a positive perception of digitalization as a tool for improving efficiency. However, the other half (Astana – 50%, Atyrau – 50%) disagree with this statement. The implementation of automation often leads to staff reductions, as labor productivity increases significantly. It can be said that employees are concerned about the sustainability of their jobs.

In the city of Astana, 71% of respondents reacted positively to the statement "Remote work with digital tools has become much easier," which confirms the general trend toward an increase in flexible forms of employment. In the city of Atyrau, slightly less than 31% of respondents support this view.

Opinions on the statement "The implementation of digital technologies would create new jobs in my industry" were divided: in the city of Astana, 50% of respondents believe that digitalization contributes to the creation of new jobs, while 48% disagree with this; in the city of Atyrau, 30% of respondents believe digitalization contributes to job creation, while 60% disagree.

The majority of respondents (Astana – 80%, Atyrau – 65%) agreed with the statement "To have a successful career, an employee must possess digital skills." However, only 20% noted that "My organization offers digital skills training programs," and just (Astana – 10%, Atyrau – 8%) of respondents indicated that they "Regularly study new digital technologies related to their profession." This confirms the importance of digital literacy in today's professional environment. The responses suggest that in many cases, employees have to learn digital tools on their own in order to acquire digital skills.

The majority of respondents (Astana – 54%, Atyrau – 51%) agree that "Remote work in my field has become increasingly popular in recent years," while (Astana – 45%, Atyrau – 34%) of respondents disagree with this statement.

The majority of respondents (Astana – 76%, Atyrau – 70%) supported the statement "The implementation of digital technologies increases the risk of losing personal data." Additionally, most respondents (Astana – 70%, Atyrau – 71%) agreed with the statement that "Automation and artificial intelligence can lead to job loss," highlighting the need to enhance cybersecurity and reflecting current concerns about changes in employment patterns.

The statement "I have all the digital tools necessary for effective work" was supported by 45% of respondents in Astana and 49% in Atyrau, while half of the respondents (Astana – 50%, Atyrau – 50%) disagreed with this statement, indicating a moderate level of access to technological resources.

As a result of the survey, we found that salary bonuses related to the growing digitalization of workplaces are higher for residents of Astana than for those of Atyrau. The survey also took into account health insurance, pension insurance, unemployment insurance, accident insurance, property insurance, housing, and labor contract insurance, the work of trade unions, and other control variables that concern the population. The growing digitalization has a positive impact on the protection of fundamental labor rights and interests. Due to the increasing digitalization of workplaces, opportunities for contract employment and union membership have increased. Labor and social risk insurance has also improved. During the survey, we also found that as work becomes increasingly digital, employee satisfaction, work schedules, flexibility, and work intensity all improve. The increasing level of digitalization in the workplace has a positive impact on improving working conditions.

3.2. Independent Samples T-Test

To assess the average level and identify differences in the perception of digital changes in the workplace between residents of Astana and Atyrau, we use the independent samples t-test method. To assess the average level of differences in the perception of digital changes in the workplace between residents of Astana and Atyrau, we use the independent samples t-test method. As shown in Table 4, there are average differences in the perception of quantitative changes in the workplace between residents of Astana and Atyrau.

For the following parameters, the difference between the mean values of the models is insignificant: labor market digitalization, competencies and skills, work-life balance, and the impact of digital technologies on working conditions. For the following parameters, there is a statistically significant difference between the mean values in the two groups: flexibility of employment forms, risks of digitalization, and the work environment and working conditions.

Table 4.
t-criterion for independent simples.

Parameters	Distribution Parameters	Astana	Atyrau	t-value
Digitalization of the labor market	The average value	6.08	6.02	0.108
	Standard deviation	0.54	0.55	
Competencies and skills	The average value	3.04	2.83	0.233
	Standard deviation	0.84	0.83	
Flexibility of forms of employment	The average value	4.09	2.84	1.722
	Standard deviation	0.71	0.69	
Risks of digitalization	The average value	6.89	4.56	5.151
	Standard deviation	0.44	0.48	
Work environment and working conditions	The average value	6.67	4.56	6.861
	Standard deviation	0.30	0.31	
Work-life balance	The average value	4.55	4.54	0.022*
	Standard deviation	0.44	0.43	
The impact of digital technologies on working conditions	The average value	7.54	7.45	0.293
	Standard deviation	0.30	0.31	

Note: *: $p<0.05$

4. Results

An analysis of the relationships between variables was conducted to determine the degree of correlation. Logarithmic wages positively correlate with education and relevant digital skills, as well as the flexibility of forms of employment, while they negatively correlate with the work environment and working conditions, work-life balance, and risks of digitalization (Table 5). The results confirm a positive correlation between variables such as gender, age, education, labor market digitalization, competencies and skills, flexibility of employment forms, the impact of digital technologies on working conditions, ergonomics, working conditions, and logarithmic wages. The results also confirm a negative correlation between variables such as the risks of digital transition, work-life balance, and logarithmic wages (for the city of Astana).

The results confirm a positive correlation between variables such as gender, age, education, labor market digitalization, competencies and skills, flexibility of employment forms, the impact of digital technologies on working conditions, ergonomics, working conditions, work-life balance, and logarithmic wages. The results also confirm a negative correlation between variables such as the risks of digital transition and logarithmic wages (for the city of Atyrau).

Table 5.
Results of the Multiple Regression Analysis.

Parameters 1	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	ln(S)	**Mean value of the dependent variable**	**Adjusted R^2**	**F-statistic**	**Reproducibility**
Gender	0.035** (0.014)	0.055	0.003	18.012	1024
Age	0.038** (0.034)	0.033	0.009	14.675	1024
Education	0.054 (0.056)	0.001	0.008	12.092	1024
Digitalization of the labor market	0.006 (0.045)	0.009	0.014	1.0676	1024
Competencies and skills	0.097 (0.032)	0.002	0.014	10.643	1024
Flexibility of employment forms	0.054 (0.011)	0.093	0.007	5.098	1024
Risks of digitalization	-0.054*** (0.001)	0.033	0.005	6.765	1024
Work environment and working conditions	0.043*** (0.087)	0.061	0.002	12.098	1024
Work-life balance	-0.005*** (0.014)	0.005	0.005	10.021	1024
Impact of digital technologies on working conditions	0.023 (0.012)	0.034	0.041	10.321	1024
Parameters 2	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
	ln(S)	Mean value of the dependent variable	Adjusted R^2	F-statistic	Reproducibility
Gender	0.044** (0.012)	0.044	0.029	14.009	1024
Age	0.038** (0.034)	0.062	0.037	14.012	1024
Education	0.064 (0.081)	0.002	0.055	8.091	1024
Digitalization of the labor market	0.035** (0.045)	0.007	0.003	4.0668	1024
Competencies and skills	0.092 (0.062)	0.007	0.090	9.680	1024
Flexibility of forms of employment	0.031 (0.001)	0.003	0.050	6.098	1024
Risks of digitalization	-0.034*** (0.001)	0.005	0.067	5.765	1024
Work environment and working conditions	0.021*** (0.005)	0.041	0.042	10.007	1024
Work-life balance	0.006 (0.006)	0.025	0.001	8.020	1024
Impact of digital technologies on working conditions	0.063 (0.002)	0.021	0.020	9.377	1024

Note: Parameters 1 все переменные для города Астана, Parameters 2 все переменные для города Атырау.
*: p<0.05, **: p<0.01, ***: p<0.001.

But there are also negative aspects of digitalization. As control variables (Equation 1), we selected unpaid overtime work, forced overtime work, and the total amount of overtime in logarithmic form. The total amount of unpaid overtime work is used as the dependent variable. In Table 6, the total shift duration and the total duration of unpaid overtime work are used as dependent variables. The total duration of overtime work is calculated based on the number of "overtime hours worked in the past month" and unpaid overtime work. Total working time is determined by subtracting the total duration of overtime work and the duration of paid overtime work.

The regression results are presented in Table 6. The findings show that positions with a higher level of digitalization may involve more overtime work. Regarding the share of overtime, "for every one standard deviation increase in the level of digitalization, the share of overtime increases by 0.4%." The degree of digitalization has a similar effect on the share of forced overtime: for every standard deviation increase in job digitalization, the proportion rises by 0.4%.

The length of the working day increased by 8%, and the total duration of unpaid overtime increased by 11%, although high-level positions offer a better foundation for employees in terms of rights and interest protection, as well as a more flexible and independent work However they also increase the burden on employees working overtime (in most cases, for the city of Astana). The digital use of the Internet has blurred the boundaries between work and personal life, leading to a heavier workload for employees.

The level of digitalization has a significant impact on the overall situation regarding overtime, its duration, and the length of unpaid overtime, but it does not affect forced overtime.

Table 6.
Level of Workplace Digitalization and Overtime Work.

Parameters 1	**(1)** **Overtime work**	**(2)** **Forced overtime work**	**(3)** **ln (Total overtime hours)**	**(4)** **ln (Unpaid overtime hours)**
Workplace digitalization	0.042* (0.006)	0.004** (0.003)	0.081* (0.022)	0.112* (0.014)
Sample size	832	832	832	832
Mean of the dependent variable (hours/month)	0.342	0.087	10.43	5.65
Parameters 2	(5) Overtime work	(6) Forced overtime work	(7) ln (Total overtime hours)	(8) ln (Unpaid overtime hours)
Workplace Digitalization	0.031* (0.005)	0.004** (0.007)	0.087* (0.043)	0.165* (0.009)
Sample Size	798	798	798	798
Mean Dependent Variable (hours/month)	0.433	0.023	9.46	7.99

Note: The mean value of the dependent variable, which refers to the total duration of overtime and the duration of unpaid overtime, represents the average value before the logarithmic transformation. The unit of measurement is hours per month.
*: p<0.05, **: p<0.01, ***: p<0.001
Parameters 1: all variables for the city of Astana
Parameters 2: all variables for the city of Atyrau.

To study how digitalization affects the work environment, variables related to job satisfaction, task autonomy, and schedule flexibility were selected.

Table 7.
Level of Workplace Digitalization and Work Environment.

Parameters 1	**(1)** **Job Satisfaction**	**(2)** **Task Autonomy**	**(3)** **Schedule Flexibility**
Workplace Digitalization	0.065* (0.008)	0.006** (0.012)	0.082* (0.021)
Sample Size	832	832	832
Mean Dependent Variable (hours/month)	0.654	0.345	13.13
Parameters 2	(5) Job satisfaction	(6) Autonomy in task performance	(7) Schedule flexibility
Workplace Digitalization	0.037* (0.006)	0.004** (0.005)	0.056* (0.003)
Sample Size	798	798	798
Mean Dependent Variable (hours/month)	0.4331	0.020	10.41

Note: The mean value of the dependent variable, which refers to the total duration of overtime and the duration of unpaid overtime, represents the average value of the dependent variable before the logarithmic transformation. The unit of measurement is hours per month.
*: p<0.05, **: p<0.01, ***: p<0.001
Parameters 1: all variables for the city of Astana
Parameters 2: all variables for the city of Atyrau.

As shown in Table 7, the more digitalized the work becomes, the more satisfied and independent employees feel in performing tasks and managing their working time. An increase in the level of workplace digitalization has a positive impact on improving working conditions. Greater flexibility in the workplace is also achieved through functional comfort for women, the elderly, and other vulnerable groups.

5. Discussion

Digital transformation of the economy has also increased the demand for high-quality and highly skilled labor. The digital transformation of the economy to some extent, influences the digital transformation of businesses. Company-level digital transformation affects not only science and technology enterprises, such as integrated circuit manufacturing, software, and information services, but also companies across various sectors, including manufacturing and retail.

This process involves not only the simultaneous implementation and management of digital technologies within enterprises but also the use of these technologies to drive systematic changes in organizational structure, business models, workforce composition, management systems, and other aspects of corporate operations. As a result, the demand is growing for high-quality and highly skilled professionals, such as software engineers, data analysts, and network engineers, who can not only increase employee income but also contribute to technological innovation and sustainable quality development. When faced with the impact of the digital transformation of the economy on employment, we must adopt a rational, objective, and well-reasoned approach. It is important to understand that the digital transformation of the economy is not only an inevitable step in adapting to a new wave of scientific and technological revolution and industrial change, but also a vital support for the country's development.

The future of the labor sphere will be shaped by artificial intelligence, and both employees and employers must be prepared for the upcoming changes. By investing in technology and education, we can ensure a smooth and fair transition to an AI-driven labor market for everyone.

In particular, the impact of the digital transformation of the economy on employment varies depending on the region, industry, and demographic group. From a regional perspective, regions with a high level of economic development benefit from advanced digital infrastructure, strong educational resources, and high-tech research and development opportunities. The degree of digital transformation in the economy is also relatively high, which has contributed to an overall increase in employment.

6. Conclusion

Addressing the issue of income inequality in the labor market is an important matter. Digitalization has created more employment opportunities and contributed to the improvement of employment structure.

This study has shown that the growing digitalization of workplaces creates both opportunities and challenges for the labor market. It enables various groups to equally receive wage premiums, which positively influences employment support for vulnerable groups, improves formal labor contracts, promotes the establishment of trade union systems, and increases insurance benefits. However, employees also face higher workloads and longer overtime hours. Voluntary unpaid overtime work has led to the violation of "hidden" rights and interests (in most cases, in the city of Astana).

According to the study, workforce digitalization has a positive impact on wage premiums, and vulnerable groups such as women, the elderly, and individuals with low levels of education can equally benefit from the wage premium associated with digitalization. The development of workforce digitalization will also lead to an overall increase in wages in the labor market.

Organizations should actively embrace technological progress, placing special emphasis on retraining and upskilling employees to adapt to the changes brought about by new technologies. Training employees in digital skills not only increases productivity but also helps them adapt to the new environment.

References

[1] S. N. Wodajeneh, D. K. Azene, B. B. Abebe, K. J. Sileyew, and G. T. Dadi, "Ergonomic risk factors analysis in remote workplace," *Theoretical Issues in Ergonomics Science*, vol. 24, no. 6, pp. 681-697, 2023. https://doi.org/10.1080/1463922X.2022.2135788

[2] T. M. Choi, S. Kumar, X. Yue, and H. L. Chan, "Disruptive technologies and operations management in the industry 4.0 era and beyond," *Production and Operations Management*, vol. 31, no. 1, pp. 9-31, 2022. https://doi.org/10.1111/poms.13622

[3] P. Stavropoulos and D. Mourtzis, "Digital twins in industry 4.0," in Design and operation of production networks for mass personalization in the era of cloud technology: Elsevier, 2022, pp. 277-316.

[4] M. Matthess and S. Kunkel, "Structural change and digitalization in developing countries: Conceptually linking the two transformations," *Technology in Society*, vol. 63, p. 101428, 2020. https://doi.org/10.1016/j.techsoc.2020.101428

[5] V. Babich and G. Hilary, "OM forum—Distributed ledgers and operations: What operations management researchers should know about blockchain technology," *Manufacturing & Service Operations Management*, vol. 22, no. 2, pp. 223-240, 2020.

[6] U. Bodkhe *et al.*, "Blockchain for industry 4.0: A comprehensive review," *IEEE Access*, vol. 8, pp. 79764-79800, 2020. https://doi.org/10.1109/ACCESS.2020.2988579

[7] R. P. Pradhan, G. Mallik, and T. P. Bagchi, "Information communication technology (ICT) infrastructure and economic growth: A causality evinced by cross-country panel data," *IIMB Management Review*, vol. 30, no. 1, pp. 91-103, 2018. https://doi.org/10.1016/j.iimb.2018.01.001

[8] B. Bergvall-Kåreborn and D. Howcroft, "'The future's bright, the future's mobile': a study of Apple and Google mobile application developers," *Work, employment and society*, vol. 27, no. 6, pp. 964-981, 2013.

[9] C. Turner and J. Oyekan, "Manufacturing in the age of human-centric and sustainable industry 5.0: Application to holonic, flexible, reconfigurable and smart manufacturing systems," *Sustainability*, vol. 15, no. 13, p. 10169, 2023. https://doi.org/10.3390/su151310169

[10] G. G. Haftu, "Information communications technology and economic growth in Sub-Saharan Africa: A panel data approach," *Telecommunications Policy*, vol. 43, no. 1, pp. 88-99, 2019. https://doi.org/10.1016/j.telpol.2018.03.010

[11] H. Hur, "Job security matters: A systematic review and meta-analysis of the relationship between job security and work attitudes," *Journal of Management & Organization*, vol. 28, no. 5, pp. 925-955, 2022. https://doi.org/10.1017/jmo.2019.3

[12] A. N. Ciucu-Durnoi, C. Delcea, A. Stănescu, C. A. Teodorescu, and V. M. Vargas, "Beyond industry 4.0: Tracing the path to industry 5.0 through bibliometric analysis," *Sustainability*, vol. 16, no. 12, p. 5251, 2024. https://10.3390/su16125251

[13] G. Myovella, M. Karacuka, and J. Haucap, "Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies," *Telecommunications Policy*, vol. 44, no. 2, p. 101856, 2020. https://doi.org/10.1016/j.telpol.2019.101856

[14] C. B. Frey and M. A. Osborne, "The future of employment: How susceptible are jobs to computerisation?," *Technological Forecasting and Social Change*, vol. 114, pp. 254-280, 2017. https://doi.org/10.1016/j.techfore.2016.08.019

[15] S. Kerr, T. Maczulskij, and M. Maliranta, "Within and between firm trends in job polarization: The roles of globalization and technology," *Journal of Economic Geography*, vol. 20, no. 4, pp. 1003-1039, 2020.

[16] G. Pellegrino, M. Piva, and M. Vivarelli, "Beyond R&D: The role of embodied technological change in affecting employment," *Journal of Evolutionary Economics*, vol. 29, no. 4, pp. 1151-1171, 2019. https://doi.org/10.1007/s00191-018-0592-2

[17] M. Li, X. Chen, Z. Wang, and R. Zhou, "Sustainable development in the digital economy: How platform exploitation perception influences digital workers' well-being via job rewards and job security," *Sustainability*, vol. 17, no. 5, pp. 2071-1050, 2025. https://10.3390/su17051920

[18] Y. Zhang, H. Luo, and Y. Tian, "AI-driven automation in sustainable material development," *Journal of Cleaner Production*, vol. 278, p. 124381, 2021. https://doi.org/10.1016/j.jclepro.2020.124381

[19] S. San, "Labor supply and directed technical change: Evidence from the termination of the bracero program in 1964," *American Economic Journal: Applied Economics*, vol. 15, no. 1, pp. 136-163, 2023. https://doi.org/10.1257/app.20200664

[20] G. Capone, F. Malerba, R. R. Nelson, L. Orsenigo, and S. G. Winter, "History friendly models: Retrospective and future perspectives," *Eurasian Business Review*, vol. 9, pp. 1-23, 2019. https://doi.org/10.1007/s40821-019-00115-4

[21] G. Dosi and P. Mohnen, "Innovation and employment: An introduction," *Industrial and Corporate Change*, vol. 28, no. 1, pp. 45-49, 2019. https://doi.org/10.1093/icc/dty064

[22] Z. Li and F. Xu, "The influence of the sense of work gain on work input—The intermediary role of professional identity," *Soc. Sci. Chongqing*, vol. 4, pp. 170–184, 2023. https://doi.org/10.16719/j.cnki.1671-6981.20240116

[23] S. Hu, X. Liang, and C. Shen, "How does job insecurity affect work-life balance? A moderated mediation model," *Psychol. Sci*, vol. 47, pp. 132–141, 2024.

[24] P. Legris, J. Ingham, and P. Collerette, "Why do people use information technology? A critical review of the technology acceptance model," *Information & Management*, vol. 40, no. 3, pp. 191-204, 2003. https://doi.org/10.1016/S0378-7206(01)00143-4

[25] C. J. Boyce, G. D. Brown, and S. C. Moore, "Money and happiness: Rank of income, not income, affects life satisfaction," *Psychological Science*, vol. 21, no. 4, pp. 471-475, 2010. https://doi.org/10.1177/0956797610362671

[26] G. D. Brown, J. Gardner, A. J. Oswald, and J. Qian, "Does wage rank affect employees' well-being?," *Industrial Relations: A Journal of Economy and Society*, vol. 47, no. 3, pp. 355-389, 2008. https://doi.org/10.1111/j.1468-232X.2008.00525.x

[27] F. Wort, L. Walasek, and G. D. Brown, "Rank-based alternatives to mean-based ensemble models of satisfaction with earnings: Comment on putnam-farr and morewedge," *Journal of Experimental Psychology: General*, vol. 151, no. 11, pp. 2963– 2967, 2022. https://doi.org/10.1037/xge0001237

[28] A. Walker, "Data-driven compensation: Implications for pay equity," *ILR Review*, vol. 74, no. 5, pp. 1147–1173, 2021. https://doi.org/10.1177/00197939211007192

[29] D. Lothe, P. Tiwari, N. Patil, S. Patil, and V. Patil, "Salary prediction using machine learning," *International Journal*, vol. 6, no. 5, pp. 199–202, 2021. https://doi.org/10.51319/2456-0774.2021.5.0047

[30] S. Das, R. Barik, and A. Mukherjee, "Salary prediction using regression techniques," *Proceedings of Industry Interactive Innovations in Science, Engineering & Technology (I3SET2K19)*, 2020. https://dx.doi.org/10.2139/ssrn.3526707

[31] U. Bansal, A. Narang, A. Sachdeva, I. Kashyap, and S. P. Panda, "Empirical analysis of regression techniques by house price and salary prediction," presented at the In IOP Conference Series: Materials Science and Engineering (Vol. 1022, No. 1, p. 012110). IOP Publishing, 2021.

[32] M. M., L. S., W. J., and K. S., "Digitalization and the American workforce," Retrieved: https://www.brookings.edu/research/digitalization-and-the-american-workforce/, 2017.