УДК 378.1 https://www.doi.org/10.69927/BPQX3428

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THE CRITICAL ROLE OF SOFT SKILLS IN KAZAKHSTAN'S JOB MARKET FOR IT GRADUATES: JOB MARKET ANALYSIS

Annotation
This study examines the alignment between academic offerings and market demands in Kazakhstan's Information Technology (IT) sector. The main objective is to identify existing gaps and to propose possible solutions to the issues in this field. The authors listed IT-related academic programs from universities throughout Kazakhstan and job vacancies from 3 leading job portals: enbek.kz, hh.kz, and careerjet.kz, from September 2023 to January 2024. The predominant soft skills in this filed were determined by (1) job categorization using K-Nearest Neighbors (KNN), and (2) the application of Natural Language Processing (NLP) on job descriptions to find key skills required to these jobs. The present findings define the most significant soft skills corresponding to different IT clusters from analyzing the 450 job vacancies. Now, these findings might have huge implications for everyone involved in IT for education and job market for Kazakhstan. Additionally, the results of this study imply for enhancing existing curriculum for IT programs in Kazakhstan, and demonstrates the importance of a soft skills training for complementary IT studies. Thus, the findings of the study can shed a light on the discussion about IT education in Kazakhstan by determining the areas where the higher education system should tune up relevant skills to increase the employability of the graduates. Suggestions for future research are made to fill those gaps, and recommendations for universities, and industry partners.

Key words: IT Education, Job Market Analysis, Kazakhstan, Soft Skills, Natural Language Processing (NLP), K-Nearest Neighbors (KNN), Job Clusters.

Introduction. Kazakhstan has undergone massive changes in the last decade and its Information Technology (IT) sector is one of the attractive areas of this transformation in the country, driven by government strategies, investments from international capital, and strong start-up environment [1], [2], [3]. Consequently, the IT sector has emerged as a key foundation of the national economy and plays a significant role in economic diversification initiatives away from oil and gas. At a roundtable with business leaders of Kazakhstan and Germany last autumn, the President spoke about the importance of this growth and added that "Kazakhstan plans to export IT products and services in the amount of $ 1 billion by 2025 and train 100,000 internationally competitive Kazakhstanis in the IT sector." [4].

Although different reports show that Kazakhstan IT industry is going up, there is still a gap between the universities and employers in physical entities. Such a mismatch, which is a widespread problem in rapidly developing areas, is especially pronounced in Kazakhstan. The reason is that the rapid development of the IT community often exceeds the pace at which educational programs are updated. This disassociation covers not only the learning of these important technical skills but also, more and more importantly, the development of soft skills required to excel in IT careers. The lagging pace of universities behind the changing trends in the IT sector leaves the graduates in a situation where their education is distant from the expectations of the employers, as identified in scientific literature discussing these issues.

According to [5], [6], [7] research, the difference in expectations regarding the requirements for job seekers and the skills taught in educational organizations is one of the main problems in today’s IT industry. These studies stress the importance this problem and suggest possible solutions to solve it, which may serve as a guide for Kazakhstan's multi-faceted IT educational industry. In [8],

[9], and [10], the authors present methodologies and tools designed to directly inform educational content through job market analysis, thereby enhancing graduate employability. Authors in [11], [12] and [13] gave an advice for addressing this issue discussing that the curriculum should be created using the data-driven method. They suggest that the list of skills and qualifications that are considered as learning expectations should be identified by statistically analyzing the data.

This study aims to explore the correlation between the IT programs offered by higher educational institutions and the labor market's requirements in Kazakhstan, particularly focusing on soft skills. The main idea is to find mismatches in these two directions and find areas for improvement. Addressing this issue is important in order to enhance the quality of graduates and the competitiveness of Kazakhstan's IT sector. Moreover, by focusing on soft skills, the study brings attention to a crucial aspect of IT education that is essential for the development of future professionals.

Materials and methods. In this study, we explored the correlation between Kazakhstan's IT academic programs and market demands by employing a dual approach: (1) cataloging university IT specialties and (2) analyzing job offers. Firstly, we assessed IT-related academic programs across Kazakhstani universities to build a database reflecting the educational landscape. Secondly, we analyzed 450 job vacancies from key local portals such as enbek.kz, hh.kz, and careerjet.kz, in a period from September 2023 to January 2024. The job vacancies were analyzed to document essential criteria such as required skills and qualifications.

This research employs K-means clustering to analyze and group IT academic specialties in Kazakhstan into distinct clusters. The methodology includes data preprocessing, feature extraction through TF-IDF vectorization, determining the optimal number of clusters, and analyzing the clustering results.

The process of clustering started with Data Collection and Preprocessing:

- Data Collection: The dataset includes 98 academic specialties in IT, gathered from various universities in Kazakhstan.
- Data Cleaning: Specialty names were standardized to remove redundancy

After that, given that our dataset consists of 98 unique IT specialties, we use TF-IDF (Term Frequency-Inverse Document Frequency) vectorization to transform these textual names into numerical representations. TF-IDF is particularly suitable for text data, as it emphasizes terms unique to individual specialties while down-weighting common words that appear across multiple specialties.

TF-IDF Formula for our data is given below, refer to Equation (1):

$$TF - IDF(t,d) = TF(t,d) \times IDF(t). \quad (1)$$

where:

- TF is the frequency of term *t* within a specific specialty name *d*. Since specialty names are typically short, TF for our data will primarily distinguish terms unique to each name.
- IDF is calculated as in equation (2):

$$IDF(t) = \log\left(\frac{N}{1 + |\{d \in D: t \in d\}|}\right) \quad (2)$$

where:

- *N* is the total number of specialty names
- $|\{d \in D: t \in d\}|$ is the count of specialty names containing term *t*

To determine the optimal number of clusters *k*, we used the Elbow Method. The method involves running K-means clustering for various values of *k*, plotting the Sum of Squared Distances (SSE) for each *k*, and identifying the “elbow”.

After determining number of clusters, the K-Nearest Neighbors (KNN) algorithm was employed to categorize job vacancies into clusters. This process helped in revealing prevalent job types in the IT sector. Then we applied Euclidean distance to measure the closeness of each job vacancy vector to the cluster centroids. After that, we applied Natural Language Processing (NLP) to job descriptions, extracting the top listed soft skills like communication and teamwork. The primary sources of data for our study were the official websites of Kazakhstani universities [14], where detailed information on IT-related academic programs was obtained. Additionally, job listings were sourced from the aforementioned job portals, which are widely recognized as leading employment platforms in Kazakhstan. The choice of these sources was guided by the aim to ensure the representativeness and relevance of the data collected.

Results and discussions. Our comprehensive analysis aimed to bridge the gap between academic offerings and market needs in Kazakhstan's IT sector. We meticulously cataloged IT-related academic tracks from universities nationwide, revealing a spectrum of 98 unique specialties. Firstly, we applied the K-means clustering algorithm to categorize the collected IT specialties. The process involved pre-processing the data which included normalization and feature extraction. The optimal number of clusters (k) was determined by utilizing the Elbow Method. The sum of squared distances was used in making a decision on identifying the 'elbow point'. The results of this method are showed that the effective number of k is 5; refer to Figure 1, indicating that the specialties can be categorized to 5 clusters with minimum error. These clusters represent the underlying patterns and similarities among the various IT specialties offered across the nation's universities.

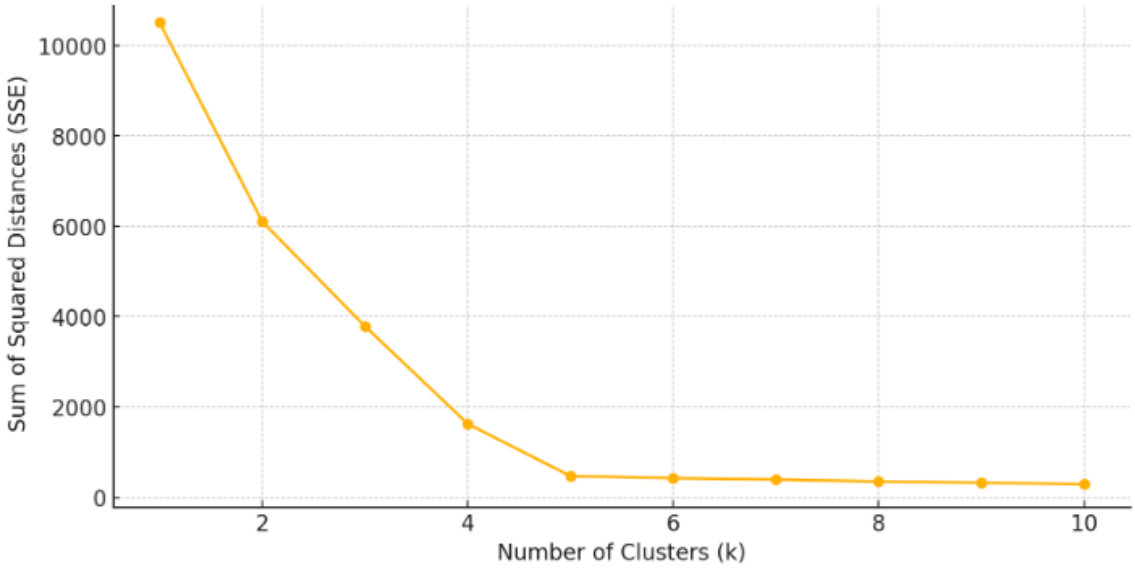

Figure 1. Results of Elbow Method

Source: Authored by the researcher

The table 1 allows for a clear and organized presentation of each IT specialty and its corresponding job cluster. It's structured to provide an overview that aligns educational programs with market demands based on the predefined clusters.

Table 1. Classification of IT Academic Specialties into Clusters Based on K-Means Analysis

IT Specialties	**Cluster**
Computer Science, Software Engineering, Applied Computer Science in Design, Programming and Development of Software Packages, Artificial Intelligence Technologies, Computer Science and Software Engineering, Intelligent Robotics, Computer Science (Network and WEB Technologies), Computing and Software/Smart Computing, Data Science and Machine Learning	Software Development and Computer Science

IT Management, IT Design and Management, Business Analytics and Big Data, Business Analytics and IT Project Management, Business Informatics, IT Entrepreneurship and Digital Economy, Digital Economy, IT in Business, Product Management, Information Technology in Business, IT Management, Digital Agricultural Systems and Complexes, Administration, Management and Protection of Computer Systems and Networks in Enterprises, Financial Mathematics	IT Management and Business
Information Systems and Technologies, Industrial Information Systems (English), Information and Software Systems, Information Systems, Information Systems in the Oil and Gas Industry, Information Technology, Corporate Information Systems, Applied Informatics, Design of Digital Analytical Educational Systems, Information Systems Architecture, Information Systems in Business, Industry and Education, Information Systems in Management, Information Engineering in Economics, Information Systems in Business, Network and System Administration	Information Systems and Technology
Computer Technology and Software (Security of Computer Systems and Networks), Computer Systems and Software, System and Network Administration, Information Technology and Data Protection, Mathematical Methods for Information Security, Cyber-Physical Systems, Cryptology, Information and Communication Technologies and Security, Administration, Management and Protection of Computer Systems and Networks	IT Security and Networking
Agroinformatics, Mathematical Economics and Data Analysis, Digital Engineering, IT Analytics, IT Medicine, Big Data Analysis, Data Science, Digital Management and Design, Automation and Robotics, Big Data Analytics, SMART Systems Design, Industrial Automation, Data Engineering, Smart Technologies, Software Architect, Media Technology, Telematics, IT in Healthcare, Modeling and Design of Virtual Reality, Artificial Intelligence, Information Processing and Data Visualization, Biocomputing, Immersive Technologies, Mathematical and Computational Sciences, Data Science, IT Audit, Economic-Mathematical and Computer Modeling, Engineering Mathematics, Computer Science and Information and Communication Technologies	Emerging Technologies and AI

Source: Authored by the researcher

As mentioned in previous section we categorized 450 job vacancies sourced from three prominent Kazakhstani job portals. The vacancies were classified into five primary clusters based on their descriptions and required qualifications:

- Software Development and Computer Science: 47.95%
- IT Management and Business: 8.22%
- Information Systems and Technology: 17.81%
- IT Security and Networking: 10.96%
- Emerging Technologies and AI: 15.07%

This categorization provided a clear view of the job market's composition and allowed us to directly compare it with the academic programs available.

Then the Natural Language Processing (NLP) was employed to analyze the job descriptions concerning the soft skills requirement in the text of the job vacancies. This approach allowed us to extract and categorize the prevalent soft skills mentioned across different job clusters.

The findings were visualized using barcharts, which demonstrated the frequency and importance of various soft skills within each job cluster, refer to Figure 2:

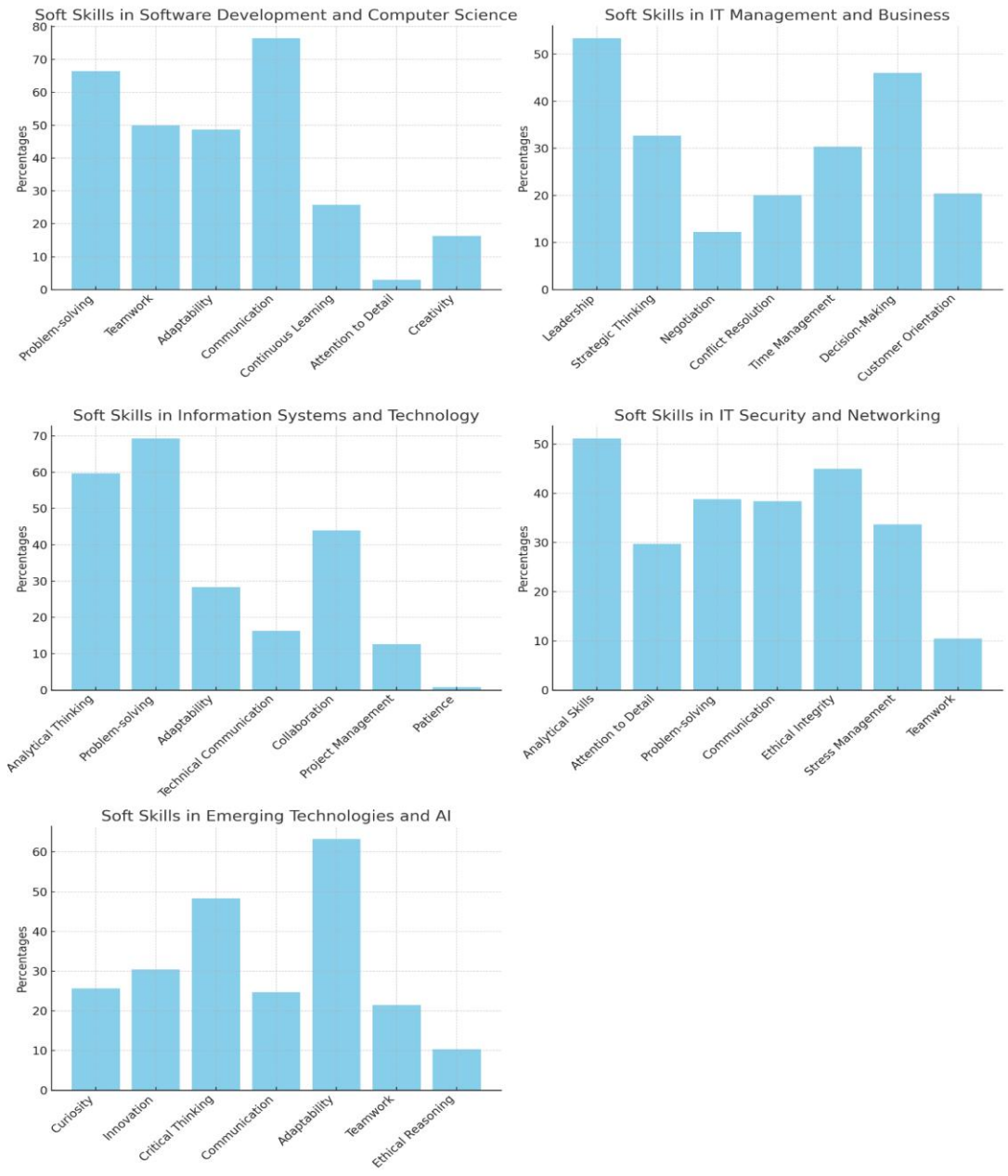

Figure 2. Soft Skills Importance by Job Cluster - Composite Analysis
Source: Authored by the researcher

The following paragraph shows the list of soft skills predominant in each job cluster according to the results of job description analysis.

In Software Development and Computer Science cluster soft skills like *Problem-solving*, *Teamwork*, *Adaptability*, *Continuous Learning*, and *Communication* topped the list. The requirement of these skills can be because of the dynamic nature of the projects in this specific cluster that will require specialists to quickly adapt to the changes and be active learner. Moreover, the project based work mainly requires to work in a team that justifies need of skills like teamwork and communication.

Whereas, for IT Management and Business sector it seems that skills like *Leadership*, *Strategic Thinking*, *Negotiation*, *Time Management*, and *Decision-Making* are more important than other soft skills. This can be because these skills are crucial for managing teams, projects, and strategic initiatives within IT businesses.

In the Information Systems and Technology cluster soft skills like *Analytical Thinking*, *Problem-solving*, *Adaptability*, *Technical Communication*, and *Collaboration* seems to be valued. This shows

that the professionals in this cluster are expected to interpret complex data and work across different departments.

The IT Security and Networking cluster seems to be similar to the previous cluster in terms of skills' requirement. The analysis showed that skills like *Analytical Skills*, *Attention to Detail*, *Problem-solving*, *Communication*, and *Ethical Integrity* are emphasized in vacancies of this cluster.

Whereas, employers of Emerging Technologies and AI sector likely to prioritize skills like *Curiosity*, *Innovation*, *Critical Thinking*, *Communication*, and *Adaptability*. These skills seem to reflect the innovative and exploratory nature of working with new technologies.

The barcharts in Figure 2 not only illustrates the distribution of soft skills across clusters but also highlights the universal importance of Problem-solving and Teamwork by showing their value across all IT domains.

This analysis demonstrated that soft skills such as problem-solving, teamwork, adaptability, and communication are highly valued across all IT job clusters. However, it seems that there is a lack of focused training and development in these areas within university curricula. This fact brings a thought that today's educational system is still lack of systemized way of teaching the soft skills and still focusing on technical qualifications. This study showed that considering the evolving nature of the IT industry, characterized by teamwork, dynamic problem-solving, and continuous learning, the higher education system should use an approach which will balance technical knowledge with soft skills development.

The findings from our research have profound implications for curriculum development and pedagogical approaches within Kazakhstan's IT education system. There is a clear need for universities to realign their programs to better match the job market's needs, particularly by incorporating soft skills development courses created considering the special requirements of the specific cluster of the IT sector.

Conclusion. Our research has provided valuable discussion on how to make closer the Kazakhstan's IT education and the industry. The results of the study demonstrated the there is still a significant gap between educational programs offered by academic institutions and the soft skills required by employers. The list of top soft skills for each cluster identified in this study can be helpful for Kazakhstan's IT education system and industry institutions. For universities, it would be needed to update and diversify their IT curricula to include more market-relevant specialties and to incorporate soft skills development into their educational programs considering the needs of specific specialties. This could involve partnerships with industry stakeholders to ensure that the skills taught are aligned with real-world requirements. Further investigation is needed to explore effective methods for integrating soft skills into IT education and to identify best practices for determining the industry needs. Additionally, studies tracking the further career path of graduates are needed in order to assess the long-term effect of curriculum changes and industry-academia collaborations. This shows that to make a strong correlation between educational programs and required skills for job market there should be a collaborative effort among universities and industry institutions. By considering the importance of connection between educational systems and industry, and thus by adapting the curricular to the needs of the industry Kazakhstan can enhance the employability of the IT graduates.

Acknowledgment. This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (grant AP14871966).

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АТ ТҮЛЕКТЕРІ ҮШІН ҚАЗАҚСТАНДЫҚ ЕҢБЕК НАРЫҒЫНДАҒЫ ИКЕМДІ ДАҒДЫЛАРДЫҢ РӨЛІ: ЕҢБЕК НАРЫҒЫН ТАЛДАУ

Аңдатпа

Бұл зерттеу Қазақстандағы ақпараттық технологиялар (АТ) саласындағы оқу бағдарламалары мен нарық сұраныстарының арасындағы байланысты анықтайды және нақты шаралар ұсынады. Қазақстандағы университеттерден АТ саласына байланысты оқу бағдарламаларын толық каталогтау жүзеге асырылды және 2023 жылдың қыркүйегінен 2024 жылдың қаңтарына дейінгі аралықта enbek.kz, hh.kz және careerjet.kz сияқты белгілі жұмыс порталдарынан жұмыс орындары туралы деректер жинақталды. Жұмыс орындарын топтастыру үшін K-Nearest Neighbors (KNN) мен табиғи тілді өңдеу (NLP) әдістерін қолдана отырып, жұмыс сипаттамаларында жиі кездесетін икемді дағдылар ажыратылды. Бұл талдау арқылы оқу бағдарламары мен нарықтық талаптар арасындағы сәйкестік айқындалды. Бұл нәтижелер Қазақстанның АТ білім беру жүйесі мен еңбек нарығы үшін маңызды, олар икемді дағдыларды қамтитын кешенді АТ білім беру саласына көшуге және оқу бағдарламасын жаңартуға шақырады. Бұл зерттеу Қазақстандағы АТ білім беру саласының мәселелерін талқылап, жақсартуға үлес қосады; университеттерге, саясаткерлерге және өнеркәсіп өкілдеріне нарықтық талаптарға сай келетін оқу бағдарламаларын әзірлеуге бастама болады.

Түйінді сөздер: АТ білім, еңбек нарығын талдау, Қазақстан, икемді дағдылар, NLP, KNN, жұмыс кластерлері.

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РОЛЬ ГИБКИХ НАВЫКОВ НА РЫНКЕ ТРУДА КАЗАХСТАНА ДЛЯ ИТ-ВЫПУСКНИКОВ: АНАЛИЗ РЫНКА ТРУДА

Аннотация

Данное исследование определяет взаимосвязь между учебными программами по информационным технологиям (ИТ) и потребностями рынка в Казахстане и предлагает конкретные меры. Авторы провели полную каталогизацию программ обучения в сфере ИТ в университетах Казахстана и собрали данные о вакансиях с известных порталов вакансий, таких как enbek.kz, hh.kz и Careerjet.kz, за период с сентября 2023 года по январь 2024 года. Для вычленения мягких навыков, наиболее часто встречающихся в описаниях должностей, от групповых должностей, использовались методы K-Nearest Neighbours (KNN) и обработка естественного языка (NLP). На основе этого анализа определялось соответствие программ обучения требованиям рынка. Эти результаты важны для казахстанской системы ИТ-образования и рынка труда, они требуют обновления учебной программы и перехода к комплексному ИТ-образованию, включающему гибкие навыки. Настоящее исследование будет способствовать обсуждению вопросов улучшения ИТ-образования в Казахстане и станет отправной точкой для университетов, политиков и представителей промышленности для разработки учебных программ, отвечающих требованиям рынка.

Ключевые слова: ИТ-образование, анализ рынка труда, Казахстан, гибкие навыки, НЛП, КНН, кластеры рабочих мест.