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IQTISODIYOT FANLARI

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Tomorqa xo'jaliklari faoliyatidan olingan daromadga noqishloq xo'jaligi faoliyati ta'sirini iqtisodiy baholash.....8

RO'ZMAMATOV ABBOS TOLIBJON O'G'LI

O'zbekistonda chakana savdo tarmog'ining tarkibiy o'zgarishlari va savdo xizmatlarini rivojlantirish yo'nalishlari.....17

АЙТМУРАТОВА УЛБИКЕ ЖАЛГАСОВНА

Развитие методических подходов к комплексной оценке эффективности привлечения финансирования акционерными обществами через рынок капитала.....26

BAXRONOVA NILUFAR SUNNAT QIZI

Raqamli transformatsiya va yashil iqtisodiyot integratsiyasining innovatsion iqtisodiy o'sishga ta'sir mexanizmlari.....36

KARAMATOVA NOIBA HUSNITDINOVNA

Korxonada ichki nazorat va audit tizimini takomillashtirish yo'nalishlari.....44

VEI ZHIBO

Madaniy meros turizmida raqamli kommunikatsiya, jamoatchilik ishtiroki va inklyuziv o'sish – Samarqand misolida.....53

ISMIGUL ABDULLAYEVA

Improving data management systems of small and medium enterprises through cloud technologies in the digital economy.....65





IMPROVING DATA MANAGEMENT SYSTEMS OF SMALL AND MEDIUM ENTERPRISES THROUGH CLOUD TECHNOLOGIES IN THE DIGITAL ECONOMY

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Abstract. This scientific article examines the conceptual framework for modernizing the information infrastructure of small and medium-sized enterprises (SMEs) within modern digital transformation processes. The relevance of the study is driven by the exponential growth of data flows in SMEs, alongside the technical and financial unreadiness of traditional management systems to process such volumes of information. Based on the Total Cost of Ownership (TCO) methodology, this paper analyzes the economic efficiency of cloud technologies and proposes a hybrid cloud architecture that complies with the national data localization legislation of the Republic of Uzbekistan. The study outlines mechanisms for optimizing operational costs, strengthening cybersecurity, and enhancing business process agility through cloud transformation.

Keywords: digital economy, small and medium enterprises (SMEs), cloud technologies, data management systems, TCO analysis, hybrid cloud, digital transformation, IT infrastructure, economic efficiency.

Annotatsiya. Ushbu ilmiy maqolada zamonaviy raqamli transformatsiya jarayonlari sharoitida kichik va o'rta biznes subyektlarining (KOB) axborot infratuzilmasini modernizatsiya qilishning konseptual asoslari tadqiq etilgan. Tadqiqotning dolzarbligi KOB subyektlarida ma'lumotlar oqimining eksponensial ravishda ortib borishi, an'anaviy boshqaruv tizimlarining esa bunday hajmdagi axborotni qayta ishlash uchun texnik va moliyaviy jihatdan yetarli darajada tayyor emasligi bilan izohlanadi. Mazkur tadqiqotda Total Cost of Ownership (TCO) metodologiyasi asosida bulutli texnologiyalarning iqtisodiy samaradorligi tahlil qilinib, O'zbekiston Respublikasining milliy ma'lumotlarni lokalizatsiya qilish to'g'risidagi qonunchilik talablariga muvofiq gibrid bulutli arxitektura taklif etilgan. Tadqiqotda bulutli transformatsiya orqali operatsion xarajatlarni optimallashtirish, kiberxavfsizlikni mustahkamlash hamda biznes jarayonlarining moslashuvchanligini oshirish mexanizmlari yoritilgan.

Kalit so'zlar: raqamli iqtisodiyot, kichik va o'rta biznes (KOB), bulutli texnologiyalar, ma'lumotlarni boshqarish tizimlari, TCO tahlili, gibrid bulut, raqamli transformatsiya, IT infratuzilmasi, iqtisodiy samaradorlik.

Аннотация. В данной научной статье исследуются концептуальные основы модернизации информационной инфраструктуры субъектов малого и среднего бизнеса (МСБ) в условиях современных процессов цифровой трансформации. Актуальность исследования обусловлена экспоненциальным ростом потоков данных в субъектах МСБ, а также технической и финансовой неготовностью традиционных систем управления к обработке таких объемов информации. На основе методологии Total Cost of Ownership (TCO) проведен анализ экономической эффективности облачных технологий и предложена гибридная облачная архитектура, соответствующая требованиям национального законодательства Республики Узбекистан в сфере локализации данных. В исследовании рассмотрены механизмы оптимизации операционных затрат, повышения уровня кибербезопасности и обеспечения гибкости бизнес-процессов посредством облачной трансформации.

Ключевые слова: цифровая экономика, малый и средний бизнес (МСБ), облачные технологии, системы управления данными, ТСО-анализ, гибридное облако, цифровая трансформация, IT-инфраструктура, экономическая эффективность.





INTRODUCTION

Global digital transformation processes necessitate a fundamental revision of business operations across all sectors of the modern economy. Today, information resources and data management systems have evolved from mere technical infrastructure components into primary strategic assets that define an enterprise's market position. For small and medium-sized enterprises (SMEs) in particular, rapid data processing, storage efficiency, and data security serve as critical prerequisites for enhancing operational performance.

Under the "Digital Uzbekistan – 2030" Strategy, approved by Decree No. UP-6079 of the President of the Republic of Uzbekistan on October 5, 2020, digitizing the real sector of the economy and expanding the cloud services market have been identified as top priorities. Implementing this strategy requires business structures at all levels to modernize their information systems in accordance with international standards. However, SMEs encounter systemic challenges in data management—most notably, the prohibitively high economic cost of building and maintaining traditional local IT infrastructure. Purchasing modern server hardware, acquiring licensed software, and retaining dedicated technical support personnel require significant capital expenditures (CAPEX) that often exceed the financial capabilities of SMEs.

Furthermore, traditional management models suffer from inefficient capacity allocation. Empirical findings indicate that SMEs typically utilize only 15% to 20% of their available server capacity. The remaining 80% represents "frozen" working capital that yields no economic return while continuing to generate depreciation and energy costs. This inefficiency restricts the adaptability of data management systems and hinders rapid response to market fluctuations.

In this context, cloud technologies emerge as both a technological innovation and a financial optimization tool for SMEs. Cloud transformation allows organizations to shift data management costs from capital expenditures to operational expenditures (OPEX). Considering legal aspects of data governance—specifically Article 27 of the Law of the Republic of Uzbekistan "On Personal Data"—improving data management systems through hybrid cloud deployment models presents a highly relevant theoretical and practical issue.

LITERATURE REVIEW

Modernizing the technological infrastructure of SMEs in a digital economy is a central topic in contemporary economic research. Numerous scholars have examined the economic mechanisms of enhancing data management systems through cloud solutions.

The conceptual role of cloud computing in data management was grounded by researchers such as M. Armbrust and I. Stoica through the "pay-as-you-go" resource allocation model. Their findings demonstrate that cloud platforms provide operational elasticity for data management systems while significantly optimizing hardware costs for small businesses.





In Uzbekistan, foundational methodological contributions to cloud technology research have been made by Academician S. S. Gulyamov and his research group. Gulyamov conceptualizes the digital economy as a "data-driven ecosystem" and positions cloud platforms as its central "nervous system." His work emphasizes that establishing centralized data storage and ubiquitous access is essential to fostering national economic competitiveness.

At the enterprise level, N. E. Norboyeva has conducted critical research evaluating the practical efficiency of cloud solutions. In her study on the effective application of cloud technologies in corporate operations, Norboyeva established a systematic framework for integrating cloud services into managerial processes. Her findings confirm that adopting cloud models accelerates internal information flows and eliminates the risk of hardware obsolescence.

Additionally, while researchers such as R. Buyya have studied latency reduction techniques in data management, a holistic scientific framework addressing the economic-legal balance of hybrid cloud models for SMEs—specifically aligning with national regulatory constraints—remains underrepresented. This study aims to address this research gap.

METHODOLOGY

The methodological foundation of this study relies on structural modeling, comparative economic evaluation, and quantitative analysis. The primary strategy focuses on analyzing current data management practices within SMEs and formulating an optimal economic-technical model for infrastructure improvement.

During the initial stage, a representative SME operating in Uzbekistan's digital market was selected, characterized by average computational workloads and a database volume ranging from 500 GB to 2 TB. To objectively assess the economic efficiency of the data management system, the internationally recognized Total Cost of Ownership (TCO) methodology was applied. This approach accounts for direct hardware acquisition costs alongside energy consumption, licensing, IT staff compensation, and potential financial losses stemming from system downtime.

The core methodological phase involved designing a hybrid cloud deployment architecture tailored for data management systems. Data streams were categorized based on confidentiality levels and processing intensity. To maintain strict compliance with Article 27 of the Law of the Republic of Uzbekistan "On Personal Data," confidential and personal records were assigned to local servers, whereas general analytical and dynamic operational data were allocated to public cloud platforms.

In the final phase, financial parameters for both traditional and proposed hybrid models were projected over a one-year operational cycle. Comparative analytical methods were then used to evaluate the impact of cloud transformation on corporate liquidity and operational resilience.





RESULTS AND DISCUSSION

A comparative economic analysis was conducted to evaluate traditional versus proposed hybrid cloud models for SME data management systems. Calculations reflect a one-year operational timeline based on prevailing server hardware costs and cloud provider tariffs in Uzbekistan.

Table 1

Comparative Annual Cost Analysis of Data Management Models in SMEs (in UZS)

Cost Category	Traditional Model (UZS)	Hybrid Cloud Model (UZS)	Relative Difference (%)
Hardware Costs (CAPEX)	55,000,000	8,000,000	-85.4%
Software & Licensing	12,000,000	3,500,000	-70.8%
Operational & Energy Costs	18,600,000	2,200,000	-88.1%
Technical Support & Personnel	108,000,000	21,000,000	-80.5%
Data Security & Backup	9,500,000	4,000,000	-57.8%
TOTAL ANNUAL COSTS (TCO)	203,100,000	38,700,000	-80.9%

As shown in Table 1, transitioning to a hybrid cloud model reduces hardware capital expenditures by 85.4%. This reduction allows enterprises to preserve vital working capital and reallocate financial resources toward core operational growth—a crucial benefit for SMEs that frequently face liquidity constraints.

The most substantial cost savings were observed in Operational & Energy Costs (-88.1%) and Technical Support (-80.5%). While localized server setups demand continuous cooling infrastructure and uninterrupted power supply (24/7), cloud environments delegate these overheads to the provider's shared infrastructure pool. Furthermore, reducing direct system administration labor allows enterprises to reallocate human resources toward data analytics rather than basic infrastructure maintenance.

Overall, modernizing the data management system through the proposed hybrid framework reduces the TCO from 203.1 million UZS to 38.7 million UZS annually (an overall cost reduction of 80.9%). The hybrid architecture successfully balances regulatory compliance with high processing performance.

CONCLUSION

The results of this study indicate that modernizing data management systems in SMEs is not merely a technical upgrade, but a key driver of financial architecture optimization. Transitioning from legacy, localized IT infrastructures to cloud-driven resource models allows enterprises to achieve structural capital sustainability and technological resilience against market disruptions.

The proposed hybrid model provides a structured framework for differential data governance. By securing sensitive personal data locally, businesses achieve





full regulatory compliance and eliminate legal risks, while leveraging public cloud resources to process dynamic operational data efficiently.

In conclusion, fostering public-private partnerships to advance national cloud ecosystems and integrate them into corporate management workflows is essential. This model of digital transformation strengthens both individual enterprise productivity and the overall digital maturity of the national economy.

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