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IMPROVEMENT OF ECONOMIC MECHANISMS IN THE ORGANIZATION OF INFORMATION AND COMMUNICATION TECHNOLOGY SERVICES

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ABSTRACT. The organizational and scientific-theoretical aspects of information and communication services are analyzed. The significance of information and communication technologies in society, the mechanisms for the legal regulation of the sector, and scientific approaches to the development of digital services are examined. Theoretical perspectives and practical approaches aimed at improving the efficiency of information exchange, strengthening the legal framework, and enhancing modern communication services are presented.

Keywords: information and communication services, digital technologies, legal regulation, scientific-theoretical approach, communication system, digitalization.

АННОТАЦИЯ. Проанализированы организационные и научно-теоретические аспекты организации информационно-коммуникационных услуг. Рассмотрены значение информационно-коммуникационных технологий в жизни общества, механизмы правового регулирования данной сферы, а также научные подходы к развитию цифровых услуг. Представлены теоретические положения и практические подходы, направленные на повышение эффективности информационного обмена, укрепление правовой основы и совершенствование современных коммуникационных услуг.

Ключевые слова: информационно-коммуникационные услуги, цифровые технологии, правовое регулирование, научно-теоретический подход, коммуникационная система, цифровизация.

INTRODUCTION

Uzbekistan is experiencing rapid growth in the sphere of ICT services as part of the country's digital economy. By 2023, the sector had contributed about 2.1% to GDP¹ up from 1.6% in 2021. More than 10,550 companies operate in the ICT sector, while exports increased from USD 140 million to USD 344 million between 2022 and 2023². All of these developments contribute to maintaining service quality and enhancing industry efficiency. For example, in ICT companies, the automation of financial reporting can reduce costs, increase efficiency, and improve data security, thereby strengthening overall economic performance.

In her research, Adel explored the issue of assessing the level of information security in enterprises under conditions of uncertainty using the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method. The researcher

1 https://tadviser.com/index.php/Article:ICT_market_of_Uzbekistan

2 <https://www.worldbank.org/en/news/press-release/2023/11/30/world-bank-to-support-uzbekistan-in-developing-the-digital-economy-and-creating-new-jobs-in-the-it-sector>

notes that assessing the level of information security is the first stage in the formation of an information security management system in organisations. In this process, it is important to take into account the uncertainties that affect decision-making. In particular, it is scientifically substantiated that the use of the Fuzzy AHP method, based on the theory of uncertain datasets, allows for a more accurate assessment of the priorities of factors and criteria affecting information security, as well as for effective management decisions under conditions of uncertainty.

LITERATURE REVIEW

In his research, Ismail Keshta examined data security issues in cloud computing technologies. The researcher evaluates cloud computing as a modern technology that allows users to efficiently utilise information resources located on remote servers³. The study scientifically substantiates that, alongside the advantages of cloud technologies, ensuring information security is a priority in their implementation.

Zhengbing Hu studied the issues of optimising information security systems in the context of external and internal influences on information systems. The researcher proposed a method for assessing the effectiveness of security systems based on modelling the factors affecting information systems. He also recommends software tools that enable the developed approach to be applied in practice, thereby contributing to increased efficiency in information security management⁴.

In his research, Serhii placed particular emphasis on the issues of risk-based management decision-making in information processing systems. The researcher notes that the accelerated development of information technologies and the formation of large volumes of information require innovative approaches to information security. Therefore, the use of artificial intelligence and Big Data technologies has been justified as an effective solution for processing large amounts of data in real time, predicting potential threats, and monitoring unusual situations in information systems⁵.

RESEARCH METHODOLOGY

In the process of carrying out this research, a number of scientific cognition methods were widely used. In particular, the methods of observation, analysis, data collection, systematisation, generalisation, and comparison were employed in the study of the organisational, legal, and scientific-theoretical aspects of information and communication services. In addition, statistical data, scientific literature, and analytical sources were examined in order to assess the current state of the sphere and identify its development trends.

ANALYSIS AND RESULTS

The rational use of economic mechanisms in the effective organization and development of ICT services plays an important role. These mechanisms serve to promote competition in the service market, attract investment, ensure the efficient use of financial resources, regulate prices and tariffs for services, and stimulate innovative activity. In this context, the main economic mechanisms and tools used in the organization of ICT services can be divided into the following areas:

Market-based pricing and competition. Demand- and supply-based pricing of services increases competition among providers, thereby improving service quality and efficiency. Liberalization and deregulation of telecommunications and ICT services allow prices to reflect costs and market demand, optimize the performance of providers, and promote innovation.

Investment incentives and infrastructure. Domestic and foreign investment plays an important role in the development of ICT infrastructure. Public financing, incentives for private investors, technology parks, and special economic zones attract capital investment and contribute to the modernization of broadband networks, data centers, and other ICT infrastructure.

Financial support and subsidies. The state supports ICT projects and start-ups through budgetary and extra-budgetary funds, grants, and concessional loans. These mechanisms facilitate the introduction of new services, support the entry of new providers into the market, and contribute to the financial stability of the industry.

3 Keshta I. Cloud-based Technology-Based Key Exchange Protocol for eHealth System // PLOS ONE. – 2025. – Volume 20, Number 6.

4 Hu Z., Khokhlachova Y., Sydorenko V., Opirskyy I. Method of optimization of information security systems under influences // International Journal of Intelligent Systems and Applications. – 2017. – Volume 9, Issue 12. – pp. 46–58.

5 Yevseev S., Milevskiy S., Rayevnieva O. et al. Development of a method for assessing information security risks based on Big Data technologies // Eastern-European Journal of Enterprise Technologies. – 2021. – Volume 6, Issue 9(114). – pp. 31–42.

Cost and tariff regulation. Setting cost-based tariffs contributes to the efficient use of resources and the optimization of service costs. Tariff regulation encourages providers to reduce overhead costs, optimize infrastructure, and make efficient investments.

Tax and fiscal incentives. Tax incentives and other fiscal measures contribute to the development of innovative activities among ICT enterprises and help reduce investment costs. In particular, incentives for investment in software, artificial intelligence, and cloud technologies facilitate the creation of high-value-added services.

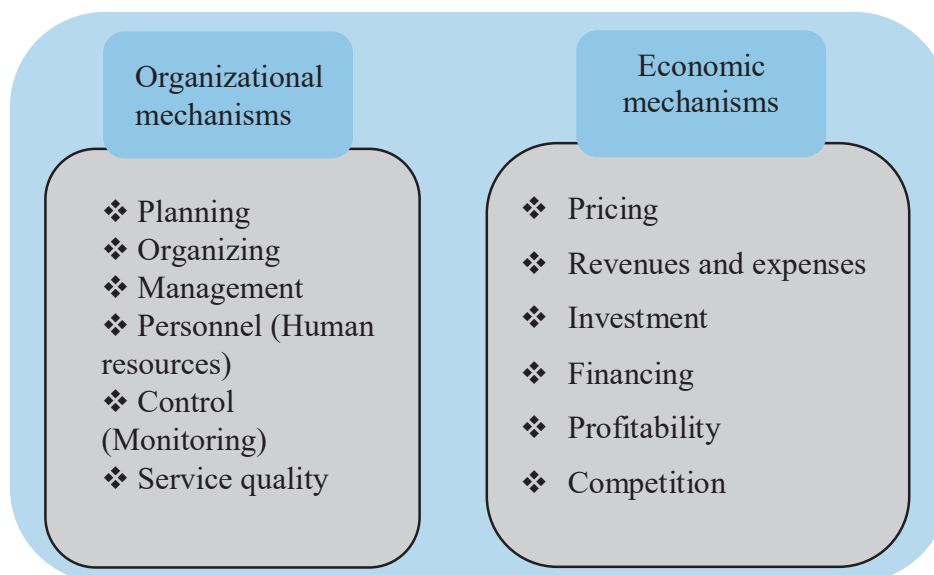


Figure 1. Organizational-Economic Mechanism of ICT Services⁶

The harmonious application of these mechanisms increases the competitiveness of ICT services, improves service quality, promotes infrastructure development, enhances the efficiency of resource use, and creates a favorable economic environment for the development of new digital services. Therefore, we believe that the coordinated use of economic mechanisms is an important factor in ensuring the long-term and sustainable development of the ICT services market.

In our opinion, in order to scientifically characterize the operating conditions of information and communication technology (ICT) enterprises, it is necessary first to identify the main factors affecting the process of service provision and the development of enterprises within the sector. In this regard, as Russell L. Ackoff points out, “as the number of variables involved in describing a phenomenon increases, it becomes more difficult to understand and manage it.”⁷ In this context, it is recognized that changes in external and internal environmental conditions in the organizational design and management of the development efficiency of ICT enterprises lead to corresponding changes in the requirements imposed on the elements of their organizational structures.

This approach makes it possible to summarize the numerous factors affecting the functioning and development of the information and communication system and express them within the framework of a functional model for the formation of the organizational structure. At the same time, a complex system of external and internal factors is expressed in a compact mathematical form through changes in the vectors of general constraints ($\mathbf{b}^0$), independent constraints ($\mathbf{b}^k$), and parameter coefficients ($\mathbf{C}^k$) of the model. As a result, the process of forming the organizational structure and making management decisions in ICT enterprises is simplified, while the possibilities for ensuring the stable functioning of the system under different conditions are expanded. In order to scientifically study the problem of modeling the zone of economic uncertainty in the activities of ICT enterprises, a three-stage mathematical model of this process was developed. The general structure of the developed model and the stages of its implementation are presented in Figure 2.

At the initial stage of modeling, the vector $\mathbf{B} = \{\mathbf{b}^0, \mathbf{b}^k, \mathbf{C}^k\}$ is taken as the main parameter. These vector components represent the values of the total constraints ($\mathbf{b}^0$), independent constraints ($\mathbf{b}^k$), and functional

⁶ Author's elaboration

⁷ Ackoff R.L. Scientific Method: Optimizing Applied Research Decisions. New York: John Wiley & Sons, 1962. – 502 p.

coefficients (**Ck**) of the linear functional model. At the same time, **each element of the vector** $B = \|b_{ij}\|$ ($i=1, \dots, n$) can take on different values in the range $[b_{min,i}; b_{max,i}]$ describing the organizational and economic conditions in which the AKTX enterprise operates. During the study, it was found necessary to form a combination of M random vectors representing conditions of economic uncertainty. The **resulting vectors** $\tilde{B} = \|\tilde{b}^0, \tilde{b}^k, \tilde{C}^k\|$ are formed on the basis of the initial **vector** B . During modeling, two important conditions are considered.

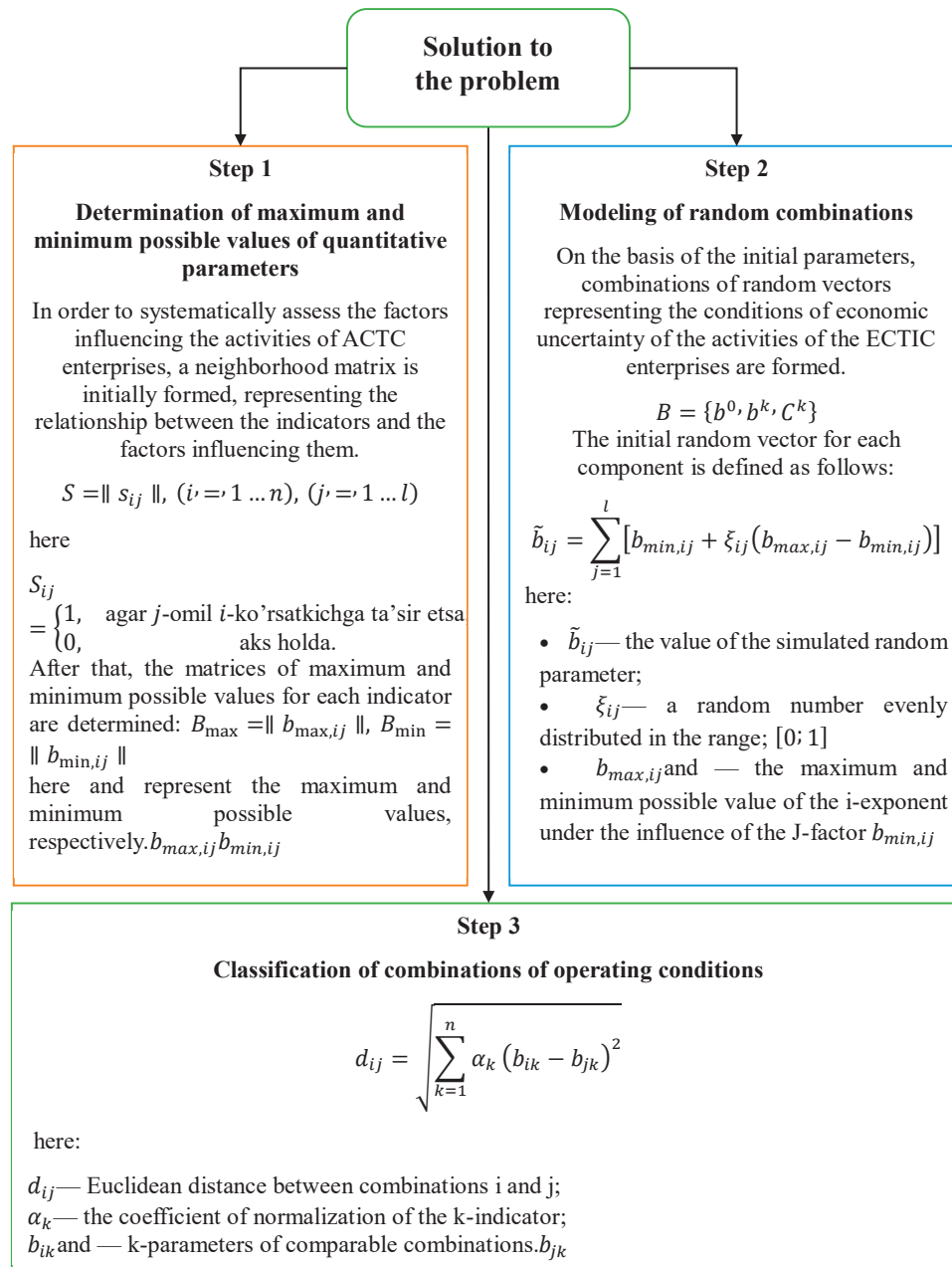


Figure 2. A three-stage conceptual-mathematical model of modeling the zone of economic uncertainty in the activities of ECTIC enterprises⁸

As a result of the research, a three-stage mathematical model was developed to assess and model the zone of economic uncertainty in the activities of ICT enterprises (Figure 2). The main purpose of this model is to identify the factors that shape economic uncertainty, mathematically assess their impact on enterprise activities, and scientifically classify possible development conditions. At the first stage of the model, external and internal factors influencing the activities of ICT enterprises are identified, and their impact on economic indicators is assessed using an adjacency matrix.

⁸ Author's elaboration

For this:

$$S = \| S_{ij} \|, (i = 1 \dots n), (j = 1 \dots l)$$

An adjacent matrix is formed. In this matrix

$$S_{ij} = \begin{cases} 1, & \text{agar } j\text{-omil } i\text{-ko'rsatkichga ta'sir etsa; aks holda.} \\ 0, & \end{cases}$$

After that, the maximum and minimum possible values for each indicator are determined:

$$B_{max} = \| b_{max,ij} \|, B_{min} = \| b_{min,ij} \|$$

Here and respectively, under the influence of the J-factor, it represents the maximum and minimum possible values of the i-exponent. As a result, a base of initial parameters is formed to characterize the zone of economic uncertainty.

In the second stage of the model, random combinations describing conditions of economic uncertainty are modeled. At the same time, it represents the initial state of the activity of the AKTC enterprise.

$$B = \{b^0, b^k, C^k\}$$

Vector is taken as the basis. Probabilistic variations in parameters are evaluated on the principle of maximum entropy. If only the range (boundary) of a parameter is known, and there is no additional information about its internal distribution, then the law of uniform distribution applies. In this case, the value of the random parameter is determined using the following expression:

$$\tilde{b}_{ij} = b_{min,ij} + \xi_{ij}(b_{max,ij} - b_{min,ij}),$$

where — $\xi_{ij} [0; 1]$ refers to a random number evenly distributed in an interval.

Since several independent factors can affect the activities of an enterprise at once, the final value of random parameters is determined as follows:

$$M = \{\tilde{B}_m\}, m = 1, \dots, M$$

where — represents the number of factors influencing indicator i. On the basis of this approach, it is necessary to

A random set of combinations is formed. However, the huge number of combinations complicates the optimization calculations. Therefore, in the next stage, their number will be reduced.

$$N \ll M$$

Conditional reduction is considered expedient.

In the third stage of the model, the formed combinations are divided into clusters according to the degree of mutual similarity. Using the Euclidean distance as a grouping criterion, it is defined as:

$$d_{mm'} = \sqrt{\sum_{i=1}^n p_i^2 (\tilde{b}_{mi} - \tilde{b}_{m'i})^2},$$

here:

$d_{mm'}$ — Euclidean distance between combinations m and m';

p_i — the normalization coefficient of indicator i;

$\tilde{b}_{mi}$ and — the i-component values in the realizations m and m', respectively.

$$\tilde{b}_{m'i}$$

Thus, the three-stage mathematical model developed as a result of the study creates a consistent methodological basis for the comprehensive assessment and modeling of economic uncertainty in the activities of ICT enterprises. At the first stage of the model, the factors that shape economic uncertainty are systematized, and the limits of their influence on indicators are determined. At the second stage, possible combinations of economic conditions are modeled based on the principle of maximum entropy, and various scenarios for the development of enterprise activities are formed. At the third stage, the resulting combinations are clustered based on Euclidean distance, economic conditions that are close to one another are grouped, and representative options are selected. The scientific significance of the proposed model lies in the integration of economic uncertainty, probabilistic modeling, and clustering processes into a single mathematical system, making it possible to assess the activities of ICT enterprises in accordance with changing external and internal environmental conditions. The practical application of the model serves to scientifically substantiate management decisions, optimize the volume of calculations, reduce the level of risk, and ensure the sustainable and effective development of ICT enterprises.

Based on the calculated distances, combinations are grouped into clusters according to their degree of mutual proximity. From each formed cluster, one representative vector is selected and used as the main information base for further optimization of the activities of ICT enterprises and the development of management decisions.

Thus, the proposed three-stage mathematical model allows for a comprehensive assessment of economic uncertainty in the activities of ICT enterprises, the formation of possible development scenarios, and scientifically grounded decision-making through the clustering of similar economic conditions. The practical application of the model ensures the sustainable development of enterprises, the rational use of resources, and a reduction in the level of risks arising from the influence of external and internal factors.

The competitiveness of enterprises in the context of the digital economy largely depends on the degree of rational distribution of their information services across regional markets. Differences in the formation of demand for information services across regions, variations in service efficiency, and limited resources require enterprises to develop economically sound distribution strategies. In this context, the optimization of information service flows across regional markets is one of the important factors not only in increasing enterprise income but also in ensuring the efficient use of available resources and fully meeting market needs.

During the study, it was considered appropriate to express the process of distributing information services provided by ICT enterprises across regional markets from an economic and mathematical perspective. At the same time, the main condition is that the volume of information services produced by the enterprise should be equal to the total demand of regional markets.

$$\sum_{i=1}^z a_i = \sum_{j=1}^n b_j = S$$

here:

a_i — the volume of information and communication services on type i ;

b_j — j - market demand for information services;

S — The total volume of services.

This link allows ensuring a balance between the opportunities of the enterprise and the demand of regional markets. The results of the study showed that proportionality of the volume of services with market needs is an important condition for rational use of resources and increasing cost-effectiveness.

Determination of the volume of domestic demand for information services is determined by the following expression:

$$\sum_{i=1}^5 X_{ij} = b_j, j = 1, 2, \dots, n$$

Also, the available volume of information services of each type is represented by the following equality:

$$\sum_{j=1}^n X_{ij} = a_i, i = 1, 2, 3, 4, 5$$

These restrictions make it possible to maintain a balance between supply and demand in the distribution of information services. During the study, it was found that it is precisely this balance that plays an important role in raising the economic sustainability of the enterprise. It is recommended to use the following purpose function to determine the optimal option for the distribution of information services by regional markets:

$$Z(X) = \frac{1}{S} \sum_{i=1}^5 \sum_{j=1}^n p_{ij} X_{ij} \rightarrow \max$$

here:

X_{ij} — the volume of type I-type information services aimed at the j-regional market;

p_{ij} — an indicator of cost efficiency obtained from the implementation of type I-type information services in the j-regional market.

This function of purpose allows to distribute services across regions in order to achieve the maximum cost efficiency of the enterprise. The results of the study showed that taking into account when distributing services not only the volume of demand, but also the efficiency of their implementation significantly improves the economic results of the enterprise. In order to assess the feasibility of the proposed approach, initial distribution plans were initially formulated based on the Northwest Angle method and the maximum efficiency level method. As a result of the calculations, it turned out that the plan developed on the basis of the method of maximum level of efficiency provides a higher level of cost efficiency of the enterprise. This result confirms the need to use cost-effectiveness indicators as a priority criterion in the distribution of services. The optimality of the formed plan was verified based on the potential method. At the same time, the empty cells were calculated using the following expression:

$$\beta_{ij} = p_{ij} + \varphi_i + \varphi_j$$

here:

β_{ij} — the price of an empty cell;

φ_i and φ_j — row and column potentials, respectively.

As a result of the calculation, it is established that the condition for all empty cells is true. This situation confirms the optimism of the developed distribution plan and the practical feasibility of the chosen economic and mathematical approach.

CONCLUSION AND SUGGESTIONS

Based on the scientific research, we conclude that one of the most important processes for the effective organization of the activities of ICT enterprises is achieving the highest level of cost-effectiveness in the distribution of information services among regional consumers, as well as applying methods for identifying and effectively meeting the needs of the population. We believe that the proposed economic and mathematical approach will contribute to managing the flow of information services, ensuring the rational use of resources, increasing the competitiveness of enterprises, and promoting sustainable development in regional information services markets. Based on the results of our research, we consider it appropriate to formulate the following specific suggestions:

First, it is necessary to strengthen the scientific justification of management decisions by introducing a three-stage mathematical modeling approach into the process of assessing and managing economic uncertainty in ICT enterprises.

Second, it is desirable to increase the efficiency of the use of available resources by applying optimization methods based on cost-effectiveness criteria in the distribution of information services across regional markets.

Third, it is necessary to expand public-private partnership mechanisms and improve preferential financing and tax incentives in order to stimulate the investment activity of ICT enterprises.

Fourth, it is recommended to improve service quality, labor productivity, and the competitiveness of enterprises by introducing innovative technologies into the ICT services market and accelerating digital transformation processes.

Fifth, combining the results of economic and mathematical modeling in assessing the activities of ICT enterprises with correlation and regression analysis, as well as establishing a system for the systematic monitoring of demand for services across regions, will enable more effective management of the strategic development of enterprises.

The effective organization of information and communication technology services is directly related to the interaction of economic mechanisms, the rational use of resources, and decision-making in accordance with market demand. The comprehensive application of pricing, investment, tax, credit, and government support mechanisms in the activities of ICT enterprises contributes to improving service quality and enhancing economic efficiency.

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