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## Labor market–education system discrepancies in Kazakhstan’s digital ERA: Challenges and modeling solutions

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### Abstract

Kazakhstan’s rapid digital transformation has intensified the demand for digital skills, yet the country’s education system continues to lag behind evolving labor market requirements, resulting in persistent vertical and horizontal mismatches. This study addresses the gap by developing a conceptual model to evaluate the alignment between educational outputs and employer needs across qualification levels, fields of study, and digital competencies. The model draws on national education supply data, labor demand trends, and feedback mechanisms, including public–private partnerships and lifelong learning initiatives. Its application reveals substantial skill mismatches in both technical and non-technical disciplines, with particularly acute gaps in ICT-related and hybrid digital roles, as well as marked regional disparities. The findings suggest that incorporating employer feedback and promoting curriculum adaptability are critical to reducing these mismatches. The study concludes that strategic reforms such as embedding digital competencies into formal education, strengthening multi-stakeholder collaboration, and tailoring educational approaches to regional labor market dynamics are essential for closing the skills gap. This research offers a practical framework for diagnosing systemic misalignment and supports evidence-based policymaking aimed at developing a workforce prepared for the demands of a digital economy.

**Keywords:** Digital transformation, Education policy, Kazakhstan, Labor market–education alignment, Skills mismatch, Workforce development.

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## **1. Introduction**

The accelerating pace of digital transformation is reshaping global labor markets, challenging established models of education and workforce development. The rapid spread of automation, artificial intelligence (AI), and digital platforms is redefining the skills required for sustainable employability, making the alignment between education systems and labor market demands a priority on national policy agendas. This challenge is particularly acute for middle-income economies undergoing structural transitions, where the capacity to adapt determines long-term competitiveness in the global economy.

Kazakhstan illustrates these dynamics through its ongoing efforts to modernize the economy, diversify employment structures, and strengthen its technological capacity. However, persistent mismatches between educational outputs and labor market requirements continue to hinder progress. These mismatches take three main forms: vertical (qualification level misalignment), horizontal (employment outside the field of study), and skill-based (competency gaps).

The urgency of addressing these issues is heightened by the growing complexity of contemporary job roles, which often demand hybrid competencies – combining technical expertise with digital literacy, problem-solving abilities, and adaptability. National labor market surveys indicate that more than two-thirds of employers consider graduates underprepared for tasks involving cloud computing, data analytics, and AI applications. This situation is further compounded by limited employer participation in curriculum development, slow adoption of competency-based education frameworks, and marked disparities in access to advanced training infrastructure between urban and rural areas.

Without the implementation of a dynamic, feedback-driven mechanism for identifying and addressing skills mismatches, Kazakhstan risks widening the gap between graduate capabilities and market demands. In the context of rapid technological change, this gap could undermine economic diversification, reduce productivity, and weaken the country's competitive position in the global economy.

This study aims to develop and present a conceptual model that captures the mechanisms of education–labor market misalignment in Kazakhstan, with a particular focus on digital transformation and skills development. The proposed model integrates four dimensions: education supply, labor market demand, mismatch typologies, and feedback mechanisms for policy and curricular adaptation.

Specifically, the study tests the following hypothesis:

*In Kazakhstan, the absence of a structured feedback mechanism between labor market demands and educational output is a primary driver of persistent skills mismatch, particularly in digital-intensive sectors.*

By applying the model to Kazakhstan's current labor and education landscape, the research contributes to a more systematic understanding of mismatch dynamics and supports evidence-based strategies for skills policy reform. Furthermore, it offers a replicable analytical tool for other emerging economies undergoing similar transitions.

This paper is situated at the intersection of labor economics, education policy, and digital transformation studies. While grounded in the Kazakhstani context, the research speaks to broader global debates about future workforce readiness, education system adaptability, and the socio-economic implications of digital change.

### *1.1. Literature Review and Research Overview*

The interrelation between education systems and labor market dynamics has been extensively examined in economics, sociology, and policy studies. Classical human capital theory [1] emphasizes the contribution of education to productivity growth, innovation, and long-term economic development. More contemporary approaches, particularly the theory of skill-biased technological change [2, 3] highlight that digitalization and automation disproportionately increase the demand for highly skilled labor while reducing the need for routine and manual tasks.

A consistent theme in labor economics is the skills mismatch between graduates' qualifications and job requirements [4, 5]. This phenomenon, typically classified into vertical mismatch (over- or under-qualification) and horizontal mismatch (employment outside one's field of study), is especially pronounced in emerging economies experiencing rapid technological transformations [6]. In Kazakhstan, structural and skills-based mismatches are associated with outdated curricula, limited employer involvement, and insufficient labor market feedback mechanisms [7, 8].

Global evidence underscores the accelerating demand for digital competencies across industries [9-11], including expertise in artificial intelligence (AI), cloud computing, cybersecurity, and data analytics. Forecasts indicate that by 2027, nearly half of workers' core skills will be disrupted, and emerging occupational roles will require a combination of technical expertise and transversal skills such as adaptability, creativity, and problem-solving [12]. However, empirical research suggests that expanding higher education enrollment alone is insufficient; curriculum modernization and competency-based learning models are necessary to align graduate skills with evolving labor market needs [13, 14].

Employer engagement is recognized as a critical factor in enhancing graduate employability. Empirical studies demonstrate that higher education institutions (HEIs) with strong industry partnerships implemented through internships, applied research projects, and co-designed curricula achieve higher graduate employment rates and wage outcomes [15-17]. The Triple Helix Model [18] conceptualizes innovation as the result of synergistic collaboration between academia, industry, and government. In Kazakhstan, although strategic policy documents endorse such cooperation, actual employer participation in educational program development remains sporadic and often symbolic [19].

Internationally, public–private partnerships (PPPs) have proven effective in bridging education–employment gaps. Germany's dual education system and Singapore's SkillsFuture initiative exemplify how joint industry investment in training enhances workforce adaptability and retention [20, 21]. Replication of these models in Kazakhstan will require targeted policy measures, including tax incentives, co-funding mechanisms, and streamlined regulatory frameworks [22].

Labor mobility and knowledge obsolescence further shape labor market dynamics. High employee turnover, particularly among young workers, reduces productivity and exacerbates skills shortages [23, 24]. In rapidly evolving

digital environments, lifelong learning and continuous professional development (CPD) are increasingly indispensable. Flexible training formats, such as modular programs, micro-credentials, and industry-recognized certifications, enable workers to remain competitive in dynamic labor markets [25-27].

National and international labor market assessments for Kazakhstan highlight persistent productivity gaps, underemployment, and significant regional disparities in access to quality education [28, 29]. Digital transformation is altering occupational structures by reducing demand for low-skilled labor while expanding opportunities in high-skill digital sectors [30]. However, educational reforms have lagged behind market shifts, with many graduates lacking practical experience and adequate digital literacy [31]. Graduates from rural areas face compounded disadvantages due to limited industrial diversification and weaker ICT infrastructure [32].

Young people, while generally adaptable and technologically oriented, remain disproportionately affected by labor market volatility. National strategic programs emphasize practice-oriented learning, entrepreneurship education, and enhanced employer collaboration; however, implementation remains inconsistent across regions [33, 34].

The analytical report *Kazakhstan's Labour Market 2023* [35] confirms these systemic challenges and emphasizes the urgency of aligning education policy with labor market foresight. Key priorities include comprehensive curriculum reform, expansion of vocational and applied learning pathways, integration of digital and green skills, and institutionalized employer education partnerships. Without these measures, the skills gap is likely to widen in the context of accelerated technological change.

In summary, the literature converges on several strategic priorities for narrowing the education labour market gap in Kazakhstan:

1. Digital skills integration – embedding AI, programming, cybersecurity, and data analytics across academic disciplines.
2. Employer partnerships – scaling internships, collaborative R&D initiatives, and co-developed curricula.
3. Business incentives – fostering corporate investment in training through PPPs and fiscal benefits.
4. Lifelong learning – promoting flexible, stackable learning formats to counteract skills obsolescence.

Adopting these strategies, anchored in international best practices and tailored to Kazakhstan's socio-economic context, offers a pathway toward developing a workforce equipped with future-oriented, market-relevant competencies in a digitally transforming economy.

### *1.2. Identified Gaps and Analytical Positioning*

Despite a substantial body of literature addressing the relationship between education and labor market dynamics, several critical research gaps remain. First, most empirical studies on skills mismatch and labor market responsiveness have been conducted in advanced economies, where institutional capacities, industrial structures, and innovation ecosystems differ significantly from those in emerging economies such as Kazakhstan [4-6, 20, 21]. Consequently, the direct transferability of policy models such as Germany's dual system or Singapore's SkillsFuture to the Kazakhstani context remains underexplored.

Second, existing research in Kazakhstan is fragmented and primarily descriptive, often focusing on macroeconomic indicators (e.g., employment rates, sectoral output) without systematically linking these trends to micro-level mechanisms such as curriculum design, competency development, or employer engagement [7, 8, 19, 28]. This limits the ability to identify causal relationships between educational reforms and labor market outcomes.

Third, while global discourse increasingly emphasizes the integration of digital skills and transversal competencies [9-14], Kazakhstani studies rarely address the interplay between digital transformation, sector-specific skill demands, and regional disparities in education access. Rural-urban inequalities, in particular, remain insufficiently quantified, despite their critical implications for inclusive labor market development [29, 32].

Fourth, there is a lack of longitudinal analyses that track how graduates' skills and employability evolve in response to technological change. Most available datasets are cross-sectional, preventing robust evaluation of the long-term impacts of educational interventions or policy measures [25-27].

From an analytical standpoint, this study positions itself at the intersection of education policy analysis, labor economics, and digital transformation studies. It seeks to:

Examine the structural and skills-based mismatches in Kazakhstan within the broader global trend of skill-biased technological change.

Assess the extent to which current educational reforms address the specific competencies demanded by a digitally driven labor market.

Identify institutional, regulatory, and socio-economic barriers to effective employer-education collaboration.

Propose evidence-based policy recommendations that adapt international best practices to Kazakhstan's socio-economic and technological context.

By addressing these gaps, the research contributes to both theoretical debates on human capital development under digitalization and the practical policy discourse on aligning education systems with evolving labor market demands in emerging economies.

## **2. Materials and Methods**

This study applied a mixed-methods research design integrating quantitative statistical modeling with qualitative content analysis to assess the alignment between Kazakhstan's education system and labor market in the context of digital transformation. The analytical

framework was grounded in the conceptual model outlined in Section 1.2, enabling the systematic identification and categorization of vertical, horizontal, and skill-based mismatches.

The empirical foundation combined primary and secondary data sources. Primary data were obtained through structured surveys of employers and students conducted by the authors between March and July 2024 in eight regions of Kazakhstan, covering manufacturing, ICT, agriculture, and service sectors. Employer surveys assessed graduates' preparedness for digitally mediated work, while student surveys measured perceived skills acquisition, readiness for the labor market, and awareness of sectoral trends. Secondary data were sourced from official statistical sources, including the Bureau of National Statistics, the Ministry of Science and Higher Education, and analytical reports by the Center for the Development of Human Resources [36] and the European Training Foundation [37].

Quantitative analysis involved computing the mismatch index  $M_{i,r,t}$ , which integrates the absolute difference between educational supply and labor demand with qualitative gaps in competencies, weighted according to the parameters of the conceptual model. Skill match coefficients were derived from employer survey responses using a five-point Likert scale and normalized to a [0, 1] range. Regional and sectoral disaggregation allowed for the identification of spatial patterns and industry-specific disparities.

The qualitative component of the research focused on a comparative analysis with selected post-Soviet economies undergoing similar digital transitions, supported by policy document analysis to determine the degree of integration of digital competencies and soft skills into curricula.

Table 1 summarizes the variables employed in the analysis and their data sources.

**Table 1.**  
Variables and data sources used in the study.

Variable	Definition/Measurement	Type	Source
Graduate output ( $E_{i,r,t}$ )	Number of graduates by field, region, and year	Quantitative	Bureau of National Statistics ( <a href="https://stat.gov.kz/">https://stat.gov.kz/</a> ); Ministry of Science and Higher Education of the Republic of Kazakhstan
Labor demand ( $D_{i,r,t}$ )	Number of vacancies by sector, region, and year	Quantitative	Bureau of National Statistics; Electronic Labor Exchange ( <a href="https://enbek.kz/">https://enbek.kz/</a> )
Skill match coefficient ( $S_{i,r,t}$ )	Employer-rated match between graduate competencies and job requirements (Likert scale, normalized)	Quantitative	Employer survey (authors' fieldwork)
Digital skills integration index	Extent of digital competency inclusion in curricula	Qualitative	Ministry of Science and Higher Education; curriculum content analysis
Soft skills integration index	Inclusion of teamwork, adaptability, and critical thinking in curricula	Qualitative	Curriculum content analysis
Mismatch index ( $M_{i,r,t}$ )	Composite indicator integrating supply-demand and skill gap measures	Quantitative	Calculated by the authors

Source: Table compiled by the authors based on primary survey data (2024) and secondary sources, including CDHR (2021–2023) and national statistical databases.

The integration of quantitative and qualitative methods ensured both statistical rigor and contextual depth in evaluating education–labor market alignment. The combination of primary survey data with official statistical sources provided a robust evidence base for calculating sector- and region-specific mismatch indicators, while the qualitative policy analysis captured the structural and institutional factors influencing digital skills integration. This methodological approach enables the identification of not only measurable disparities in supply and demand but also the systemic barriers to curriculum responsiveness, thereby offering a comprehensive foundation for subsequent results interpretation and policy recommendations.

### 3. Results

#### 3.1. Descriptive Analysis of Education–Labor Market Mismatch in Kazakhstan

The application of the conceptual model to Kazakhstan's education-labor market system revealed a complex, multi-layered structure of mismatches that reflects systemic inefficiencies and undermines the effectiveness of workforce development in the context of digital transformation. By integrating education supply, labor market demand, mismatch typologies, and feedback mechanisms, the model enabled a structured diagnosis of the underlying forms and severity of misalignment, namely, vertical, horizontal, and skill-based, each of which affects specific sectors, regions, and graduate profiles with varying degrees of intensity. To structure these findings, a comparative framework was applied, highlighting the definition, causes, affected fields, and consequences of each mismatch type. This framework is summarized in Table 2.

**Table 2.**  
Distinctive Features of Education–Labor Market Mismatch Types in Kazakhstan.

Mismatch Type	Definition	Typical Causes	Primary Affected Fields	Consequences
Vertical Mismatch	Employment at a qualification level lower than the attained education level	Overproduction in certain fields; lack of workforce planning	Law, Education, Economics	Underemployment, wage penalties, job dissatisfaction
Horizontal Mismatch	Employment outside of the graduate’s field of study or specialization	Disconnection between regional supply and sectoral demand	ICT, Agriculture, Engineering	Skill underutilization, low productivity, and weak career growth
Skill-Based Mismatch	Gaps between actual graduate competencies and employer expectations	Outdated curricula, lack of digital and soft skill integration	All sectors, especially digital	Reduced employability, need for retraining, hiring delays for employers

Source: Table compiled by the authors based on sources [20-23, 26, 27, 29].

Vertical mismatch remains a central structural problem in Kazakhstan. In particular, fields of study such as law, management, and education exhibit significant over-enrollment, resulting in qualification surplus and overeducation. According to the *Centre for the Development of Human Resources* [2, 20], nearly 38% of graduates from these fields are employed in positions not requiring higher education qualifications, leading to reduced wage returns and job dissatisfaction. This issue is further exacerbated by the absence of proactive enrollment forecasting mechanisms and the limited coordination between educational planning bodies and labor market analysts.

Horizontal mismatch was found to be concentrated in peripheral regions, where educational offerings are poorly aligned with local labor market demands. For example, agricultural and ICT graduates from rural universities often face employment constraints due to the urban concentration of relevant industries.

Skill-based mismatch emerged as the most prevalent and rapidly intensifying form of misalignment, particularly in areas such as digital literacy, soft skills, and applied competencies. Employer surveys conducted by the European Training Foundation [37] and analyzed in CDHR [28] indicate that over 67% of employers consider university graduates to be inadequately prepared for digitally mediated tasks. The lack of integration of cloud computing, data analysis, and digital communication platforms into university curricula has exacerbated this issue. Additionally, soft skills such as teamwork, adaptability, and critical thinking often remain underdeveloped in most academic programs.

Table 3 illustrates how mismatch intensity varies across sectors and types.

**Table 3.**  
Sectoral Mismatch Intensity by Type (Kazakhstan, 2021–2024).

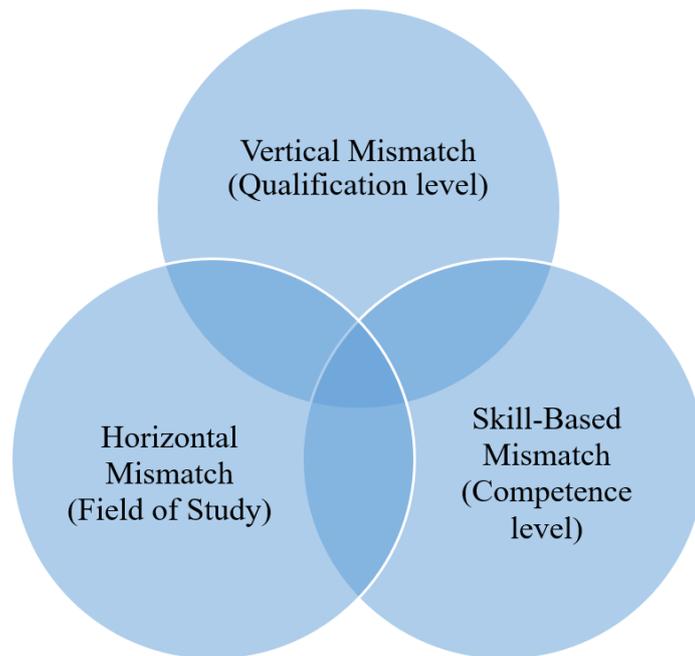
Sector	Vertical Mismatch	Horizontal Mismatch	Skill-Based Mismatch
Law & Public Admin	High	Medium	Medium
Education	High	Medium	Medium
ICT & Digital Services	Medium	Medium	<b>High</b>
Agriculture	Medium	High	Low
Engineering	Medium	Medium	Medium
Health Sciences	Low	Low	Medium

Source: Compiled by the authors based on national statistics, CDHR (2021–2023), European Training Foundation [37] and employer survey data collected in 2024.

As summarized in Table 3, the three types of mismatch differ not only in form but also in origin and impact. Vertical mismatch stems largely from oversupply in traditional academic disciplines, leading to overqualification and reduced labor productivity. Horizontal mismatch reflects regional and structural misalignment, particularly between rural education institutions and urban-based industries. The most critical and transversal is skill-based mismatch, which spans all sectors and results from curricular inertia and insufficient integration of digital and soft skills.

A more in-depth examination of regional differences revealed significant urban–rural disparities. Institutions in Astana and Almaty benefit from proximity to high-tech employers, stronger PPPs, and better infrastructure, leading to relatively lower levels of mismatch. In contrast, rural and peripheral universities often operate in isolation from local economic needs, and their graduates are at greater risk of becoming NEETs (Not in Employment, Education, or Training). These differences are not only institutional but also infrastructural, reflecting unequal access to digital learning environments and employer networks.

The mismatch mechanism itself, as identified by the model, follows a cumulative logic; vertical mismatches often coincide with horizontal ones, and both amplify skill gaps. This is illustrated in Figure 1, which visualizes the interlocking nature of misalignment in Kazakhstan’s education employment system.



**Figure 1.** Interrelation of Mismatch Types in Kazakhstan’s Education–Labor Market System.

Finally, the study found that existing feedback mechanisms between employers and educational institutions remain fragmented and largely informal. Only 22% of higher education institutions report updating curricula in response to employer feedback or labor market forecasts, according to CDHR [28]. Policy initiatives such as Digital Kazakhstan have introduced frameworks for digital upskilling, but these remain under-implemented and disconnected from curriculum governance structures.

Taken together, the findings support the study’s initial hypothesis that the lack of institutionalized, data-driven feedback mechanisms is a key driver of the persistent mismatch in Kazakhstan, especially in the digital sector. The model thus proves effective not only in categorizing the types of misalignment but also in uncovering the mechanisms through which they reinforce one another. By offering a structured lens for diagnosing and interpreting these dynamics, the model creates a foundation for informed policy response and further empirical investigation.

*3.2. Evidence from Employer and Student Surveys: Skills, Gaps, and Digital Economy Challenges*

As part of the empirical component of this study, two complementary surveys were conducted in 2024: one targeting employers from key sectors of Kazakhstan’s economy and another involving students from universities and vocational institutions across the country. The aim was to capture both the demand-side and supply-side perspectives on graduate preparedness and alignment with labor market requirements in the context of the digital economy.

The employer survey results (Table 4) indicate a persistent gap between the competencies of recent graduates and the expectations of industry. Only 10.8% of employers reported being fully satisfied with graduate preparedness, while 32.4% remained neutral and 29.7% expressed dissatisfaction. The most frequently cited deficiencies were insufficient practical training (21.6%), curricula that fail to reflect current labor market needs (16.2%), and inadequate digital competencies (10.8%). These findings align with prior national reports that emphasize the urgency of integrating practical and digital skill development into higher education programs.

**Table 4.** Employer Survey Findings on Graduate Preparedness and Skills Gaps in Kazakhstan’s Digital Economy.

Survey Dimension	Key Findings
Overall satisfaction with graduate preparedness	32.4% neutral; 10.8% satisfied; 29.7% dissatisfied
Main deficiencies in graduate training	21.6% insufficient practical training; 16.2% curriculum–market mismatch; 10.8% low digital competencies
Most essential skills for the digital economy	20% creativity & innovation; 20% proficiency in digital technologies; 20% analytical thinking
Primary labor market constraints	35% shortage of qualified personnel; 15% high competition for specialists; 10% excessive salary expectations
Perceived readiness of graduates for digital work	20% well-prepared; 25% average; 55% underprepared
Preferred measures to strengthen collaboration	30% expand internships; 25% professional training programs; 15% business participation in curriculum design

Employers also identified a set of priority competencies for the digital economy, notably creativity and innovation (20%), proficiency in digital technologies (20%), and analytical thinking (20%). At the same time, 35% of respondents pointed to a shortage of qualified personnel as a major constraint, followed by intense competition for talent (15%) and high salary expectations among graduates (10%). When asked about the perceived readiness of graduates for digitally mediated work, only one in five considered them well-prepared, while over half assessed them as underprepared.

In terms of collaboration, 40.5% of employers reported active partnerships with educational institutions, often involving internships and joint training programs. However, 27% described their cooperation as limited, 10.8% expressed doubt about its feasibility, and 13.5% conveyed negative views, frequently citing rigid curricula, insufficient internship capacity, and limited institutional responsiveness. These responses underscore the structural barriers that continue to inhibit effective education-industry integration in Kazakhstan.

The student survey results (Table 5) provide further insight into the supply side of the education–labor market interface. Students displayed a strong preference for practical, experience-based learning, with 31.5% prioritizing participation in real-world projects and 24.6% favoring internships. When considering personal adaptation to the demands of the digital economy, the most valued strategies were flexibility and adaptability (31.8%) and continuous skill upgrading (28.3%), reflecting a recognition of the dynamic nature of technological change.

**Table 5.**  
Student Survey Findings on Digital Skills, Career Readiness, and Education–Labor Market Alignment.

Survey Dimension	Key Findings
Preferred forms of practical learning	31.5% real-world projects with enterprises; 24.6% internships
Key personal adaptation strategies	31.8% flexibility & adaptability; 28.3% continuous skill upgrading
Perceived institutional support for digital transformation	30.5% moderate; 15.6% low; 14% very low
Most in-demand technology courses	47.7% Artificial Intelligence; 14% Internet of Things; 14% Augmented Reality; 17.4% view tech emphasis as excessive
Career development priorities	29.3% access to professional development resources; 13.4% flexible/remote work options

Perceptions of institutional support for digital transformation were mixed: 30.5% rated support as moderate, but significant proportions considered it low (15.6%) or very low (14%). Artificial Intelligence emerged as the most in-demand technology-related course (47.7%), followed by the Internet of Things and Augmented Reality (14% each). Notably, 17.4% of students viewed the emphasis on such courses as excessive, suggesting variation in priorities by academic specialization.

Career development priorities highlight the importance of access to professional development resources (29.3%) and flexible or remote work arrangements (13.4%), reflecting broader global labor market trends. The convergence of findings from both surveys underscores a clear misalignment between educational outputs and employer needs, particularly in the domains of digital literacy, applied competencies, and work readiness.

Taken together, the results confirm that both employers and students recognize the need for systemic reform in curriculum design, the integration of practical training, and digital skill development. Addressing these issues requires a coordinated strategy involving educational institutions, industry, and policymakers to ensure that graduates are better equipped for the realities of Kazakhstan’s evolving digital economy.

### 3.3. Conceptual Model: Components, Structure, and Formalization

To comprehensively assess the alignment between Kazakhstan’s education system and labor market in the context of digital transformation, this study develops a conceptual model that integrates structural, institutional, and competency-based dimensions. Unlike fragmented analytical approaches that consider educational output, labor demand, or mismatch typologies in isolation, the proposed model provides a unified framework for diagnosing and interpreting the dynamics of misalignment across sectors and regions.

The model conceptualizes education not solely as a passive producer of qualifications but as an active institutional system that both shapes and responds to the evolving competency requirements of the economy. Labor demand, in turn, is treated as sectorally diverse, technologically dynamic, and regionally uneven. The interplay between these two subsystems often results in mismatches, which the model classifies into three categories:

- Vertical mismatch – discrepancy between qualification level and job requirements;
- Horizontal mismatch – misalignment between field of study and job function;
- Skill-based mismatch – gaps in competencies needed for effective job performance.

These mismatches rarely occur in isolation and frequently overlap, particularly in transitional economies where mechanisms of systemic feedback are underdeveloped or informal.

A key feature of the model is its emphasis on structural responsiveness. The framework incorporates a feedback loop that evaluates how labor market signals, such as sectoral hiring trends, vacancy structures, and employer satisfaction, are translated into curriculum adjustments and institutional reforms. In Kazakhstan, this mechanism remains weak, with employer participation in curriculum development largely ad hoc and symbolic. The model thus serves both as a diagnostic tool and as a normative reference for policy reform.

The core components of the model are presented in Table 6.

**Table 6.**  
Core components of the conceptual model for education–labor market alignment.

Model component	Functional role	Relevance in the Kazakhstani context
Education supply	Tracks graduate numbers, specialization, and skill profiles	Oversupply in social sciences; under-integration of digital and practice-oriented skills.
Labor market demand	Captures hiring trends, vacancy profiles, and competency requirements	Rising need for hybrid and digital roles; sectoral fragmentation.
Mismatch diagnostics	Identifies vertical, horizontal, and skill-based misalignment	Persistent overqualification; regional mismatch; digital skills gap
Feedback mechanism	Models the responsiveness between labor market needs and curriculum design	Weak employer engagement; lack of dynamic feedback structures
Systemic adaptability	Evaluates institutional capacity to reform, reskill, and respond to change	Curriculum reform inertia; limited scaling of pilot public–private partnerships.

To operationalize the model and enable empirical application, a mismatch index is introduced. Let  $M_{i,r,t}$  denote the mismatch score for sector  $i$ , region  $r$ , and year  $t$ . This index integrates both structural imbalances and qualitative competency gaps.

$$M_{i,r,t} = \alpha \cdot |E_{i,r,t} - D_{i,r,t}| + \beta \cdot (1 - S_{i,r,t})$$

where:

$E_{i,r,t}$  – number of graduates in field  $i$  for region  $r$  and year  $t$ ;

$D_{i,r,t}$  – corresponding job demand (vacancies);

$S_{i,r,t} \in [0,1]$  – skill match coefficient derived from employer assessments;

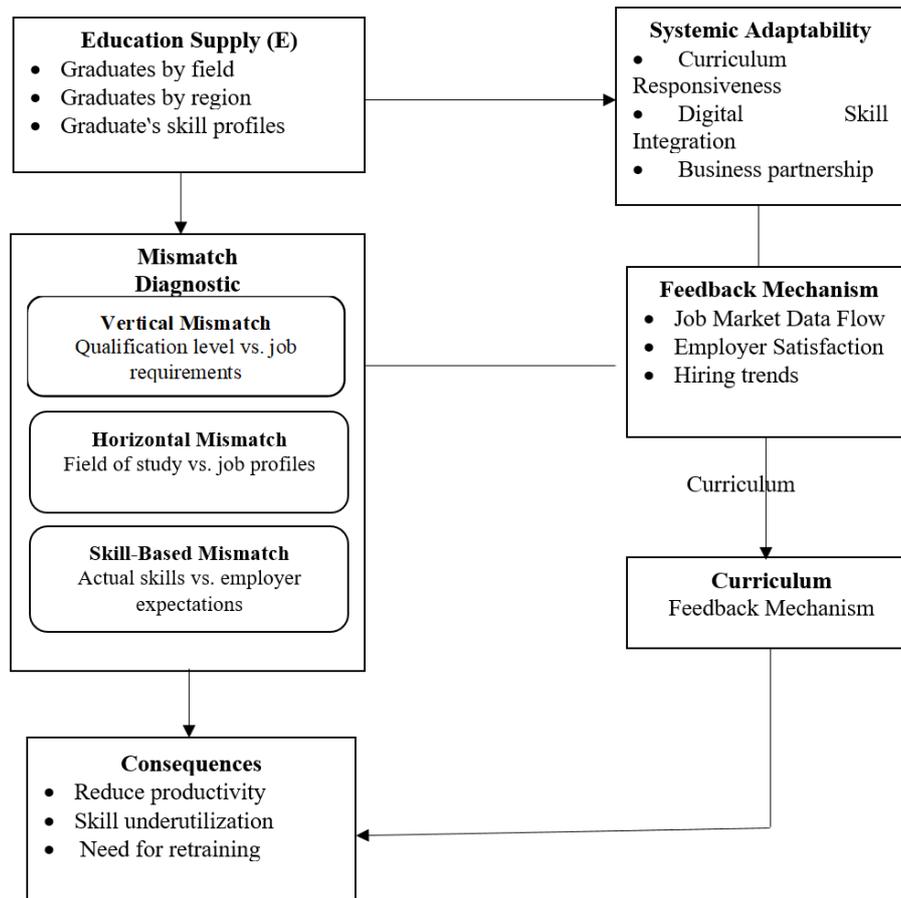
$\alpha$  – weight for quantitative supply–demand imbalance;

$\beta$  – weight for qualitative skill gaps.

The first term  $\alpha \cdot |E - D|$  captures the quantitative misalignment between graduate supply and labor demand, while the second term  $\beta \cdot (1 - S)$  reflects qualitative deficiencies in competencies. A higher  $M$  value indicates greater mismatch severity, signaling areas where strategic interventions are required.

This mathematical formalization enhances the model’s diagnostic and predictive capabilities. It allows cross-sectional comparisons across regions and sectors, enables longitudinal tracking of mismatch dynamics, and provides a foundation for scenario-based policy simulations. The approach is particularly suited for guiding Kazakhstan’s transition toward a digitally adaptive labor market in line with the country’s national digital agenda.

The overall structure of the conceptual model and the relationships among its core components are illustrated in Figure 2.



**Figure 2.** Conceptual model of education–labor market alignment in the context of Kazakhstan’s digital transformation.

The model integrates education supply, labor market demand, mismatch diagnostics, feedback mechanisms, and systemic adaptability, encompassing both structural and competency-based dimensions. Arrows indicate the direction of influence between components, while the feedback loop illustrates how labor market signals are translated into curriculum reform. This framework provides a systematic basis for diagnosing the origins of misalignment and supports the formulation of evidence-based reform strategies applicable in both academic research and practical workforce planning.

#### 4. Discussion

The results of this study provide a multidimensional understanding of the systemic factors underlying education-labor market misalignment in Kazakhstan. By applying the proposed conceptual model, the analysis was able to distinguish three primary forms of mismatch: vertical, horizontal, and skill-based, while also revealing the interdependencies between them. These findings demonstrate that mismatch is not simply a product of isolated inefficiencies, but rather the cumulative outcome of structural imbalances, governance inertia, and insufficient institutional responsiveness to technological and economic shifts.

The persistence of vertical mismatch, most pronounced in disciplines such as law, education, and economics, highlights a lack of strategic enrollment regulation aligned with sectoral labor absorption capacity. This is consistent with earlier national reports by the Center for the Development of Human Resources [36], which have emphasized the oversupply of graduates in low-demand fields. Without a formal mechanism for linking tertiary admission quotas to labor market forecasts, educational output will continue to exceed absorptive capacity in certain sectors, perpetuating underemployment and wage penalties.

Horizontal mismatch, while less visible in national aggregates, emerges sharply in regional breakdowns. Rural and mono-industrial regions face a scarcity of sectoral diversity, forcing graduates to accept positions outside their field of study. This spatial disconnection is exacerbated by weak infrastructure for remote work and limited inter-regional labor mobility. The model’s ability to disaggregate mismatch by region provides clear evidence that policies aimed at curriculum reform alone will be insufficient without parallel regional economic diversification strategies.

The skill-based mismatch represents the most pervasive challenge and reflects a chronic lag in aligning curricula with the skill demands of a digitally transforming economy. Employer survey results confirm that digital proficiency and transversal skills, such as communication, teamwork, and problem-solving, are consistently underdeveloped among graduates. This aligns with European Training Foundation [37] findings that skill obsolescence in transition economies can occur within as little as three years without ongoing upskilling interventions. The persistence of such deficits underscores

the need for systemic curriculum redesign, modular learning formats, and the integration of digital competency development across all disciplines.

One of the most critical insights from both the model and the survey is the absence of an institutionalized feedback loop between labor market actors and educational providers. Although pilot public–private partnerships exist, they remain fragmented, project-dependent, and often lack formal governance frameworks. The low proportion of institutions regularly consulting employers on curricular design (18% in the survey) demonstrates that employer involvement is still more symbolic than functional. Yet, the high willingness of companies (72%) to participate in dual education and internship programs suggests untapped potential for active co-production of skills.

From a policy perspective, these findings suggest that tackling the mismatch in Kazakhstan requires a multi-pronged strategy. First, the integration of a national skills forecasting system, supported by real-time labor market analytics, is crucial to inform both enrollment policies and curriculum design. Second, targeted incentives should be introduced to encourage employer participation not merely as advisors but as co-investors in human capital development. Third, educational institutions must adopt flexible and modular curriculum structures capable of rapid adaptation to sectoral and technological shifts. Finally, regional disparities must be addressed through localized program design that reflects the specific economic and demographic conditions of each region.

In broader terms, this study demonstrates the diagnostic power of the proposed conceptual model in identifying and categorizing mismatch phenomena while offering a structured platform for policy planning. The model's adaptability suggests that it could be applied beyond Kazakhstan, particularly in other post-Soviet and emerging economies undergoing similar labor market transitions. However, the findings also underline that without a sustained political commitment to bridging the gap between educational planning and labor market needs, structural mismatch will remain a persistent constraint on economic competitiveness in the digital era.

## 5. Conclusion

This study has examined the systemic misalignment between Kazakhstan's education system and the labor market under the accelerating pressures of digital transformation. Using a conceptual model that integrates education supply, labor market demand, mismatch diagnostics, feedback mechanisms, and systemic adaptability, the research has revealed that vertical, horizontal, and skill-based mismatches are not isolated phenomena but interlinked, mutually reinforcing gaps.

Analysis of statistical data, combined with employer and student surveys, has revealed that the most pressing deficiencies lie in digital competencies, the application of practical skills, and the institutionalization of feedback loops between universities and employers. The findings underscore that a sustainable solution requires coordinated efforts from educational institutions, businesses, and policymakers. Embedding digital and interdisciplinary skills in curricula, expanding practice-based training opportunities, and ensuring continuous, data-driven curriculum updates are critical steps toward closing the skills gap.

### 5.1. Limitations and Directions for Future Research

While the study contributes a comprehensive analytical framework, certain methodological and empirical constraints must be acknowledged. The mismatch index relies on aggregated sectoral and regional data, which may obscure micro-level variations and short-term labor market shifts. Survey samples, although diverse, are skewed toward urban centres, potentially underrepresenting rural labor realities. Furthermore, the current model assumes primarily linear relationships, while in practice, labor market dynamics are often shaped by non-linear shocks such as technological disruptions or policy reforms.

Future research should focus on longitudinal tracking of graduates' career paths to capture the evolution of mismatch over time, targeted studies on rural labor market dynamics, and cross-border mobility analyses. The quantification of emerging skill clusters, particularly in green technologies, AI ethics, and interdisciplinary innovation, remains an important gap. Incorporating advanced simulation techniques, such as system dynamics and agent-based modeling, would enhance predictive capacity and policy relevance.

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