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PROSPECTIVE DIRECTIONS FOR THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN UZBEKISTAN

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Abstract: This article identifies and systematizes the most promising directions for the development of artificial intelligence (AI) technologies in Uzbekistan. The study is motivated by the transition from general digitalization to an AI-centered model of economic modernization and public-service delivery. Using a qualitative policy-analysis methodology, the paper combines a structured review of international research, comparative institutional evidence, and analysis of Uzbekistan's regulatory and strategic documents. Particular attention is paid to Presidential Resolution No. PQ-358 of 14 October 2024, which approved the Strategy for the Development of Artificial Intelligence Technologies until 2030, as well as earlier measures that established the national digital and AI policy architecture. The findings indicate seven interdependent priorities: sovereign and energy-efficient computing infrastructure; high-quality sectoral and Uzbek-language data; human capital and applied research; AI adoption in public administration and priority industries; an innovation and venture ecosystem; trustworthy AI governance and cybersecurity; and international cooperation with measurable implementation indicators. The paper argues that Uzbekistan's comparative advantage is unlikely to arise from competing in frontier-model scale alone. A more viable pathway is specialization in domain-specific, multilingual and resource-efficient AI solutions adapted to public services, agriculture, healthcare, finance, transport, education, energy and industrial processes. The article concludes with policy recommendations for converting strategic targets into a sustainable national AI ecosystem.

Keywords: artificial intelligence; Uzbekistan; digital economy; AI strategy; innovation ecosystem; data governance; human capital; public administration; Uzbek language technologies.

Annotatsiya. Ushbu maqolada O‘zbekistonda sun’iy intellekt (SI) texnologiyalarini rivojlantirishning eng istiqbolli yo‘nalishlari aniqlanadi va tizimlashtiriladi. Tadqiqot umumiy raqamlashtirish bosqichidan iqtisodiy modernizatsiya hamda davlat xizmatlarini ko‘rsatishda SI markaziy o‘rin tutadigan modelga o‘tish jarayoniga bag‘ishlangan. Sifatga asoslangan siyosiy-institutsional tahlil usuli orqali xalqaro ilmiy adabiyotlar, qiyosiy tajriba hamda O‘zbekistonning normativ-huquqiy va strategik hujjatlari o‘rganildi. Xususan, 2024-yil 14-oktabrdagi PQ-358-son qaror bilan tasdiqlangan “Sun’iy intellekt texnologiyalarini 2030-yilga qadar rivojlantirish strategiyasi” va undan oldingi raqamli transformatsiya hamda SI siyosatini shakllantirgan hujjatlarga alohida e’tibor qaratildi. Natijalar yettita o‘zaro bog‘liq ustuvor yo‘nalishni ko‘rsatadi: hisoblash infratuzilmasi; sifatli tarmoq va o‘zbek tilidagi ma’lumotlar; kadrlar va amaliy tadqiqotlar; davlat boshqaruvi hamda ustuvor tarmoqlarda SI; innovatsion va venchur ekotizim; ishonchli SI boshqaruvi va kiberxavfsizlik; xalqaro hamkorlik va o‘lchanadigan ijro ko‘rsatkichlari. O‘zbekiston uchun eng maqbul yo‘l faqat yirik universal modellar hajmi bo‘yicha raqobatlashish

emas, balki mahalliy ehtiyojlarga mos, ko‘p tilli, resurs-tejamkor va tarmoq ixtisoslashuviga ega SI yechimlarini rivojlantirish ekani asoslanadi.

Kalit so‘zlar: sun’iy intellekt; O‘zbekiston; raqamli iqtisodiyot; SI strategiyasi; innovatsion ekotizim; ma’lumotlarni boshqarish; inson kapitali; davlat boshqaruvi; o‘zbek tili texnologiyalari.

Аннотация. В статье определены и систематизированы перспективные направления развития технологий искусственного интеллекта (ИИ) в Узбекистане. Исследование рассматривает переход от общей цифровизации к модели экономической модернизации и предоставления государственных услуг, в которой ИИ становится одним из ключевых инструментов. Методология основана на качественном анализе государственной политики, обзоре международной научной литературы, сравнительных институциональных данных и нормативно-стратегических документов Республики Узбекистан. Особое внимание уделено Постановлению Президента Республики Узбекистан № ПП-358 от 14 октября 2024 года, утвердившему Стратегию развития технологий искусственного интеллекта до 2030 года, а также более ранним документам цифровой и ИИ-политики. Результаты выделяют семь взаимосвязанных приоритетов: вычислительная инфраструктура; качественные отраслевые и узбекоязычные данные; человеческий капитал и прикладные исследования; внедрение ИИ в государственное управление и приоритетные отрасли; инновационная и венчурная экосистема; надежное управление ИИ и кибербезопасность; международное сотрудничество и измеримые показатели реализации. Обосновывается, что устойчивое преимущество Узбекистана может формироваться прежде всего через специализированные, многоязычные и ресурсоэффективные ИИ-решения, адаптированные к национальным задачам.

Ключевые слова: искусственный интеллект; Узбекистан; цифровая экономика; стратегия ИИ; инновационная экосистема; управление данными; человеческий капитал; государственное управление; технологии узбекского языка.

Introduction

Artificial intelligence has moved from a specialized field of computer science to a general-purpose technology that affects productivity, organizational design, public administration, education, scientific research and the delivery of social services. The rapid diffusion of generative AI has further reduced the cost of access to advanced analytical and language capabilities. At the same time, international evidence shows that the economic and social gains from AI are not automatic: they depend on complementary investments in digital infrastructure, skills, organizational change, data availability and institutions capable of managing risk. For emerging economies, the central policy question is therefore not whether AI should be adopted, but how adoption can be organized so that domestic firms, public institutions and citizens capture a meaningful share of the value created.

Uzbekistan enters this technological transition after a period of accelerated digital transformation. The “Digital Uzbekistan – 2030” Strategy established the long-term foundation for digital infrastructure, e-government and the digital economy. Presidential Resolution No. PQ-4996 of 17 February 2021 then introduced a dedicated program for studying and implementing AI technologies, including measures on open and high-quality data, Uzbek-language datasets, speech analysis and synthesis, high-performance infrastructure, specialist training, standards, confidentiality and risk prevention. Presidential Resolution No. PQ-5234 of 26 August 2021

complemented this framework by creating a special regime for experimental AI projects and innovative business models.

A decisive policy milestone was reached with Presidential Resolution No. PQ-358 of 14 October 2024, which approved the Strategy for the Development of Artificial Intelligence Technologies until 2030. The Strategy sets measurable national targets, including increasing the volume of AI-based software products and services to USD 1.5 billion, raising the share of AI-enabled services on the Unified Interactive Public Services Portal to 10 percent, expanding the number of AI research laboratories to ten, launching high-performance computing servers, and placing Uzbekistan among the top 50 countries in the Government AI Readiness Index. It also provides for a 2024–2026 action plan and the formation of large datasets in social and economic sectors.

Against this background, the purpose of this article is to identify the prospective directions that can convert Uzbekistan's strategic ambition into a durable AI ecosystem. The research asks three questions:

1. which technological and institutional capabilities are most important for national AI readiness;
2. which sectoral applications offer a plausible combination of economic, social and administrative value for Uzbekistan;
3. what policy mechanisms can reduce the risks of fragmented projects, skills shortages, weak data governance and excessive technological dependence?

The contribution of the article is an integrated framework that connects infrastructure, data, human capital, sectoral deployment, innovation, governance and international cooperation rather than treating them as separate policy domains.

Literature Review

The international literature increasingly treats AI as a general-purpose technology whose impact depends on complementary innovation. Brynjolfsson, Rock and Syverson explain that major technologies may initially produce a productivity "J-curve": measurable gains lag behind invention because firms must redesign processes, accumulate intangible capital and learn new organizational practices. This insight is particularly relevant for public-sector and enterprise AI projects in Uzbekistan. Purchasing software or computing equipment alone does not guarantee productivity; workflow redesign, interoperable data and staff capabilities are equally important[7].

Research on automation also emphasizes distributional effects. Acemoglu and Restrepo distinguish between technologies that substitute for tasks and those that create new tasks in which human labor has comparative advantage[5]. For policy, this means that AI strategy should not be limited to maximizing automation. It should also encourage augmentation: decision-support systems for doctors, teachers, agronomists, engineers, civil servants and entrepreneurs can increase human productivity while preserving accountability and local knowledge. This approach is especially important in a young labor market where employment creation remains a strategic concern.

Recent evidence confirms that AI adoption is accelerating but remains uneven. OECD analysis reports that AI uptake among firms in OECD economies rose substantially between 2021 and 2025, while small and medium-sized enterprises continue to face barriers related to cost, infrastructure and skills. The OECD also identifies skills as a core component of the enabling infrastructure for AI and recommends continuous monitoring of changing skill demand, broader access to AI-relevant competencies and lifelong learning. Stanford's AI Index similarly documents rapid improvements in model capability, declining access costs, expanding business adoption and

growing regulatory attention, while highlighting continuing concerns over trust, bias, misuse and data protection.

The governance literature has shifted from abstract ethical principles toward operational risk management. The OECD AI Principles emphasize inclusive growth, human-centered values, transparency, robustness and accountability. UNESCO's Recommendation on the Ethics of Artificial Intelligence adds proportionality, safety, privacy, fairness, human oversight, sustainability and multi-stakeholder governance. The NIST AI Risk Management Framework translates similar principles into organizational functions for governing, mapping, measuring and managing AI risks. For Uzbekistan, these frameworks are useful not as templates to copy mechanically, but as reference points for developing locally appropriate standards, procurement rules and assurance procedures.

Uzbekistan's AI policy has evolved in stages. The first stage was broad digital transformation under Presidential Decree No. PF-6079 of 5 October 2020, which approved the "Digital Uzbekistan – 2030" Strategy[1]. It established priorities for telecommunications infrastructure, digital government, digitalization of industries and regions, and the development of the digital economy. This framework matters because AI systems require reliable connectivity, interoperable digital services and machine-readable administrative processes before advanced models can be deployed at scale.

The second stage began with Presidential Resolution No. PQ-4996 of 17 February 2021. The resolution's implementation program anticipated many issues that later became central globally: the openness and quality of data for machine learning, the creation of large volumes of digital data in the state language, Uzbek speech analysis and synthesis, modern high-technology infrastructure, specialized higher-education tracks, common standards, and systems for preventing AI-related risks and protecting confidentiality[2]. Presidential Resolution No. PQ-5234 of 26 August 2021 added an experimental legal regime intended to facilitate testing of AI-based business models, products and services. Together, these documents created an early institutional bridge between research, regulation and commercialization[3].

The third stage is the AI Strategy to 2030 approved by Resolution No. PQ-358 in 2024. Compared with the earlier framework, it is more outcome-oriented[4]. It specifies national targets and identifies the creation of technical infrastructure, improvement of the regulatory base and standards, international cooperation, implementation of priority projects, and improvement of population skills and professional capacity. Importantly, it also calls for large datasets and high-performance computing capacity, recognizing two bottlenecks that often constrain domestic AI development: access to quality data and access to compute.

Uzbek scholarly and professional discussions on AI commonly focus on digital economy modernization, intelligent public services, education, finance, agriculture and legal regulation. However, a recurring limitation is fragmentation: sectoral studies may describe a promising application without examining whether data governance, computing capacity, procurement, skills and risk controls are simultaneously available. The present study therefore uses the national policy documents as the core Uzbek literature and institutional evidence, while integrating them with international research to construct a cross-sectoral development framework. This approach also reduces the risk of relying on unverified claims about rapidly changing AI projects.

Methodology

The study uses a qualitative, policy-oriented research design. The unit of analysis is Uzbekistan's national AI ecosystem rather than a single technology or enterprise. The evidence base consists of three groups of sources:

1. peer-reviewed and widely cited international research on AI, productivity, labor and general-purpose technologies;
2. international institutional frameworks and reports produced by the OECD, UNESCO, NIST, ITU and Stanford HAI;
3. official legal and strategic documents of the Republic of Uzbekistan, primarily the "Digital Uzbekistan – 2030" Strategy, Resolutions No. PQ-4996 and PQ-5234 of 2021, and Resolution No. PQ-358 of 2024.

The analytical procedure followed four steps. First, the documents were coded into seven capability domains: computing infrastructure, data, human capital and research, sectoral adoption, innovation finance and entrepreneurship, governance and security, and international cooperation. Second, the international literature was used to identify enabling conditions and recurrent risks in each domain. Third, these conditions were compared with Uzbekistan's stated policy targets and institutional trajectory. Fourth, prospective directions were prioritized according to four qualitative criteria: strategic relevance to national targets, feasibility under resource constraints, potential cross-sector spillovers, and contribution to technological resilience.

This method does not attempt to estimate a causal macroeconomic effect of AI on Uzbekistan's GDP, because sufficiently mature and comparable national adoption data are not yet available for such an estimate. The results should therefore be interpreted as a structured policy synthesis rather than an econometric forecast. The advantage of the approach is that it makes explicit the complementarities that determine whether individual AI projects can scale into a national capability.

Results and Discussion

Priority 1: sovereign, scalable and energy-efficient AI infrastructure

The first prospective direction is the creation of a layered computing ecosystem. Uzbekistan does not need to reproduce the full hyperscale infrastructure of the largest AI economies. It does, however, need dependable access to high-performance computing for research, public-sector pilots and commercially relevant model training and inference. The 2030 Strategy's target of launching high-performance servers should therefore be implemented as shared national capacity with transparent allocation rules for universities, research laboratories, startups and priority public projects.

A practical architecture would combine domestic secure compute for sensitive workloads, commercial cloud capacity for elastic demand, and international partnerships for frontier-scale experiments. Energy efficiency should be built into procurement because AI compute can create significant electricity and cooling requirements. Model selection should also be treated as an infrastructure decision: smaller task-specific models, retrieval-augmented systems and efficient open-weight models can often provide better cost-performance for Uzbek organizations than very large general-purpose systems.

Priority 2: national data infrastructure and Uzbek-language AI

Data is likely to be Uzbekistan's most important locally controllable AI asset. The policy foundation already exists: PQ-4996 explicitly called for improved openness and quality of digital data and for large volumes of state-language data, while PQ-358 provides for sectoral "big data" resources. The next step is to move from the concept of data accumulation to data engineering and governance. High-value datasets should have clear ownership, metadata, quality indicators, access rules, anonymization procedures and machine-readable interfaces.

Uzbek-language AI deserves treatment as strategic digital infrastructure. General-purpose multilingual models have improved rapidly, but lower-resource languages still face gaps in high-

quality corpora, terminology, dialect coverage, speech data and domain-specific benchmarks. Investment should therefore target legally reusable Uzbek text corpora, parallel Uzbek–Russian–English resources, speech recognition and synthesis datasets, optical character recognition for Latin and Cyrillic Uzbek, terminology banks, and evaluation benchmarks. These resources can support education, e-government, media accessibility, legal technology and customer-service applications while reducing dependence on foreign-language interfaces.

A national data-space model could be introduced in priority sectors. Instead of centralizing all data, interoperable standards could allow authorized institutions to exchange defined datasets while maintaining security and legal accountability. Privacy-enhancing technologies, de-identification and controlled research environments would make it possible to use sensitive health, finance or social data without turning openness into uncontrolled disclosure.

Priority 3: human capital, research laboratories and AI diffusion skills

The third direction is a two-level human-capital strategy. The first level concerns advanced specialists: machine-learning engineers, data engineers, AI researchers, cybersecurity experts, product managers and specialists in AI assurance. The second level concerns diffusion skills among non-technical professionals. OECD evidence suggests that the shortage of skills is a major barrier to adoption; therefore, AI literacy for managers, civil servants, teachers, doctors, engineers and SME owners may generate broader economic effects than expanding specialist enrollment alone[8].

The target of ten AI research laboratories should be used to create specialization rather than duplication. Laboratories could focus on Uzbek-language technologies, computer vision for agriculture and industry, medical AI, intelligent transport and logistics, fintech and fraud detection, energy optimization, and trustworthy AI. Competitive grants should require collaboration among universities, firms and public agencies and should evaluate not only publications but also datasets, open benchmarks, patents, prototypes, spin-offs and verified deployment outcomes.

Curricula should integrate mathematics, statistics, computer science, domain knowledge, ethics and communication. Short-cycle professional certificates and micro-credentials can complement degree programs. A national AI talent program could support doctoral training, visiting researchers and diaspora collaboration, while return incentives and joint appointments can reduce brain drain without requiring all expertise to be permanently located in one institution.

Priority 4: mission-oriented AI adoption in public administration and key sectors

The fourth direction is to organize adoption around clearly defined national missions rather than isolated demonstrations. Public administration is a natural anchor because the 2030 Strategy sets a target for AI-enabled services on the Unified Interactive Public Services Portal. High-value use cases include multilingual citizen assistance, document classification, fraud and anomaly detection, case prioritization, regulatory analytics and decision support. However, systems affecting rights or access to public benefits should retain meaningful human oversight, audit trails and appeal mechanisms.

Agriculture offers a second mission area. AI can combine satellite imagery, weather data, soil information, sensor data and farm records to support irrigation scheduling, crop monitoring, pest detection and yield forecasting. For Uzbekistan, water efficiency gives this domain particular strategic importance. The strongest projects will be those that connect AI predictions with actual agronomic decisions and measure water, yield and cost outcomes rather than model accuracy alone.

Healthcare, education, finance, transport, energy and industry provide additional opportunities. In healthcare, AI can support imaging triage, clinical documentation and resource planning, but clinical validation and data protection are essential. In education, adaptive learning, automated formative feedback and Uzbek-language tutoring can expand access, provided that teachers remain

responsible for pedagogical decisions. In finance, AI can improve risk assessment, anti-fraud systems and customer service. In transport and logistics, demand forecasting and route optimization can strengthen Uzbekistan's role as a regional connectivity hub. In energy and industry, predictive maintenance, load forecasting and process optimization can reduce costs and improve reliability.

Priority 5: innovation, startups, SMEs and commercialization

A national AI strategy becomes economically meaningful when research and public investment generate scalable products and firms. Uzbekistan should therefore strengthen the commercialization chain from university research to prototype, pilot customer, venture financing and export. Regulatory sandboxes, first-customer public procurement and co-financing can lower the risk of early deployment. The special experimental regime established in 2021 provides a useful institutional precedent for this approach.

SMEs require special attention because they often cannot afford dedicated AI teams or large computing budgets. Shared cloud credits, model APIs, sectoral digital platforms and advisory programs can reduce fixed costs. Export policy should focus on niches where Uzbekistan can combine language, regional knowledge and competitive software talent: multilingual business automation, fintech, logistics, education technology, public-sector digital solutions and AI-enabled outsourcing. The 2030 target of USD 1.5 billion in AI-based products and services will be more credible if measurement distinguishes domestic adoption, service exports, AI-enabled IT exports and genuinely AI-native products.

Priority 6: trustworthy AI governance, cybersecurity and standards

The sixth direction is a risk-based governance framework that supports innovation while protecting citizens and institutions. The appropriate objective is neither unregulated experimentation nor blanket restriction. A tiered approach can classify systems according to potential harm, with stronger documentation, testing, human oversight and audit requirements for high-impact applications in health, finance, employment, education, law enforcement and public benefits.

Uzbekistan can adapt international principles from UNESCO[10], OECD and NIST to national law and administrative practice. Priority instruments include AI impact assessments for high-risk public systems, model and dataset documentation, procurement standards, cybersecurity testing, incident reporting, rules for synthetic media in official communication, privacy safeguards, and clear institutional responsibility for automated decisions. Governance capacity should be distributed: a central coordinating body can define standards, while sector regulators retain responsibility for domain-specific risks.

Cybersecurity must be integrated with AI policy. AI expands the attack surface through model manipulation, data poisoning, prompt injection, leakage of confidential information and automated social engineering. Conversely, AI can strengthen threat detection and security operations. National AI projects should therefore include security-by-design requirements, controlled access to sensitive models and datasets, red-team testing, logging and recovery procedures[9].

Priority 7: international cooperation, benchmarks and implementation discipline

Uzbekistan's AI ecosystem will remain deeply connected to global technology markets. International cooperation should therefore focus on access to research networks, compute, standards, investment and markets rather than only on ceremonial agreements. Joint laboratories, regional datasets, academic exchanges and participation in international benchmarking can accelerate learning. Cooperation with Central Asian neighbors is especially relevant for shared challenges such as water management, transport corridors, energy systems and multilingual digital services.

Implementation discipline is equally important. The 2030 Strategy contains measurable headline targets; these should be complemented by annual indicators covering compute utilization, dataset quality, number of trained specialists, research outputs, startup financing, AI adoption by firms, public-service performance, safety incidents and export revenue. Independent evaluation should identify projects that should be scaled, redesigned or discontinued. A portfolio approach is preferable to assuming that every pilot will succeed.

Table 1. Integrated framework of prospective directions

Direction	Core policy instrument	Expected outcome	Key implementation risk
Compute infrastructure	Shared HPC/cloud capacity; secure public compute; energy-efficient procurement	Lower entry barriers for research, startups and public AI	High cost, underutilization, energy constraints
Data and Uzbek-language AI	Sectoral data spaces; standards; corpora; speech/OCR benchmarks	Locally relevant models and interoperable services	Poor data quality, privacy leakage, fragmented ownership
Human capital and research	Specialized labs; grants; micro-credentials; diaspora links	Stronger specialist pipeline and diffusion skills	Brain drain, duplicated programs, weak industry links
Mission-oriented adoption	Public-service, agriculture, health, education, finance, transport, energy missions	Measurable productivity and service-quality gains	Pilot fragmentation, weak evaluation, automation bias
Innovation ecosystem	Sandboxes; public procurement; cloud credits; venture co-financing	Commercialization, SME adoption and exports	Dependence on subsidies, limited scale-up capital
Governance and security	Risk tiers; impact assessment; audits; incident reporting; cyber testing	Trustworthy and accountable AI deployment	Overregulation or weak enforcement
International cooperation	Joint R&D; standards participation; regional projects; market access	Faster learning and reduced isolation	Vendor dependence and limited technology transfer

Conclusion and Recommendations

Uzbekistan has moved from a general digitalization agenda to a dedicated AI development strategy with explicit targets for 2030. The policy sequence from “Digital Uzbekistan – 2030” to

the 2021 AI resolutions and the 2024 AI Strategy demonstrates increasing institutional maturity: infrastructure, data, language resources, skills, experimentation, standards and risk management are now recognized as interconnected elements of national capability. The central challenge for the next stage is implementation at scale.

The analysis suggests that Uzbekistan should avoid defining success primarily by the size of domestically trained frontier models. A more sustainable comparative advantage can be built through resource-efficient and domain-specific AI, strong Uzbek-language technologies, high-quality sectoral data, skilled users, and rapid translation of research into public and commercial applications. This model is compatible with the country's 2030 targets and can produce spillovers across government, services and industry.

Five practical recommendations follow. First, establish shared national AI compute and data infrastructure with transparent access, security and utilization metrics. Second, treat Uzbek-language datasets, benchmarks and speech technologies as public-interest digital infrastructure and fund them on a multi-year basis. Third, organize the ten planned AI laboratories around differentiated national missions and require measurable research-to-deployment outcomes. Fourth, introduce risk-based AI governance for high-impact systems, including impact assessment, human oversight, cybersecurity testing and incident reporting. Fifth, connect public procurement, startup support and export policy so that successful pilots can become commercially sustainable products rather than remaining isolated demonstrations.

Finally, monitoring should be continuous and evidence-based. The national AI portfolio should publish annual progress against the Strategy's headline targets and complementary indicators on skills, datasets, adoption, research, investment, exports and safety. This would make it possible to redirect resources as technology changes. In a field characterized by rapid technical progress, adaptive institutions and implementation capacity may ultimately be more important than any single model or platform.

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