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Identifying risks in the digital transformation of higher education

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ABSTRACT

This study examines the risks affecting digital transformation in higher education institutions in Kazakhstan through a multi-method research approach. The investigation integrates quantitative surveys (N=4,971 students), qualitative focus groups (N=100 faculty and administrators), and expert evaluations using PEST analysis to provide a comprehensive assessment of transformation challenges. Key findings revealed that scientific and technical factors emerged as the most significant risk drivers ($\bar{x}$ = 8.25), followed by economic constraints ($\bar{x}$ = 7.62) and organizational readiness barriers ($\bar{x}$= 6.71). Survey results indicated that while 64.4% of students perceived digital technologies as beneficial for learning, 47.8% reported difficulties with digital platform usage. Focus group interviews highlighted critical challenges in three domains: infrastructure limitations (cited by 68% of faculty), pedagogical adaptation needs (noted by 72%), and ethical implications of AI integration (expressed by 85%). The PEST analysis identified technological factors as primary risk drivers, with rapid platform adoption and data security concerns ranked highest. The study advances a comprehensive framework for understanding and mitigating both internal and external risks in digital transformation, emphasizing the need for targeted policy interventions, organizational development strategies, and enhanced institutional readiness measures. These findings provide actionable insights for policymakers and institutional leaders implementing digital transformation initiatives in emerging educational contexts.

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Introduction

In the context of higher education, the growing importance of digitalization as a crucial aspect influencing learning, teaching, and educational administration processes has become increasingly evident. For universities seeking to lead in innovation, digital transformation emerges as a priority for development and remains essential for maintaining competitiveness in the educational services

market. Digital transformation in universities is driven by the imperative to create and disseminate scientific knowledge, technological expertise, and professional skills (Abil et al., 2023). Consequently, this shift demands the development of modern learning models and prompts organizational and cultural changes (Mukh & Salhab, 2021; Taratukhina & Avdeeva, 2021; Shelepaeva, 2023). These transformational changes require careful consideration of both technological infrastructure and institutional readiness within specific socioeconomic contexts.

Today, learning has evolved into a communicative process tailored to the specific educational environment, aiming to develop key competencies in students. This transformation emphasizes students' ability to select the most relevant information for solving professional challenges and pursuing personal development through flexible and adaptive learning scenarios. In this process, universities act as key aggregators of professional and scientific knowledge and as guiding institutions for individuals preparing for their future professions (Taratukhina & Avdeeva, 2021). Experts in digital learning assert that the transformation of higher education relies on digital technologies to optimize processes, improve the experiences of students and teachers, and establish new learning models rooted in management, collaboration, and support strategies (Vial, 2019; Ovrelid et al., 2023; Shelepaeva, 2023). For instance, digital transformation is described as a series of "profound and coordinated changes in culture, workforce, and technology" (Martin & Xie, 2022, p. 1) that enable new educational and operational models, fundamentally reshaping an institution's operations, strategies, and value propositions (Martin & Xie, 2022).

Thus, at the heart of digital transformation are technologies that significantly change the educational landscape, helping universities to remain competitive in the digital world. Recent frameworks for understanding digital transformation in higher education (Cheng, 2024; Gkrimpizi et al., 2023) emphasize multiple dimensions including digital learning technologies, instructional modality, personnel development, and organizational policies. These dimensions interact within a complex ecosystem of technological adoption and institutional change (Vial, 2019). Contemporary research highlights the importance of considering these dimensions within specific institutional contexts, acknowledging that the level of digital development varies significantly across universities based on their unique organizational characteristics and environmental conditions.

The above classification of digital technologies for universities is not the only one. For example, the Higher Education Digital Capability Framework is an open-source platform-based capability assessment tool for higher education that includes four dimensions, 16 domains, and over 70 capabilities (Higher Education Digital Capability Framework, 2018). However, despite the opportunities offered by digital technologies, digitalization has significant implications for the education system as a whole. These consequences can be interpreted as potential risks that may lead to dehumanization of education as a social institution. At the same time, digital transformation should be seen as a process of radical organizational change (Yureva et al., 2020), involving participants based on multiple choices of actions in an interactive mode, taking into account local rules and requirements that necessitate the application of broader rules and resources (Antonopoulou et al., 2023).

Shelepaeva (2023) considers several classifications of potential risks in the conditions of digitalization of higher education, including external (financial, strategic, operational, and force majeure), internal (resources, accounting policy, and IT), and risks arising from the implementation of information educational activities in the Internet space, the realization of which may lead to an increase in social tension associated with the lack of development of digital competencies of process participants. In some cases, the use of platform solutions for the higher education system requires restructuring at the state level to prevent the emergence of risks. For example, the impact of globalization processes can provoke the risk of increasing the influence of global technological players on educational values and ideas and risks of reducing the availability of educational services. In addition, the digitalization of education also poses new challenges to the academic community related to ethical risks in digital learning analytics and research, as well as the use of artificial intelligence in teaching and research activities (Gkrimpizi et al., 2023). Similarly, Zvereva (2023) raises the issue of digital ethics in higher education, noting that traditional moral values are undergoing significant

changes and must be modernized and codified. Digital ethics should regulate relationships and interactions within the development of e-culture in areas where the natural realm is increasingly merging with information resources. However, the pace of implementing ethics originating in the information world continues to lag behind the rapid development of technology.

Digitalization is changing the relationship between students and instructors. According to Ovrelid et al. (2023), this requires maximizing the reliability and inclusiveness of the environment in which online classes are offered. In addition, increased access to algorithms and data changes most courses in a variety of ways, even redefining the subject area. In continuing this theme, Frolova et al. (2023) argue that, under conditions of digitalized learning, it is the communication between students and teachers that undergoes the greatest transformation. For instance, there may be difficulty utilizing the "sense of audience," a decrease in visual contact, and a lack of non-verbal cues from students. Additionally, risks arise when teachers are unable to adapt their methods to students' needs, potentially resulting in reduced motivation and job satisfaction. The results of the study of the role structure of pedagogical activity in the conditions of digitalization of the educational environment (Gileva, 2023) show that teachers do not fully implement the role of "driver," a term that refers to educators actively engaging students in the learning process and the profession by fostering enthusiasm, motivation, and a sense of purpose (Gileva, 2023, p. 113). This involves adopting innovative and interactive teaching methods to establish a deeper connection between students and their academic as well as professional aspirations. This role involves guiding students through interactive, innovative methods while cultivating a deeper connection to their academic and professional goals (Çepni, et al, 2010). A comprehensive three-year Erasmus+ project Key Action 3: "Supporting Policy Reform - Policy Innovation Initiatives - Promising Cooperation Projects" based on seven leading European HEIs identified risks in three areas of higher education digitalization with a focus on inter-university cooperation: organizations, pedagogy, and technology (Stranger & Mobuchon, 2023). In the organizational area, risks related to trust, faculty incentives, legal frameworks, operational requirements, external policies, and needs are addressed. The pedagogical perspective revealed challenges in pedagogical support, especially in developing faculty digital skills. In the technological aspect, risks related to software selection and centralized digital structures are relevant.

In the evolving landscape of higher education, digital transformation is crucial for universities to maintain competitiveness and foster innovation. Frameworks such as the Technology-Organization-Environment (TOE) model and the Higher Education Digital Capability Framework provide insights into integrating technologies, yet challenges persist, especially in contexts like Kazakhstan, where infrastructural and digital literacy gaps exist. Potential risks include dehumanization of education, ethical dilemmas in digital learning, and the influence of global technological entities. These risks are influenced by external factors such as political, economic, sociocultural, and technological dimensions, necessitating a balanced approach that leverages digital benefits while preserving humanistic values. This study aims to identify these risks by examining stakeholder perceptions and external influences, offering strategies to enhance the resilience and future-readiness of higher education systems.

Conceptual Framework

This study's theoretical architecture integrates the Technology-Organization-Environment (TOE) framework (Tornatzky & Fleischer, 1990) with contemporary digital maturity paradigms to analyse the multifaceted risks associated with digital transformation in higher education. The TOE framework helps contextualize digital transformation risks by linking technological adoption, organizational readiness, and environmental pressures, as seen in recent studies (Gkrimpizi et al., 2023; Shelepaeva, 2023). This theoretical synthesis provides a robust analytical lens through which to examine the complex interplay of technological innovation, organizational change, and environmental influences in educational contexts, particularly within emerging economies. Digital maturity, defined

as the readiness and capability of institutions to adopt and sustain digital technologies, encompasses infrastructure, organizational culture, technical expertise, and stakeholder engagement (HOLON IQ, 2018). Recent studies emphasize the role of institutional policies in shaping digital adoption strategies, with universities implementing structured frameworks to enhance digital competency among faculty and students (Marquez et al., 2024). Furthermore, the effectiveness of digital competency frameworks in higher education has been critically assessed, highlighting gaps in implementation and alignment with institutional goals (Hakimi et al., 2024). The framework encompasses three critical dimensions, each operationalized through specific components and indicators:

1. Technological Context The technological dimension encompasses multiple interrelated components:

- Infrastructure readiness and digital capability assessment
- Integration of emerging technologies (e.g., AI, cloud computing)
- Technical architecture and system interoperability
- Digital security and data governance protocols

These elements collectively determine an institution's capacity for technological innovation and sustainable digital transformation. Recent empirical evidence suggests that technological readiness significantly influences transformation outcomes (Gkrimpizi et al., 2023; Cheng, 2024).

2. Organizational Context The organizational dimension encompasses critical institutional factors:

- Leadership commitment and change management capacity
- Digital literacy and competency development frameworks
- Resource allocation and strategic alignment mechanisms
- Cultural adaptation and resistance management strategies

These organizational elements create the foundational infrastructure necessary for successful digital transformation initiatives. Contemporary research by Abil et al. (2023) emphasizes the crucial role of organizational readiness in facilitating sustainable technological change.

3. Environmental Context The environmental dimension addresses external factors that shape transformation trajectories:

- Regulatory compliance and policy frameworks
- Stakeholder expectations and market dynamics
- Competitive pressures and innovation demands - Socioeconomic factors and regional influences.

These environmental parameters significantly influence institutional capacity for digital transformation, particularly in developing economies (Mukh & Salhab, 2021). The methodological operationalization of this theoretical framework encompasses:

1. Quantitative assessment of technological readiness using validated instruments
2. Qualitative exploration of organizational dynamics through structured interviews
3. Mixed-method analysis of environmental factors using PEST framework
4. Integration of stakeholder perspectives across all three dimensions

This theoretical framework guides both data collection and analysis, ensuring methodological coherence and theoretical rigor. Its application is particularly relevant in the context of Kazakhstan's higher education system, where institutional transformation occurs within unique socio-economic and cultural parameters. The TOE model has been widely applied to analyse digital transformation processes by linking technological, organizational, and environmental factors (Tornatzky & Fleischer, 1990). Recent studies emphasize that the interplay between digital maturity, institutional readiness, and macro-environmental forces plays a key role in shaping digital transformation outcomes (Shelepaeva, 2023; Gkrimpizi et al., 2023). This study adopts the TOE framework to assess the potential risks and opportunities presented by digital transformation in higher education institutions.

Literature Review

Digital transformation in higher education is a pivotal trend driven by global competitiveness, sustainability, and the demands of the industry 4.0 era. This transformation is increasingly important as institutions strive to maintain their competitive edge in a knowledge-based economy (Pham, 2023). The COVID-19 pandemic further accelerated this shift, compelling institutions to rapidly adopt digital technologies (Matsieli & Mutula, 2024; Marks & AL-Ali, 2020). Existing research highlights a multidimensional perspective on this transformation, encompassing technological, organizational, and socio-political dimensions.

Technological advancements are at the core of digital transformation. Vial (2019) defines digital transformation as the adoption of innovative technologies that enable new educational and operational models, fundamentally reshaping an institution's value propositions. Technologies such as learning management systems, virtual reality tools, and artificial intelligence-driven learning platforms have revolutionized educational delivery and student engagement (Martin & Xie, 2022). However, the disparity in digital maturity across institutions often leads to uneven adoption of these technologies. For example, the Higher Education Digital Capability Framework identifies significant gaps in technological readiness among institutions, emphasizing the need for targeted strategies to address these disparities (HOLON IQ, 2018).

Organizational readiness is a significant determinant of successful digital transformation. According to Vial (2019), leadership commitment, resource allocation, and faculty development are crucial for fostering a culture conducive to technological integration. Martin and Xie (2022) further underscore the role of organizational policies and planning in ensuring the sustainable implementation of digital initiatives. Despite these advancements, challenges persist. Faculty resistance to change and limited training opportunities hinder the seamless adoption of digital tools (Gileva, 2023). Additionally, disparities in faculty digital competencies exacerbate the challenges, as highlighted by Frolova et al. (2023).

The external environment, including socio-political and economic factors, significantly influences the digital transformation process. Regulatory frameworks and policy support are critical in enabling institutions to invest in digital infrastructure and training. However, socio-political constraints, particularly in developing economies like Kazakhstan, often pose significant barriers (Shelepaeva, 2023). Ethical concerns, such as data privacy and the use of AI in education, further complicate the digital transformation landscape (Gkrimpizi et al., 2023; Zvereva, 2023). These ethical challenges underscore the need for comprehensive guidelines to regulate the use of technology in higher education.

The impact of digital transformation on teaching and learning is significant, with a notable shift towards flexible, technology-enhanced learning environments (Tri & Hoang, 2023). Sustainability is also a critical consideration in digital education, as highlighted by Shenkoya & Kim (2023), who argue that digital transformation can lead to more efficient and environmentally friendly educational practices. Successful implementation of digital transformation involves strategic planning and investment in infrastructure, as proposed by Alenezi & Akour (2023). Human resources management is also crucial, with Tiwow et al. (2023) emphasizing the importance of developing digital competencies among faculty and staff.

International perspectives reveal diverse approaches to digital transformation. For instance, Xiao (2019) examines digital transformation in Chinese universities, while Bond et al. (2018) explore student and teacher perceptions of digital media use in German higher education. The impact on educators and students is profound, with Gorrell (2023) highlighting increased workloads among educators and Multisilta et al. (2023) emphasizing teachers' expectations in digital transformation projects. Addressing the digital divide is essential for equity and access, as noted by Matsieli & Mutula (2024) and Akour & Alenezi (2022). Sustainability and future directions in digital transformation advocate for a holistic approach, considering environmental, social, and economic

factors (AbadSegura et al., 2020), and fostering innovation through human capital development (Ngo & Vu, 2023).

While digital transformation presents numerous opportunities, it also introduces potential risks. The dehumanization of education, exacerbated by over-reliance on technology, is a significant concern (Yureva et al., 2020). Additionally, infrastructural deficits, such as limited internet access and outdated technological tools, hinder the successful implementation of digital initiatives (Antonopoulou et al., 2023). Despite these challenges, institutions that effectively navigate these risks can foster innovation, enhance student learning experiences, and improve operational efficiency.

Existing literature emphasizes the importance of contextualizing digital transformation strategies to address local challenges. For instance, in transitional economies like Kazakhstan, infrastructural and socio-economic constraints necessitate tailored approaches to digitalization (Ovrelid et al., 2023). By integrating stakeholder perspectives and addressing macroenvironmental factors, institutions can develop resilient strategies that promote sustainable digital transformation (Stranger & Mobuchon, 2023). Shelepaeva (2023) highlights infrastructural deficits, ethical concerns, and limited digital literacy as critical barriers. Similarly, Marquez et al. (2024) argue that institutional policies play a decisive role in shaping digital learning adoption, with universities that implement clear policies achieving greater success in digital transformation efforts. Moreover, the effectiveness of digital competency frameworks in bridging digital literacy gaps has been critically analyzed, revealing discrepancies between intended outcomes and actual institutional practices (Hakimi et al., 2024).

However, few investigations consider how external macroenvironmental forces—political and legal contexts, economic pressures, socio-demographic shifts, and the rapidly evolving technological landscape—collectively magnify or mitigate the risks of digitalization in higher education (Shelepaeva, 2023). Studies have identified and classified risks within higher education institutions (HEIs), but comprehensive frameworks that map these risks to macro-level influences, particularly in rapidly developing educational systems such as Kazakhstan's, remain limited (Antonopoulou et al., 2023). Thus, a pressing need exists for research that integrates multi-stakeholder perspectives to systematically evaluate these macroenvironmental factors and propose targeted interventions.

While existing literature extensively documents the challenges of digital transformation in higher education, few investigations consider how external macroenvironmental forces—political and legal contexts, economic pressures, socio-demographic shifts, and the rapidly evolving technological landscape—collectively magnify or mitigate the risks of digitalization in higher education. Studies have identified and classified risks within higher education institutions (HEIs), but comprehensive frameworks that map these risks to macro-level influences, particularly in rapidly developing educational systems such as Kazakhstan's, remain limited. Thus, a pressing need exists for research that integrates multi-stakeholder perspectives to systematically evaluate these macroenvironmental factors and propose targeted interventions.

By addressing these unexplored dimensions, the present study contributes to both practice and scholarship. It offers university administrators, policymakers, and educators a clearer understanding of how diverse macroenvironmental variables shape the outcomes of digital transformation initiatives. In so doing, it advances the conversation on strategic measures for preventing or managing potential threats, including ethical dilemmas, infrastructural inefficiencies, and skill gaps. Against this backdrop, this research aims to identify the potential risks associated with the digital transformation of higher education in Kazakhstan by systematically examining the interplay of external and internal drivers. Specifically, it seeks to develop a holistic framework for recognizing and mitigating these risks, thereby promoting a more resilient and future-oriented educational landscape. This study aims to examine the risks associated with digital transformation in higher education by exploring stakeholder perceptions, external environmental factors, and institutional challenges by answering these questions:

1. How do key stakeholders, including students, faculty, and administrators, perceive the digital transformation of higher education?

2. What external factors, including political, economic, sociocultural, and technological dimensions, influence the emergence of potential risks in the context of digital transformation?
3. What specific threats arise from these external factors, and how do they impact the successful implementation of digital transformation in higher education?

Methods

Research Design

This study employed a combination of quantitative and qualitative methods, conducted in four main stages, aligning closely with the research questions. In his systematic review of Multi-Method Research (MMR) in security studies, Peez (2023) defines it as an empirical social science approach that integrates qualitative and quantitative data to comprehensively address complex research inquiries. This method includes at least one quantitative and one qualitative approach, with no strict adherence to a single research paradigm (Demir-Yıldız, 2023). In this study, MMR was essential for addressing both the nuanced perceptions of digitalization and the external factors influencing risks, thereby ensuring an integrative analysis of the research questions. The quantitative components emphasized generalizability and external validity through surveys, while the qualitative focus groups and expert consultations enabled in-depth exploration of contextual and internal dynamics. This approach ensured that findings from various stages were synthesized to provide a holistic understanding of the complexities surrounding digital transformation in higher education. Proponents of this design say that the key contribution of MMR is to ensure both external and internal validity. Quantitative methods focus on external validity (i.e., the generalizability of results to multiple cases), while qualitative methods assess internal validity (i.e., the strength of the causal argument for the specific case under study). Importantly, MMR approaches can facilitate the reflexivity needed for the researcher to identify their own biases (Peez, 2023). This quality of MMR (Javdani & Larsen, 2023) notes the suitability of the approach for understanding context, respecting marginalized voices, and uncovering paradoxes.

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The first stage involved a preliminary study, which included a review of relevant literature and an analysis of international practices in the digitalization of higher education. The second stage included a large-scale survey of students, focusing on the following indicators of university digitalization:
- Perceptions of digitalization processes;
- Impact of digitalization on the quality of education;
- Challenges associated with digitalization;
- Digitalization needs.

Focus group interviews were then conducted with university professors and administrators to identify key needs, barriers, and potential solutions for optimizing digital transformation in higher education. The questions proposed for discussion included assessment and targeting of digital solutions implemented over the last three years; analysis of existing barriers and ways to overcome them, as well as positive and negative sides of digitalization in higher education.

According to Gibson (2007) focus groups, provide good results in preliminary research, program design and evaluation, questionnaire development and adaptation, and for exploring

attitudes and perspectives on various topics. In addition, this method is applicable for collecting data on topics that have high levels of problematic, complex and sensitive (Walsh et al., 2023). Focus group interviews, emphasize an interpretive approach to posing and resolving research questions, describe and illuminate the context and setting in which the research is conducted, and separate the researcher from prior adherence to theoretical constructs or hypotheses formulated prior to data collection (Karim & Widen, 2023).

Focus groups, as a qualitative research method, allow participants to present, explain, and discuss their individual perspectives in an interactive setting. This approach helps identify common and opposing views, as well as underlying perceptions through collective discourse (Siedl & Mara, 2022). Nicholson and Shrives (2022) note that interaction is both a key characteristic and an advantage of focus groups, the authors suggest that it is within the analysis of interaction in focus group settings that there is an unexplored frontier area, especially when it comes to the spontaneous utterances and body language of informants.

An undeniable advantage of focus groups is the ability to adapt the method to a particular cultural context. An example of such adaptation is Ortega's study "Charlas y Comidas: humanizing focus groups and Interviews" (Ortega, 2023). An important conclusion obtained by Ortega is that there is a need for greater use of alternative forms of data collection. This is in line with the critical turn in qualitative research towards discourses and practices, where research involves not just the acquisition of information, but the mutual exchange of information by all participants in the process.

In the next stage, results from the student survey, focus group interviews, and international digitalization experiences were analysed. Based on this analysis, key macroeconomic factors were identified and categorized into four groups. At the fourth stage, in order to assess the degree of influence and probability of occurrence of each factor, a Stakeholder Map was developed and relevant experts were engaged for expert analysis.

The expert survey method, where experts in a particular subject area answer questions about specific problems, is used to obtain information about complex or specialized topics where expert opinion is of great value (Rubin & Rubin, 2012). It is important to remember that expert surveys are aimed at obtaining knowledge, not opinion. Therefore, the concept of «expert» may include not only «professionals» in the narrow sense, but also those who have personal social experience in this or that sphere (Belanovsky, 2019).

The number of experts to be interviewed is determined by the specific situation and the objectives of the study. The optimal number may vary depending on the purpose of the research, the complexity of the topic, and the availability of experts. When selecting experts, purposive sampling is traditionally used with a focus on finding carriers of experience and knowledge. However, researchers also say that probing and prompting are more important for obtaining rich data than the number of interviews (Weller et al., 2018). In other words, a small sample with intensive probing of the topic will be more productive than a large sample with superficial interviews without probing.

The fifth stage of the study includes the identification of potential risks and the development of preventive measures and responses to them. For this purpose, we applied the PEST analysis method, which is a rather effective method in the process of strategic management (Summut-Bonnici & Galea) to identify a number of political-legal, economic, socio-demographic and scientific-technical groups of factors (Johnson & Scholes, 2001), that have a direct impact on the activities of organizations (Bîrsan et al., 2016).

The stages of the study are shown schematically in Figure 1.

Figure 1

Flowchart of research
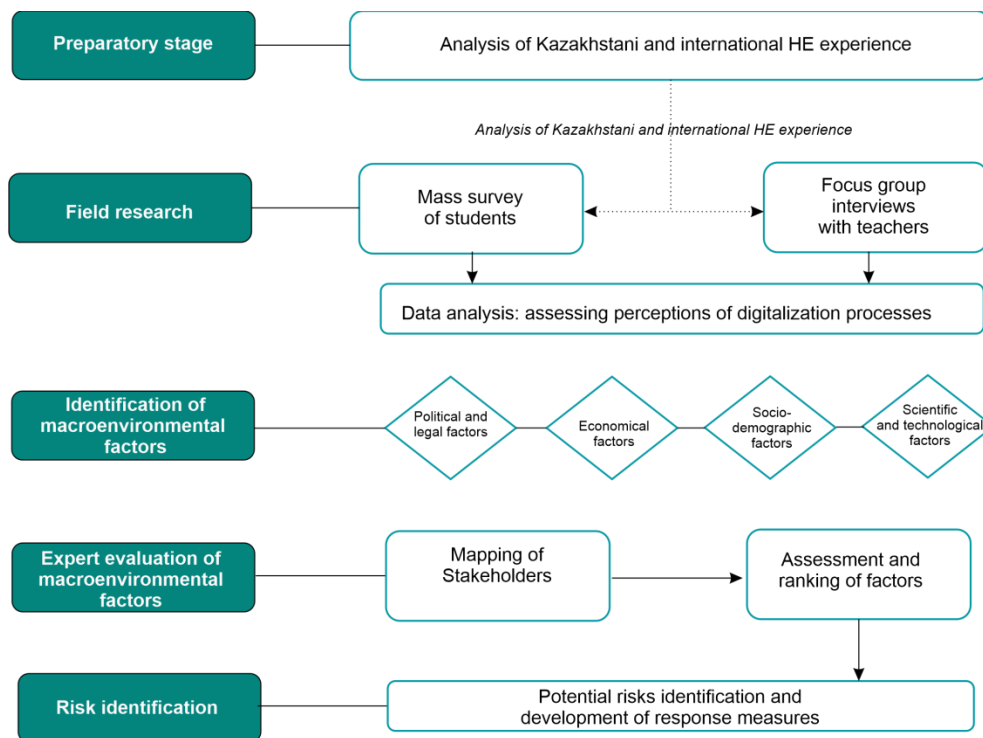
Participants

For the mass survey, a representative sample for the whole territory of the country, which totalled 4,971 students, was determined taking into account a 97% confidence level and a confidence interval of 1.54%. The regional cross-section included all oblasts of Kazakhstan, as well as three megacities: Almaty, Astana and Shymkent. The sample varied by region. 100 teachers and administrators from 5 universities were recruited to participate in focus group interviews. A total of 10 focus groups were conducted. University stakeholders with significant experience of co-operation with higher education were involved as experts to assess macro-environmental factors.

Data Collection Tools

Online questionnaires were used for the mass survey (Appendix 1). For focus group interviews a guide was developed (Appendix 2), including 7 logical blocks: 1) infrastructure and level of digitalisation, 2) perception of digitalisation processes, 3) digitalisation and quality of education, 4) impact of digital technologies on the learning process, 5) problems caused by digitalisation, 6) Use of artificial intelligence tools, 7) basic needs related to digitalisation. In order to assess the significance of each factor, an expert survey sheet (Appendix 3) with two rating scales was developed and tested. The evaluation scales include assessment of the impact of each factor on a scale from 1 to 5 (1 - minimum impact, 5 - maximum impact of the factor) and the probability of change of each factor on a three-point scale (where 0 - the factor will cease to exist within one or two years, 1 - the factor will not change within one or two years, 2 - the factor will increase within one or two years).

The survey questionnaire was developed to capture a broad spectrum of insights from students and faculty members regarding their perceptions, experiences, and needs related to digital transformation. It included closed-ended and Likert-scale questions addressing four primary dimensions: perceptions of digitalization, the impact of digitalization on education quality, challenges and barriers, and digital needs and recommendations. The reliability of the questionnaire was

established through a pilot test involving 150 participants, resulting in Cronbach's alpha values ranging from 0.81 to 0.89 across dimensions, indicating high internal consistency. To ensure validity, a panel of five experts reviewed the instrument for clarity, relevance, and comprehensiveness, confirming content validity. Construct validity was further supported through exploratory factor analysis, which revealed a well-defined factor structure consistent with the theoretical framework.

The focus group interview guide was designed to facilitate in-depth discussions with faculty members and administrators on digital transformation in higher education. The guide comprised seven logical blocks, ranging from infrastructure readiness and perceptions of digitalization to ethical concerns and suggestions for improvement. Reliability was ensured through preliminary focus group sessions, which refined question clarity and structure, with inter-rater reliability during data coding achieving a Cohen's kappa of 0.87, demonstrating substantial agreement among coders. Validity was addressed through iterative feedback from an expert panel, ensuring that the guide was culturally and contextually appropriate for the unique challenges of Kazakhstan's higher education sector.

The expert survey tool was constructed to evaluate macroenvironmental factors influencing digital transformation using a PEST analysis framework. The instrument employed two rating scales: one for assessing the impact of each factor on a 5-point Likert scale and another for evaluating the probability of change on a 3-point scale. Reliability was confirmed through a preliminary test with ten experts, achieving an intra-class correlation coefficient (ICC) of 0.91, indicating excellent reliability. Validity was ensured through consultations with domain experts to confirm the tool's comprehensiveness and face validity, while concurrent validity was established by aligning findings with similar studies, showing strong consistency.

Data Analysis

Data processing for the final results of the mass survey was conducted using SPSS Statistics software, which provides a wide range of tools for statistical analysis and data visualization. The focus group surveys were analysed by the research team using descriptive content analysis and interpretive techniques, which enabled the identification of key categories and themes reflecting the participants' views on the problem under study. Processing of the results of expert assessment and ranking of factors was carried out using the capabilities of MS Excel. To ensure credibility and rigor in qualitative data analysis, this study employed multiple validation techniques. Triangulation was achieved by comparing focus group data with survey responses and expert interviews. Transferability was ensured by contextualizing findings within international digital transformation studies. To maintain consistency (dependability), an inter-coder reliability check was conducted, yielding a Cohen's kappa of 0.87. Finally, confirmability was strengthened by using an audit trail and expert validation to minimize researcher bias (Creswell & Poth, 2018; Weller et al., 2018).

Results

The results of the study are presented here under subheadings according to the research questions respectively.

Research Question 1: How Do Key Stakeholders, Including Students, Faculty, and Administrators, Perceive the Digital Transformation of Higher Education?

Digitalization Needs for a Comfortable Learning Environment

The analysis of student responses revealed several areas where digitalization is necessary to improve the learning experience. Among the most frequently mentioned needs were features such as automatic notifications for schedule changes, online application systems for retaking sessions, and better access to Wi-Fi networks. These needs reflect the growing demand for more seamless and

accessible administrative processes, as well as infrastructure improvements that can directly impact the quality of education.

As presented in Table 1, automatic notifications of schedule changes achieved the highest mean score (M = 0.29), indicating its importance among the surveyed students. Similarly, online application systems for retaking sessions scored a mean of 0.28, reflecting a significant demand for solutions that simplify academic processes. Access to Wi-Fi networks was also identified as a critical factor, with a mean score of 0.26. Platforms to find internships and a system for submitting applications for scholarships and grants were other noteworthy suggestions, highlighting the need for digital tools to support academic and career development.

Table 1

Highlighted digitalization needs for students

Digitalization Need	Mean Score	% of Students Agreeing
Automatic notifications of schedule changes	0.29	18%
Online application systems for retaking sessions	0.28	16%
Access to Wi-Fi networks	0.26	18%
Platform for finding internships and vacancies	0.25	19%
Submitting applications for scholarships	0.22	21%

The results indicate that students value features that enhance communication, simplify administrative workflows, and improve access to resources. These priorities provide actionable guidance for higher education institutions seeking to align their digital transformation efforts with the expectations of their primary stakeholders.

Impact of Digitalization on the Quality of Education

Students' perceptions of the role of digital technologies in improving the quality of education were assessed using a Likert-scale. Table 2 summarizes their responses. A substantial proportion of students (37.3%) strongly agreed that digital technologies such as online lectures and e-books enhanced their understanding of learning materials. An additional 27.1% agreed that digital tools were a valuable complement to traditional methods.

Interestingly, 22.2% of respondents expressed neutrality, indicating no significant difference between traditional and digital methods in terms of educational quality. However, a smaller subset of students expressed disagreement, citing challenges such as limited technical resources or a preference for in-person instruction.

Table 2

Student perceptions of digitalization and quality of education

Response	Percentage
Strongly Agree	37.3%
Agree	27.1%
Neutral	22.2%
Rather Disagree	7.8%
Strongly Disagree	5.6%

These findings underscore the positive contributions of digital technologies to education while highlighting areas for improvement to address technical limitations and varying student preferences.

Challenges in Using Digital Platforms

Students were also asked about difficulties encountered when using digital learning platforms. As shown in Table 3, 47.8% of respondents adopted a neutral stance, suggesting familiarity with digital platforms but acknowledging areas for improvement in usability and interface design. A smaller proportion of respondents (16.0%) disagreed that they faced challenges, reflecting confidence in using digital tools. However, 18.8% rather agreed that digital platforms were difficult to use, with some citing issues such as interface complexity and insufficient training.

Table 3

Challenges in using digital platforms

Response	Percentage
Neutral	47.8%
Disagree	16.0%
Agree	18.8%

These results suggest that while many students are accustomed to digital platforms, there remains considerable room for improvement, particularly in simplifying platform navigation and providing adequate support for users.

Advantages and Challenges of Digitalization Identified by Teaching Staff

The qualitative data gathered from focus group discussions with teaching staff provided insights into the benefits and challenges posed by digitalization in universities. Table 4 below presents the findings.

Table 4

Advantages and Challenges of Digitalization Identified by Teaching Staff

Category	Description	Examples/Key Points
Advantages		
Administrative Efficiency	Optimization of administrative processes and improved management efficiency.	- Reduced routine tasks - Increased transparency in workflows
Student Progress Monitoring	Enhanced tracking of student progress through learning management systems (LMS) and analytics.	- Adaptation of programs to individual student needs
Access to Resources	Improved availability of electronic resources, including global scientific databases and libraries.	- Integration of innovative and interactive content - Systematic organization and retrieval of information

Category	Description	Examples/Key Points
Challenges		
Digital Skills Gap	Insufficient digital competencies among faculty, particularly older staff.	- Discrepancies between faculty and student digital literacy - Younger teachers more adept with digital tools
Infrastructure Limitations	Outdated infrastructure and limited resources hinder digital transformation.	- Need for high-speed internet, equipped classrooms, and multimedia tools (e.g., lecture recording studios)
Pedagogy Balance	Difficulty in balancing traditional and digital teaching methods.	- Importance of pedagogical skills - Need to blend conventional and digital methods for student engagement
Ethical AI Concerns	Scepticism and ethical concerns regarding the use of AI in education.	- Potential benefits (e.g., data visualization, gamified learning) - Need for regulatory guidelines and ethical standards

Note. Adapted from focus group discussions with teaching staff.

Teaching staff consistently acknowledged several advantages, such as the optimization of administrative processes, improved management efficiency, and enhanced monitoring of student progress. The introduction of learning management systems (LMS) and analytics platforms allows universities to adapt educational programs to students' individual needs, reducing routine administrative tasks and increasing transparency in academic and operational workflows.

In addition, teachers highlighted the improved availability of electronic resources, including access to global scientific databases and electronic libraries. These tools enhance the quality of education by enabling faculty to integrate innovative and interactive content into their courses. The ability to systematically organize and retrieve information was also noted as a key advantage of digitalization. Despite these benefits, teaching staff expressed concerns about several challenges. One prominent issue was the need for continuous professional development to align with the rapid evolution of digital technologies. Teachers identified the following key areas of concern:

1. Insufficient Digital Skills among Faculty: Many teachers acknowledged gaps in their digital competencies, leading to discrepancies between the digital literacy of faculty and students. Younger teachers, however, appeared more adept at integrating digital tools into their teaching practices.

2. Outdated Infrastructure and Limited Resources: Teachers emphasized the need for high-speed internet, adequately equipped classrooms, and sufficient multimedia tools, including studios for recording lectures. Without these resources, the potential of digital transformation is significantly constrained.

3. Balancing Traditional and Digital Pedagogy: Faculty members noted that the integration of digital technologies should not overshadow the importance of traditional teaching methods. Pedagogical skills remain essential, and the ability to blend conventional and digital methods is critical for fostering student engagement.

4. **Ethical Considerations in Artificial Intelligence (AI)**: The use of AI tools in education emerged as a new area of concern. Although some faculty members acknowledged the potential benefits of AI for tasks such as data visualization and gamified learning, many expressed scepticisms about its broader applications. Faculty suggested that regulatory guidelines and ethical standards should govern the use of AI in academic settings to maintain academic integrity.

These findings suggest that while digitalization offers numerous advantages, addressing challenges related to digital literacy, infrastructure, and ethical concerns is essential for ensuring the successful integration of technology into higher education.

Research Question 2: What External Factors, Including Political, Economic, Socio-Demographic, and Technological Dimensions, Influence the Emergence of Potential Risks in the Context of Digital Transformation?

External Environmental Factors Impacting Digital Transformation

An expert survey was conducted to identify the macroenvironmental factors influencing digital transformation in Kazakhstan's higher education sector. The experts evaluated factors across political, economic, socio-demographic, and scientific and technical domains. Table 5 presents the ranked factors, categorized by their weighted average scores.

Table 5

Ranked Macroenvironmental Factors Influencing Digital Transformation

Category	Top Factor	Weighted Score
Political and Legal	Changes in regulations for digital transformation	6.63
Economic	Costs of maintaining digital infrastructure	7.62
Socio-Demographic	Shortage of digital-savvy teaching staff	6.71
Scientific and Technical	Introduction of new digital platforms	8.80

The results indicate that the most influential factors stem from the scientific and technical domain, particularly the introduction of new or updated digital platforms, which scored the highest average rank of 8.80. Economic factors, such as the costs associated with maintaining digital infrastructure, also featured prominently, followed by political and legal considerations, including regulatory changes. The shortage of qualified teaching staff was identified as a significant socio-demographic challenge.

Research Question 3: What Specific Threats Arise from These External Factors, and How Do They Impact the Successful Implementation of Digital Transformation in Higher Education?

Identified Risks and Proposed Mitigation Strategies

Experts identified a range of potential risks associated with digital transformation, which were categorized based on macroenvironmental factors. Table 6 summarizes these risks and outlines proposed mitigation strategies to address them.

Table 6

Identified Risks and Mitigation Strategies

Category	Risk	Proposed Mitigation
Political and Legal	Data protection non-compliance	Develop robust data governance frameworks
Economic	Financial constraints for digital infrastructure	Encourage public-private funding partnerships
Socio-Demographic	Insufficient digital competencies among faculty	Invest in faculty training programs
Scientific and Technical	Unreliable digital platforms	Conduct regular audits and upgrades

The findings underscore the importance of a coordinated response to mitigate these risks. For example, improving data governance policies can address regulatory risks, while targeted investments in digital literacy training can enhance the competencies of teaching staff. Additionally, establishing public-private partnerships can alleviate financial constraints and ensure sustained funding for infrastructure upgrades.

Recommendations for Mitigating Risks

Based on the identified factors, experts proposed several strategies to mitigate potential risks and enhance the effectiveness of digital transformation efforts. Table 7 summarizes the key risks and corresponding mitigation strategies across the four macroenvironmental categories.

Table 7

Identified Risks and Mitigation Strategies

Category	Risk	Proposed Mitigation
Political and Legal	Ambiguity in regulatory policies	Develop clear and consistent regulations
Economic	High costs of digital infrastructure maintenance	Create public-private partnerships
Socio-Demographic	Gaps in digital literacy among faculty	Implement nationwide digital literacy training
Scientific and Technical	Poor adoption of new technologies	Foster cross-institutional collaborations

Experts emphasized that a multi-stakeholder approach is essential for addressing these challenges. For instance, strengthening public-private partnerships can alleviate economic constraints, while nationwide training initiatives can bridge gaps in digital literacy among faculty members. Developing a unified regulatory framework for digital transformation can ensure consistent adoption and compliance across institutions.

External Environment Factors That Have the Greatest Impact on the Emergence of Potential Risks in the Context of Digitalization of Higher Education in Kazakhstan

To participate in the expert survey to answer the second research question "*What factors of the external environment have the greatest impact on the emergence of potential risks in the conditions of digitalization of higher education in Kazakhstan*" attracted experts who are both major and indirect stakeholders according to the developed map of stakeholders. As a result of the expert survey, the values of factors on 13 scorecards were obtained, and the procedure of ranking the results of expert assessments was carried out. Based on the weighted average value ($N_{total} \geq 4.5$) for each factor and the forecast of changes, the final PEST analysis matrix with ranked macroeconomic factors was developed (Table 8).

Table 8

Ranked macro-environmental factors

Political and legal		Economical	
Changes in normative legal acts and program documents regulating the processes of digital transformation of universities	6.63	Dynamics of the cost of Internet communication services. maintenance of telecommunication systems. cyber security services. software development and customization	7.62
State policy for the development of higher education and science. including digitalization processes	6.51	Costs of purchasing modern laboratory and training equipment and computer hardware and software	7.10
Changes in normative legal acts and program documents regulating activities in the sphere of higher and postgraduate education	5.96	Dynamics of industry development (taking into account digitalization of production) and the need for new competencies formation	5.86
Ethical principles and guidelines for the protection of human subjects of research	5.17	Dynamics of the labour market: demand for personnel in the implemented areas of training	5.51
Socio-demographic		Scientific and technical	
Lack of highly qualified specialists and staff turnover in the higher and postgraduate education sector	6.71	Introduction of new or updated digital platforms for higher and postgraduate education	8.80
Media influence	4.58	Adoption and promotion of generative artificial intelligence	8.66
		Level of digital maturity and technical capabilities of HEIs	8.57
		Information security and protection of personal data	8.24
		Speed of change in the development of «end-to-end» digital technologies	8.17
		Innovation potential of HEIs	7.68
		Directional vector and dynamics of capitalization in R&D	7.62

According to the results obtained, the greatest influence on the digitalization of higher education is exerted by the scientific and technical group of factors (the average rank of the factor is 8.25). The distribution of average ranks by other weights was as follows:

- economic factors– 6.52
- political and legal – 6.07
- socio-demographic – 5.65.

Discussion

1. How Do Key Stakeholders, Including Students, Faculty, and Administrators, Perceive the Digital Transformation of Higher Education?

The findings revealed that most students perceived the level of digitalization in their institutions as "average," indicating that while universities are transitioning to more modern methods, digital technologies are still predominantly supplementary tools rather than primary methods. This result aligns with studies such as those by Martin and Xie (2022), who highlighted that digital transformation in higher education often begins with a transitional phase, where traditional teaching methods coexist with digital tools. Universities must establish structured approaches to digital adoption to overcome these risks (Vial, 2019). Recent findings emphasize that universities with well-defined digital learning policies experience fewer challenges in adopting new technologies, as structured policies enhance faculty engagement and student participation (Karim & Widen, 2024). Similarly, Gileva (2023) emphasized that this stage is marked by hybrid forms of learning that integrate basic digital components without fully replacing conventional approaches. However, this finding contrasts with institutions in technologically advanced regions, where studies like those by Vial (2019) report a higher level of integration of digital technologies as primary instructional tools. The implications of this result suggest that universities in Kazakhstan may need to accelerate their adoption of advanced technologies to remain competitive globally while simultaneously addressing the infrastructural and cultural barriers that hinder full-scale digital transformation.

Students overwhelmingly agreed that digital tools, such as online lectures and e-books, enhanced their understanding of learning materials, with 37.3% strongly agreeing to this effect. This result is consistent with prior research by Vial (2019), which noted that digital technologies improve accessibility to educational content and foster personalized learning experiences. The findings are also supported by Gileva (2023), who reported that digital tools provide flexibility and enhance students' ability to engage with complex learning materials. However, the current study found that some students (13.4%) disagreed or remained neutral about the benefits of digital technologies, citing technical challenges or a preference for traditional classroom interaction. This nuance highlights an area of divergence from studies such as those by Shelepaeva (2023), who reported a more uniform positive perception of digitalization's impact on educational quality. The mixed results in this study indicate the need for institutions to address technological barriers and diversify teaching approaches to cater to varying student preferences.

The study revealed a divided opinion regarding the usability of digital platforms, with 47.8% of students adopting a neutral stance and 18.8% indicating that these platforms caused difficulties. This result aligns with Shelepaeva's (2023) findings, which emphasized that many institutions face usability challenges, including complex interfaces and inadequate training for both students and faculty. However, Martin and Xie (2022) reported more optimistic results, noting that the adoption of user-centered design principles significantly reduced the usability challenges in some institutions. The divergence between this study and others may be attributed to regional disparities in infrastructure and resources. This result underscores the importance of improving the design and accessibility of digital platforms to ensure a seamless user experience. Universities in Kazakhstan can draw lessons from global best practices to simplify interfaces and provide targeted training programs.

Students identified several areas requiring digitalization, including online access to lectures and automatic notifications of schedule changes. These findings are consistent with research by HOLON IQ (2018), which highlighted the importance of robust communication systems and access to online resources as foundational components of successful digital transformation. Furthermore, this study aligns with Shelepaeva (2023), who found that streamlining administrative processes through digital tools significantly improves student satisfaction. However, the specific emphasis on tools such as automatic notifications and internship platforms in this study highlights a localized priority, possibly reflecting unique gaps in Kazakhstani universities. Addressing these needs could serve as a key strategy for institutions to enhance student engagement and streamline their academic experience.

Teaching staff acknowledged the benefits of digitalization, including enhanced administrative efficiency and access to global knowledge resources. These findings align with studies by Vial (2019) and Gileva (2023), who similarly reported that digital tools improve management workflows and provide innovative teaching materials. However, faculty also highlighted challenges such as gaps in digital literacy, outdated infrastructure, and ethical concerns surrounding AI use. These concerns are echoed by Shelepaeva (2023), who identified similar barriers in institutions undergoing digital transformation. Nevertheless, the ethical dilemmas surrounding AI use discussed in this study represent a relatively novel area of inquiry, as noted by Martin and Xie (2022). The alignment with prior literature suggests that while digitalization offers numerous benefits, its success is contingent on addressing systemic challenges, particularly in faculty training and infrastructure development.

2. What External Factors, Including Political, Economic, Sociocultural, and Technological Dimensions, Influence the Emergence of Potential Risks in the Context of Digital Transformation?

The study identified scientific and technical factors, such as the introduction of new digital platforms, as the most significant influences on digital transformation. This result corroborates the findings of HOLON IQ (2018), which emphasized the role of technological advancements in shaping the trajectory of digitalization. Additionally, economic constraints, including the costs associated with maintaining digital infrastructure, were highlighted as a major barrier, aligning with research by Shelepaeva (2023). However, the prioritization of scientific and technical factors in this study diverges slightly from Vial (2019), who argued that organizational culture often plays a more prominent role in digital transformation efforts. This divergence underscores the unique contextual challenges faced by Kazakhstani institutions, where external factors such as policy and infrastructure limitations hold greater sway. Addressing these macroenvironmental factors will be critical for universities seeking to optimize their digital transformation strategies.

The findings of this study have significant implications for both policy and practice. The alignment of many results with prior literature underscores the universality of certain challenges, such as usability issues and faculty training gaps, in digital transformation. However, the localized nuances, such as the prioritization of administrative tools and the ethical concerns surrounding AI, highlight the need for region-specific strategies. Policymakers must consider these findings to allocate resources effectively, update regulatory frameworks, and promote equitable access to digital technologies across institutions. For practitioners, the results emphasize the importance of fostering a culture of innovation, providing comprehensive training, and addressing infrastructural barriers to ensure a successful transition to digitalized education.

3. What Specific Threats Arise from These External Factors, and How Do They Impact the Successful Implementation of Digital Transformation in Higher Education?

The findings of this study also revealed a significant disparity between the digital literacy levels of students and teaching staff. While many younger faculty members were comfortable with incorporating digital tools into their teaching practices, more experienced educators struggled to

adapt to these changes. This finding aligns with research by Gileva (2023), who noted that gaps in digital competencies among faculty often result in a mismatch between student expectations and teaching practices. Similarly, Shelepaeva (2023) emphasized the importance of targeted training programs for faculty to bridge this gap. However, the current study further highlights the paradoxical situation where students sometimes exhibit higher levels of digital competence than their instructors. This underscores the urgent need for continuous professional development initiatives that equip faculty with the skills necessary to effectively integrate digital tools into their pedagogy and adapt to evolving technological demands.

Another critical finding was the ethical dilemma associated with the use of artificial intelligence (AI) in education. Faculty members expressed concerns about potential misuse of AI tools and their implications for academic integrity. These concerns resonate with the observations of Martin and Xie (2022), who highlighted the need for clear regulatory frameworks to govern the ethical use of AI in higher education. The current study adds depth to this discourse by emphasizing the scepticism among educators regarding AI's capabilities and its broader application in teaching and learning. Addressing these concerns requires institutions to establish robust guidelines and promote a culture of ethical responsibility while leveraging AI to enhance educational outcomes.

Finally, the macroenvironmental factors influencing digital transformation were found to be dominated by scientific and technical considerations, particularly the introduction of new digital platforms. This finding supports the conclusions of HOLON IQ (2018), which identified technological innovation as a primary driver of digital transformation in higher education. However, the study also highlighted significant economic constraints, such as the high costs of maintaining digital infrastructure, which align with Shelepaeva's (2023) findings. These challenges are compounded by political and legal barriers, including ambiguous regulatory policies. Unlike studies in regions with more robust policy frameworks, such as those reported by Vial (2019), the current study underscores the critical role of policy reform in creating an enabling environment for digital transformation. The findings suggest that a multi-stakeholder approach, involving policymakers, educators, and industry partners, is essential for overcoming these barriers and ensuring sustainable progress.

The cumulative findings of this study provide valuable insights into the current state of digital transformation in Kazakhstan's higher education system. They reveal both universal challenges, such as infrastructure limitations and gaps in digital literacy, and context-specific issues, including economic constraints and ethical concerns related to AI. By addressing these challenges through strategic investments, regulatory reforms, and targeted training programs, institutions can create a more inclusive and technologically advanced learning environment that meets the needs of all stakeholders.

The findings revealed that most students perceived the level of digitalization in their institutions as "average," indicating that while universities are transitioning to more modern methods, digital technologies are still predominantly supplementary tools rather than primary methods. This result aligns with studies such as those by Martin and Xie (2022), who highlighted that digital transformation in higher education often begins with a transitional phase, where traditional teaching methods coexist with digital tools. Universities must establish structured approaches to digital adoption to overcome these risks (Vial, 2019). Recent findings emphasize that universities with well-defined digital learning policies experience fewer challenges in adopting new technologies, as structured policies enhance faculty engagement and student participation (Karim & Widen, 2024). Similarly, Gileva (2023) emphasized that this stage is marked by hybrid forms of learning that integrate basic digital components without fully replacing conventional approaches. However, this finding contrasts with institutions in technologically advanced regions, where studies like those by Vial (2019) report a higher level of integration of digital technologies as primary instructional tools. The implications of this result suggest that universities in Kazakhstan may need to accelerate their adoption of advanced technologies to remain competitive globally while simultaneously addressing the infrastructural and cultural barriers that hinder full-scale digital transformation.

Conclusion and Implications

In order to prevent the identified risks of digitalization of higher education, it is possible to formulate several key recommendations aimed at improving the digitalization of the educational process in higher education institutions. These recommendations aim to mitigate identified challenges and improve student satisfaction with the educational process.

1. Enhancing internet connectivity and technical infrastructure to ensure reliable, high-speed access across all academic and communal areas of higher education institutions. This is especially important in conditions when a significant part of study materials and assignments are available only online. In addition, it is important to modernize computer equipment in study areas. Providing students with access to modern computers that support up-to-date software solutions will significantly increase the efficiency of the educational process, especially for students of technical and natural sciences.

2. Updating and expanding the software used: it is recommended to regularly update the programs used, as well as to expand their list to include modern tools that meet the requirements of specific educational areas. Special emphasis should be placed on introducing specialized programs and simulators for technical, medical, and natural sciences students to enhance professional skills and workplace readiness.

3. It is necessary to eliminate the problems related to the duplication of digital documents on paper and completely switch to electronic document management. This will not only simplify administrative procedures, but also reduce the burden on students and teachers, making the educational process more convenient and efficient.

4. Improve the integration of digital learning platforms, such as Learning Management Systems (LMS), to seamlessly align with overall learning processes. This includes creating more intuitive interfaces, offering support throughout usage stages, and regularly updating platform features.

5. Offer continuous training on digital tools and software for students and faculty to enhance their technical proficiency. This will enable students and teachers to use technology more confidently in the learning process and increase the readiness of graduates for their future careers.

6. Increased access to innovative digital tools such as virtual laboratories, simulations and other interactive platforms is recommended. These tools can significantly enrich the learning process and make it more interactive and enjoyable.

7. Encouraging the use of technologies such as *generative artificial intelligence* can also open up new opportunities to personalize learning and improve feedback between students and instructors.

8. It is necessary *to strengthen information security and personal data protection requirements*, as well as *ethical requirements* for the use of generative artificial intelligence.

The implementation of the proposed measures will be aimed at improving the efficiency of the process of digital transformation of higher education in Kazakhstan and will ensure a high level of adaptation of the educational environment of universities and participants of the educational process to the introduction and use of digital technologies in the campus environment. The study findings should be interpreted within the context of certain limitations. First, while the sample size was substantial, the regional distribution of participants may not fully represent all institutional contexts within Kazakhstan. Second, the rapid evolution of digital technologies means that some identified risks may evolve or become obsolete as new challenges emerge. Third, the expert evaluations, while rigorous, may reflect individual biases or institutional perspectives that could influence risk assessment outcomes. Future research should address these limitations through longitudinal studies that track risk evolution over time and comparative analyses across different regional contexts.

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Appendix

Appendix 1. Survey Questions

Perception of Digitalisation Processes

1. **Assess the level of digitalisation in your educational institution?**

Processes	Low	Below Average	Average	Above Average	High
Educational and Scientific Process	1	2	3	4	5
Administrative Process	1	2	3	4	5

2. **Which digital tools do you find most useful?**

1. _____
2. _____
3. _____

Digitalisation and quality of education:

3. To what extent do you agree with the following statements? (Rate on a scale from 1 to 5, where 1 = strongly disagree, 2 = somewhat disagree, 3 = neutral, 4 = somewhat agree, 5 = strongly agree)

Statement	Rating				
The use of digital technologies (e.g., online lectures, e-books and others) has improved my understanding of learning materials compared to traditional methods.	1	2	3	4	5
Digital tools (e.g., online tests, interactive assignments and others) have helped me better prepare for exams compared to traditional methods	1	2	3	4	5
Digital learning methods have improved my ability to acquire knowledge compared to traditional methods	1	2	3	4	5
Digital tools have enhanced my self-learning skills	1	2	3	4	5
Digital technologies have improved my organisation of the learning process and time management	1	2	3	4	5
The use of digital technologies has positively impacted my academic performance	1	2	3	4	5

Problems in digitalisation:

4. To what extent do you agree with the statement: "I find it difficult to use digital educational platforms (e.g., learning management systems, online libraries and others)?"

Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1	2	3	4	5

5. To what extent do you agree with the statement: "In my university, digital documents are often duplicated on paper, creating additional difficulties"?

Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
1	2	3	4	5

Digitalisation Needs:

6. Which processes, in your opinion, need to be digitized to ensure more comfortable learning conditions?

1. _____
2. _____

Appendix 2. Guide for Focus Group Discussion (FGD) Among Students

1. **INFRASTRUCTURE AND DIGITALISATION LEVEL**
1. How do you evaluate the quality of wireless internet connectivity at your university?
2. How satisfied are you with the availability of computers in the learning areas of your university?
3. How satisfied are you with the quality of computers in the learning areas of your university?
4. To what extent does the software used at your university meet the requirements of your learning process?
5. Which digital tools do you use most often during your studies? (*Examples may include tools for communication with professors: messengers, video conferencing. For preparing assignments: Microsoft Word, Google Docs, LibreOffice Writer for creating and editing texts. Online boards: Miro, Mural, Google Jamboard for collaboration and brainstorming. Online learning platforms: Coursera, edX, Udemy for acquiring new skills and knowledge. Graphic editors: Adobe Photoshop, GIMP, Canva for creating and editing images. Video editors: Adobe Premiere Pro, DaVinci Resolve, Shotcut for video editing.*) **Do not read aloud! You may prompt if participants find it difficult to answer.**

2. **PERCEPTION OF DIGITALISATION PROCESSES**
1. How do you assess the level of digitalisation in your university?
2. What digital technologies are available at your university? What platforms exist for hosting educational materials? How effective are they in helping you understand the educational content?
3. Are you aware of the electronic library in your university? Do you use online resources that provide access to e-books, academic journals, databases and other informational materials?
4. How helpful are digital tools, such as online tests, interactive assignments and other methods, in preparing for exams compared to traditional methods?
5. To what extent have digital learning methods improved your ability to acquire knowledge compared to traditional methods?
6. How have digital tools impacted your self-learning skills, organisation of the learning process and time management?
7. Do you think the use of digital technologies has positively affected your academic performance? If yes, how? If not, why?

3. **USAGE OF ARTIFICIAL INTELLIGENCE**
1. What GAI tools do you know?
2. Have you used AI tools such as ChatGPT during this academic year? For what purposes?
3. How frequently do you use them?
4. Do you think it is appropriate to use GAI for completing assignments? Why? Are there specific boundaries for when it is acceptable or unacceptable? What does it depend on?
5. Do you know how GAI generates responses? Can the information it provides always be trusted?
6. Do you know how to frame questions for GAI to receive the answers you need?
7. Do you believe frequent use of GAI can negatively affect the learning process? (For example, loss of skills in information searching, text writing and information analysis.) **Do not read aloud the part in parentheses! Mention them only to stimulate discussion.**
8. How do you think the use of tools such as GPT will affect academic integrity?
9. Have professors discussed the rules and norms regarding the use of GAI or when it is appropriate to use it for completing assignments?

Appendix 3. Guide for Conducting FGDs Among Faculty Members

1. **Infrastructure and Digitalisation Level**
- How do you evaluate the quality of wireless internet connectivity at your university?
- How satisfied are you with the availability of computers in the learning areas of your university?
- How satisfied are you with the quality of computers in the learning areas of your university?
- To what extent does the software used at your university meet the requirements of your teaching?
- Which digital resources and tools do you most frequently use in teaching (e.g., for educational or administrative purposes)?

2. **Perception of Digitalisation Processes**
- How would you rate the level of digitalisation at your institution (Educational and Scientific Process and Administrative Process)?
- Which of the digital tools you use do you consider the most useful?

3. **Digitalisation and Teaching Quality**
- How do digital tools help or hinder your teaching?
- How has your teaching changed due to digital technologies?
- What impact has digitalisation had on your interaction with students?

4. **Impact of Digitalisation on Education Quality**
- How do you evaluate the impact of digital technologies on the quality of student learning?
- Which digital resources and tools, in your opinion, most contribute to improving the quality of education?
- What major challenges do you observe from students in integrating digital technologies into the learning process?

5. **Challenges in Digitalisation**
- What problems do you encounter when using digital technologies in teaching?
- To what extent do current digital platforms and resources meet your teaching needs?

6. **Use of Artificial Intelligence Tools**
- Generative Artificial Intelligence (GAI) tools, such as ChatGPT, are becoming increasingly common in academic institutions. How often have you observed students using such tools to complete academic tasks during this academic year?
- How often have you used generative AI tools in teaching this academic year and for what purposes?
- To what extent do you agree with the following statements:
  - I understand how GAI generates answers.
  - I understand how to frame questions for GAI to get the desired answers.
  - I understand how using GAI can assist me in teaching.
  - I understand how using GAI can hinder my teaching.
- Which GAI tools do you use?
- Should GAI be integrated into the learning process in your department?
- What major obstacles do you foresee in integrating GAI into the learning process in your department?
- Do you think it is necessary to increase control over students' use of generative AI in the learning process?

7. **Digitalisation Needs**
- In which areas do you feel the greatest need for digital technologies to improve the quality of education?
- Which digital technologies would you such as to see implemented at your institution?
- Which specific administrative or educational processes in your institution, in your opinion, require new digital solutions?