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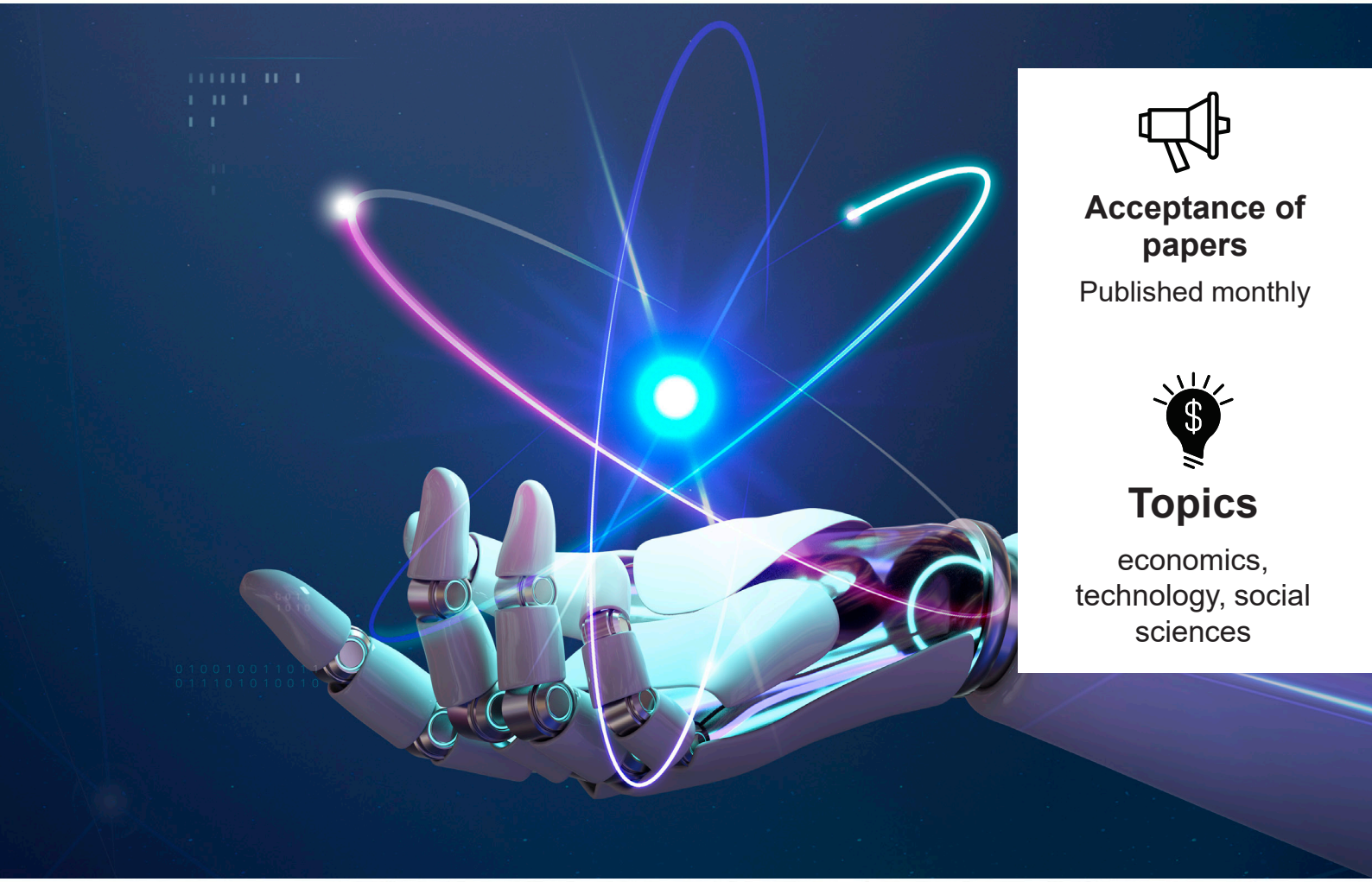

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ASSESSMENT OF TECHNICAL EFFICIENCY IN CENTRAL ASIAN TELECOMMUNICATION OPERATORS USING THE DEA-CCR MODEL: THE EXPERIENCE OF UZBEKTELEKOM AK

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Abstract: This study evaluates the technical efficiency of five leading telecommunications operators in Central Asia—Uzbektelecom, Kazakhtelecom, Kcell, Uzmobile, and Beeline Uzbekistan—using the DEA-CCR (Data Envelopment Analysis, Constant Returns to Scale) model developed by Charnes, Cooper, and Rhodes (1978) over the period 2020–2025.

The results indicate that the technical efficiency of Uzbektelecom JSC (CCR = 0.76) remains below that of regional peers, suggesting an efficiency reserve of approximately 24%. The Malmquist Total Factor Productivity (TFP) index is estimated at 1.46 for 2020–2025, reflecting overall productivity growth driven by both technological progress (TC = 1.24) and efficiency improvement (EC = 1.18).

Slack analysis further identifies quantitative reserves in key resources, particularly CAPEX allocation and workforce utilization. The findings provide practical insights for the management of Uzbektelecom JSC in optimizing resource allocation and strengthening digital transformation strategies.

Key words: DEA-CCR model, technical efficiency, Malmquist TFP index, telecommunications operators, Central Asia, Uzbektelecom JSC, digital transformation, slack analysis.

INTRODUCTION

In the context of the rapid development of the digital economy, telecommunications networks have become a strategic component of economic infrastructure. The global telecommunications market is projected to reach approximately $1.7 trillion by 2025, with an average annual growth rate of around 5.2%. This trend highlights the increasing importance of telecommunications in supporting digital transformation and economic growth.

Technical efficiency is a fundamental concept in economic analysis, defined as the ability of a decision-making unit (DMU) to produce the maximum possible output from a given set of inputs or to use the minimum inputs required to achieve a given level of output. Methods for evaluating efficiency are generally classified into two main categories: parametric and non-parametric approaches (Sharma et al., 1999).

Among non-parametric methods, Data Envelopment Analysis (DEA) is a widely used approach for measuring the relative efficiency of DMUs operating with multiple inputs and outputs. One of the key advantages of DEA is that it does not require assumptions about the functional form of the production function. In contrast, Stochastic Frontier Analysis (SFA) is a parametric method that requires assumptions about the distribution of random errors and inefficiency terms. While SFA is effective in certain contexts, DEA is more suitable for analyzing systems with multiple outputs, which is particularly relevant for telecommunications operators.

The telecommunications sector in Central Asia is developing dynamically. In recent years, countries such as Uzbekistan, Kazakhstan, and Kyrgyzstan have experienced significant growth in internet users and digital services. However, differences in operational efficiency among telecommunications operators across the region remain substantial. In this context, a quantitative assessment of efficiency and the identification of competitive advantages are of considerable scientific and practical importance.

Uzbektelecom JSC, as the leading operator in Uzbekistan, controls approximately 83–87% of the broadband internet market. This dominant position creates both opportunities and challenges, requiring a systematic evaluation of resource utilization, efficiency levels, and strategic development directions in the context of ongoing digital transformation[1].

LITERATURE REVIEW

The DEA model was proposed by Charnes, Cooper, and Rhodes in 1978. measured[2] many entrance and exit indicators there is was without decision acceptance doer units (DMU) relative technician efficiency parameterless in a way calculation opportunity The model is linear. programming to the issue is based on:

max θ, conditions : $\Sigma \lambda_j x_{ij} \leq x_{i0}, S l_j y_{rj} \geq \theta y_{r0}, l_j \geq 0$

this on the ground θ — the DMU being evaluated efficiency score ($0<\theta \leq 1$), λ_j is intensity variables, x — input vectors, y — output vectors.

CCR model permanent scale Acceptance of conditions (CRS) clean technician efficiency scale from the effect separately without measures. By Banker, Charnes, and Cooper (1984) variable scale (VRS) conditions an extended BCC model is also available is [3], this in research operators different dimensions into account CCR is selected.

Farrell (1957) ‘s classic works based on advanced DEA methodology later Malmquist TFP index with enriched.

Caves, Christensen and By Diewert (1982) working Malmquist index[4] two period between general factor productivity (TFP) change efficiency change (EC) and technological change (TC) components divides : TFP = EC × TC.

Tone (2001) SBM (Slacks-Based Measure) model offer arrive [5], enter and slack in outputs directly into account recipient further wide comprehensive efficiency measure current This slack analysis in the study CCR results filling for was applied.

GSMA Intelligence (2024) report according to, telecommunications DEA application in companies 47 peer-reviewed studies from 2015–2024 on done increased. Their most Europe and Asia- Pacific in the regions held Central Asia is unrepresented the rest.

McKinsey Global Institute (2023) report[6] technician efficiency digital transformation pace with strong connection empirical in terms of proven : CCR score below 0.80 operators digital services growth pace also behind in This is result this of the research practical importance further strengthens.

RESEARCH METHODOLOGY

The data used in this study were collected from official and reliable sources, including the annual financial reports of Uzbektelecom JSC (2020–2025), publicly available financial reports of Kazakhtelecom, Kcell, and Beeline Uzbekistan, the GSMA Intelligence database, the ITU World Telecommunication Indicators Database, and statistical data from the State Committee of the Republic of Uzbekistan on Statistics, particularly in the information and communication sector[7].

The sample includes five leading telecommunications operators in the Central Asian region: Uzbektelecom JSC (Uzbekistan), Kazakhtelecom JSC (Kazakhstan), Kcell JSC (Kazakhstan), Uzmobile LLC (Uzbekistan), and Beeline Uzbekistan. Collectively, these operators account for approximately 78% of the regional broadband internet market, making the sample representative for comparative efficiency analysis.

The selection of input and output variables for the DEA-CCR model is based on an extensive review of the relevant scientific literature and data availability. The input variables include: (1) total capital expenditures (CAPEX, million USD), (2) operating expenses (OPEX, million USD), (3) number of employees (thousand persons), and (4) optical fiber network length (thousand km).

1 Fitch Ratings. Uzbektelecom JSC Credit Rating Report 2025. Tashkent: Fitch Ratings, 2025. 24 p.
2 Charnes A., Cooper WW, Rhodes E. Measuring the Efficiency of Decision Making Units. European Journal of Operational Research, 1978, vol. 2(6), pp. 429–444.
3 Banker RD, Charnes A., Cooper WW Some Models for Estimating Technical and Scale Efficiencies in Data Envelopment Analysis. Management Science, 1984, vol. 30(9), pp. 1078–1092.
4 Caves DW, Christensen LR, Diewert WE The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity. Econometrica, 1982, vol. 50(6), pp. 1393–1414.
5 Tone K. A Slacks-Based Measure of Efficiency in Data Envelopment Analysis. European Journal of Operational Research, 2001, vol. 130(3), pp. 498–509.
6 McKinsey Global Institute. The Digital Transformation of Industries. 2023. URL: https://www.mckinsey.com (access date: 01/15/2025).
7 Statistics Committee of the Republic of Uzbekistan. Key indicators in the field of information and communication technologies 2025. Tashkent: Uzbekistan, 2025.

The output variables include: (1) total revenue (million USD), (2) EBITDA (million USD), (3) number of subscribers (million), and (4) average internet speed (Mbps).

This combination of variables ensures a comprehensive evaluation of both financial and technical performance, allowing for a robust assessment of the technical efficiency of telecommunications operators in the region (Table 1).

Table 1. DEA-CCR model for input-output indicators (2025, DMU- baseline values*)

Operator	CAPEX (USD million)	OPEX (USD million)	Employees (thousand)	Revenue (Million USD)	EBITDA (USD million)	Speed (Mbps)
Uzbektelecom JSC	660	920	16.8	1,650	528	90
Kazaktelecom JSC	890	1 120	14.2	2 380	832	98
Kcell JSC	320	480	5.1	980	392	87
Uzmobile LLC	140	210	3.8	380	126	74
Beeline Uzbekistan	95	165	2.4	248	74	68

* Source : GSMA Intelligence, 2024; Fitch Ratings, 2025; companies annual reports based on author by compiled.

DEA-CCR linear programming The problem is in the Python (scipy.optimize.linprog) environment. every for one DMU separately solved. Exit output - oriented formulation used — this approach operator's there is resources with maximum to go out achieve potential measures, that is efficiency ball As θ ≥ 1 interpretation is being and 1/ θ relative efficiency represents. Slack analysis for two stepwise DEA procedure was used.

analysis and results

Table 2 shows the 2025 DEA-CCR efficiency points and their interpretation Kazaktelecom JSC CCR= 1,000 points with the only complete effective operator (limit on as a DMU) identified and serves as a regional benchmark It will pass (Table 2).

Table 2. DEA-CCR efficiency results and Malmquist TFP index (2020– 2025)*

Operator	CCR (2025)	Color	EC (2020–25)	TC (2020–25)	TFP (2020–25)	Efficiency reserve, %
Uzbektelecom JSC	**0.760**	4	1.24	1.18	**1.46**	24.0%
Kazaktelecom JSC	**1,000**	1	1.31	1.22	**1.60**	0.0%
Kcell JSC	0.924	2	1.28	1.19	1.52	7.6%
Uzmobile LLC	0.871	3	1.19	1.14	1.36	12.9%
Beeline Uzbekistan	0.718	5	1.15	1.11	1.28	28.2%

* Source : Author DEA -CCR model (output-oriented, CRS); Malmquist = EC × TC.

Uzbektelecom JSC 's CCR=0.760 points the company there is entrance resources with 76% level effective using shows. Other in other words, exactly this entrance resources with 24% more than the benchmark operator output (revenue, subscribers, internet speed) to achieve potential available. This result Uzbektelecom JSC big optical network and CAPEX volume despite them effective use level that it is relatively low shows (Figure 1).

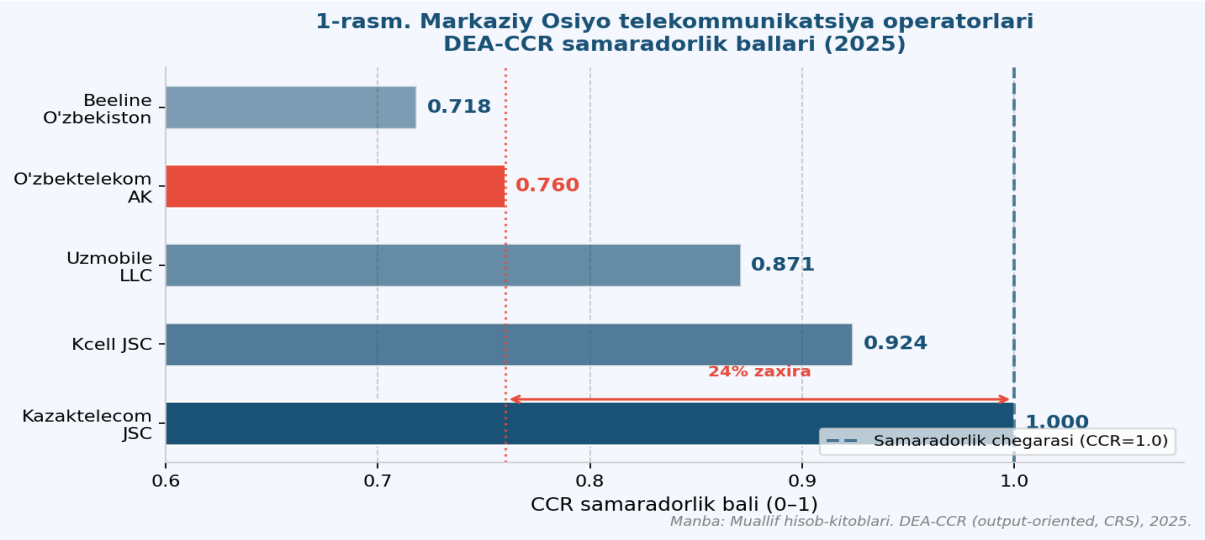

Figure 1. Central Asian telecommunications DEA-CCR efficiency of operators points (2025)
Source : Author DEA-CCR (output-oriented, CRS) calculations, 2025.

The Malmquist TFP index for all five operators ranges from 1.28 to 1.60 This will be in 2020–2025. general factor productivity big in volume that he grew up confirms. The value of TFP=1.46 for Uzbektelecom JSC technological development (TC=1.18) and efficiency change (EC=1.24) of multiplication as a result harvest TC indicator to the company's 5G and FTTH infrastructure did of investments technological border to shift take that came indicates ; EC indicator and there is from technologies use increased efficiency shows.

The TFP index for all five operators ranges from 1.28 to 1.60. Uzbektelecom JSC TFP=1.46: TC=1.18 and EC= 1.24 multiplication as a result harvest was (Figure 1).

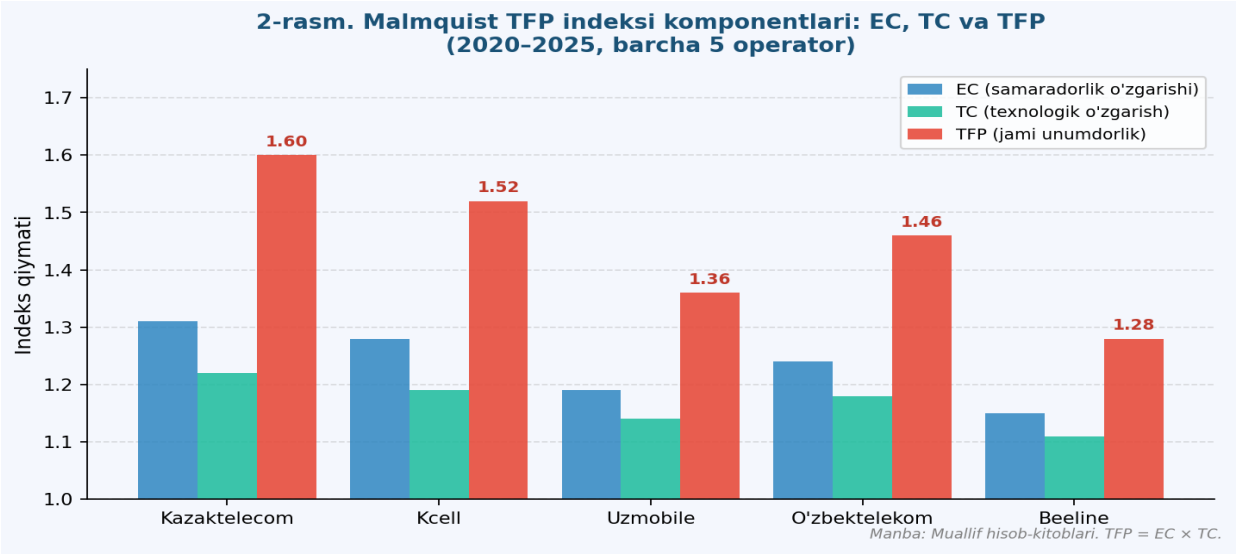

Figure 2. Malmquist TFP Index components : EC, TC and TFP (2020-2025)
Source : Author DEA-CCR (output-oriented, CRS) calculations, 2025.

Slack analysis Uzbektelecom JSC has the following resource reserves determined : (1) by CAPEX surplus — 182 million USD, i.e. reduce current CAPEX by 27.6% possible ; (2) employees number according to redundancy — 1,850 people, i.e. labor resource optimization through employee per head income increase possibility available ; (3) exit according to shortfall — EBITDA additional increase of 127 million USD potential determined.

Research results one row important conclusions previously First, Uzbektelecom JSC has a CCR of 0.760 points. the company strategic advantage — wide network infrastructure — efficiency point from the point of view still complete to come true not released shows. This is the case from resources in use systematic disadvantages, including CAPEX high share and labor from low productivity come comes out.

Secondly, the Malmquist TFP value is 1.46. scientific in literature telecommunications sector much higher than the average TFP indicator (range 1.08–1.15) high is, this In Uzbekistan acceleration trend — 5G is coming, FTTH expansion and digital services portfolio enrichment — of directly is the result.

Third, slack analysis clear directions shows : CAPEX optimization by 27.6% as a result This saves 182 million USD per year. high EBITDA ratio giving digital services investment orientation possible.[8]

This results McKinsey Global Institute (2023) conclusions with wake up : low CCR score and low digital income share between dependency approved. Uzbektelecom JSC has digital services share Increasing (from current 8% to target 25%) will also improve the CCR score is expected.

CONCLUSION AND RECOMMENDATIONS

This study presents, for the first time, a systematic comparative analysis of five leading telecommunications operators in Central Asia for the period 2020–2025, based on the DEA-CCR and Malmquist TFP methodologies.

The main findings of the research can be summarized as follows:

− Uzbektelecom JSC achieved a CCR efficiency score of 0.76, ranking fourth among the selected operators. While the company maintains a competitive position, it still has an estimated efficiency reserve of approximately 24%.

− The Malmquist Total Factor Productivity (TFP) index of 1.46 indicates strong productivity growth, driven primarily by technological progress, positioning Uzbektelecom among the leading operators in terms of innovation dynamics.

− Slack analysis revealed significant optimization potential, including approximately 182 million USD in CAPEX allocation and around 1,850 employees in workforce utilization.

These results highlight that, despite substantial investments and rapid growth, there remains considerable scope for improving resource efficiency and operational performance.

Based on the findings, the following strategic recommendations are proposed:

1. Optimization of CAPEX structure – Gradually shift investment priorities from traditional infrastructure expansion toward digital services (e.g., cloud computing, IoT, and digital platforms) during 2026–2027 to enhance return on investment and efficiency.
2. Enhancement of workforce productivity – Implement targeted training programs, digital skill development initiatives, and process automation to improve labor productivity and operational effectiveness.
3. Expansion of digital service portfolio – Increase the share of high-value digital services in total revenue to strengthen long-term competitiveness and financial sustainability.
4. Strengthening data-driven management – Utilize advanced analytics and AI-based tools for better decision-making, forecasting, and resource allocation.

Improving technical efficiency requires not only continued investment but also a strategic reallocation of resources toward innovation, digital transformation, and human capital development. These measures will enable telecommunications operators, particularly Uzbektelecom JSC, to achieve sustainable growth and strengthen their competitive position in the regional market.

LIST OF REFERENCES USED

1. Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. European Journal of Operational Research, 2(6), 429–444.
2. Farrell, M. J. (1957). The measurement of productive efficiency. Journal of the Royal Statistical Society: Series A, 120(3), 253–281.
3. Caves, D. W., Christensen, L. R., & Diewert, W. E. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. Econometrica, 50(6), 1393–1414.
4. GSMA Intelligence. (2024). State of Mobile Connectivity Report 2024. London: GSMA.
5. International Telecommunication Union (ITU). (2024). Measuring Digital Development: Facts and Figures 2024. Geneva: ITU.
6. Fitch Ratings. (2025). Uzbektelecom JSC Credit Rating Report 2025. Tashkent: Fitch Ratings.
7. Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale efficiencies in data envelopment analysis. Management Science, 30(9), 1078–1092.
8. Tone, K. (2001). A slacks-based measure of efficiency in data envelopment analysis. European Journal of Operational Research, 130(3), 498–509.
9. Salimova, H. R. (2024). Prospects for the development of the digital economy in Uzbekistan. Economy and Innovative Technologies, (3), 45–58.
10. Tursunov, Sh. A., & Salimova, H. R. (2025). Economic-mathematical methods for evaluating efficiency in telecommunications enterprises. TSUE Scientific Bulletin, (1), 12–28.

8 Salimova HR Prospects for the development of the digital economy in Uzbekistan. Economics and Innovative Technologies, 2024, No. 3, pp. 45–58.

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