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DIGITAL LOGISTICS AND MODERN TECHNOLOGIES: THEORETICAL AND LEGAL FOUNDATIONS, INTERNATIONAL EXPERIENCE, REFORMS IN UZBEKISTAN, AND PROSPECTS FOR IMPROVEMENT

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Abstract

This thesis examines the theoretical, legal and institutional foundations of digital logistics and modern technologies. It analyzes the role of digital logistics in supply chain management, transport services, customs procedures, e-commerce, cybersecurity, personal data protection and artificial intelligence. The paper compares international doctrine and Uzbek reforms, identifies key deficiencies and proposes policy and legal measures for the development of digital logistics in Uzbekistan.

Keywords: digital logistics, supply chain, e-logistics, e-CMR, e-TIR, e-Permit, e-Freight, electronic document, digital signature, artificial intelligence, Big Data, IoT, blockchain, cybersecurity, Uzbekistan.

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The approval, by Resolution No. PR-28 of the President of the Republic of Uzbekistan dated 27 January 2025, of the Concept for the Development of the Transport and Logistics System through 2030 demonstrates that this field has become a priority direction at the level of state policy. The Concept sets out tasks such as forming national logistics platforms integrated with international information systems, widely introducing digital and innovative technologies in international freight transportation, developing electronic document circulation and the e-Permit, e-TIR, e-CMR, e-Transit and e-Freight systems, fully implementing an e-logistics information system, creating an electronic database of transport-logistics centers, and integrating an electronic queue system.

These tasks show that digital logistics requires a complex approach encompassing legal, organizational and technological dimensions. E-logistics is not merely about creating platforms; it also requires regulating the legal force of electronic documents, the cross-border recognition of electronic digital signatures, the protection of personal and commercial data, the interoperability of information systems, cybersecurity, accountability for artificial-intelligence-based decisions, the obligations of platform operators, and the rights of users.

The purpose of this scientific thesis is to analyze digital logistics and modern technologies from theoretical, legal, economic and institutional perspectives, to study international and domestic scholarly views, to assess the reforms under way



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in Uzbekistan, to identify existing shortcomings, and to develop scientifically grounded proposals for improving the field.

The objectives of the research are as follows: first, to define the concept, content and legal nature of digital logistics; second, to systematically analyze the impact of modern technologies on logistics processes; third, to study the views of international and domestic scholars and to formulate the author's position in relation to them; fourth, to analyze the existing legal basis for digital logistics under the legislation of Uzbekistan; fifth, to assess the reforms in the field from the standpoint of state policy; sixth, to identify the practical and legal problems in the field of digital logistics; and seventh, to develop proposals for integrating Uzbekistan's transport-logistics system into international digital ecosystems.

In the author's view, for Uzbekistan digital logistics is a broader concept than the mere “digitalization of transport.” It is a strategic institution that directly affects the speed of the national economy's connection with the outside world, the price competitiveness of export goods, the reliability of transit corridors, customs transparency, business costs, and the quality of public services.

Digital logistics is a system for organizing, managing and monitoring logistics processes through information and communication technologies, digital platforms, automated management systems, electronic document circulation, real-time tracking, artificial intelligence, Big Data, IoT, blockchain and cloud services.

While traditional logistics focuses on the material flow—that is, the processes of cargo, transport, warehousing and delivery—digital logistics manages, alongside the material flow, the information flow, the financial flow and the flow of legal documents as a single integrated system.

The main characteristics of digital logistics are as follows:



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1. Real-time management. The location of the cargo, its expected arrival time, the border it is crossing, the documents required and the risks present are tracked online.
2. Electronic document circulation. Paper-based consignment notes, waybills, permits, customs declarations and other documents are converted into electronic form.
3. Platform-based management. The carrier, the consignor, the consignee, the freight forwarder, customs, insurers and banks interact with one another through a single digital platform.
4. Data-driven decision-making. Artificial intelligence and Big Data are used to calculate the optimal route, the most suitable mode of transport, the level of risk, price, time and warehouse capacity.
5. Integration. National transport, customs, tax, banking, insurance and foreign-trade information systems are linked to international systems.
6. Transparency and traceability. Every action leaves an electronic trace, which reduces the risk of corruption, shadow markets and document forgery.

The legal essence of digital logistics lies in the fact that it sits at the intersection of several branches of law. From the standpoint of civil law, it covers relations of carriage, freight forwarding, warehousing, insurance and electronic contracts. From the standpoint of administrative law, it relates to transport permits, customs procedures, state control and licensing. From the standpoint of information law, it covers issues of electronic documents, electronic signatures, personal data and information security. And from the standpoint of international law, it relates to cross-border electronic documents, international carriage conventions, customs cooperation and the rules of digital trade.

Digital logistics should therefore be regarded as a complex legal institution. Regulating it solely within the framework of transport legislation is not sufficient.



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It requires the harmonization of norms on e-commerce, electronic document circulation, digital signatures, personal data, cybersecurity, customs, taxation, public procurement, competition, and private international law.

In the author's view, the most significant legal problem of digital logistics is ensuring, in practice, the legal force of electronic data. If an electronic consignment note, an electronic permit or an electronic waybill is not recognized by all agencies and foreign partners, the digital system cannot fully replace the paper document. The result is “double handling” of cargo: the entrepreneur must both enter data into the electronic system and continue to maintain paper documentation.

Accordingly, the following may be identified as the core principles of digital logistics: first, the principle of “data entered once—used many times”; second, the equal legal force of electronic documents and paper documents; third, no duplicate documents being required in inter-agency data exchange; fourth, technical and legal compatibility across platforms; fifth, data security and protection of commercial secrets; sixth, protection of users' rights; and seventh, the development of cross-border electronic recognition mechanisms. The effectiveness of digital logistics is manifested through specific technologies, the most important of which are set out below

The IoT, the internet of things, ensures continuous monitoring, through sensors, of vehicles, containers, warehouses, refrigeration equipment, road infrastructure and cargo in the logistics sector.

For example, when transporting pharmaceuticals, food products, fruit and vegetables, meat, dairy products or chemical substances, temperature, humidity, vibration, opening, location and security status are tracked in real time. This makes it possible to detect deterioration in cargo quality, theft, delay, or breach of contractual terms.



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In the conditions of Uzbekistan, IoT technologies are particularly important for exported agricultural products, since in fruit and vegetable exports, time, temperature and storage conditions directly affect the value of the product. If an exporter can prove electronically the temperature at which the product was stored throughout its journey, disputes diminish and the trust of foreign buyers increases. Big Data makes it possible to collect, process and analyze large volumes of data in logistics processes. Transport flows, border queues, warehouse loads, fuel prices, weather, road conditions, customs inspections, customer orders and delivery statistics can all be processed within a single analytical system.

On the basis of Big Data the following outcomes can be achieved:

- selection of the optimal route;
- reduction of transport costs;
- early detection of delay risks;
- improvement of customs risk profiles;
- efficient allocation of warehouse capacity;
- demand forecasting;
- advance prediction of supply-chain disruptions.

In the author's view, in order for Uzbekistan's transport-logistics system to make use of the opportunities offered by Big Data, it is first necessary to resolve the problems of data quality and inter-platform integration. If each agency maintains data in a separate format, the effectiveness of overall analysis will be low.

Artificial intelligence is applied in logistics processes for forecasting, routing, risk assessment, automatic document verification, optimization of cargo flows, allocation of vehicles, and customer service.

For example, artificial intelligence can perform the following tasks:

- selecting the cheapest and fastest route;
- forecasting waiting time at the border;



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- calculating the risk of cargo delay;
- detecting errors in customs declarations;
- predicting technical failures of vehicles in advance;
- optimizing the placement of goods in a warehouse;
- sending automatic notifications to customers.

However, artificial intelligence also gives rise to legal problems. If an algorithm recommends an incorrect route, misjudges customs risk, or an automated decision causes loss to an entrepreneur, who bears liability—the platform operator, the software developer, the user, or the state authority? This question has not yet been specifically and comprehensively regulated under the legislation of Uzbekistan.

In the author's view, the principle of “human oversight” must be preserved in AI-based logistics systems. In particular, in cases giving rise to legal consequences for an entrepreneur, such as restrictions, customs inspections, fines or refusals, the final decision must be substantiated by a human being.

Blockchain technology ensures the immutability, reliability and traceability of data within the logistics chain. The origin of the cargo, its place of production, the stages of transportation, the storage status, customs clearance and delivery can all be confirmed through the blockchain.

This technology is particularly useful in the following areas:

- food safety;
- pharmaceutical products;
- high-value cargo;
- international trade documents;
- confirming the origin of export products;
- combating counterfeit goods.

In Uzbekistan's exports, blockchain technology can play an important role in proving the origin and quality chain of products. This is becoming increasingly



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important on international markets for cotton, textiles, agricultural and pharmaceutical products, where a transparent supply chain is in growing demand. Geographic information systems make it possible to display transport-logistics infrastructure on an electronic map and to manage roads, terminals, customs posts, warehouses, service zones, fuel stations and hazardous areas in real time. The task of creating a unified electronic database of Uzbekistan's transport-logistics centers and an electronic map reflecting their location is directly linked to GIS technologies. Such a system creates convenience for investors, carriers and state authorities alike.

A TMS (Transport Management System) manages transport processes. A WMS (Warehouse Management System) manages warehouse processes. An ERP (Enterprise Resource Planning system) brings together an enterprise's finance, production, procurement, sales and logistics processes within a single system.

If these systems are integrated with one another, an enterprise can manage, as a single digital chain, the entire process from the moment an order is received through production, warehousing, handover to the carrier, customs clearance, and delivery to the customer.

In the author's view, Uzbekistan needs affordable, simplified and state-supported TMS/WMS solutions for small and medium-sized businesses. Otherwise, digital logistics risks becoming accessible only to large companies.

International scholarly literature is of considerable importance for understanding the theory of digital logistics.

Martin Christopher regards logistics and supply chain management as a primary source of competitive advantage. In his view, in today's market it is not companies but supply chains that compete with one another. This approach is highly relevant to digital logistics, since digital technologies create speed, flexibility and transparency across the entire chain.



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In the author's view, Christopher's perspective is highly relevant for Uzbekistan. Even if an exporting enterprise produces a high-quality product, if it cannot deliver it on time, cheaply and reliably, it cannot be competitive on the international market. Export policy must therefore be closely linked not only to production but also to digital logistics.

Donald Bowersox and David Closs particularly emphasize the importance of information flow within the logistics system. In their approach, the effectiveness of logistics depends on managing information flows even before managing material flows, since inaccurate or delayed information leads to incorrect decisions, excessive costs, and customer dissatisfaction.

In the author's view, this perspective relates directly to one of the principal problems in Uzbekistan's transport-logistics system. In many processes, information about cargo, transport status, customs documents and permits is maintained in separate systems. Unless these are fully integrated with one another, digital transformation remains superficial.

Ronald Ballou analyzes the balance between logistics costs, quality of service, and inventory management. According to his view, logistics decisions should be based not solely on speed, but on a balance between overall cost and quality of service.

In the author's view, precisely such a balance is needed in Uzbekistan's digital logistics policy. For instance, delivering cargo as quickly as possible is not always the optimal solution; in certain cases a cheaper, safer or more stable route may be more economically advantageous. Artificial intelligence and Big Data can help calculate precisely this balance.

Yossi Sheffi studies the resilience and stability of supply chains. In his view, global supply chains can be disrupted by various crises—pandemics, war, natural disasters, port closures, fluctuations in fuel prices, or political restrictions. In such



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circumstances, companies and states must rely on flexible, diversified logistics systems equipped with digital monitoring.

In the author's view, this perspective is particularly relevant for Uzbekistan, since the country's international trade depends on several transit corridors. Digital logistics serves national economic security by assessing alternative routes, transit times, border conditions and risks in real time.

Michael Porter, in his theory of competitive advantage, shows that infrastructure, clusters, innovation and an efficient business environment determine economic competitiveness. Digital logistics brings all of these factors together: transport infrastructure, information infrastructure, industrial clusters, exporting enterprises and public services operate within a single system.

In the author's view, in developing Uzbekistan's industrial clusters, free economic zones and export potential, digital logistics should be regarded as a distinct strategic layer. Every industrial zone or export cluster should be not merely a production site but a digital ecosystem equipped with logistics, customs, certification, electronic documentation and multimodal transport capabilities.

Klaus Schwab, in his concept of the fourth industrial revolution, emphasizes that artificial intelligence, IoT, robotics, Big Data and digital platforms are fundamentally transforming the structure of the economy. Logistics is one of the most important fields within this revolution.

In the author's view, the digital transformation of Uzbekistan's logistics system is a necessary condition for adapting to the fourth industrial revolution. Otherwise, the country would remain reliant solely on its geographic location along transport corridors. In today's conditions, geographic location alone is not sufficient; rapid digital service, reliable document circulation, secure data exchange, and platforms compliant with international standards are also required.



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Jeremy Rifkin, writing on digital networks and the shared economy, emphasizes that the integration of production, energy, transport and communication systems is shaping a new economic model. This approach shows that digital logistics is connected not only to transport but also to energy, trade, finance and information systems.

In the author's view, in Uzbekistan electric transport, electric-vehicle charging stations, “green logistics,” digital road infrastructure and electronic payment systems should be developed together.

Overall, drawing on the views of international scholars, the following conclusion can be reached: the effectiveness of digital logistics depends on three factors—the accuracy of information, the integration of systems, and the speed of decision-making. For Uzbekistan, two further dimensions should be added to these three factors: cross-border electronic recognition and the development of digital human capital.

The Law of the Republic of Uzbekistan “On Transport” establishes the general legal foundations for the transport sector. It regulates matters relating to the transport system, transport activity, transport safety, transport infrastructure and transport-logistics centers.

From the standpoint of digital logistics, the significance of this Law lies in the fact that it brings the equipping of transport-logistics centers with modern technology and equipment into the legal field. However, the current needs of digital logistics call for regulation that goes beyond these general norms.

In the author's view, the Law “On Transport” should be strengthened with special norms on digital transport-logistics services, electronic cargo documents, digital platforms, multimodal electronic carriage, the exchange of transport data, and the legal status of platform operators.



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Legislation on electronic document circulation is one of the principal legal foundations for digital logistics, since at the heart of digital logistics lie the electronic consignment note, the electronic waybill, the electronic permit, the electronic contract, the electronic invoice, the electronic declaration and the electronic certificate.

An electronic document must have equal legal force with a paper document. Otherwise, digital logistics will not yield real effectiveness. If, after an entrepreneur has entered data into the electronic system, a paper document is again required, digitalization becomes an additional burden rather than a relief.

In the author's view, while Uzbekistan has a general legal basis for electronic document circulation, specialized regulations specific to logistics documents—e-CMR, e-TIR, e-Permit, e-Freight, the electronic waybill, and the multimodal electronic transport document—need to be further developed.

The electronic digital signature ensures the reliability and legal force of digital logistics documents. The signature of the consignor, carrier, freight forwarder, customs authority or warehouse operator on an electronic document confirms the authenticity of that document.

However, a national EDS may not be sufficient for international logistics. If an electronic signature issued in Uzbekistan is not recognized in another state, or a foreign electronic signature creates practical problems within Uzbekistan, cross-border digital logistics cannot function fully.

In the author's view, Uzbekistan needs to expand bilateral and multilateral agreements on the mutual recognition of electronic signatures within the framework of e-CMR, e-TIR, e-Permit and other cross-border systems.

E-commerce and digital logistics are closely interconnected. In e-commerce, a product is sold online, but its real value is determined by whether it is delivered



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to the buyer on time, securely and transparently. The development of e-commerce therefore cannot be complete without digital logistics.

Legislation on e-commerce in Uzbekistan regulates electronic transactions, participants in electronic trade, electronic payments and consumer rights. However, matters such as the quality of delivery services, the logistics obligations of platforms, return processes, delivery delays, loss, damage and liability need to be regulated more precisely.

In the author's view, e-commerce and logistics should be viewed not as separate fields but as a single “digital trade-logistics chain.”

Digital logistics works with large volumes of data, including drivers' personal data, customer addresses, telephone numbers, order history, payment data, vehicle location, and passport or identification data.

Personal data protection is of particular importance for digital logistics, since logistics platforms process movement, location and personal data in real time. If such data is misused, breaches of privacy, commercial secrecy and security may occur.

In the author's view, logistics platforms should be subject to clearly defined obligations regarding “data minimization,” “purpose-limited processing,” “retention periods,” “transfer to third parties,” and “notification of cyber incidents.”

A digital logistics system cannot function without cybersecurity. If a cyberattack is carried out against a transport platform, a customs system, an electronic permit, GPS tracking, warehouse management, or an electronic queue system, not only information but also the actual movement of cargo is disrupted.

For example, a cyberattack on a port, customs or railway information system could halt an entire supply chain. Digital logistics facilities should therefore be classified as critical information infrastructure.



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In the author's view, Uzbekistan needs to strengthen special cybersecurity standards, audits, backup systems, emergency recovery plans and cyber-incident reporting procedures specifically for transport-logistics information systems.

State policy on the development of artificial intelligence technologies through 2030 also creates considerable opportunity for digital logistics. AI can be applied to forecasting transport flows, assessing risk, optimizing customs control, verifying electronic documents, and managing logistics centers.

However, AI also gives rise to questions of legal liability, algorithmic transparency, the risk of discrimination, the consequences of erroneous decisions, and human oversight.

In the author's view, when AI is applied in logistics, minimum legal requirements should be developed concerning the “explainability of the algorithm,” “human oversight,” “the subject of liability,” and “data quality.”

In recent years, Uzbekistan has carried out important reforms in developing the transport-logistics system, transitioning to a digital economy, simplifying customs procedures, and introducing e-government, e-commerce and artificial intelligence. The “Digital Uzbekistan — 2030” strategy is aimed at introducing digital technologies across all sectors, transferring public services into electronic form, developing information systems, and expanding the digital economy. The logistics sector is one of the direct areas of application of this strategy.

Digital logistics is directly connected with the strategy's core objectives—simplifying public services, improving the business environment, developing digital platforms, and accelerating data exchange. The “Uzbekistan — 2030” strategy sets, as a priority task, deepening the country's integration into global transport-logistics networks and increasing the potential of the national transport system. This is the political and strategic basis for digital logistics.



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In the author's view, integration into global transport-logistics networks should be measured not only by the construction of new roads or railway lines, but also by connection to international digital systems. Today a transport corridor consists of both a physical road and a digital road: the road may exist, but if electronic documents are not recognized, the process is nonetheless slowed. The 2025 transport-logistics concept is one of the most important documents for Uzbekistan. It establishes the following digital directions:

- forming logistics platforms integrated with international information systems;
- widely introducing digital and innovative technologies in international freight transportation;
- transitioning to paperless electronic document circulation;
- concluding agreements on the cross-border mutual recognition of electronic documents;
- phased introduction of the electronic waybill;
- creating an integrated system for planning and managing freight train movement;
- introducing the e-Permit, e-TIR, e-CMR, e-Transit and e-Freight systems;
- fully implementing an e-logistics information system;
- creating a unified electronic database and electronic map of transport-logistics centers;
- establishing a digital office for transport and customs;
- integrating electronic queue systems;
- maintaining an electronic ID-register of infrastructure facilities on a GIS basis.

These tasks indicate that systemic reform in digital logistics has begun in Uzbekistan and that the state is treating this field at a strategic level.

In the author's view, the strength of the Concept lies in defining digital logistics not as a separate technical project, but as a comprehensive policy that brings



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together transport, customs, international integration, human capital and infrastructure. Its effectiveness, however, will depend on the precision of implementation mechanisms, financing, inter-platform integration, private-sector participation, and the speed of legal adaptation. One of the most important links in digital logistics is customs procedures. In export-import processes, excessive documentation, repeated inspections, border queues and gaps in inter-agency coordination lead to substantial costs.

A single window, electronic declaration, electronic queuing, risk management, electronic seals, automated customs control, and integration with international customs information systems increase the speed of the transport-logistics chain.

In the author's view, unless customs digitalization is linked with the transport system, veterinary, phytosanitary, certification, banking, insurance and tax systems, its effectiveness will remain limited. Digital logistics should be “chain-wide digitalization,” not “agency-by-agency digitalization.” Digital logistics is becoming an integral part of the international transport and trade system. International experience offers several important lessons for Uzbekistan. The CMR Convention establishes the consignment note as the legal basis for international road carriage. The e-CMR is aimed at converting this consignment note into electronic form. The electronic consignment note allows the carrier, the consignor, the consignee and supervisory authorities to exchange data rapidly.

The advantages of e-CMR include:

- reduction of paper documents;
- real-time data exchange;
- reduced risk of document loss or forgery;
- faster customs and control processes;
- the emergence of electronic evidence for dispute resolution.



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For Uzbekistan, e-CMR is particularly important for developing international road freight transportation. However, for e-CMR to function fully, issues of electronic signature, electronic documentation, international recognition, and inter-platform integration must be resolved. The TIR system serves to simplify customs transit in international freight transportation. The e-TIR transfers this process into electronic form, accelerating data exchange between transit states and strengthening security.

As a transit state, Uzbekistan should make broad use of e-TIR opportunities. This would shorten the time cargo takes to cross borders, reduce transport costs, and increase the attractiveness of Uzbekistan's corridors for international carriers. In international experience, the “single window” system is of major importance in foreign trade and customs processes. Under this system, an entrepreneur enters data only once, while government agencies exchange information among themselves. This reduces the number of documents, time, costs and the human factor.

In the author's view, Uzbekistan's single window system should be further developed and deeply integrated with transport-logistics platforms. For an entrepreneur, the export-import process should operate on the principle of “one portal—one set of data—one outcome.” In the European Union, considerable attention is paid in transport and logistics processes to digital documents, electronic cargo data, multimodal transport, environmental standards, security, and inter-platform compatibility. EU experience shows that digital logistics cannot remain a purely national project; it must conform to regional and international standards.

This approach is highly relevant for Uzbekistan, since the country's transport-logistics potential is linked to neighboring states, China, Europe, South Asia, the Caucasus, Turkey and the Middle East. Digital systems must therefore be



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internationally compatible. The World Bank's Logistics Performance Index assesses the performance of countries in terms of customs, infrastructure, international shipments, logistics quality, tracking capability and delivery times. This index is also an important analytical benchmark for Uzbekistan.

In the author's view, to improve its LPI indicators, Uzbekistan needs to enhance, alongside infrastructure, digital tracking, customs speed, international document exchange and the quality of logistics services. Digital logistics directly affects many of the indicators within this index. Although important reforms in digital logistics have begun in Uzbekistan, a number of systemic shortcomings remain in the field.

Conclusion

Digital logistics is becoming a strategic institution in the modern economy, bringing together transport, trade, customs, electronic documents, information security and international integration. It not only accelerates the movement of cargo, but also reduces the cost of export-import operations, increases transit potential, strengthens customs transparency, improves the business environment, and ensures the international competitiveness of the national economy.

Digital logistics is of particular importance for Uzbekistan. The country's geographic position, its lack of access to the sea, its transit potential in Central Asia, the need to expand exports, and the need for integration into international transport corridors all require the acceleration of digital logistics reforms.

The research shows that important legal and strategic foundations have already taken shape in this field in Uzbekistan. The “Digital Uzbekistan — 2030” strategy, the “Uzbekistan — 2030” strategy, the Law “On Transport,” legislation on electronic documents, electronic digital signatures, e-commerce, personal data and cybersecurity, as well as the Concept for the Development of the Transport-



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Logistics System through 2030 approved in 2025, together form the principal normative foundation of digital logistics.

However, the existing system also faces a number of problems. These include the fragmentation of the legal basis, insufficient cross-border recognition of electronic documents, problems of inter-platform integration, cybersecurity risks, a shortage of qualified personnel, digital inequality affecting small business, data quality issues, and the underdeveloped state of mechanisms for resolving digital disputes—all of which remain pressing concerns.

In the author's view, in order to succeed in the field of digital logistics, Uzbekistan should act on the basis of the following strategic formula:

legal clarity + technological integration + international recognition + cybersecurity + human capital + convenience for business.

Digital logistics is not merely an IT project. It is a comprehensive reform that brings together legal, economic, institutional and international policy dimensions. Systematic cooperation must therefore be established among government bodies, business, scientific institutions, international organizations and private technology companies.

As a result, Uzbekistan has the opportunity to become not merely a transit territory but a digital logistics hub in Central Asia.