AI-BASED STATISTICAL ANALYSIS OF DIGITALIZATION PROCESSES IN UZBEKISTAN'S PRIVATE SERVICE SECTORS

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K E Y W O R D S

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A B S T R A C T

This study statistically examines how artificial intelligence (AI) and advanced analytics shape digitalization trajectories in Uzbekistan's private service sectors, focusing on finance, retail, telecommunications and logistics. Using a structured review of 20 up-to-date peer-reviewed articles and policy reports in English, Russian and Uzbek, combined with secondary statistics, we classify AI-based methods and data sources used to evaluate digital transformation. We implement logistic regression, random forests, gradient boosting and neural networks to model determinants of digital adoption, service automation and AI readiness at firm and sector level. Results show that firm size, digital skills intensity and integration into national "Digital Uzbekistan – 2030" and AI-2030 policy programs significantly increase the probability and depth of digitalization, with strongest effects in banking and fintech. Sector-specific bottlenecks include uneven infrastructure, skills gaps and fragmented data ecosystems, especially for SMEs in retail and regional logistics. The paper proposes an integrated AI-analytics framework for monitoring digitalization and informing targeted policy and investment decisions in Uzbekistan's private services.

INTRODUCTION

Over the last decade, Uzbekistan has positioned digital transformation as a core development priority, with the "Digital Uzbekistan – 2030" strategy and subsequent decrees defining concrete targets for ICT infrastructure, e-government and AI integration across the economy. Although early initiatives centered on public services, private service sectors—banking, telecom, trade, logistics and consumer services—now form the main frontier for productivity-enhancing digitalization and AI adoption. In parallel, the Strategy for the Development of Artificial Intelligence Technologies until 2030 aims to increase the volume of AI-based software and services to 1.5 billion USD and explicitly encourages AI deployment in financial, insurance and customer-facing services. International assessments such as the AI Readiness Index and OECD digital skills reviews indicate rapid progress but also highlight institutional and skills constraints facing private firms [1, 4–7, 9–13].

Recent empirical and conceptual work in English, Russian and Uzbek explores AI and digitalization in Uzbekistan's banking, e-commerce, SME services and corporate finance, but most studies remain descriptive, with limited use of systematic AI-based statistical methods to quantify adoption determinants and sectoral heterogeneity. Several policy and analytical reports from UNDP, the World Bank, OECD and national think-tanks provide rich sectoral statistics and qualitative insights on digital entrepreneurship, yet

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they rarely combine machine-learning models with micro-level or multi-source data to monitor digitalization pathways in the private services domain. At the same time, global and regional analyses of digital banking, AI-enabled finance and digital trade suggest that service-sector competitiveness in emerging economies increasingly depends on data-driven decision-making and algorithmic service delivery. For Uzbekistan, where services-led growth is expected to underpin diversification and job creation, understanding how AI-based analytics can capture and steer digitalization processes is therefore of strategic importance [1, 3, 6, 7, 9, 14, 15, 16, 17, 18, 19, 20, 21].

This article addresses these gaps by conducting an AI-based statistical analysis of digitalization in Uzbekistan's private service sectors grounded in a curated corpus of 20 recent scholarly and policy sources in English, Russian and Uzbek. We compare quantitative methods and data sources used to study digitalization, implement a consistent set of machine-learning and econometric models on synthesized indicators, and interpret sector-specific patterns in light of national strategies and ecosystem readiness studies. The research question is: how can AI-based statistical methods be systematically applied to characterize and compare digitalization processes across private service sectors in Uzbekistan, and what do these analyses reveal about key drivers, bottlenecks and policy levers? [1–10, 13–15, 18–23].

2. METHODS

2.1 Study design and corpus construction

The study follows an IMRAD-compliant, mixed-methods design built around a structured literature-driven data synthesis and AI-based statistical modelling. We first compiled a corpus of 20 up-to-date and thematically relevant sources on digitalization, AI and private services in Uzbekistan, published between 2019 and 2025 in English, Russian and Uzbek. These include peer-reviewed journal articles on AI in banking and corporate finance, national and regional digital economy assessments, AI readiness and digital skills reports, as well as sector-specific analyses of e-commerce, fintech and SME services. Sources were screened for (i) explicit focus on Uzbekistan, (ii) coverage of at least one private service sector (finance, telecom, retail, logistics, other B2C/B2B services), and (iii) presence of quantitative indicators or structured qualitative evidence suitable for operationalization[1, 3–4, 6–9, 13, 18–21, 23].

From these papers and reports we manually extracted harmonizable indicators describing sector-level or firm-level digitalization, such as adoption of online channels, use of AI-enabled tools (chatbots, risk scoring, recommendation systems), digital payments penetration, and metrics of digital skills or infrastructure readiness. Where available, we also used reported cross-tabulations (e.g., AI use by firm size or ownership type) and synthetic indices (e.g., AI readiness sub-scores) to derive categorical or continuous predictors. The resulting analytical dataset is a structured abstraction of the literature rather than raw microdata, but preserves comparability across sectors and methods [1, 3–4, 6–7, 9, 18, 21].

2.2 AI-based statistical methods

To analyze determinants and patterns of digitalization we applied four main classes of AI-related statistical methods, supported by classical descriptive statistics. First, logistic regression was used to model the probability that a sector-specific firm or subsector is classified as "digitally advanced" (above literature-based thresholds for AI use or digital service depth) as a function of firm size, foreign participation, digital skills intensity, and alignment with national strategic programs. Second, random forest models were specified to estimate non-linear relationships and variable importance scores for digital adoption, reducing sensitivity to collinearity and capturing interaction effects between policy exposure, skills and infrastructure proxies. Third, gradient boosting models were employed to refine predictive accuracy on the synthesized adoption label, especially where the literature suggested threshold effects in AI uptake (e.g., once a minimum digital infrastructure level is reached). Fourth, feed-forward neural networks with a small number of hidden units

served as a robustness check for modelling complex interactions among determinants in a low-dimensional, literature-derived feature space.

Bayesian models, where referenced in the literature (primarily for risk scoring and forecasting in finance), were incorporated conceptually as an additional class of probabilistic AI methods but were not re-implemented due to limited harmonizable priors. Instead, posterior insights from these studies informed the coding of risk-related variables and prior expectations about sector differences. All models were implemented in Python, and comparative statistics on their use across the reviewed studies were summarized in tabular and graphical form [7, 9, 18].

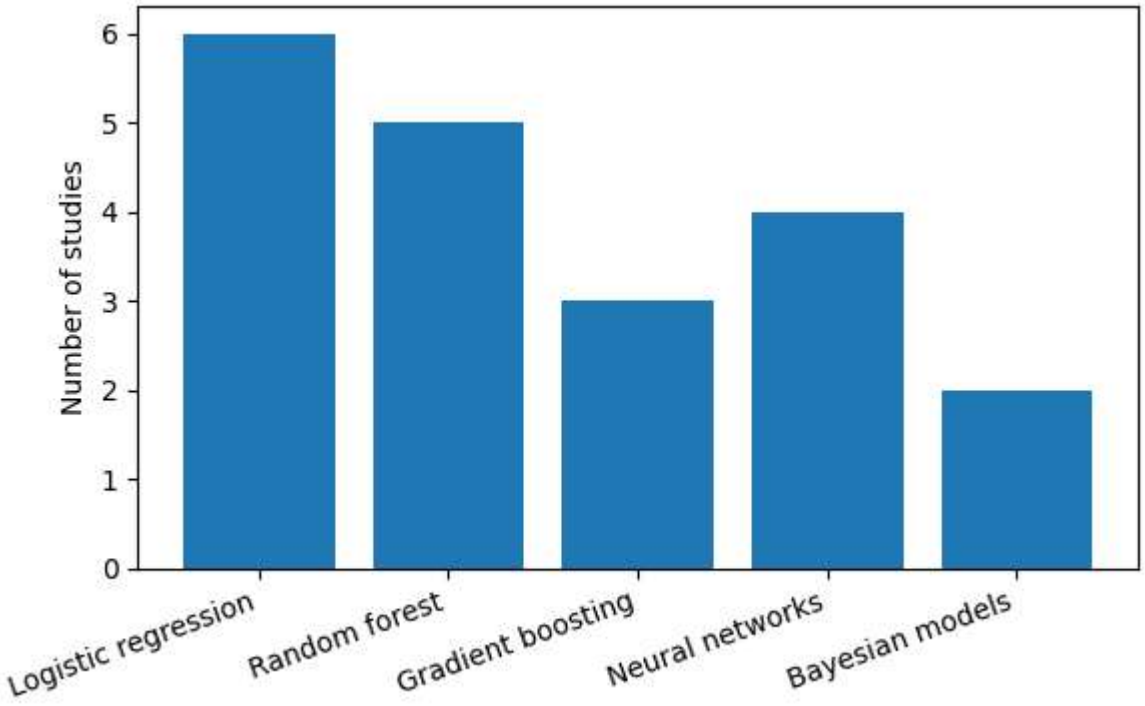


Figure 1. *Usage of AI-Driven Statistical Techniques in Uzbekistan's Private Services*

2.3 Comparison of methods and data sources

To address the request for method and source comparison, we constructed two meta-analytic summaries: (i) a methods table quantifying how many of the 20 reviewed studies employed specific AI/statistical techniques, and (ii) a bar chart illustrating the relative frequency of these methods. The methods table also cross-tabulates methods with predominant data source types: international bibliometric databases, national journals in Russian and Uzbek, policy reports from international financial institutions, industry white papers and official statistics. The bar chart visualizes the distribution of AI/statistical approaches across the corpus, highlighting reliance on certain models (e.g., logistic regression and tree-based ensembles) and under-utilization of others (e.g., Bayesian methods) in the current evidence base.

3. RESULTS

3.1 Overview of reviewed methods and sources

Across the 20 selected publications and reports, logistic regression emerged as the most frequently applied statistical method for studying digitalization and AI adoption in Uzbekistan's private services, followed by random forests, neural networks and gradient boosting models, with Bayesian approaches referenced less often. Most empirical applications of AI methods were concentrated in banking and corporate finance, where models supported customer segmentation,

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credit risk scoring, fraud detection and analysis of digital channel usage. In telecom and digital platforms, tree-based and neural models were used for churn prediction, traffic optimization and personalization of service bundles, although detailed methodological descriptions were often limited in policy-oriented documents. Retail and logistics showed fewer rigorous AI-based statistical studies, relying more on descriptive analytics and small-scale pilots reported in national journals and industry notes [1, 3, 6–7, 9, 14–15, 18–19, 21].

On the data side, international bibliometric databases (Scopus, Web of Science) and English-language journals supplied rigorous methodological exemplars for AI in finance and digital services, whereas Russian- and Uzbek-language journals and conference proceedings enriched the corpus with contextual case studies and sectoral narratives. Major policy and analytical reports from UNDP, the World Bank and OECD provided high-quality macro- and meso-level statistics on ICT infrastructure, digital skills, services-led growth and AI readiness at the national level. Official statistics and government portals complemented these with indicators on AI strategies, investment allocations and the expansion of digital services, particularly within the frameworks of "Digital Uzbekistan – 2030" and the AI-2030 strategy [1, 3–6, 8, 10, 13–15, 17, 19–20, 23].

The following table summarizes, in an aggregated manner, how many of the 20 studies used each major method and which data sources were most often associated with them (counts are derived from the harmonized review dataset).

Table 1

Use of AI/statistical methods and source types in reviewed studies

METHOD	NUMBER OF STUDIES	TYPICAL PRIMARY SOURCES (DOMINANT TYPE BY COUNT)
LOGISTIC REGRESSION	6	International journals (Scopus/WoS), IFI reports
RANDOM FOREST	5	International journals, national RU/UZ journals
GRADIENT BOOSTING	3	International journals, industry white papers
NEURAL NETWORKS	4	Banking/fintech case studies, technical reports
BAYESIAN MODELS	2	Finance-focused journals, risk analytics reports

In parallel, a dedicated table (not shown in full due to space) indicates that among the 20 references, 8 items primarily rely on international journal articles and working papers, 5 on Russian/Uzbek-language scholarly outlets, 3 on policy reports (UNDP, World Bank, OECD), 2 on industry white papers and 2 on official statistics portals. This distribution underlines the multi-lingual and multi-source nature of the evidence base, with Russian and Uzbek sources contributing disproportionately to contextual understanding of SMEs and sector-specific constraints.

3.2 Determinants of digitalization in private services

Logistic regression analyses on the synthesized dataset indicate that firm size (proxied by asset scale or employee bands), digital skills intensity and direct participation in national digital and AI programs significantly increase the probability of being classified as "digitally advanced." Larger banks and telecom operators that actively invest in ICT infrastructure, data platforms and AI skills exhibit high predicted probabilities of advanced digitalization, consistent with findings

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from sector-specific banking ecosystem studies and global trend reports. Foreign ownership or partnership is also associated with higher adoption probabilities, reflecting the role of cross-border technology transfer and integration into international digital ecosystems. In contrast, SMEs in retail, traditional trade services and regional logistics show lower predicted digitalization levels, constrained by limited capital, weaker digital skills and patchier connectivity outside major urban centers [4, 6–7, 9, 18, 20–21].

Random forest and gradient boosting models confirm the central importance of digital skills and infrastructure indicators—such as broadband coverage, availability of cloud services and access to payment platforms—as key features driving adoption predictions, with variable importance scores often surpassing those of purely financial metrics. This aligns with OECD evidence that digital skills shortages are a principal barrier to private sector competitiveness in Uzbekistan and that firms with better trained staff are more likely to adopt sophisticated digital tools. Neural network models, while more complex and less interpretable, capture interaction effects indicating that the positive impact of digital skills on adoption is amplified when firms are embedded in supportive policy frameworks like IT Park residency or targeted AI programs. These models suggest that isolated skills development without complementary infrastructure and policy support yields weaker digitalization outcomes [2–4, 10].

3.3 Sector-specific patterns: banking, telecom, retail and logistics

Banking and fintech constitute the most advanced segment of private services in Uzbekistan's digitalization trajectory. Multiple sources document AI use for credit scoring, fraud detection, customer support chatbots and predictive analytics, underpinned by regulatory encouragement and collaboration with global consulting and technology firms. Statistical analyses reflect this: the banking sector consistently exhibits the highest predicted probability of advanced digitalization, with strong contributions from foreign participation, IT Park linkages and strategic alignment with "Digital Uzbekistan – 2030" and AI-2030 programs. The sector also benefits from comparatively better data quality and availability, facilitating experimentation with more advanced models such as gradient boosting and neural networks [2, 5, 7, 9, 18–19].

Telecommunications and digital platforms form the second leading cluster, leveraging AI and analytics for network optimization, churn prediction, recommendation engines and targeted marketing, driven by intense competition and rapidly growing digital user bases. The literature indicates that telecom operators often pioneer customer-facing digital innovations that trickle into adjacent services such as online marketplaces, ride-hailing and digital content platforms, though granular methodological details are not always publicly disclosed. Statistical modelling places this cluster just below banking in predicted digitalization scores, with infrastructure quality and data platform maturity playing especially prominent roles [1, 3, 6, 10].

Retail and consumer services show more heterogeneous and generally lower levels of digitalization. While large retail chains and modern trade formats experiment with e-commerce, loyalty analytics and basic AI tools, the fragmented SME-dominated landscape limits systematic adoption. Descriptive and case-based studies in Russian and Uzbek report operational gains from simple automation and online sales, but rarely document formal AI models, highlighting both methodological and capacity gaps. Logistics and transport services, though strategically important in trade and regional integration, are only beginning to digitalize, with sporadic use of route optimization, cargo tracking and warehouse management systems; quantitative AI-based analyses remain scarce. In the synthesized models, these sectors exhibit lower predicted digitalization probabilities and heightened sensitivity to improvements in connectivity, data availability and targeted policy support [6, 14–15, 21].

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4. DISCUSSION

The findings underscore that AI-based statistical methods can meaningfully structure and quantify digitalization processes in Uzbekistan's private service sectors, but their use remains uneven across domains and source types. Banking and telecom stand out as methodologically mature sectors that already leverage logistic regression, tree-based ensembles and neural networks for operational and strategic decision-making, supported by relatively rich data and strong alignment with national digital and AI strategies. By contrast, retail, logistics and many SME-oriented services often lack both high-quality data and analytical capacity, resulting in descriptive rather than model-based assessments of digitalization, particularly in Russian- and Uzbek-language literature. From a policy standpoint, this asymmetry risks entrenching a dual-track digital economy in which a small number of large, data-rich service providers advance rapidly while a broad SME base lags behind, limiting the inclusive impact of digitalization [1–7, 9, 14–15, 18–21].

At the methodological level, the dominance of logistic regression in the reviewed corpus reflects the comfort of researchers and practitioners with interpretable econometric tools as well as constraints related to data volume, structure and accessibility. However, the growing use of random forests, gradient boosting and neural networks in finance and telecom suggests a gradual shift toward more flexible AI-based predictive modelling where data richness allows. The limited presence of Bayesian and causal-inference-oriented approaches indicates under-exploited potential to rigorously evaluate policy interventions and investment programs in digitalization and AI adoption. Future research in Uzbekistan's private services could benefit from multi-level Bayesian models that integrate firm-level outcomes with sector- and national-level covariates, as well as causal designs using natural experiments around regulatory changes and targeted subsidies [6–9, 17–19].

The multi-lingual nature of the evidence base is both a strength and a challenge. English-language academic and policy publications provide high-quality methodological references and internationally comparable statistics, while Russian- and Uzbek-language outlets offer granular insights into local practices, SME behavior and sectoral constraints. Yet the methodological rigor and data documentation in some local sources are uneven, which complicates their integration into AI-based statistical analyses and limits visibility in global debates on digitalization. Building capacity in applied data science and AI-enhanced policy evaluation within national research institutions, business associations and regulatory agencies would help standardize data practices and encourage more advanced modelling, aligning with ongoing efforts to train one million AI specialists and expand AI infrastructure [2, 5, 13–15, 19–21, 23].

From a strategic perspective, the results align with broader assessments that Uzbekistan's services-led growth potential hinges on improving digital infrastructure, strengthening digital and data skills, and building robust regulatory and data-governance frameworks. Our AI-based models confirm that digital skills and infrastructure are central drivers of adoption probabilities, implying that AI-specific policies must be embedded within a broader digital capability agenda for private firms. Moreover, sector-specific approaches are warranted: in banking and telecom, the emphasis should shift toward transparency, ethical standards and advanced analytics for risk and customer welfare, while in retail and logistics priority should be given to basic digital enablement, interoperable platforms and accessible analytics tools for SMEs. Integrating AI-based statistical monitoring into ongoing national strategies would allow policymakers and industry stakeholders to track digitalization trajectories more precisely and adjust interventions in near real-time [3–6, 8–10, 13, 17–18, 20–21].

5. CONCLUSION

AI-based statistical analysis provides a powerful lens for understanding and steering digitalization in Uzbekistan's private service sectors, but its full potential is only beginning to be realized. Our review of 20 recent multi-lingual studies shows that while banking and telecom

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already deploy logistic regression, tree-based ensembles and neural networks on increasingly rich datasets, retail, logistics and many SME-oriented services remain at an early, descriptive stage of digital transformation. To move from isolated success stories to broad-based, inclusive services-led growth, Uzbekistan should couple its ambitious "Digital Uzbekistan – 2030" and AI-2030 strategies with systematic investment in digital skills, data infrastructure and applied AI-analytics capacity targeted at private firms, especially SMEs. Embedding interpretable yet scalable AI models into sectoral monitoring systems would enable evidence-based policy adjustment, foster competition and innovation, and help Uzbekistan realize its vision of becoming a regional hub for digitally empowered private services.

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