ECONOMY AND BUSINESS
Research paper/Түпнұсқа мақала/Оригинальная статья
DOI: https://doi.org/10.51885/3107-2755_SSADH_2026_3_4

IRSTI 27.43.51
JEL: C02, J24, O33, M53, I25

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Application Of Correlation-Regression Method For Risk Management In Technical Higher Education Institutions

ABSTRACT. The purpose of the work is to assess current risks in universities using mathematical methods. A decrease in the number of applicants to technical universities in the country that train engineering and technical personnel is one of the main risks in the strategic development program. The paper identified conditions that may affect this risk and carried out a regression analysis based on the data obtained. For completeness of the results obtained, the correlation and regression method was used. A unified system of indicators has been created through the signs and features of economic, social, personal and information factors of accessibility of higher education. As a result of the study, a regression equation was created and the amount of risk was calculated, the significance of the models obtained was assessed, and an explanation of the results obtained in the modeling process was given. The theoretical and methodological significance of the study lies in improving the methodology by substantiating the possibility of using correlation and regression analysis and economic and mathematical modeling.

KEYWORDS: risk assessment, mathematical model, correlation and regression method, educational activity, university.

CONFLICT OF INTEREST: The authors declares that there is no conflict of interest.

ACKNOWLEDGEMENTS AND FUNDING: We express our gratitude to the staff of D. Serikbayev East Kazakhstan Technical University, who presented the official data.

FOR CITATION: Seriktayeva, A.S., Rakhmetullina, Zh.T., Mukhamedova, R.O., Soltanbekova, K.K. (2026). Application Of Correlation-Regression Method For Risk Management In Technical Higher Education Institutions. *Social Sciences & Digital Humanities, 3*(3), 57–71. https://doi.org/10.51885/3107-2755_SSADH_2026_3_4

Article history:
Received: 10.08.2026
Accepted: 17.09.2026
Published: 30.09.2026

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Д. Серікбаев атындағы Шығыс Қазақстан техникалық университеті, Өскемен қ., Қазақстан

Техникалық жоғары оқу орындарында тәуекелдерді басқару үшін корреляциялық-регрессиялық әдісті қолдану

АҢДАТПА. Жұмыстың мақсаты-математикалық әдістерді қолдана отырып, университеттердегі ағымдағы тәуекелдерді бағалау. Инженерлік-техникалық кадрларды даярлайтын елдің техникалық жоғары оқу орындарында талапкерлер санының азаюы стратегиялық даму бағдарламасындағы негізгі тәуекелдердің бірі болып табылады. Мақалада осы тәуекелге әсер етуі мүмкін жағдайлар анықталды және алынған мәліметтер негізінде регрессиялық талдау жүргізілді. Алынған нәтижелердің толықтығы үшін корреляция және регрессия әдісі қолданылды. Жоғары білімнің қолжетімділігінің экономикалық, әлеуметтік, жеке және ақпараттық факторларының белгілері мен ерекшеліктерін ескеретін көрсеткіштердің бірыңғай жүйесі құрылды. Зерттеу нәтижесінде регрессия теңдеуі құрылды және тәуекел мөлшері есептелді, алынған модельдердің маңыздылығы бағаланды және модельдеу процесінде алынған нәтижелерге түсініктеме берілді. Зерттеудің теориялық және әдіснамалық маңыздылығы корреляциялық-регрессиялық талдау мен экономикалық-математикалық модельдеуді қолдану мүмкіндігін негіздеу арқылы әдіснаманы жетілдіру болып табылады.

ТҮЙІН СӨЗДЕР: тәуекелдерді бағалау, математикалық модель, корреляциялық-регрессиялық әдіс, білім беру қызметі, ЖОО.

МҮДДЕЛЕР ҚАҚТЫҒЫСЫ: Авторлар мүдделер қақтығысының жоқтығын мәлімдейді.

ҚАРЖЫЛАНДЫРУ ЖӘНЕ АЛҒЫС: Ресми деректерді ұсынған Д. Серікбаев атындағы Шығыс Қазақстан техникалық университетінің қызметкерлеріне алғысымызды білдіреміз.

ДӘЙЕКСӨЗ ҮШІН: Серіктаева, А.С., Рахметуллина, Ж.Т., Мухамедова, Р.О., Солтанбекова, Қ.Қ. (2026). Техникалық жоғары оқу орындарында тәуекелдерді басқару үшін корреляциялық-регрессиялық әдісті қолдану. *Social Sciences & Digital Humanities, 3*(3), 57–71. https://doi.org/10.51885/3107-2755_SSADH_2026_3_4

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Применение корреляционно-регрессионного метода для управления рисками в технических вузах

АННОТАЦИЯ. Цель работы – оценить текущие риски в университетах с использованием математических методов. Сокращение числа абитуриентов в технических вузах страны, которые готовят инженерно-технические кадры, является одним из основных рисков в программе стратегического развития. В статье были определены условия, которые могут повлиять на этот риск, и проведен регрессионный анализ на основе полученных данных. Для полноты полученных результатов был использован метод корреляции и регрессии. Создана единая система показателей, учитывающая признаки и особенности экономических, социальных, личностных и информационных факторов доступности высшего образования. В результате исследования было составлено уравнение регрессии и рассчитана величина риска, оценена значимость полученных моделей и дано объяснение результатов, полученных в процессе моделирования. Теоретическая и методологическая значимость исследования заключается в совершенствовании методологии путем обоснования возможности использования корреляционно-регрессионного анализа и экономико-математического моделирования.

КЛЮЧЕВЫЕ СЛОВА: оценка рисков, математическая модель, корреляционно-регрессионный метод, образовательная деятельность, университет.

КОНФЛИКТ ИНТЕРЕСОВ: Авторы заявляют об отсутствии конфликта интересов.

ФИНАНСИРОВАНИЕ И БЛАГОДАРНОСТИ: Мы выражаем благодарность сотрудникам Восточно-Казахстанского технического университета имени Д. Серикбаева за предоставление официальных данных.

ДЛЯ ЦИТИРОВАНИЯ: Серіктаева, А.С., Рахметуллина, Ж.Т., Мухамедова, Р.О., Солтанбекова, Қ.Қ. (2026). Применение корреляционно-регрессионного метода для управления рисками в технических вузах. *Social Sciences & Digital Humanities, 3*(3), 57–71. https://doi.org/10.51885/3107-2755_SSADH_2026_3_4

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INTRODUCTION

The sphere of higher education is one of the main elements of ensuring the economic security of the state, since the main purpose of higher educational institutions, including technical ones, is to train and graduate highly qualified specialists for industries in demand on the labor market. Further development of specific methods for conducting research in universities in terms of reducing risks and developing and implementing a risk management system is one of the main strategic goals of universities. To achieve this goal, it becomes necessary to carry out work aimed at solving such tasks as analysing existing problems of the educational process, studying the main approaches to classifying risks in the field of education and identifying the main risk factors, identifying significant risks in the implementation of educational activities of higher educational institutions.

There can be many risks in higher education institutions. This happens in the field of education, upbringing or management.

One of the most promising approaches to managing such risks is the use of statistical and analytical methods, particularly the correlation-regression method. This method allows for the identification and quantification of relationships between various risk factors, enabling informed decisions and targeted interventions. As technical universities often deal with complex systems – such as enrollment flows, resource allocation, or staff workload dynamics–the ability to model and predict outcomes using statistical tools becomes a valuable asset in strategic planning.

Since each risk in a technical university depends on different circumstances, it is impossible to create a general mathematical model that covers everything. Since the representation of mathematical models of trends associated with all possible risks using a regression equation is a problem, it is necessary to conduct an individual risk analysis.

One of the current risks that may arise in regional technical universities is the low total number of applicants to undergraduate technical universities based on a competition for state educational grants. This is one of the most important strategic indicators for a regional technical university. The management of this risk is assessed using the correlation and regression method.

Forecasting the number of applicants to technical universities will help universities form long-term development strategies, including updating curricula, introducing new educational technologies and expanding international cooperation. All this is part of the institutional trajectories of engineering and technical personnel training.

The relationship between the forecasting of applicants' admission to technical universities and the institutional trajectories of engineering and technical personnel training is manifested in several key aspects: planning educational programs, optimising resources, adapting to changes in demand, communication with the labor market, strategic development of the university. The forecast of admission of applicants to technical universities is closely related to the formation of institutional trajectories for the training of engineering and technical personnel.

The object of the study is risk management in technical universities.

The subject of the study is the application of correlation and regression methods in risk management in technical universities.

The main hypothesis is that the application of the correlation-regression method can effectively identify and quantify key risk factors in technical higher education institutions, enabling the development of predictive models that improve risk management processes, reduce the likelihood of adverse events, and enhance institutional performance.

LITERATURE REVIEW

The article analyses what research has been conducted around the issue under consideration. The article “Digitalization of Education in Modern Scientific Discourse: New Trends and Risk Analysis” presents the results of a systematic review of modern scientific publications on the digitisation of education. In a review of Russian and foreign studies, it can be concluded that there is a link between high student achievement and the use of digital technologies. The article substantiates the conclusion that digital technologies are a necessary, but at the same time insufficient condition

for improving the quality of educational work and moral and educational activities (Frolova et al., 2020).

The article “Digital Transformation of Legal Education: Problems, Risks and Prospects” highlights the objectives of the study: to identify risks, problems of digitalization of legal education, as well as to formulate directions for the development of legal regulation of the introduction of digital technologies in legal education in Russia. As a result of the study, it was found that the process of digital transformation involves the implementation of organizational, economic and legal measures. The chi-square test was used in the article to study statistical hypotheses (Demchenko et al., 2021).

The article “An Investigation of the Relationship between the Fear of Receiving Negative Criticism and of Taking Academic Risk through Canonical Correlation Analysis” presents the purpose of the study. It says that the aim is to explore the relationship between the fear of receiving negative criticism and academic risk using canonical correlation analysis, which used a relational model. The scale of “short-term fear of negative assessment” and the scale of perception of academic risk were used as a data collection tool. The results of the canonical correlation analysis in the study showed that there is a significant relationship between the fear of receiving negative criticism and academic risky behavior. It was found that the total variance between them was 35% (Cetin et al., 2014).

In the scientific work of M. Takeuchi's “The situated multiliteracies approach to classroom participation: English language learners' participation in classroom mathematics practices” guided by sociocultural theory and the theory of multiple literacy, learning is perceived as a change in participation in practice through a variety of physical and symbolic means. The aim of the study is to study the participation of English language learners in mathematical experiments in urban classrooms. This study describes the successful participation of English language learners in classroom math lessons (Takeuchi, 2015).

The article “Evidence-based education policies: Transforming educational practice and research” discusses the prospects and problems of randomized and strictly coordinated experiments as the basis of policy and practice in education. As a result, it was concluded that focusing on rigorous methods for evaluating repetitive programs and practices is important to increase confidence in educational research among policy makers and educators (Slavin, 2002).

The article “Safety risk assessment of a Pb-Zn mine based on fuzzy-grey correlation analysis” emphasizes the importance for the mining industry, where the development of risk assessment and safety management methods is the basis of industrial development of society. In order to prevent accidental loss or damage to human life and property, a safety risk assessment method is required for continuous mine risk assessment. Based on the requirements for mine safety assessment, the article proposes a Pb-Zn mine safety risk assessment model based on the gray fuzzy correlation analysis method, which is also compared with the risk assessment model based on the TOPSIS fuzzy method. The results obtained as a result of experiments show that the proposed correlation model is less sensitive to risk and has less impact on the assessment results with different assessment approaches (Dong et al., 2020).

The article “risk assessment of floating offshore wind turbine based on correlation-FMEA” states that a floating offshore wind farm has a complex structure consisting of interdependent subsystems and is subject to adverse effects in harsh operating conditions. When analyzing risks and reliability, two problems need to be solved. These are: complexity and cross-correlation of the system failure mode. The study conducted a risk assessment using a method of analysis of modified types and consequences of failures (FMEA), known as correlation FMEA. A number of high priority failure types have been identified by the traditional FMEA. The vector method of reliability indicators was used and the corresponding relationships were analyzed to obtain correlation coefficients. Based on the results of the study, recommendations for the design of a wind power plant are given (Kang et al., 2017).

MATERIALS AND METHODS OF RESEARCH

In modern conditions, technical higher education institutions face numerous risks that can negatively impact their functioning and development. These risks may be associated with academic

activities, finances, management, and other aspects. However, many institutions lack a systematic approach to managing these risks, making it difficult to make informed decisions.

The absence of clear and quantitatively justified methods for risk analysis leads to ineffective management and can result in resource losses, decreased education quality, and damage to the institutions' reputations. Moreover, traditional risk management methods often do not consider the interrelationships between various factors, limiting opportunities for forecasting and taking preventive measures.

The correlation-regression method offers the ability to quantitatively assess the influence of various factors on the level of risks, yet its application in the context of technical universities remains insufficiently researched. It is essential to identify which factors significantly impact risks and how the obtained data can be utilized to enhance the resilience and competitiveness of educational institutions.

Thus, the problem lies in the necessity to develop and implement a systematic approach to risk management using correlation-regression analysis, which will allow for more effective responses to the challenges of the modern educational process and ensure the stable development of technical higher education institutions.

The following assumptions were made in the research work:

– The data collected for risk analysis in technical higher education institutions is sufficiently complete and reliable for conduction correlation-regression analysis.

– The relationships identified through correlation-regression analysis can be used to predict risks and develop recommendations for managing them.

– Technical higher education institutions can adapt their management strategies based on the results of correlation-regression analysis, allowing for more effective risk mitigation.

Simplifications adopted in the work:

– It is assumed that the relationships between risks and factors are linear, which allows the use of simple linear models for analysis.

– Temporary changes in risks and factors and their impact on the results of the analysis are not taken into account.

Based on these scientific works, research work was carried out at D. Serikbayev East Kazakhstan Technical University in Ust-Kamenogorsk. In the problem area under study, it is possible to accumulate a database based on official data for the period from 2011 to 2022. In risk management, the application of the correlation and regression method to research is differentiated. The data has the form (Table 1).

Table 1. Data

Number of grants allocated	Total birth rate in the Republic of Kazakhstan (per 1000 people)	Population	The number of students in the school	GDP, billion USD	The number of graduates	The number of students enrolled in universities
31387	22,51	16440470	2541862	200,38	151448	1195
34315	22,7	16673933	2551502	215,9	172762	1029
35053	22,73	16910246	2597942	243,78	168774	905
34165	23,1	17160855	2685063	227,44	149895	920
20057	22,71	17415715	2799585	184,36	133309	1306
31700	22,52	17669896	2930583	137,28	129406	1205
31702	21,64	17918214	3050770	159,4	124369	1190
42982	21,77	17157337	3186234	170,54	127414	966
54000	21,73	18395567	3337783	181,67	143089	986
53864	22,76	18631779	3481347	171,1	117204	1235
56000	23,5	18879552	3597159	197,1	140643	1451
64061	20,41	19503159	3600000	220,5	161430	1424

Database elements:

Population of the Republic of Kazakhstan.
Total birth rate in the Republic of Kazakhstan (per 1000 people).
Gross domestic product (GDP), billion USD.
Number of grants allocated by year.
The number of students in the school.
The number of graduates.
The number of students enrolled in universities.

The Microsoft Excel program was used for correlation and regression analysis. Multiple regression was used in regression analysis because the risk depended on several factors. The least squares method is used to determine the vector for estimating regression coefficients.

At the first stage, a correlation analysis was carried out based on a quantitative method for determining the density and direction of the relationship between the sample variables (Grandars.ru, n.d.). The result of the correlation analysis performed in Excel is shown in the figure below (Fig. 1).

	Number of grants allocated	Total birth rate in the Republic of Kazakhstan (per 1000 people)	Population	The number of students in the school	GDP, billion USD	The number of graduates	The number of students enrolled in universities
Number of grants allocated	1						
Total birth rate in the Republic of Kazakhstan (per 1000 people)	-0,376639725	1					
Population	0,800516349	-0,393586998	1				
The number of students in the school	0,850439112	-0,362433376	0,931967315	1			
GDP, billion USD	0,104543521	0,099557893	-0,173316571	-0,293129157	1		
The number of graduates	0,01950386	-0,035929081	-0,273050499	-0,419373939	0,845859337	1	
The number of students enrolled in universities	0,316166804	-0,119994157	0,638185043	0,554429355	-0,243524968	-0,2447541	1

Figure 1. Correlation analysis

The Pearson correlation coefficient determines the measure of the direct relationship between the r-variables (1):

$$r = \frac{\sum Z_{X_i} Z_{Y_i}}{n-1} \quad (1)$$

In turn, Z_{X_i} , Z_{Y_i} are calculated using the following formulas (2, 3):

$$Z_{X_i} = \frac{X_i - \bar{X}}{S_X} \quad (2)$$

$$Z_{Y_i} = \frac{Y_i - \bar{Y}}{S_Y} \quad (3)$$

Where, $\bar{X}$, $\bar{Y}$- is the average value. S_X , S_Y - is the standard deviation of the variables (Menshev, 2020). The standard deviation, in turn, is determined by the formulas (4-5):

$$S_x = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (4)$$

$$S_y = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad (5)$$

To assess the strength of the connection in correlation theory, the Cheddock scale of statistics is used: weak – from 0.1 to 0.3; average -from 0.3 to 0.5; observed -from 0.5 to 0.7; high – from 0.7 to 0.9; very high – from 0.9 to 1.0 to [8].

As a result of the analysis, it can be seen that the population and the number of students at school positively correlate with the numerical values of the variables of students enrolled in universities.

To assess the importance of correlation coefficients, assume that the significance level is $\alpha = 0{,}05$. The degree of freedom is calculated by the formula (6):

$$df = n - m - 1 \quad (6)$$

Where, n – number of observations,m – number of connections (factor variables).

Then*:* $df = 12 - 6 - 1 = 5$.

If the statistical significance of the correlation coefficient is estimated based on the Student's t-test (7), then:

$$\mathrm{t} = \frac{r\sqrt{n-m-1}}{\sqrt{1-r^2}}. \quad (7)$$

If $\mathrm{t} > t_{table}$, then the linear coefficient is considered important, which means "the relationship between dependent and independent variables is important" (Grandars.ru, n.d.).

The value of the t-criterion for each variable is calculated below:

For the variable "number of allocated grants":

$\mathrm{t} = \frac{0{,}361601126011\sqrt{12-6-1}}{\sqrt{1-0{,}361601126011^2}} = 0{,}867248923$

For the variable «total birth rate in the Republic of Kazakhstan (per 1000 people)»:

$\mathrm{t} = \frac{-0{,}119994156625569\sqrt{12-6-1}}{\sqrt{1-(-0{,}119994156625569)^2}} = -0{,}27027$

For the variable «Population»:

$\mathrm{t} = \frac{0{,}638185042814284\sqrt{12-6-1}}{\sqrt{1-0{,}638185042814284^2}} = 1{,}853561$

For the variable «the number of students in the school»:

$\mathrm{t} = \frac{0{,}554429355491145\sqrt{12-6-1}}{\sqrt{1-0{,}554429355491145^2}} = 1{,}48966097$

For the variable «GDP, billion USD»:

$\mathrm{t} = \frac{-0{,}243524967675702\sqrt{12-6-1}}{\sqrt{1-(-0{,}243524967675702)^2}} = -0{,}56144$

For the variable «the number of graduates»:

$\mathrm{t} = \frac{-0{,}244754103049278\sqrt{12-6-1}}{\sqrt{1-(-0{,}244754103049278)^2}} = -0{,}56144$

The tabular value is determined from the following Student's table (Table 2).

Table 2. Important values of the Student's t-test

p			
df	0.05	0.01	0.001
1	12.70	63.65	636.61
2	4.303	9.925	31.602
3	3.182	5.841	12.923
4	2.776	4.604	8.610
5	2.571	4.032	6.869
6	2.447	3.707	5.959
7	2.365	3.499	5.408
8	2.306	3.355	5.041
9	2.262	3.250	4.781
10	2.228	3.169	4.587
Note: compiled by the authors based on (Saadalov et al., 2021)			

Then the tabular value was equal to this $t_{table} = 2.571$. It can be concluded that all calculated criteria are less than tabular values, and all Pearson correlation coefficients are not statistically significant.

A regression analysis will now be performed. Since there are several independent variables in the study, multiple regression is created. The variable of the number of students enrolled in the university is defined as a dependent variable. Since multiple regression analysis is a method of determining the dependence of one variable on two or more independent variables (Cody & Smith, 1991), the task of regression analysis is to create a mathematical model that allows you to estimate the value of a dependent variable based on the values of independent variables. Regression analysis further allows for the development of predictive models that can forecast the likelihood of risk events occurring under different scenarios.

The least squares method is used to determine the vector for estimating regression coefficients. Using the least squares method, the vector s is obtained from the expression (8):

$$s = (X^T X)^{-1} X^T Y \quad (8)$$

An identity column is added to the matrix of variables X_i, and the matrix Y has the form:

$$X_i = \begin{pmatrix} 1 & 31387 & 22.51 & 16440470 & 2541862 & 200.38 & 151448 \\ 1 & 34315 & 22.7 & 16673933 & 2551502 & 215.9 & 172762 \\ 1 & 35053 & 22.73 & 16910246 & 2597942 & 243.78 & 168774 \\ 1 & 34165 & 23.1 & 17160855 & 2685063 & 227.44 & 149895 \\ 1 & 20057 & 22.71 & 17415715 & 2799585 & 184.36 & 133309 \\ 1 & 31700 & 22.52 & 17669896 & 2930583 & 137.28 & 129406 \\ 1 & 31702 & 21.64 & 17918214 & 3050770 & 159.4 & 124369 \\ 1 & 42982 & 21.77 & 17157337 & 3186234 & 170.54 & 127414 \\ 1 & 54000 & 21.73 & 18395567 & 3337783 & 181.67 & 143089 \\ 1 & 53864 & 22.76 & 18631779 & 3481347 & 171.1 & 117204 \\ 1 & 56000 & 23.5 & 18879552 & 3597159 & 197.1 & 140643 \\ 1 & 64061 & 20.41 & 19503159 & 3600000 & 220.5 & 161430 \end{pmatrix} Y = \begin{pmatrix} 1195 \\ 1029 \\ 905 \\ 920 \\ 1306 \\ 1205 \\ 1190 \\ 966 \\ 986 \\ 1235 \\ 1451 \\ 1424 \end{pmatrix}$$

Matrix X^T:

$X^T =$

$$\begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 31387 & 34315 & 35053 & 34165 & 20057 & 31700 & 31702 & 42982 & 54000 & 53864 & 56000 & 64061 \\ 22.51 & 22.7 & 22.73 & 23.1 & 22.71 & 22.52 & 21.64 & 21.77 & 21.73 & 22.76 & 23.5 & 20.41 \\ 16440470 & 16673933 & 16910246 & 17160855 & 17415715 & 17669896 & 17918214 & 17157337 & 18395567 & 18631779 & 18879552 & 19503159 \\ 2541862 & 2551502 & 2597942 & 2685063 & 2799585 & 2930583 & 3050770 & 3186234 & 3337783 & 3481347 & 3597159 & 3600000 \\ 200.38 & 215.9 & 243.78 & 227.44 & 184.36 & 137.28 & 159.4 & 170.54 & 181.67 & 171.1 & 197.1 & 220.5 \\ 151448 & 172762 & 168774 & 149895 & 133309 & 129406 & 124369 & 127414 & 143089 & 117204 & 140643 & 161430 \end{pmatrix}$$

Matrix X^T multiplies by matrix X:

$X^T X =$

$$\begin{pmatrix} 12 & 489286 & 268,08 & 212756723 & 36359830 & 2309,45 & 1719743 \\ 489286 & 21875407622 & 10885415,6 & 8785770627770 & 1532674090626 & 94635938 & 70171484988 \\ 268,08 & 10885415,6 & 5996,3986 & 4749585132,04 & 810945586,28 & 51621,0803 & 38413201,66 \\ 212756723 & 8785770627770 & 4749585132,04 & 3,78E+15 & 6,486E+14 & 40889774550,7 & 30439246040015 \\ 36359830 & 1532674090626 & 810945586,28 & 6,486E+14 & 1,1197E+14 & 6957173176,25 & 5177233078374 \\ 2309,45 & 94635938 & 51621,0803 & 40889774550,73 & 6957173176,25 & 454997,1149 & 336142248,97 \\ 1719743 & 70171484988 & 38413201,66 & 30439246040015 & 5177233078384 & 336142248,97 & 250006895209 \end{pmatrix}$$

The number 12 lying at the intersection of the 1st row and the 1st column in the matrix ($X^T X$) is taken as the sum of the product of elements of the 1st row of the matrix X^T and the product of the 1st column of the matrix X. Product (XT * Y) is:

$$X^T * Y = \begin{pmatrix} 13812 \\ 571856203 \\ 308354,4 \\ 246144413104 \\ 42316740279 \\ 2642524,32 \\ 1970295153 \end{pmatrix}$$

The inverse matrix of $(X^TX)^{-1}$ is:

$$(X^TX)^{-1}=\begin{pmatrix} 272{,}4171 & 0{,}0000316 & -5{,}3005 & -8{,}0E-6 & -1{,}0E-6 & 0{,}07947 & -0{,}000292 \\ 0{,}000316 & 0 & & & 1{,}0E-6 & 0 & 0 & 0 & 0 \\ -5{,}3005 & 1{,}0E-6 & & 0{,}183 & 0 & 0 & -0{,}00277 & 5{,}0E-6 \\ -8{,}0E-6 & 0 & & 0 & 0 & 0 & 0 & 0 \\ -1{,}0E-6 & 0 & & 0 & 0 & 0 & 0 & 0 \\ 0{,}07947 & 0 & & -0{,}00277 & 0 & 0 & 0{,}000389 & -1{,}0E-6 \\ -0{,}000292 & 0 & & 5{,}0E-6 & 0 & 0 & -1{,}0E-6 & 0 \end{pmatrix}$$

The vector of estimation of regression coefficients:

$$Y(X) = (X^TX)^{-1}X^TY = \begin{pmatrix} -3852{,}2762 \\ -0{,}1577 \\ 43{,}6036 \\ 0{,}000134 \\ 0{,}00053 \\ -1{,}5633 \\ 0{,}00695 \end{pmatrix}$$

As a result, the coefficients of the regression equation were found. The result of the regression analysis is shown in the figure below (Fig. 2).

CONCLUSION OF THE RESULTS

Regression statistics	
Multiple R	0,767427567
R-squared	0,58894507
The normalized R-square	0,095679154
The standard error	179,5623998
Observations	12

Analysis of variance

	df	SS	MS	F	Significance F
Regression	6	230980,7228	38496,78714	1,193970739	0,432222327
Remains	5	161213,2772	32242,65543		
Total	11	392194			

	Coefficients	The standard error	t-statistics	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y-intersection	-3852,276245	2963,688616	-1,299824895	0,25035614	-11470,68037	3766,127878	-11470,68	3766,1279
Number of grants allocated	-0,015766776	0,014047319	-1,12240462	0,31267768	-0,05187656	0,020343008	-0,051877	0,020343
Total birth rate in the Republic of Kazakhstan (per 1000 people)	43,6035582	76,81045166	0,567677409	0,594794479	-153,8439936	241,05111	-153,844	241,05111
Population	0,000133713	0,000185991	0,718922108	0,504375279	-0,000344392	0,000611819	-0,000344	0,0006118
The number of students in the school	0,000529959	0,000778592	0,680663809	0,526320652	-0,001471474	0,002531393	-0,001471	0,0025314
GDP, billion USD	-1,563278185	3,539528681	-0,44166281	0,677180221	-10,66192632	7,55536995	-10,66193	7,5553699
The number of graduates	0,00695293	0,008010307	0,867997956	0,425087195	-0,01363822	0,027544081	-0,013638	0,0275441

Figure 2. The result of the regression analysis

Then the regression equation will look like (9):

$$y = -0.015766776x_1 + 43.6035582x_2 + 0.000133713x_3 + 0.000529959x_4 - 1.563278185x_5 + 0.00695293x_6 - 3852.276245 \quad (9)$$

Where, x_1- the number of grants allocated, x_2– the total birth rate in the Republic of Kazakhstan (per 1000 people), x_3– the population, x_4 –the number of students in school, x_5 - GDP, billion USD, x_6-The number of graduates, y–the number of students enrolled in universities.

Statistical analysis can be carried out by performing calculations such as the significance of the regression equation and checking its coefficients, absolute and relative approximation errors (Fig. 3):

Y	Y(x)	ε	ε^2	(Y-Ycp)^2	|ε:Y|
1193	919,5158	275,484	75891,568	1936	0,230531
1029	1041,894	-12,894	166,252	14884	0,01253
905	1016,463	-111,463	12424,017	60516	0,123164
920	1020,557	-100,557	10111,744	53361	0,109301
1306	1272,784	33,216	1103,283	24025	0,025433
1205	1230,8	-25,800	665,631	2916	0,021411
1190	1219,693	-29,693	881,681	1521	0,024952
966	1021,32	-55,320	3060,327	34225	0,057267
986	1183,328	-197,328	38938,357	27225	0,20013
1235	1174,599	60,401	3648,258	7056	0,045908
1451	1390,018	60,982	3718,758	90000	0,042027
1424	1321,027	102,973	10603,372	74529	0,072312

Figure 3. Calculations

Distortion value: ε = Y-Y (x) = Y-X * s (absolute approximation error). Average approximation error (10):

$$A = \frac{\sum|\varepsilon:Y|}{n}100\% = \frac{0.968}{12}100\% = 8.07\% \quad (10)$$

Estimation of variance (11):

$$S_e^2 = \big(Y - Y(X)\big)^T\big(Y - Y(X)\big) = 161213.277 \quad (11)$$

The unmodified variance estimate is (12):

$$S^2 = \frac{1}{n-m-1}S_e^2 = \frac{1}{12-6-1}161213.277 = 32242.6554 \quad (12)$$

Standard deviation estimate (Standard error for Y) (13):

$$S = \sqrt{S^2} = \sqrt{32242.6554} = 179.562 \quad (13)$$

RESULTS AND DISCUSSION

The coefficient of determination, denoted as r-squared, measures how well the regression equation models the actual data points. The result of the calculations was 0.5889. Defined as a good enough value.

The coefficient of determination ($R^2 = 0.5889$) indicates moderate explanatory power of the model. The selected factors explain 58.89% of the variation in the number of applicants. This means that approximately 41% of the variation in the number of applicants remains unexplained by the selected factors. Potential additional predictors could include the unemployment rate among graduates or investments in university infrastructure.

To improve the accuracy of the model, it is recommended:

– include indicators of graduate employment (average duration of job search, salary level),

– take into account changes in educational standards,

– add parameters for digitalization of the educational process.

It is possible to make an explanation of the coefficients of the regression equation (9) with an economic and statistical interpretation:

– A 1% increase in the total birth rate in the Republic of Kazakhstan is associated with a 0.43% rise in applicants ($p<0.05$).

– Reflects the long-term demographic effect (graduates after 17-18 years).

– Population increase by 1 million = +134 students.

The expected values of the correlation tender were used to calculate the deviations along with the observed values. The calculation of the expected values according to the regression equation is obtained (Table 3).

Table 3. Expected values

Year	Number of grants allo-cated	Total birth rate in the Republic of Kazakhstan (per 1000 people)	Population	The number of students in the school	GDP, billion USD	The number of graduates	The number of students enrolled in universities	The value of regression
2011	31387	22,51	16440470	2541862	200,38	151448	1195	919,5157564
2012	34315	22,70	16673933	2551502	215,90	172762	1029	1041,893871
2013	35053	22,73	16910246	2597942	243,78	168774	905	1016,463073
2014	34165	23,10	17160855	2685063	227,44	149895	920	1020,557168
2015	20057	22,71	17415715	2799585	184,36	133309	1306	1272,78429
2016	31700	22,52	17669896	2930583	137,28	129406	1205	1230,799819
2017	31702	21,64	17918214	3050770	159,40	124369	1190	1219,693111
2018	42982	21,77	17157337	3186234	170,54	127414	966	1021,320219
2019	54000	21,73	18395567	3337783	181,67	143089	986	1183,328044
2020	53864	22,76	18631779	3481347	171,10	117204	1235	1174,598942
2021	56000	23,50	18879552	3597159	197,10	140643	1451	1390,018379
2022	64061	20,41	19503159	3600000	220,50	161430	1424	1321,027326
2023	60187,65152	21,74363636	19348763,85	3752213,106	176,435303	129743,4848		1348,842145

After obtaining the regression equation in 2023, the approximate value of all independent variables is entered, and it is possible to calculate how many applicants will enter a technical university this year. Excel uses the prediction function “forecast”. Presumably, enrolling x_1= 61188, x_2 = 21,7, x_3= 19348764, x_4= 3752213, x_5= 17644, it turns out that the number of students enrolled is about 1349 people.

In addition, a regression line was built (Fig.4).

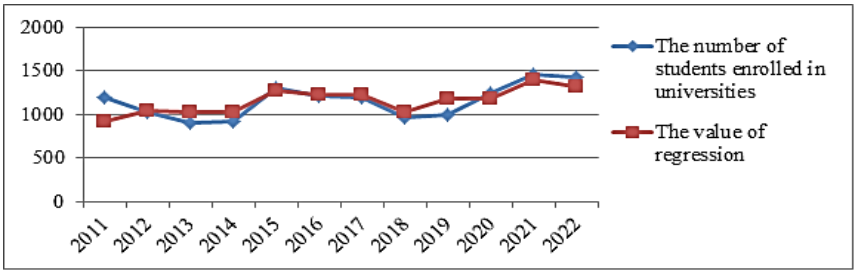


Figure 4. Regression line

As a result of the work, it is assessed whether the risk of a low number of applicants to the university is possible. In general, according to the strategic plan for the development of the university, 1900 students should enrol in the bachelor's degree in 2023. Risk coefficients can be used as indicators of the risk level, reflecting the probability of adverse outcomes when one of the stakeholders reaches a certain level. Then the amount of risk:

$$r = \frac{1900-1349}{1900} = 0.29$$

The risk value is less than 0.5. The work identified factors that may affect the risk. As a result of the correlation analysis, it can be seen that the population and the number of students at school positively correlate with the numerical values of the variables of students enrolled in universities.

The coefficient of determination, denoted as r-squared, measures how well the regression equation models the actual data points. The result of the calculations was 0.5889. Defined as a good enough value.

It can be seen that the difference between the regression values and the already known values is small (Fig.4).

According to the results of the risk value, the risk may occur to the least possibilities. The university plan can only be implemented by 71%. This level means that the risk in question may occur.

The results of the study clearly show that indicators such as the number of grants allocated annually, the number of school graduates, the total birth rate in the Republic of Kazakhstan affect the goal set by the university and contribute to the emergence of risks.

This method has not yet been used in risk assessment in higher education. Thus, the results of the study allow other researchers to use the correlation and regression method in education.

The solutions obtained in the study on applying the correlation-regression method for risk management in technical higher education institutions hold significant value in addressing the identified problem.

One of the key findings of the study is the need to implement a systematic approach to risk management. Applying the correlation-regression method not only identifies key factors affecting risks but also determines their interconnections.

The study successfully quantified the influence of various factors on risk levels. This was made possible through the use of statistical methods, which aids in forecasting and developing preventive measures. However, it is important to note that results may vary depending on the specifics of each educational institution, and further research is required for generalization.

Despite positive outcomes, it is essential to consider the limitations of this study. For example, the use of linear models may not fully capture the complex relationships between factors and risks.

In conclusion, although the obtained solutions significantly address the problem and provide valuable tools for managing risks in technical higher education institutions, further research is necessary to deepen understanding and refine approaches to risk management in this field.

CONCLUSION

The study examined the probability of certain risks occurring in technical universities. It demonstrated the application of the correlation-regression method for risk analysis and management in technical universities. The research identified key relationships between factors influencing educational processes and managerial decisions and proposed quantitative models for their prediction. Additionally, the study employed methods such as observation, fact collection, analysis, and others. The main approaches to risk classification in the field of education were also considered.

The novelty of this work lies in the adaptation and testing of statistical methods in the context of risk management in the educational environment, an approach previously applied mainly in economics and engineering. The obtained results can be used to develop strategies for risk minimization, enhance the resilience of educational programs, and improve the quality of specialist training.

However, this study has certain limitations. First, the analysis was conducted based on available data, which may limit the generalizability of the results. Second, the models used assume linear relationships between variables, which do not always capture the complex interconnections in the educational environment.

By systematically applying these methods, institutions can transition from reactive to proactive risk management strategies. Furthermore, regular use of statistical modeling fosters a data-driven culture among administrators and faculty, encouraging continuous monitoring, early warning systems, and evidence-based decision-making.

Future research directions include the integration of machine learning methods and advanced factor analysis to achieve more accurate risk modeling. The study demonstrates that the correlation regression method is effective for risk assessment, but it can be improved by integrating machine

learning. For example, random forest or gradient boosting algorithms could take into account interactions between factors. It is also important to expand the sample to include data from other countries for comparison. Such steps will help to create a universal model applicable in a global context. Additionally, further studies could consider additional factors, such as socio-economic conditions, the level of education digitalization, and the psychological aspects of student adaptation. This would allow for the development of more comprehensive models for effective risk management in technical universities.

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