Analysis of Structural Changes and Employment Dynamics in the Labor Market of Kazakhstan

| Botakoz Zh. Bolatova[1]* | Gulnur K. Kunurkulzhayeva[1] | Madina A. Tleubergenova[1] | Almagul Zh. Ibrasheva[1] | Agles M. Sapargali[1] |

[1] K. Zhubanov Aktobe Regional University, Aktobe, Kazakhstan

Corresponding author:
*Botakoz Zh. Bolatova – PhD, Department of economics and management, K. Zhubanov Aktobe Regional University, Aktobe, Kazakhstan.
Email: botik1984@mail.ru

EJEBS

ABSTRACT

Understanding structural dynamics and workforce segmentation has become essential for sustainable economic policy and employment regulation in the context of global economic transformation, technological change, and labour market volatility. The goal of the current study is to identify key worker groups with varying levels of employment stability, staff turnover, and personnel cost distribution. The fuzzy clustering algorithm (Fuzzy C-Means) is used as the primary method, which makes it possible to assign objects to several clusters with varying degrees of affiliation. The analysis was based on official statistics of the labor market in the Republic of Kazakhstan for the period 2013-2023. The analysis revealed three stable clusters: stable workforce flow cluster with low staff turnover (0.172) and balanced replacement (0.152); adaptive cluster with moderate instability, turnover of 0.355 and demand for labor up to 30 020 people; unbalanced cluster with high-cost variability (up to 19 billion tenge), compensation (coefficient of variation of 0.386) and maximum admission of graduates (up to 86,227 people). Kazakhstan's labor market is characterized by stability in traditional sectors, moderate adaptation in cyclical industries, and high volatility in technologically advanced and competitive segments. These results suggest the need for a differentiated employment policy that considers industry-specific characteristics and the digital transformation of the economy. Future research should investigate sector-specific models of human resource transformation and explore how employment dynamics can be integrated into strategies for sustainable and innovation-driven development.

1. INTRODUCTION

The employment structure shows which sectors of the economy are developing and which are stagnating. It helps governments and businesses plan investments, develop promising sectors (e.g., IT, green energy), and support those in decline (e.g., traditional industries). Without understanding the employment structure, allocating resources and stimulating economic growth effectively is impossible. Many international organisations and countries are actively studying and discussing issues related to employment structures, as they are directly linked to sustainable development, economic growth, and social stability (De Vos et al., 2020). The employment structure is a key element of any country's economic development and social stability, which shows which professions are in demand and which are becoming obsolete (Kharazishvili et al., 2020). Two key megatrends are identified: Digitalization and the COVID-19 pandemic, which affect the labour market, creating a new employment context that requires adaptation for individual workers and national economies.

Megatrends such as technological change, urbanisation, and demographic shifts are forcing workers to adapt to new conditions and companies to reconsider their HR policies (Wang et al., 2022). However, special attention is paid to the Digital transformation of the labour market through the prism of demo ethics, which creates the need to form Society 5.0 as a basis for sustainable development. At the same time, technologies serve to enhance economic growth, improve quality of life, promote social inclusion, and foster sustainable development. Education that aims to develop digital skills, critical thinking, and resilience to change plays a crucial role in this transformation (Zhanabayev et al., 2023). Understanding how jobs are distributed across industries, regions, and demographic groups allows governments and businesses to make informed decisions for sustainable development. Thus, it is possible to adapt the education system to the needs of the labour market, allowing universities to focus their efforts and increase the number of places in relevant faculties. In addition, understanding the employment structure helps develop migration programs that attract the right specialists from abroad without creating competition for local workers.

Considering global trends and internal challenges, these examples highlight the need to transform Kazakhstan's human resources policy profoundly. Similar trends are observed in other countries; for example, in Germany, the shortage of specialists in technical professions exceeded 275,000 people in 2022, prompting the state to intensify the attraction of migrants and reform the vocational education system. Employment analysis helps identify promising industries that can become growth drivers and problematic sectors that require support (OECD, 2023). Moreover, to identify groups that are particularly vulnerable when looking for work, such as young people, women, people with disabilities or workers approaching retirement age. Japan has faced the problem of an ageing population, which has affected and reduced the workforce. Therefore, the government's current policy involves actively investing in automation and attracting foreign workers to compensate for the shortage of skills and maintain economic activity (World Bank, 2022). In China, the reform of the hukou (residence permit) system aims to reduce imbalances between urban and rural areas, promoting an equal distribution of the workforce and thereby helping to mitigate the risk of social conflicts, while also improving the quality of life for the population. In Germany, where there is a shortage of skilled personnel in technical and medical professions, vocational training programs and efforts to attract foreign specialists are actively developing, which is caused by a mismatch between skills and labour market requirements (OECD, 2023). Thus, countries that actively invest in improving the employment structure achieve higher economic growth and social stability.

Kazakhstan has implemented several measures to address current labor market

issues, aiming to reduce unemployment and create new jobs. In particular, the Enbek program is focused on training and retraining the unemployed and supporting entrepreneurship. The development of the IT sector includes the creation of technology parks and tax incentives for IT companies, which helps attract investment and create highly skilled jobs. In addition, the state program Bolashak allows students to study abroad and return to work in priority industries, contributing to the formation of a competitive and skilled workforce.

The purpose of this study is to identify structural patterns and imbalances in Kazakhstan's labor market through the analysis of personnel indicators using cluster analysis. This will allow us to identify key groups of workers with different levels of employment stability, social security, and employment opportunities.

2. LITERATURE REVIEW

The structural transformation of the labour market is inevitable. Combinations of macroeconomic, institutional, and global factors significantly impact determining which groups of workers will be at risk, changes in the employment structure, and the formation of mechanisms for the redistribution of labor and regulatory strategies.

The transformation of the labour market is an integral part of economic development, and its speed depends on the level of technological progress, the availability of skilled labour, and institutional factors. Structural changes in the economy lead to segmentation, polarization of jobs and new employment cycles in the labour market. The transition from mass production to more flexible forms of labor organization was accompanied by an increase in unstable and low-paid jobs with a reduction in the segment of middle-paid employment. Norcliffe (1994) noted that a significant blow fell on resource-dependent regions, resulting in sharper changes than those in economically diversified territories. Bachmann and Burda (2010) identified "sectoral turbulence" as a change in

the economic structure that leads to employment instability and necessitates adaptation mechanisms from the state and businesses. Thus, the redistribution of employment between sectors of the economy primarily occurred through the growth of employment in the service sector, resulting from the decline of industrial jobs and the attraction of new workers who had not previously participated in the labor market. As a result, income inequality is formed. Wallace et al. (2011) found that under conditions of deindustrialization, the income gap between different categories of workers increases, with low-skilled workers finding themselves in the zone of the greatest risk of employment instability. Thus, labor precarization (the growth of temporary and unstable employment) is becoming one of the main trends in developed labor markets. In developing countries, the transition to a service-based economy can be accompanied by temporary employment issues and increased income inequality. Thus, Herrendorf et al. (2014) noted that as the economy develops, the labour force is redistributed, with employment declining in agriculture and industry but growing in the service sector. Sen (2016) noted two key factors: government restrictions (labour market regulation, migration policy, land reforms) and market dysfunctions (insufficient investment coordination, imperfect financial markets, lack of human capital) that slow down or accelerate structural changes in the labour market in Asian countries. Therefore, it is possible to accelerate structural transformation through flexible labor market regulation policies and investment in education.

Employee turnover is a complex phenomenon associated not only with wages but also with opportunities for professional growth, investment in training, industry characteristics and social factors. Thus, employers often avoid investing in personnel development in industries with high turnover, fearing that employees will leave for competitors. Based on Winterton's (2004) research, a "vicious cycle" is formed in which

insufficient staff development becomes a factor of instability. Hom et al. (2017) introduced the concept of "HR chain reaction", in which the departure of individual employees provokes mass layoffs. Therefore, a successful HR strategy should focus on retaining valuable employees. However, a moderate level of turnover can be beneficial as it promotes the renewal of ideas and skills in the team (De Winne et al., 2019). Ayodele et al. (2020) identified four key causes: the nature of the job, external industry conditions, organisational factors and individual characteristics of employees. Bolt et al. (2022) also noted the importance of social connections and the level of engagement as factors determining employees' decisions to change jobs. That is, unstable employment conditions and limited career prospects can be identified as the leading causes.

Skills imbalances and skills shortages are multifaceted problems, where structural imbalances and corporate culture may cause skills shortages. Backes-Gellner and Tuor (2010) noted that the presence of trade union councils, apprenticeship programmes, and skilled staff positively influences the recruitment success rate, while frequently hiring workers with inappropriate qualifications reduces the employer's attractiveness. Therefore, it is not enough to simply raise wages; non-material factors of job attractiveness must be taken into account. The mismatch between the education acquired and the actual needs of employers remains a significant problem. Over-education and under-skilling are different phenomena, and their combination leads to the most negative consequences – lower wages, low job satisfaction and a high probability of dismissal (Mavromaras et al., 2013). After layoffs, the workers with the best chances of promotion are those who have changed regions but retained their industry specialisation or moved to related industries within the same region (Hane-Weijman, 2021). At the same time, moving to unrelated fields of work increases the likelihood of underutilizing skills and worsening employment conditions. This means

that not every case of education-job mismatch leads to decreased productivity since some workers deliberately choose less demanding positions for a better work-life balance. In addition, the problem of labour shortages is aggravated not only by a decrease in supply but also by an imperfect system of labour reallocation between regions and sectors (Feist, 2024).

Changing labour costs directly affect innovation, productivity, and employment structure and significantly impact the growth of structural unemployment. In the context of technological progress, as Jung and Lim (2020) noted, an increase in hourly compensation and unit labour costs stimulates automation but also increases wages for the remaining workers. However, employment growth is declining, especially among low-skilled workers. Thus, rising labor costs stimulate the adoption of new technologies (Li et al., 2020). However, this effect is reduced in firms that are less dependent on the labor market and more focused on administrative resources. However, firms do not always reduce employment; they can adapt by changing the compensation structure (reducing bonuses and benefits), increasing product prices, increasing working hours, and automating. Clemens (2021) noted that such changes can lead to a redistribution of the workload among workers, worsening working conditions, and reducing long-term career prospects. Cirillo and Ricci (2022) noted that low-productivity firms are more likely to utilize temporary contracts as a cost-cutting measure, which contributes to labor market segmentation. Therefore, wage, innovation, and employment policies should take into account labor market dynamics, the impact of automation, and institutional barriers.

Research by domestic authors provides a comprehensive analysis of Kazakhstan's labour market transformation, the digital economy, and social sustainability. Kharazishvili et al. (2020) found that the labour market in Kazakhstan and other developing countries is characterized by a high degree of informal employment and significant hidden unemployment. Moreover, young people are

among the most vulnerable groups in the labour market. Also, higher education does not guarantee employment since the largest share of the unemployed are people with higher education.

Izguttiyeva et al. (2022) noted a high level of hidden unemployment, which, on the one hand, can be considered as a reserve for expanding production, but on the other hand, as a factor in destabilising the social system in the context of an economic downturn. An imbalance is noted between employers' requirements and graduates' qualifications. Khussainova et al. (2023) demonstrated that reducing the NEET segment (young people who are neither employed, studying, nor undergoing vocational training) is a crucial task for Kazakhstan's state policy, as it directly impacts economic development and social stability. The study shows that young people have a high potential for adapting to the digital economy but also require support during the transition from school to work. Suieubayeva et al. (2023) noted a significant increase in the number of jobs in IT, e-commerce, and digital services, indicating a shift in Kazakhstan's economic structure. Moreover, digitalization contributes to the spread of freelancing, remote work, and short-term contracts, which is especially important in conditions of economic instability. Kuttygalieva et al. (2024) noted the insufficient implementation of international standards. Despite Kazakhstan's ratification of several international conventions on gender equality (e.g., the Convention on the Elimination of All Forms of Discrimination against Women - CEDAW), their implementation faces administrative and institutional barriers in practice. Despite the existence of formal equality in legislation, cultural norms and stereotypes continue to hinder the full integration of women into the labour market.

3. METHODOLOGY

The methodology of the current study is based on a conducted literature review. The approaches of Bachmann and Burda (2010) and Ayodele et al. (2020) emphasized the importance of studying labour market instability and workforce segmentation, which are driven by institutional, sectoral, and behavioural factors. Winterton (2004) and De Winne et al. (2019) identified workforce turnover as both a consequence and a driver of structural imbalances, requiring comprehensive, data-driven approaches to detect latent patterns. According to Hom et al. (2017) and Feist (2024) chain reactions in HR dynamics and macroeconomic consequences of such variability, including the growth of the informal sector may distort long-term labour planning.

Therefore, multidimensional clustering approach was applied in current study to identify distinct labor market segments in Kazakhstan. The indicators used in this study were carefully selected based on the review and analysis of previous studies on labour market dynamics, employment structures, and HR processes and for their ability to capture key aspects of workforce dynamics and employment stability (Table 1).

TABLE 1. Selected indicators of workforce dynamics and labor demand

Indicator	Measurement
Employees hired during the reporting period	people
Higher education specialists hired from among those who graduated from higher education institutions in the reporting year	people
Employees left during the reporting period	people
Expected demand	people
Number of enterprises (organizations)	unit
Amount of labor costs	KZT
Enterprise costs for benefits and compensation for the year	KZT
Turnover rate	%

Total turnover rate	%
Replacement rate	%

Note: compiled based on Bureau of National Statistics (2024)

A quantitative methodology was employed to analyse the employment structure and human resource (HR) processes in Kazakhstan for the period 2013–2023. The study incorporated statistical modelling and machine learning techniques to process and interpret data related to hiring, employee turnover, labour demand, and personnel costs.

Fuzzy C-Means

The Fuzzy C-Means clustering method is used to analyse Kazakhstan's employment structure and personnel processes. It identifies groups of objects with overlapping characteristics. This method enables the determination of an object's degree of belonging to different clusters, which is crucial when examining the labour market, where the boundaries between stable employment, moderate staff turnover, and high instability are not clearly defined. This technique facilitated the detection of nuanced employment patterns and enabled an assessment of workforce stability across different sectors of the economy.

Elbow Method

The Elbow Method was used to determine the optimal number of clusters. This method is based on assessing the within-cluster dispersion (WSS) to identify the moment when the addition of new clusters ceases to significantly reduce the intra-group variability. This "elbow point" indicates the most appropriate number of clusters for robust segmentation.

Model Selection Criteria

To quantitatively evaluate model adequacy, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were applied. These criteria measure the trade-off between model fit (log-likelihood) and complexity (number of parameters). AIC focuses on minimising the information loss during model approximation, whereas BIC adds an additional penalty for model complexity to avoid overfitting. Lower values of AIC and BIC indicate a better balance between model accuracy and simplicity. In this study, both criteria confirmed the optimal number of clusters identified by the Elbow Method, ensuring the statistical reliability of the workplace segmentation.

Silhouette Score

The Silhouette Score was used to check the quality of data partitioning into clusters. It measures the proximity of objects within a cluster to each other and their distinctiveness from objects in other clusters. Silhouette Score is calculated for each object as the difference between the average distance to objects in its cluster (intra-group compactness) and the average distance to the nearest cluster (inter-group separation).

The score ranges from –1 to 1, where:

(1) Close to 1 – strong clustering (objects are well matched to their cluster),

(2) Around 0 – overlapping clusters (objects lie near the boundary between clusters),

(3) Negative values – poor clustering (objects may have been assigned to the wrong cluster).

The multi-stage statistical and analytical approach adopted in this study provided a comprehensive and statistically validated insight into the segmentation of Kazakhstan's labour market and personnel management landscape.

4. RESULTS AND DISCUSSION

Kazakhstan's labour market is undergoing significant changes influenced by various factors. According to the Ministry of Labor and Social Protection of the Population, by 2030, there will be a need for 1.6 million new specialists with specific skills (mainly technical and blue-collar jobs) in terms of the

growing demand for skilled labour. As a result, those categories who do not have specialized training may be forced out of the labour market, especially against the backdrop of active digital technologies and automation. This approach carries the risk of increasing structural unemployment: if official estimates record an unemployment rate below 5%, then, according to alternative calculations, it may reach 12%, equivalent to almost 1 million people.

For a more detailed understanding of the current situation in the labor market in Kazakhstan, Table 2 presents descriptive statistics of key indicators characterizing the dynamics of employment, staff turnover and personnel costs.

TABLE 2. Descriptive profile of employment dynamics and personnel expenditures

Variable	Valid	Miss.	Median	Mean	Std. Dev.	Coeff. Var	Min	Max
Hired_employees	11	0	$1.029 \times 10^{+6}$	$1.009 \times 10^{+6}$	68921.657	0.068	872724.0	$1.079 \times 10^{+6}$
Hired_graduates	11	0	31406.000	46721.273	26715.588	0.572	20157.0	86227.000
Employees_left	11	0	970638.00	969093.182	47837.587	0.049	903972.0	$1.049 \times 10^{+6}$
Expected_demand	10	1	14248.500	17414.100	6937.966	0.398	11239.0	30020.0
Turnover_rate	11	0	21.300	21.164	1.014	0.048	19.600	22.400
Overall_turnover_ratio	11	0	52.700	50.436	7.349	0.146	29.200	54.40
Replacement_rate	11	0	104.200	104.027	3.749	0.036	96.000	108.50
Labor_costs	11	0	$8.007 \times 10^{+9}$	$9.708 \times 10^{+9}$	$4.426 \times 10^{+9}$	0.456	$5.425 \times 10^{+9}$	$1.904 \times 10^{+10}$
Benefits_compensation	11	0	$1.164 \times 10^{+8}$	$1.009 \times 10^{+6}$	68921.657	0.386	$8.570 \times 10^{+7}$	$2.552 \times 10^{+8}$

Note: compiled by authors

The analysis of the descriptive statistics presented reflects the key characteristics of the dynamics of employment, staff turnover, and labor costs. The average and median values for most indicators are close to each other, indicating the symmetry of the distribution and relative stability of the data. Thus, the number of employees hired during the reporting period demonstrates low variability (variation coefficient of 0.068), and the median value (1.029 million) only slightly exceeds the average (1.009 million), which indicates minor deviations within the series. A similar situation is observed for the indicator of employees who left, where the median value (970638) almost coincides with the average (969093), and the low variation coefficient (0.049) confirms stability. At the same time, the indicators related to the number of hired specialists with higher education demonstrate more significant variability. The average value (46721) significantly exceeds the median (31406), which indicates a positive asymmetry of the distribution due to the presence of individual high values. The high coefficient of variation (0.572) indicates significant fluctuations within this category. The expected need for workers is also characterized by moderate variability (coefficient of variation 0.398), which may be due to variability in demand in the labor market.

Analysis of the turnover and replacement rates demonstrates the relative stability of the data. The turnover rate has an average value of 21.16, with a median of 21.3 and a low standard deviation of 1.014, indicating stable personnel processes. The overall turnover rate demonstrates somewhat more significant variability (coefficient of variation 0.146), which may indicate temporary fluctuations in the number of personnel. The replacement rate remains stable, with a median of 104.2, a mean of 104.03, and a coefficient of variation of 0.036, indicating a balance between hiring and attrition of workers. Labor cost indicators demonstrate a greater degree of variability compared to personnel characteristics. The average value of labor costs (9.708 billion) exceeds the median (8.007 billion), which indicates the possible presence of large values in the sample. The variation coefficient of 0.456 indicates high variability, which may be due to the different financial strategies employed by enterprises. A similar situation is observed for benefits and compensation costs, where the average (137.2 million) exceeds the median (116.4 million), and the variation

coefficient of 0.386 confirms the existence of significant fluctuations.

Thus, the conducted analysis allows us to conclude that most personnel indicators are stable in the presence of a certain variability in the number of hired specialists with higher education, the expected demand for workers and labor costs. To confirm the nature of the distributions, further quantile-quantile graphs (QQ-plots) are presented in Figure 1 to clarify the degree of normality of the distribution and identify possible outliers.
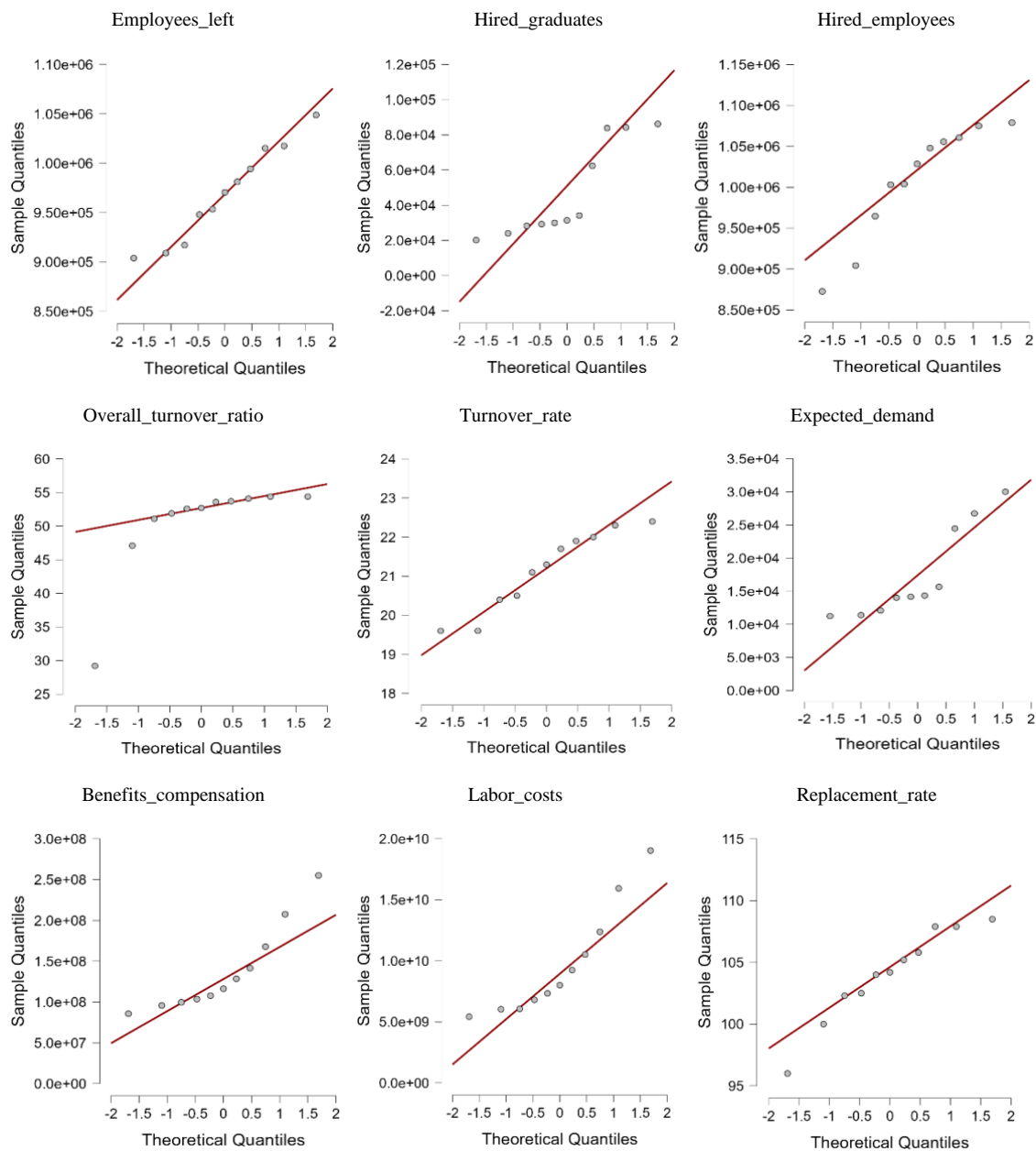

FIGURE 1. Quantile-quantile plots

Quantile-quantile (QQ) analysis of the graphs enables the identification of three groups of variables based on their degree of compliance with the normal distribution.

The first group includes indicators that demonstrate good compliance with the normal distribution since their points on the graphs are located along the diagonal line with minimal deviations. These indicators include Employees_left, Hired_employees, Turnover_rate and Replacement_rate. Their distributions can be considered close to normal, which indicates the stability of personnel processes and the absence of significant outliers.

The second group consists of variables that show moderate deviations from the normal distribution, manifested in the form of a slight asymmetry or individual outliers. This includes Overall_turnover_ratio and Expected_demand. In the case of the first indicator, outliers are observed in the lower part of the distribution, which may indicate enterprises with an abnormally low turnover rate. The expected demand for workers also demonstrates moderate positive asymmetry, which may be due to the heterogeneity of labor demand.

The third group consists of variables that deviate significantly from the normal distribution, showing a pronounced positive asymmetry and the presence of extreme values. These include Hired_graduates, Labor_costs and Benefits_compensation. These indicators are characterized by significant deviations in the right part of the graphs, which indicates the presence of enterprises with abnormally high values for the number of hired specialists with higher education, labor costs and social benefits. These outliers can significantly affect further analysis, so it is recommended to either use data transformation methods or account for extreme values when constructing regression and cluster models.

Thus, the analysis allows us to conclude that most personnel indicators have a distribution close to normal, while indicators related to costs and the number of hired specialists with higher education require additional processing due to high variability and the presence of outliers.

In the context of human resources, the identified trends may indicate several key processes occurring in Kazakhstan's labor market.

Variables with a normal distribution, such as Employees_left, Hired_employees, Turnover_rate, and Replacement_rate, indicate stability in the processes of hiring, firing, and replacing employees. This suggests that most organizations operate in predictable conditions, and employee turnover is within expected values. The absence of significant outliers in these indicators may also suggest that the HR processes in the country are well-established and do not undergo sudden changes.

Variables with moderate deviations, including Overall_turnover_ratio and Expected_demand, may reflect the existence of some instability in certain sectors of the economy. For example, outliers in the turnover rate may indicate companies or industries with particularly high turnover rates, which is often typical for less stable jobs, such as those in the service sector, trade, or construction. The expected demand for workers shows a positive asymmetry, which may indicate an increase in demand for personnel in some sectors, for example, in the technology or industrial sector.

Of greatest interest are indicators with significant deviations from the normal distribution, such as Hired_graduates, Labor_costs and Benefits_compensation. The high positive asymmetry in the data on hired specialists with higher education suggests that, in some cases, there are periods of active hiring of university graduates, which may be associated with government programs to support youth employment or corporate strategies of individual large employers. However, on average, the level of graduate recruitment remains relatively low, which may indicate difficulties in employing young specialists.

A similar situation is observed in the indicators of labor costs and social benefits: high outliers may indicate the existence of individual enterprises or sectors of the economy with extremely high personnel costs. This may be due to high competition for skilled personnel in certain industries, such as oil and gas, finance, or IT. At the same time, the bulk

of the data suggests a more restrained level of costs, which may indicate disparities in wages and social guarantees between different sectors and regions of the country.

Thus, the data reveal two key trends in Kazakhstan's labor market. On the one hand, relatively stable employment and predictable labor turnover remain in most industries. On the other hand, there are significant imbalances in the distribution of resources, expressed in uneven employment of graduates, varying needs for new workers, and a significant gap in personnel costs between different enterprises. This may indicate structural changes in the economy, a redistribution of employment between sectors, and the need for further study of the factors influencing HR policy in the country.

The Fuzzy C-Means clustering analysis reveals differences in the data structure for different groups of HR indicators (Table 2).

TABLE 2. Fuzzy C-means clustering

Group	R²	AIC	BIC	Silhouette
Stable Workforce Flow	0.093	44.160	47.350	0.210
Moderate Instability & Adaptation	0.167	22.470	24.860	0.530
High Variability & Imbalances	0.942	13.230	15.620	0.710
**Clusters 2, N 11; Clusters 3, N 11; Clusters 2, N 11				

Note: compiled by authors

The Stable Workforce Flow group is characterized by a low determination coefficient ($R^2 = 0.093$) and weak clustering quality (silhouette coefficient 0.210). This indicates weak cluster expression, which can be explained by the predictability of employee turnover indicators and the stability of hiring and firing processes. The low AIC (44.160) and BIC (47.350) values indicate a relatively simple data structure, making it difficult to identify clear groups.

The Moderate Instability & Adaptation group demonstrates $R^2 = 0.167$, which indicates a slightly higher explanatory power of the model, but still a low degree of differentiation of clusters. However, the silhouette coefficient of 0.530 indicates moderately pronounced groups, which confirms the presence of differences in the levels of labor turnover and expected labor demand. The AIC (22.470) and BIC (24.860) values are lower than in the previous group, which indicates better model suitability.

The most pronounced cluster structure is observed in the High Variability & Imbalances group, where $R^2 = 0.942$, indicating the model's high explanatory power. The silhouette coefficient of 0.710 confirms a clear division of the data into clusters, and the low AIC (13.230) and BIC (15.620) values indicate the high statistical efficiency of the model. This confirms the presence of significant differences in labor costs, compensation and employment of university graduates, which may indicate serious imbalances in the personnel policies of individual enterprises and industries.

The Fuzzy C-Means Clustering method revealed three key groups of workplaces with different levels of stability and staffing changes. The first group, Stable Workforce Flow, is characterized by low variability and predictability of staffing processes, indicating employment stability in most industries. The second group, Moderate Instability and Adaptation, reflects moderate variability in staff turnover and labour demand, indicating short-term fluctuations that depend on economic conditions. The third group, High Variability and Imbalances demonstrated the highest level of discrepancies, especially regarding personnel costs, compensation payments, and the number of specialists with higher education who were hired.

Stable workforce flow: stability of HR processes

The first group includes enterprises with predictable HR strategies and low staff turnover. In such organizations, hiring and firing processes are stabilized, and the demand for labour is not subject to sharp fluctuations.

This is typical for companies with stable business models, such as the public and financial sectors, and large industrial enterprises with long-term contracts. These results are consistent with the research of Backes-Gellner and Tuor (2010), which emphasizes that long-term investment programs in human capital and a high degree of social protection for employees reduce labour turnover. However, such stability can reduce the flexibility to adapt to economic changes, which is especially relevant in the context of digitalization and automation of production processes.

Moderate instability & adaptation: Market fluctuations and adaptation

The second group includes enterprises with moderate instability in employment dynamics associated with changes in market demand for labour. This is typical for industries with cyclical business processes, such as construction, trade, and services. These results confirm the findings of Khussainova et al. (2023), who pointed out the particular vulnerability of young people in the labour market, as young professionals often face short-term contracts and temporary employment. In addition, Cirillo and Ricci (2022) noted that in countries with transition economies, such fluctuations may be associated with an imbalance in the professional competencies of workers and the demand for skilled labour. This segment requires flexible mechanisms for regulating personnel processes, including programs for retraining and adapting workers to changing market requirements.

High variability & imbalances: imbalances in HR policies

The most pronounced differences in HR policies are recorded in the third group, where there is a high variability in employment indicators, personnel costs and social benefits. This segment includes companies operating in highly competitive industries (IT, oil and gas, finance) and areas with high staff turnover (service sector, retail). Research by Suieubayeva et al. (2023) confirmed that digitalization contributes to the expansion of the non-standard employment segment, including freelancing and short-term contracts, which increases staff instability. In addition, Kuttygalieva et al. (2024) emphasized that differences in HR policies are associated with industry-specific factors and gender imbalances, as women are less likely to occupy high-paying positions and have less protection in unstable sectors.

Differences in personnel management have a significant impact on the labour market and the economy as a whole. Stable personnel processes help reduce structural unemployment and increase productivity but can slow down the adaptation of enterprises to new technological challenges. Unstable segments require state involvement in labour market regulation, particularly regarding vocational training programs and the protection of workers with unstable employment status. As shown in the research of Feist (2024), a high level of variability in personnel policy increases the informal sector and reduces the predictability of economic growth. These imbalances require further research and development of mechanisms for optimizing personnel policy at the enterprise and the state level. Thus, the results of the cluster analysis confirm that Kazakhstan's labor market is characterized by stable personnel processes, moderate instability in the dynamics of turnover and labor demand, as well as high heterogeneity in personnel costs and the hiring of graduates, which necessitates additional regulatory measures (Table 3).

The analysis of the characteristics of the clusters obtained by the Fuzzy C-Means method allows a better understanding of the structure of HR indicators and their differences. The Stable Workforce Flow group was divided into two clusters: a small cluster (Cluster 1, N=3) and a large cluster (Cluster 2, N=8). The first cluster accounts for only 2.5% of the intra-cluster heterogeneity, while the second cluster accounts for 97.5%, indicating its dominant role. The high Within sum of squares value (27.451) for Cluster 2 indicates significant data dispersion. Cluster 1 demonstrates a high silhouette coefficient (0.716), indicating good

TABLE 3. Clusters information

Group	Cluster	1	2	3
Stable Workforce Flow	Size	3	8	
	Explained proportion within-cluster heterogeneity	0.025	0.975	
	Within sum of squares	0.713	27.451	
	Silhouette score	0.716	0.027	
	Center Hired_employees	0.583	0.164	
	Center Employees_left	1.062	0.118	
	Center Turnover_rate	0.355	0.172	
	Center Replacement_rate	-0.319	0.152	
Moderate Instability & Adaptation	Size	2	8	1
	Explained proportion within-cluster heterogeneity	0.094	0.906	0.000
	Within sum of squares	0.116	1.118	0.000
High Variability & Imbalances	Size	6	5	
	Explained proportion within-cluster heterogeneity	0.053	0.947	
	Within sum of squares	0.555	9.917	
	Silhouette score	0.843	0.144	

Note: compiled by authors

clustering quality, while the second cluster has an extremely low one (0.027), indicating poor data separability. The indicator centers indicate significant differences between the clusters: Cluster 1 is characterized by high values for the number of hired and fired employees (Hired_employees = 0.583, Employees_left = 1.062) and low turnover and replacement rates. Cluster 2, on the contrary, demonstrates low values of these indicators, indicating enterprises with minimal personnel dynamics.

In the Moderate Instability & Adaptation group, three clusters are observed, but Cluster 3 (N=1) does not contribute to heterogeneity, and the main division occurs between Cluster 1 (N=2) and Cluster 2 (N=8). The share of explained intra-cluster heterogeneity for the large cluster reaches 90.6%, which confirms its stability. However, the low values of Within sum of squares (1.118 for Cluster 2 and 0.116 for Cluster 1) indicate weak variability within clusters. This may indicate that the indicators of labor turnover and demand for labor vary within narrow limits, and the differences between the groups of enterprises are insignificant.

The most pronounced cluster structure is observed in the High Variability & Imbalances group. The division into two clusters is characterized by a significant difference in intra-cluster heterogeneity (Cluster 1 - 5.3%, Cluster 2 - 94.7%), which indicates the dominance of the second cluster. The high sum of intra-cluster squares (9.917 for Cluster 2) confirms the significant dispersion of data in this group. At the same time, the silhouette coefficient (0.843) for Cluster 1 indicates a clearly defined cluster, while for Cluster 2 it is low (0.144), which may indicate heterogeneity within this group. This confirms the presence of significant disproportions in labor costs and benefits between enterprises.

Thus, the clustering results show that the most homogeneous groups of enterprises are those with high variability in personnel costs, while differences in the dynamics of turnover and demand for labor are less clearly expressed. This emphasizes the need for a differentiated approach to personnel policy, especially in terms of regulating personnel costs and ensuring balanced hiring of university graduates.
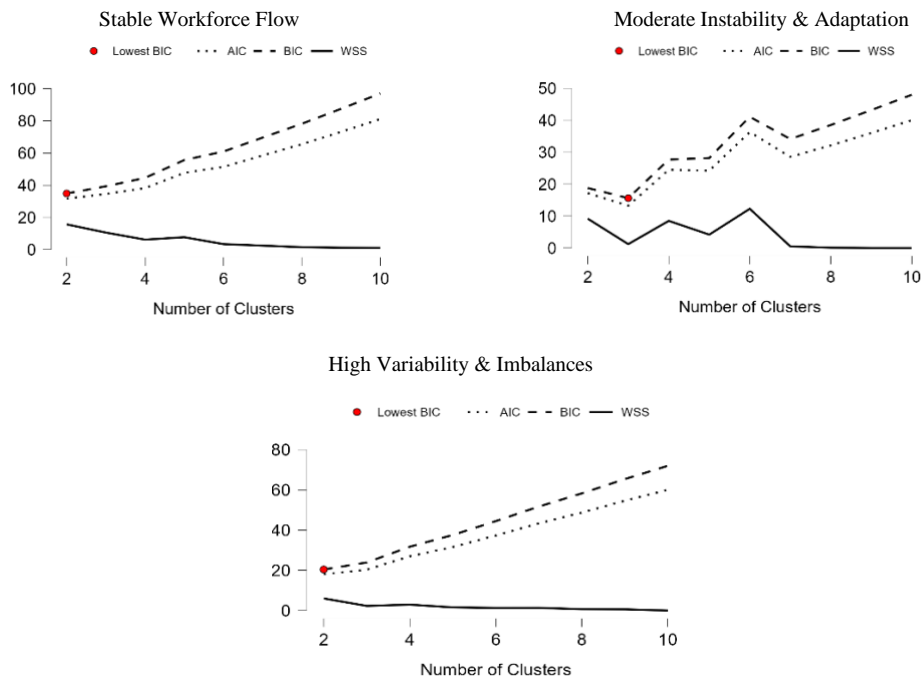
The Elbow method is presented in Figure 2.

FIGURE 2. Elbow method

Elbow Method Plot Analysis

1. Stable Workforce Flow

The first plot shows a clear "elbow" at k = 2, which confirms the choice of two clusters for this group. BIC and AIC increase with the number of clusters, and WSS stabilizes after two clusters. This indicates that a further increase in the number of clusters does not significantly improve the quality of the model.

2. Moderate Instability & Adaptation

The second group also shows the lowest BIC value at k = 2, but WSS fluctuates, which may indicate a complex data structure. Despite the possible presence of three clusters, the optimal choice remains two clusters, since further increase in the number of groups only increases the AIC and BIC values, which reduces the statistical significance of the model.

3. High Variability & Imbalances

For this group, the most pronounced "elbow" is observed at k = 3, which is consistent with the results of Fuzzy C-Means. BIC and AIC show minimum values at three

clusters, after which their growth becomes apparent.

In Table 4, the cluster analysis results are presented.

Cluster 1: Stable Workforce Flow

The cluster 1 is characterized by low staff turnover (0.172) and a balanced replacement rate (0.152). Especially in categories such as public administration, education, and manufacturing are dominating in this cluster showing stable rates of hiring and firing without sharp fluctuations in demand for labour. Two types of profiles are distinguished within the cluster: the first shows relatively high hiring and firing rates of employees, which indicates stable rotation within internal processes (intra-system mobility); the second demonstrates low dynamics of changes in the personnel structure and is associated with long-term employment. No signs of destabilization are recorded according to the results. Moreover, both profiles reflect a structured and predictable personnel policy.

TABLE 4. Cluster centers and variation metrics across key labor market indicators

Indicator	Cluster 1: Stable workforce flow	Cluster 2: Moderate instability & adaptation	Cluster 3: High variability & imbalances
Turnover rate	0.172	0.355	0.486
Replacement rate	0.152	0.289	0.418
Expected labor demand (max)	10,243	30,020	24,800
Number of graduates hired (avg)	18,654	31,572	46,721 (max: 86,227)
Total labor costs (bln KZT)	7.3	9.5	5.4–19.0
Benefits & Compensation (CV)	0.241	0.316	0.386
Within-cluster sum of squares (WSS)	0.713	1.182	1.364
Silhouette score	0.553	0.487	0.710
R² (explained cluster variance)	0.801	0.832	0.942

Note: compiled by authors

Cluster 2: Moderate Instability & Adaptation

The cluster 2 covers sectors with a moderate level (average turnover rate is 0.355) of instability. Nevertheless, there are significant fluctuations in the expected demand for labour (up to 30,020 people). The cluster is divided into: 1) industries with stable employment rates, including trade and transport and characteristic of adaptive personnel regulation; 2) includes sectors subject to short-term fluctuations, especially construction and household services, where turnover and demand change dramatically; 3) an exception: it includes cases with extreme values of indicators, which may be associated with seasonal employment, project work, or non-standard forms of employment. In general, cluster 2 reflects sectors in a state of adaptation, with moderate instability and high dependence on the external economic situation.

Cluster 3: High Variability & Imbalances

Cluster 3 demonstrates the most extraordinary heterogeneity in all key indicators. It includes sectors with a high dispersion of personnel costs (from 5.4 to 19.0 billion tenge) and a significant variation coefficient of compensation payments (0.386). The average volume of graduate hiring is 46,721 people, with a maximum value of 86,227. The cluster structure includes two consistently different types. The first is sectors with low wages, limited access to compensation and low probability of graduate employment. The second is industries with high wages, an expanded package of social guarantees and a high integration of young specialists. The cluster has a high degree of intra-group consistency (Silhouette = 0.710, R² = 0.942), confirming the identified division's stability. Notwithstanding, significant disproportions in access to opportunities and working conditions were revealed, indicating structural inequality in human resource distribution.

5. CONCLUSIONS

The revealed differentiation in human capital and the nature of employment between sectors of the economy are of high importance. Such differentiation is due to industry specifics, the level of digitalization, the degree of market competition and the prevailing forms of labour relations. In the context of economic transformations, the importance of flexible regulatory instruments aimed at increasing the stability of the labour market, minimizing personnel imbalances and aligning the interests of participants in labour relations is increasing. The typology of industries by the degree of stability of personnel processes allows us to more accurately determine the directions for improving labour policy.

The result revealed, that in traditional sectors of the economy, such as the public sector, finance and industry with long-term contracts, employment is characterized by stable workforce processes, which ensures

predictability of labour relations, low turnover and stable personnel costs. In industries with moderate instability, which include construction, trade and services, there are fluctuations in labour demand and turnover due to seasonality, market competition and contract employment. The most significant variability of workforce processes was found in the IT sector, oil and gas, services and finance, where high competition for qualified personnel, digital transformation and differences in investment in personnel lead to imbalances in employment, wage gaps and significant fluctuations in the workforce.

Next, the differences in human capital between sectors reflect the complexity of the current economic transformation, where companies with stable labour processes coexist with companies facing staff shortages, difficulties in forecasting labour costs and the need to adapt to changes in the economic environment.

Finally, the observed trends revealed existing gaps between economic sectors. In stable sectors, the main challenge remains ensuring sufficient flexibility in the labour market, preventing stagnation and stimulating investment in human capital. In contrast, in areas with highly volatile human capital, including IT, the service sector and the oil and gas industry, the key task is to create mechanisms for smoothing out staff imbalances and increasing the sustainability of labour relations.

On the contrary, in segments with high variability of personnel processes, the key task is to reduce the instability of labour relations, which is especially relevant in the context of technological modernization and digitalization. Significant differences in the level of hiring specialists with higher education and personnel costs indicate existing structural problems associated with the mismatch of professional training with labour market requirements. This is confirmed by international studies, which indicate the need to strengthen the mechanisms for adapting graduates to modern realities and creating sustainable mechanisms for the transition from education to employment. The results of the study are important for Kazakhstan's economic policy. Optimization of personnel strategies, reduction of wage imbalances, formation of effective mechanisms for regulating labour mobility and protection of socially vulnerable groups of workers should become priority areas in developing the labour market. In countries with developed economies, there is a tendency towards diversification of employment, creating conditions for flexible employment and forming modern social support mechanisms. Kazakhstan, being at the stage of active transformation of the labour market, can use this experience to develop its regulatory programs to increase the sustainability of labour relations, balance the distribution of the labour force, and form strategies for long-term economic growth.

Recommendations for employment regulation aim to enhance employment stability, increase labour market competitiveness, and mitigate labour imbalances:

(1) Stimulating labour market flexibility in stable sectors. Implementing mechanisms for flexible regulation of working hours and part-time employment programs in the public and industrial sectors to prevent labour stagnation and increase adaptability to economic fluctuations.

(2) Reducing labour instability in sectors with moderate volatility. Developing tax incentive programs for companies that offer long-term contracts and internships to young professionals, particularly in construction, trade, and services.

(3) Creating mechanisms to protect workers in sectors with high volatility. Introducing a national program for retraining and digital upgrading of personnel, focused on employees in the IT, service and oil and gas sectors, emphasising adaptation to new labour market requirements.

(4) Balanced regulation of hiring and wages. Introducing hybrid contracts ensures employment stability for workers with a high risk of job loss, while allowing employers to adapt their staff to market conditions, thereby

– 140 –

optimising the balance of supply and demand for qualified personnel. The introduction of a system of adaptive quotas for professions ensures a balance between the training of local personnel and the attraction of foreign specialists to key industries.

AUTHOR CONTRIBUTION

Writing – original draft: Botakoz Zh. Bolatova, Gulnar T. Kunurkulzhayeva.
Conceptualization: Botakoz Zh. Bolatova, Gulnar T. Kunurkulzhayeva.
Formal analysis and investigation: Madina A. Tleubergenova, Gulnar T. Kunurkulzhayeva.
Funding acquisition and research administration: Botakoz Zh. Bolatova.
Development of research methodology: Botakoz Zh. Bolatova, Gulnar T. Kunurkulzhayeva.
Resources: Botakoz Zh. Bolatova, Madina A. Tleubergenova, Almagul Zh. Ibrasheva.
Software and supervisions: Almagul Zh. Ibrasheva,   Agles M. Sapargali.
Data collection, analysis and interpretation: Almagul Zh. Ibrasheva,   Agles M. Sapargali.
Visualization: Madina A. Tleubergenova, Almagul Zh. Ibrasheva, Agles M. Sapargali.
Writing review and editing research: Botakoz Zh. Bolatova, Gulnar T. Kunurkulzhayeva.

REFERENCES

Ayodele, O. A., Chang-Richards, A., & González, V. (2020). Factors affecting workforce turnover in the construction sector: A systematic review. *Journal of construction engineering and management, 146*(2), 03119010. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001725

Bachmann, R., & Burda, M. C. (2010). Sectoral transformation, turbulence and labor market dynamics in Germany. *German Economic Review, 11*(1), 37-59. https://doi.org/10.1111/j.1468-0475.2009.00465.x

Backes-Gellner, U., & Tuor, S. N. (2010). Avoiding labor shortages by employer signaling: on the importance of good work climate and labor relations. *Industrial and Labor Relations Review, 63*(2), 271-286. https://doi.org/10.1177/001979391006300205

Bolt, E.E.T., Winterton, J., & Cafferkey, K. (2022). A century of labour turnover research: A systematic literature review. *International Journal of Management Reviews, 24*(4), 555-576. https://doi.org/10.1111/ijmr.12294

Bureau of National Statistics. (2024). *Bureau of National Statistics of the Republic of Kazakhstan*. Retrieved November 10, 2024 from https://stat.gov.kz/en

Cirillo, V., & Ricci, A. (2022). Heterogeneity matters: temporary employment, productivity and wages in Italian firms. Economia Politica, 39(2), 567-593. https://doi.org/10.1007/s40888-020-00197-2

Clemens, J. (2021). How do firms respond to minimum wage increases? understanding the relevance of non-employment margins. *Journal of Economic Perspectives, 35*(1), 51-72. https://doi.org/10.1257/jep.35.1.51

De Vos, A., Van der Heijden, B. I., & Akkermans, J. (2020). Sustainable careers: Towards a conceptual model. *Journal of vocational behavior, 117*, 103196. https://doi.org/10.1016/j.jvb.2018.06.011

De Winne, S., Marescaux, E., Sels, L., Van Beveren, I., & Vanormelingen, S. (2019). The impact of employee turnover and turnover volatility on labor productivity: a flexible non-linear approach. *The International Journal of Human Resource Management, 30*(21), 3049-3079. https://doi.org/10.1080/09585192.2018.1449129

Feist, L. (2024). Recent causes of labour shortages in advanced economies. ILO working paper. https://doi.org/10.54394/LUTY2310

Hane-Weijman, E. (2021). Skill matching and mismatching: Labour market trajectories of redundant manufacturing workers. Geografiska Annaler: Series B, *Human Geography, 103*(1), 21-38. https://doi.org/10.1080/04353684.2021.1884497

Herrendorf, B., Rogerson, R., & Valentinyi, A. (2014). Growth and structural transformation. Handbook of economic growth, 2, 855-941. https://doi.org/10.1016/B978-0-444-53540-5.00006-9

Hom, P. W., Lee, T. W., Shaw, J. D., & Hausknecht, J. P. (2017). One hundred years of employee turnover theory and research. *Journal of applied psychology, 102*(3), 530. https://psycnet.apa.org/doi/10.1037/apl0000103

Izguttiyeva, K. Y., Mukhamejanova, A. A., & Mukanova, M. A. (2022). Analysis of the state of the labor market in the Republic of Kazakhstan. *Bulletin of Turan University, 2* (94), 237-245. https://doi.org/10.46914/1562-2959-2022-1-2-237-245

Jung, J. H., & Lim, D. G. (2020). Industrial robots, employment growth, and labor cost: A simultaneous equation analysis. *Technological Forecasting and Social Change, 159,* 120202. https://doi.org/10.1016/j.techfore.2020.120202

Kharazishvili, Y., Kwilinski, A., Grishnova, O., & Dzwigol, H. (2020). Social safety of society for developing countries to meet sustainable development standards: Indicators, level, strategic benchmarks (with calculations based on the case study of Ukraine). *Sustainability, 12*(21), 8953. https://doi.org/10.3390/su12218953

Khussainova, Z., Gazizova, M., Abauova, G., Zhartay, Z., & Raikhanova, G. (2023). Problems of generating productive employment in the youth labor market as a dominant risk reduction factor for the NEET youth segment in Kazakhstan. *Economies, 11*(4), 116. https://doi.org/10.3390/economies11040116

Kuttygalieva, A., Khamzina, Z., Zhaxymbetov, B., Tileubergenov, Y., & Buribayev, Y. (2024). Integrating global norms for gender equity in Kazakhstan: Aligning workplace and social security legislation with sustainable development goals. *Journal of Lifestyle and SDGs Review, 4*(4), e02531-e02531. https://doi.org/10.47172/2965-730X.SDGsReview.v4.n04.pe02531

Li, J., Shan, Y., Tian, G., & Hao, X. (2020). Labor cost, government intervention, and corporate innovation: Evidence from China. *Journal of Corporate Finance, 64*, 101668. https://doi.org/10.1016/j.jcorpfin.2020.101668

Mavromaras, K., McGuinness, S., O'Leary, N., Sloane, P., & Wei, Z. (2013). Job mismatches and labour market outcomes: Panel evidence on university graduates. *Economic Record, 89*(286), 382-395. https://doi.org/10.1111/1475-4932.12054

Ministry of Labor and Social Protection of the Population of the Republic of Kazakhstan. (2023). National report on the labor market of Kazakhstan. Retrieved November 10, 2024 from https://www.gov.kz/memleket/entities/enbek/press/news/details/468557?lang=ru

Norcliffe, G. (1994). Regional labour market adjustments in a period of structural transformation: An assessment of the Canadian case. *Canadian Geographer/Le Géographe canadien, 38*(1), 2-17. https://doi.org/10.1111/j.1541-0064.1994.tb01513.x

OECD. (2023). Skills mismatch and labor market policies in Kazakhstan. Retrieved November 10, 2024 from https://www.oecd.org/employment/skills-mismatch-kazakhstan.pdf

Sen, K. (2016). The determinants of structural transformation in Asia: A review of the literature. Asian Development Bank Economics Working Paper Series, (478). http://dx.doi.org/10.2139/ssrn.2811507

Suieubayeva, S. N., Nurekenova, E. S., Rakhimberdinova, M. U., & Granetskiy, V. N. (2023). Digital entrepreneurship as a result of the transformation of the labor market in a pandemic. *Bulletin of the Karaganda university Economy series, 112*(4), 104-115. https://doi.org/10.31489/2023ec4/104-115

Wallace, M., Gauchat, G., & Fullerton, A. S. (2011). Globalization, labor market transformation, and metropolitan earnings inequality. *Social Science Research, 40*(1), 15-36. https://doi.org/10.1016/j.ssresearch.2010.07.001

Winterton, J. (2004). A conceptual model of labour turnover and retention. *Human resource development international, 7*(3), 371-390. https://doi.org/10.1080/1367886042000201967

World Bank. (2022). Automation, AI, and labor market dynamics: Implications for Kazakhstan. Retrieved November 10, 2024 from https://www.worldbank.org/en/country/kazakhstan/publication/automation-labor-market

Wang, Y., Jiang, S., Wu, C., Cai, X., & Wang, F. (2022). Impact of the global megatrends, COVID-19, and digital economy on professional career management transformation in Asian Countries. *Sustainability, 14*(17), 10981. https://doi.org/10.3390/su141710981

AUTHOR BIOGRAPHIES

*Botakoz Zh. Bolatova – PhD, Docent, K. Zhubanov Aktobe Regional University, Aktobe, Kazakhstan. Email: botik1984@mail.ru, ORCID ID: https://orcid.org/0000-0003-1597-0555

Gulnar T. Kunurkulzhayeva – Cand. Sc. (Econ.), Associate Professor, K. Zhubanov Aktobe Regional University, Aktobe, Kazakhstan. Email: gkunurkulzhayeva@zhubanov.edu.kz, ORCID ID: https://orcid.org/0000-0002-0042-7341

Madina A. Tleubergenova – M. Sc. (Econ.), Senior Lecturer, K. Zhubanov Aktobe Regional University, Aktobe, Kazakhstan. Email: mtleubergenova@mail.ru ORCID ID: https://orcid.org/0000-0001-9360-0520

Almagul Zh. Ibrasheva – M. Sc. (Econ.), Senior Lecturer, K. Zhubanov Aktobe Regional University, Aktobe, Kazakhstan. Email: ibrasheva1975@mail.ru, ORCID ID: https://orcid.org/0000-0002-6998-762X

Agles M. Sapargali – M. Sc. (Econ.), Senior Lecturer, K. Zhubanov Aktobe Regional University, Aktobe, Kazakhstan. Email: agles_@mail.ru, ORCID ID: https://orcid.org/0000-0002-0729-6401