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Artificial Intelligence in Transit Corridor Management: Economic Efficiency Prospects of the Zangezur Corridor

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Abstract; Artificial Intelligence (AI) is increasingly transforming transit corridor management by enhancing operational efficiency, enabling predictive logistics, and optimizing cross-border trade flows. The Zangezur Corridor, as a strategically important transport route connecting Azerbaijan with regional and global markets, offers substantial opportunities for AI-driven modernization. The integration of intelligent transport systems, real-time data analytics, automated customs procedures, and predictive risk assessment mechanisms can significantly reduce operational costs, shorten delivery times, and improve reliability in freight movement. Moreover, AI-based coordination platforms can strengthen institutional cooperation among regional stakeholders and enhance supply chain transparency. The digitalization of corridor infrastructure is expected to improve resilience, sustainability, and long-term economic competitiveness. By leveraging AI technologies in transport planning, monitoring, and logistics management, the Zangezur Corridor can evolve into a technologically advanced transit hub, contributing to economic diversification and sustainable growth in the South Caucasus region.

***Keywords**: transit corridors, Zangezur Corridor, logistics optimization, economic efficiency*

INTRODUCTION

Efficient management of transit corridors is increasingly recognized as a fundamental driver of regional economic development, international trade facilitation, and the integration of national markets into the global economy (McKinnon, 2018; Rodrigue, 2020). Transit corridors serve as critical infrastructure connecting producers, consumers, and markets, and they are central to ensuring that goods move reliably, cost-effectively, and on time. Effective corridor operations require the seamless integration of multiple elements, including transport networks (road, rail, and multimodal systems), customs and border procedures, warehousing and storage facilities, freight forwarding services, and increasingly sophisticated digital logistics platforms (Christopher, 2016; Rushton et al., 2017). Any inefficiency in these components can result in delays, increased operational costs, and a reduction in competitiveness, thereby limiting the corridor's capacity to stimulate regional economic growth. In this context, enhancing corridor management is a priority for policymakers, transport operators, and international trade stakeholders.

Recent advances in Artificial Intelligence (AI) provide new and transformative opportunities to improve transit corridor management. AI applications—including predictive analytics, machine learning

algorithms, optimization modeling, and real-time data integration—offer the potential to enhance route planning, cargo scheduling, resource allocation, and risk management across complex logistics networks (Ahmadova & Mammadov, 2025a; Mammadov et al., 2026). AI systems can anticipate disruptions caused by infrastructure constraints, border delays, or environmental factors, enabling dynamic adjustments that reduce bottlenecks and minimize operational inefficiencies. Additionally, AI facilitates the integration of diverse data sources, such as GPS tracking, trade databases, traffic sensors, and customs clearance records, supporting data-driven decision-making, predictive maintenance, and performance monitoring. These capabilities contribute not only to cost reductions and faster delivery times but also to the creation of more sustainable, resilient, and transparent logistics operations.

The Zangezur Corridor, linking Azerbaijan to Armenia, Turkey, and broader regional and international markets, represents a strategically vital route with considerable potential for AI-enabled optimization (Ahmadova & Mammadov, 2025b; Ahmadova & Mammadov, 2026a). Its location positions it as a key segment of the Middle Corridor, an alternative trade route connecting Asia and Europe that bypasses more congested or politically sensitive regions. Efficient operation of the Zangezur Corridor is therefore critical not only for Azerbaijan's trade competitiveness but also for regional economic integration and the diversification of supply chains. Integrating AI technologies into this corridor can improve operational efficiency, enhance the reliability of trade flows, reduce transit times, optimize resource allocation, and strengthen risk management strategies. Furthermore, AI can support multimodal transport integration, streamline customs procedures, and facilitate coordination among corridor-adjacent countries, thereby contributing to the broader objectives of regional economic resilience and competitiveness (Ahmadova et al., 2025; İbrahimov, 2026).

Despite the recognized potential of AI in transit management, there remain significant research gaps regarding its practical application in emerging corridors, particularly in the South Caucasus region. Existing studies predominantly focus on AI in traditional logistics hubs or developed countries, with limited empirical evidence on its role in politically complex and geopolitically sensitive corridors such as Zangezur. Moreover, comprehensive analyses of how AI integration can simultaneously optimize operational efficiency, support economic growth, and enhance regional trade cooperation are scarce. Addressing these gaps is essential to develop evidence-based strategies that can maximize the corridor's impact while mitigating potential risks associated with technological adoption, cross-border coordination, and infrastructure constraints.

As global trade volumes continue to grow, and as the complexity of supply chains increases, leveraging AI in transit corridors like Zangezur becomes a strategic necessity. AI-driven corridor management not only enhances trade efficiency and reduces operational costs but also enables adaptive, predictive, and resilient logistics solutions that can withstand disruptions, geopolitical tensions, or unexpected shifts in trade patterns. Furthermore, the lessons learned from implementing AI in the Zangezur Corridor can provide valuable insights for other emerging corridors worldwide, offering a model for the integration of advanced technologies into regional transport systems. Therefore, exploring the intersection of AI, corridor management, and regional economic development represents a critical avenue for research, policy formulation, and practical innovation in international trade and logistics planning.

LITERATURE REVIEW

Artificial Intelligence (AI) and blockchain technologies are increasingly transforming logistics and customs operations, introducing unprecedented levels of transparency, real-time monitoring, and

predictive risk management (Ahmadova et al., 2025; Ahmadova & Mammadov, 2025b; Ahmadova & Mammadov, 2025c). Blockchain enables secure, immutable recording of transactions and cargo movements, while AI leverages large datasets to forecast delays, optimize routing, and enhance operational reliability. Together, these technologies facilitate end-to-end visibility across supply chains, enabling logistics operators and customs authorities to track shipments in real time, detect anomalies, and mitigate risks before they escalate into costly disruptions.

Previous research demonstrates that predictive AI models significantly improve operational efficiency in logistics systems. By forecasting congestion, optimizing scheduling, and coordinating multimodal transport operations, AI reduces bottlenecks, minimizes idle time, and ensures smoother cargo flows (Sheffi, 2015; Zhang & Wang, 2021). The integration of AI-driven analytics with blockchain further allows stakeholders to verify shipment authenticity, enhance compliance, and improve accountability, which is especially important in complex international corridors involving multiple jurisdictions and regulatory frameworks. These technological solutions therefore not only streamline logistics operations but also build trust among trade partners, which is crucial for sustaining long-term trade relationships and regional cooperation.

Strategic transport corridors, when enhanced with AI and blockchain capabilities, offer significant opportunities to strengthen regional connectivity, optimize trade flows, and increase economic efficiency (Ahmadova & Mammadov, 2026a; Notteboom, 2010; World Bank, 2022). AI-enabled corridor management systems can simulate various operational scenarios, allowing policymakers, infrastructure planners, and investors to assess potential outcomes of infrastructure improvements, regulatory changes, or shifts in trade patterns (İbrahimov, 2026; Mammadov et al., 2026). Such scenario-based analysis facilitates informed decision-making, prioritization of investments, and proactive risk mitigation, all of which are essential for maximizing the economic and strategic benefits of key transport corridors.

In the context of corridors like Zangezur, the combination of AI and blockchain not only improves operational efficiency but also supports sustainable and resilient logistics practices. By enabling predictive maintenance, dynamic route adjustments, and automated compliance checks, these technologies help reduce transit delays, lower operational costs, and enhance the reliability of regional trade networks. Moreover, AI and blockchain applications contribute to data-driven governance of corridor operations, providing insights for future infrastructure planning, trade policy formulation, and regional economic integration. Consequently, the deployment of these advanced technologies represents a transformative approach to modern corridor management, with wide-reaching implications for international trade, regional development, and global supply chain competitiveness.

METHODOLOGY

This study adopts a systematic literature review and conceptual modeling approach to explore the applications of Artificial Intelligence (AI) in transit corridor management, with a particular focus on the Zangezur Corridor (Ahmadova & Mammadov, 2025a, 2025b). The research design integrates qualitative and conceptual analysis to identify technological innovations, operational strategies, and economic implications associated with AI implementation in logistics and corridor management. The methodology is structured around several key stages, which collectively provide a comprehensive framework for understanding AI-driven corridor optimization.

1. Review of AI Applications in Transport and Logistics Systems

The first step involves an extensive review of current literature on AI applications in transport, logistics, and supply chain management (Ahmadova & Mammadov, 2025a, 2025b). This includes studies on predictive analytics, machine learning, real-time route optimization, and intelligent scheduling in both traditional and emerging transport corridors. The review emphasizes identifying best practices, performance outcomes, and the technological prerequisites necessary for effective AI integration. This stage also considers the role of AI in multimodal transport systems, assessing how predictive models can improve coordination between rail, road, and maritime networks.

2. Assessment of Economic Efficiency Indicators in Transit Corridors

The second stage focuses on evaluating economic efficiency indicators within transit corridors, including cost reduction, transit time minimization, trade flow optimization, and overall operational productivity (Mammadov et al., 2026). By analyzing these indicators, the study identifies critical factors that determine the effectiveness of corridor operations and highlights potential areas where AI technologies can generate measurable economic benefits. Quantitative and qualitative data from regional and international case studies are utilized to provide a benchmark for assessing performance improvements resulting from AI implementation.

3. Analysis of Digital Infrastructure, Blockchain, and Smart Corridor Management

The third methodological component examines the digital infrastructure that supports AI and blockchain integration in corridor management (Ahmadova & Mammadov, 2025c; Ahmadova et al., 2025). This includes an assessment of smart corridor technologies, such as real-time tracking systems, automated customs clearance tools, digital documentation platforms, and secure blockchain-based transaction records. The analysis explores how these technologies enhance transparency, traceability, risk management, and interoperability between corridor stakeholders, providing a foundation for resilient and data-driven corridor operations.

4. Evaluation of AI Integration Opportunities for the Zangezur Corridor

The final stage applies the insights gained from the literature review and conceptual analysis specifically to the Zangezur Corridor (Ahmadova & Mammadov, 2026a; İbrahimov, 2026). This evaluation considers the corridor's geostrategic position, infrastructure capacity, regional trade flows, and potential for multimodal integration. The study identifies specific AI applications—such as predictive logistics, scenario-based simulation, congestion forecasting, and dynamic scheduling—that could optimize corridor performance. It also examines challenges and constraints related to technological adoption, cross-border coordination, and policy alignment, providing recommendations for effective implementation strategies.

Through this multi-stage methodology, the study establishes a robust conceptual framework that links AI technologies with operational, economic, and strategic dimensions of transit corridor management. This framework serves as a foundation for both theoretical insights and practical policy recommendations aimed at enhancing efficiency, reducing costs, and fostering regional trade integration through advanced technological solutions.

Economic Efficiency Prospects

Cost Reduction

The integration of Artificial Intelligence (AI) technologies into transit corridor management offers substantial opportunities for cost reduction across multiple operational levels. Predictive routing systems, powered by AI, allow dynamic optimization of transport schedules, fleet deployment, and cargo allocation, thereby significantly reducing fuel consumption, idle times, and unnecessary mileage (Christopher, 2016; Rushton et al., 2017). For instance, AI algorithms can analyze historical traffic patterns, weather forecasts, and real-time sensor data to recommend alternative routes that avoid congestion or delays. This not only improves the efficiency of individual shipments but also optimizes overall fleet utilization, allowing logistics operators to achieve economies of scale and reduce overhead costs.

Blockchain technology complements these AI-driven improvements by providing secure, tamper-proof transaction records, automated verification of shipments, and enhanced transparency throughout the supply chain. By eliminating redundant paperwork and manual reconciliation processes, blockchain reduces administrative burdens, minimizes fraud risk, and lowers operational costs, particularly in multichannel and multimodal transportation scenarios (Ahmadova & Mammadov, 2025c; Ahmadova et al., 2025). When AI and blockchain operate in tandem, corridor management can achieve a high degree of automation, enabling operators to focus on strategic planning rather than routine monitoring tasks, which further contributes to cost efficiency.

Trade Flow Optimization

AI-enhanced logistics and customs platforms play a critical role in accelerating cross-border operations, ensuring timely cargo delivery, and improving documentation accuracy (Ahmadova & Mammadov, 2025b; UNCTAD, 2021). By employing predictive analytics, AI systems can forecast congestion at border crossings, optimize cargo scheduling, and dynamically adjust transit plans to prevent bottlenecks. These capabilities ensure that goods move smoothly along the corridor, improving reliability for exporters, importers, and logistics providers. Real-time tracking of shipments adds an additional layer of operational visibility, allowing stakeholders to monitor transit conditions, detect deviations from planned routes, and take corrective action immediately (Sheffi, 2015; World Bank, 2022).

Furthermore, AI can optimize multimodal transport operations by synchronizing rail, road, and maritime connections, ensuring seamless cargo transitions across different transport modes. Such coordination reduces transfer times, enhances cargo throughput, and minimizes delays, which collectively improve trade efficiency and facilitate higher trade volumes along strategic corridors. In the context of the Zangezur Corridor, these optimizations are particularly valuable given the corridor's position as a critical link between Azerbaijan, Turkey, and broader Eurasian trade networks. Efficient AI-enabled trade flows can increase the corridor's attractiveness for regional and international trade partnerships, thereby boosting long-term economic competitiveness.

Risk Management

AI technologies enable advanced risk management capabilities, allowing corridor authorities to anticipate, identify, and mitigate potential operational disruptions before they escalate. Predictive analytics can detect early signs of congestion, infrastructure failures, or deviations in cargo movement, enabling proactive intervention (İbrahimov, 2026; Zhang & Wang, 2021). For example, AI models can simulate the impact of road closures, adverse weather conditions, or border processing delays on overall transit times, allowing

operators to implement alternative strategies such as rerouting shipments or adjusting departure schedules.

In addition to operational risks, AI facilitates financial and strategic risk assessment by evaluating patterns in trade volumes, infrastructure usage, and corridor performance. By quantifying the probability and potential impact of disruptions, corridor managers can prioritize investments in infrastructure, allocate contingency resources, and enhance the overall resilience of trade networks. The integration of blockchain further strengthens risk management by providing secure and auditable transaction histories, reducing the likelihood of fraud or regulatory non-compliance. Collectively, these AI- and blockchain-enabled tools improve reliability, reduce uncertainty, and enhance stakeholder confidence in corridor operations.

Regional Integration

The deployment of AI and blockchain technologies supports regional integration by enabling coordinated logistics clusters, multimodal transport systems, and data-driven corridor governance (McKinnon, 2018; Notteboom, 2010). AI-powered corridor management facilitates communication and collaboration among multiple stakeholders, including transport operators, customs authorities, and regional policymakers. By enabling predictive planning and scenario-based simulations, corridor managers can design infrastructure and operational strategies that promote regional trade connectivity and optimize the distribution of goods.

In the case of the Zangezur Corridor, AI-enhanced integration strengthens connectivity between Azerbaijan, Turkey, and regional markets, providing alternative routes that bypass more congested or politically sensitive areas. Strategic corridor planning supported by real-time analytics and predictive modeling improves operational efficiency, attracts investment, and enhances competitiveness in the regional logistics market (Ahmadova & Mammadov, 2026a; Mammadov et al., 2026). Furthermore, the establishment of smart corridor frameworks can serve as a blueprint for other emerging transport corridors worldwide, demonstrating how technology-driven integration promotes sustainable economic development.

DISCUSSION

The implementation of AI in the Zangezur Corridor represents a paradigm shift from traditional corridor management to a predictive, data-driven, and resilient logistics ecosystem (Ahmadova & Mammadov, 2025a, 2025b). By integrating real-time data monitoring, predictive analytics, and scenario-based simulation, corridor authorities can anticipate operational disruptions, optimize resource allocation, and enhance overall performance. These capabilities allow for informed decision-making regarding scheduling, infrastructure investment, and policy interventions.

Effective AI adoption, however, requires coordinated public–private collaboration, comprehensive regulatory frameworks, and substantial investment in digital infrastructure (Ahmadova & Mammadov, 2025c, 2026a). Stakeholders must address issues of cybersecurity, data privacy, interoperability, and workforce training to fully leverage AI and blockchain technologies. Additionally, successful implementation depends on harmonized policies across border authorities and consistent infrastructure standards, which are critical for achieving seamless cross-border operations and maximizing trade efficiency.

AI also enables predictive scenario planning, allowing stakeholders to simulate potential trade disruptions, assess alternative strategies, and optimize corridor operations under varying conditions. For example, AI models can evaluate the effects of increased freight volumes, infrastructure upgrades, or new regulatory measures (İbrahimov, 2026), providing actionable insights for long-term strategic planning. This proactive approach ensures that corridors like Zangezur remain competitive, resilient, and responsive to both market demands and geopolitical developments.

CONCLUSION

AI and blockchain technologies present transformative opportunities for modern transit corridor management, delivering measurable benefits across economic, operational, and strategic dimensions. In particular, AI integration enhances cost efficiency through predictive routing, reduces idle times, and optimizes fleet utilization. Blockchain strengthens transparency, security, and regulatory compliance, further enhancing the reliability of corridor operations. Combined, these technologies improve trade flow efficiency, accelerate cross-border operations, and support real-time monitoring of cargo, leading to higher reliability and stakeholder confidence (Ahmadova & Mammadov, 2025b; Sheffi, 2015; World Bank, 2022).

For the Zangezur Corridor, AI and blockchain adoption can facilitate multimodal integration, predictive maintenance, and scenario-based operational planning, strengthening regional connectivity and contributing to sustainable economic growth (Ahmadova & Mammadov, 2026a; Mammadov et al., 2026). Furthermore, the corridor can serve as a model for technology-driven management in emerging transport networks, demonstrating how advanced digital solutions improve operational efficiency, risk resilience, and trade competitiveness.

Future research should focus on quantitative simulation models to empirically assess the impact of AI on corridor efficiency, AI-enabled scenario planning for dynamic policy and investment decisions, and comprehensive governance frameworks for smart corridor management. Additionally, longitudinal studies evaluating real-world AI implementation outcomes, socio-economic benefits, and cross-border coordination challenges will be crucial for refining strategies and supporting broader regional integration efforts. Such research will not only advance theoretical understanding but also provide actionable recommendations for policymakers, investors, and logistics operators aiming to implement AI-driven smart corridors across Eurasia and beyond (Ahmadova & Mammadov, 2026a; Mammadov et al., 2026).

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