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PROSPECTS OF USING ARTIFICIAL INTELLIGENCE IN LOGISTICS

Summary

The purpose of this research is to examine the transformative role of Artificial Intelligence (AI) in logistics, highlighting how intelligent technologies can address the growing complexity of global supply chains. By integrating theoretical insights with practical evidence, the study aims to demonstrate AI’s potential to optimize warehouse management, transportation systems, and demand forecasting.

The methodology combines a literature review of existing theoretical frameworks with the analysis of real-world case studies from leading companies such as Amazon, Alibaba, and Walmart. Statistical data and market forecasts are also employed to evaluate the scale and trajectory of AI adoption in logistics.

The results reveal that AI integration leads to measurable improvements in efficiency, cost reduction, and customer satisfaction. Case evidence shows that AI-driven robotics, predictive analytics, and route optimization significantly reduce order-processing time, fuel consumption, and forecasting errors. Market projections further indicate that the global AI in logistics sector is expected to grow from $17.96 billion in 2024 to over $700 billion by 2034.

The novelty and originality of the research lie in its holistic perspective—connecting theoretical frameworks, industry applications, and long-term projections—while also addressing challenges such as high costs, data integration, and workforce reskilling. This comprehensive approach underscores AI as not merely a supportive tool but a strategic imperative for the future of logistics.

Key words: Artificial Intelligence (AI), logistics optimization, supply chain management, predictive analytics, smart warehousing, autonomous vehicles, demand forecasting, digital transformation.

Introduction

In the era of global interconnectivity, logistics has evolved into one of the most critical pillars of economic activity. It is no longer limited to the mere transportation of goods but encompasses a vast network of supply chain operations — including warehousing, inventory control, demand forecasting, and last-mile delivery. As businesses expand globally and customer expectations for speed and transparency increase, the pressure on logistics systems to operate more efficiently, flexibly, and intelligently has intensified. Traditional logistics models, often reliant on manual decision-making and historical data, are proving inadequate in the face of this growing complexity.

In response to these challenges, Artificial Intelligence (AI) has emerged as a transformative technology that is redefining logistics operations worldwide. AI refers to the development of systems that can perform tasks typically requiring human intelligence — such as learning from data, recognizing patterns, solving problems, and making predictions. With its ability to process vast volumes of real-time data and generate actionable insights, AI is enabling logistics companies to optimize routes, automate warehouses, forecast demand with precision, and enhance customer service through chatbots and natural language processing tools. The convergence of AI with other technologies such as the Internet of Things (IoT), cloud computing, and big data analytics is accelerating this transformation.

The practical relevance of AI in logistics is no longer speculative — it is visible in the operations of global giants like Amazon, Alibaba, and Walmart, which are leveraging AI-driven systems to improve efficiency and reduce costs. Meanwhile, small and medium enterprises (SMEs) are also beginning to adopt AI solutions tailored to their needs, thanks to the increasing affordability and accessibility of AI technologies. However, while the benefits are clear, the implementation of AI in logistics also brings new challenges, including high initial costs, cybersecurity risks, data integration issues, and potential job displacement. As such, a balanced examination of both the opportunities and the limitations is essential.

This article aims to explore the prospects of using Artificial Intelligence in the logistics sector by combining theoretical insights with real-world applications and statistical evidence. It begins by outlining the core AI technologies relevant to logistics, followed by a detailed look at their practical applications across key logistics functions such as warehousing, transportation, and customer service. The article then analyzes global case studies, highlights the measurable benefits and remaining obstacles, and concludes with a forward-looking perspective on the future integration of AI into logistics networks.

Understanding Logistics and Artificial Intelligence

Logistics is broadly defined as the process of planning, implementing, and controlling the efficient flow and storage of goods, services, and information from the point of origin to the point of consumption to meet customer requirements [3, p.4]. In the context of globalized commerce, logistics has grown from a tactical function to a strategic differentiator in supply chain management. Modern logistics incorporates not only physical transportation but also warehousing, demand forecasting, real-time inventory control, and customer satisfaction. In parallel, Artificial Intelligence (AI) has emerged as a technological force capable of enhancing these logistical components through automation and data-driven intelligence. AI refers to computational systems designed to replicate human cognitive functions such as learning, reasoning, and problem-solving [3, p.23]. Within logistics, AI primarily relies on subfields such as machine learning (enabling systems to learn from data without explicit programming), deep learning (multi-layered neural networks for pattern recognition), computer vision (interpreting visual inputs from sensors or images), and natural language processing (NLP**)** (allowing systems to understand and generate human language). These tools are now being applied to key logistics functions, including demand forecasting, robotic picking in warehouses, customer interaction via chatbots, and dynamic delivery route optimization.

AI’s suitability for logistics lies in its capacity to handle large volumes of real-time and historical data to support predictive decision-making and optimization. According to the World Economic Forum (2023), logistics firms collect terabytes of real-time data from sensors, GPS trackers, and customer transactions—data that AI systems can analyze instantly to optimize decisions, reduce waste, and anticipate disruptions [15]. A study by McKinsey (2022) found that the implementation of AI in logistics can reduce forecasting errors by up to 50% and inventory costs by 20–30% [6, p.4]. This positions AI as an essential enabler of agility and resilience in supply chains, especially during periods of market uncertainty or disruptions like pandemics or geopolitical conflicts.

From a theoretical perspective, AI in logistics is grounded in frameworks such as intelligent decision-making systems, which integrate AI algorithms with human input to optimize logistical planning under uncertain conditions [13, p.312]. Another widely studied concept is automation frameworks, which guide the full or partial replacement of human activities with machines in repetitive logistics tasks [5, p.85]. Particularly relevant in logistics is reinforcement learning (RL) — an AI paradigm where agents learn to take actions based on trial-and-error interactions with their environment to maximize long-term rewards. RL has shown promise in optimizing warehouse operations and delivery routing under dynamic conditions [18, p.44].

The cited works convincingly demonstrate that AI is not only capable of automating routine

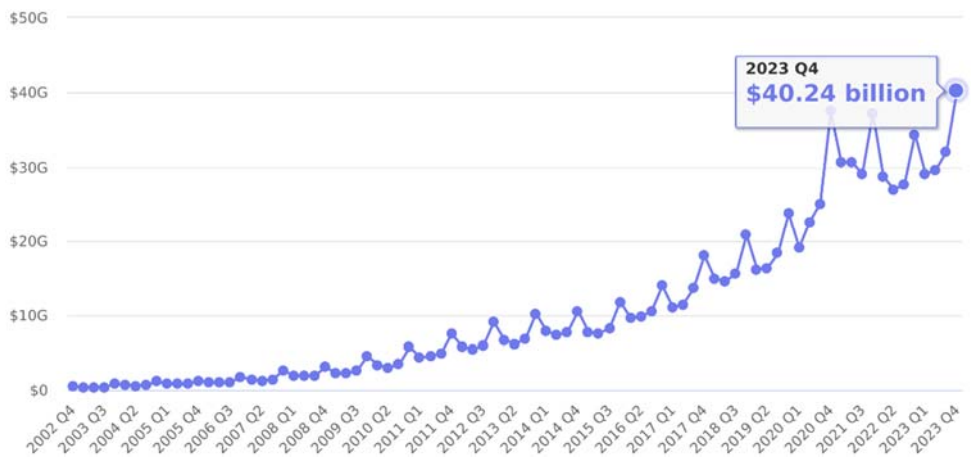
tasks but also of enabling proactive, strategic decisions that were previously unachievable using traditional systems. However, I believe that while theoretical frameworks like reinforcement learning hold great potential, their real-world application still faces practical barriers such as lack of clean data, integration challenges with legacy infrastructure, and high initial investment. These challenges must be addressed through coordinated industry-academic efforts and scalable pilot implementations.

Artificial intelligence applications in key Logistics areas

Building on the foundational role of AI in enhancing predictive decision-making and intelligent automation across logistics systems, one of the most immediate and impactful applications of AI lies in **warehouse management**. Warehouses form the physical core of the supply chain, acting as nodes where products are stored, sorted, and dispatched. Traditionally labor-intensive and vulnerable to human error, warehouse operations are being revolutionized by **AI-powered robotics, machine learning-driven inventory forecasting, and computer vision technologies.** These innovations significantly improve speed, accuracy, and cost-efficiency in material handling and stock control.

One of the earliest and most widely cited examples of AI-driven warehouse automation is **Amazon’s Kiva robotic system**. These mobile robots autonomously navigate warehouse floors to transport shelving units to human pickers, drastically reducing walking time and increasing fulfillment speed. As noted by Wurman et al. (2008), the introduction of Kiva systems allowed Amazon to improve warehouse storage density and throughput without expanding physical space [16, p.139]. According to a report by *Business Insider Intelligence* (2021), such AI-enabled robotic systems have helped Amazon reduce average order processing time from **60–75 minutes to under 15 minutes**.

Amazon has set a global benchmark for AI integration across logistics — from robotic warehouse automation to last-mile delivery optimization. In its fulfillment centers, Amazon employs more than 520,000 autonomous mobile robots (as of 2023), many of which originate from the acquisition of Kiva Systems in 2012 (Amazon Annual Report, 2023, p. 48). These robots work alongside human employees to retrieve and transport items across vast warehouses, dramatically increasing storage density and reducing processing time. Beyond the warehouse, Amazon’s AI-powered systems manage demand forecasting, inventory positioning, and route optimization. According to a research article by Zhang and Kumar (2022), Amazon’s AI-driven logistics engine uses real-time data from millions of transactions to dynamically route shipments through the most efficient fulfillment centers, thereby reducing average delivery times and improving customer satisfaction [17, p.219]. Amazon also deploys machine learning models for proactive inventory placement — predicting where products will be needed even before an order is placed.



Graph 1. Changes in the international sales of Amazon

Source: www.marketplacepulse.com

The graph of Amazon’s international sales from 2002 Q4 to 2023 Q4 illustrates a remarkable long-term growth trajectory, with particularly strong acceleration in recent years. In the early stages (2002–2016), sales increased gradually, reflecting Amazon’s steady international expansion and the growing global acceptance of e-commerce. Seasonal peaks—most evident in Q4 periods—indicate the significance of holiday shopping in driving sales. However, after 2017, the slope of the sales curve became notably steeper, with revenues surpassing $20 billion per quarter by 2019. This upward trajectory reached a historic peak of $40.24 billion in Q4 2023, signaling Amazon’s transformation into a dominant international retail and logistics powerhouse.

One of the critical drivers underpinning this sustained growth is Amazon’s strategic adoption of artificial intelligence in logistics and supply chain management. AI has played a supportive but crucial role in enabling the company to scale its operations in line with rapidly increasing global demand. For instance, AI-powered demand forecasting systems analyze historical sales, seasonal patterns, and market trends, ensuring that international warehouses are stocked optimally to avoid shortages and delivery delays. Similarly, route optimization algorithms have allowed Amazon to improve last-mile delivery efficiency by processing real-time traffic and weather data, which is essential given the sharp sales growth during peak seasons highlighted in the chart. The integration of robotics and machine learning in fulfillment centers has also been instrumental. By automating sorting, packaging, and inventory tracking, Amazon reduced order-processing times, thereby handling higher order volumes without proportional increases in labor or costs. These innovations became especially critical during the pandemic years (2020–2021), when international demand surged unexpectedly, pushing sales well above the $30 billion quarterly mark. Without AI-driven logistics, it would have been far more difficult for Amazon to manage such a sudden spike in global e-commerce activity.

Furthermore, AI contributes indirectly through dynamic pricing and personalized recommendations, which not only enhance the consumer experience but also increase conversion rates across international markets. This synergy between customer-facing AI systems and logistics-focused AI infrastructure helps explain why Amazon’s international sales growth has not only accelerated but also sustained momentum in the post-pandemic period.

Another key innovation in warehouse AI is the use of **machine learning (ML) algorithms for inventory forecasting and replenishment**. By analyzing historical sales, seasonal trends, and real-time demand signals, AI systems can accurately predict stock requirements and automate reordering processes. For example, Alibaba’s Cainiao logistics platform reportedly achieves **forecasting accuracy above 90%** using its AI-powered Smart Forecasting System, leading to both reduced holding costs and higher customer satisfaction [2, p.21] Complementing robotic movement and forecasting is the implementation of **computer vision systems** for item recognition, sorting, and quality inspection. These systems use cameras and deep learning models to detect damaged goods, verify product placement, and even guide robotic arms in picking fragile or irregularly shaped items. A study by Teik et al. (2023) demonstrated that computer vision systems, when integrated with robotics, reduced error rates in sorting by **over 40%** compared to human-operated systems [11, p.211].

The evidence shows not only measurable operational gains — such as time reduction, cost savings, and error minimization — but also opens new possibilities for scalability and responsiveness in supply chains. However, while these innovations improve efficiency, they also raise questions around workforce displacement and the need for re-skilling employees to manage and maintain these AI-driven systems. Policymakers and companies must address this transition responsibly by investing in workforce development alongside technological advancement.

Following its transformative impact on warehouse operations, **AI continues to reshape logistics by optimizing transportation and delivery processes,** which represent one of the most cost-intensive and environmentally impactful areas of the supply chain. With the exponential growth in e-commerce and just-in-time delivery expectations, logistics providers are under

increasing pressure to improve delivery accuracy, reduce fuel consumption, and manage fleets efficiently — all areas where AI technologies offer significant advantages. One of the most effective applications of AI in transportation is **AI-driven route planning**, which uses real-time data, historical traffic patterns, and predictive algorithms to determine the most efficient delivery paths. This goes far beyond traditional GPS navigation systems. Companies like **UPS** have adopted AI-powered routing systems such as **ORION (On-Road Integrated Optimization and Navigation)**, which reportedly saves the company over **10 million gallons of fuel annually** and reduces driving distance by approximately **100 million miles per year** [14]. The system uses AI to factor in traffic conditions, delivery time windows, and driver behavior to create dynamically optimized routes for thousands of vehicles.

In parallel, **real-time GPS and traffic analysis** allow for dynamic re-routing based on unexpected conditions such as road closures, weather, or congestion. AI systems continuously analyze geospatial and sensor data to alert drivers and dispatchers about changes, thereby preventing delays and reducing idle fuel consumption. According to IBM (2023), integrating AI with IoT-enabled vehicles for traffic prediction and re-routing has helped logistics companies reduce late deliveries by up to **25%** [4, p.12].

Another frontier in AI-driven logistics is the **adoption of autonomous vehicles** — including trucks, delivery vans, and drones — which are gradually being tested and, in some regions, deployed in real-world logistics scenarios. For instance, **TuSimple**, a U.S.-based autonomous trucking company, has developed self-driving trucks capable of long-haul transportation with AI-powered sensors and deep learning models to detect objects, interpret road signals, and make split-second decisions. A pilot project by TuSimple in partnership with UPS showed a **10% increase in fuel efficiency** and **reduced delivery times** across test routes [12, p.6]. Similarly, **Wing**, a subsidiary of Alphabet (Google), has piloted AI-controlled drones for last-mile delivery in Australia and the U.S., demonstrating reduced costs and faster service in low-density urban areas. The integration of AI in transportation logistics, especially considering the quantifiable improvements in route optimization, cost savings, and sustainability opens new ways for Logistics. The UPS ORION system, for instance, offers a textbook example of how AI can solve complex logistical routing problems at scale. However, I also caution that full reliance on autonomous vehicles is not yet feasible in many contexts due to regulatory hurdles, safety concerns, and technological limitations in unpredictable urban environments. Therefore, hybrid models — combining human oversight with AI decision support — seem to be the most practical and ethical transition phase for the near future.

As logistics systems become increasingly data-rich and customer-driven, AI-enabled demand forecasting and inventory control has emerged as a cornerstone of supply chain optimization. While traditional forecasting relied on historical sales trends and linear models, these approaches often failed to respond to market volatility, seasonality, or sudden shifts in consumer behavior. Artificial Intelligence, particularly through predictive analytics and machine learning (ML), offers a far more dynamic and responsive approach to forecasting demand and managing inventory levels across vast, multi-node supply chains. AI models today can analyze diverse data inputs — including real-time sales, weather, market trends, holidays, and even social media sentiment — to detect patterns and generate highly accurate forecasts. These insights allow companies to balance supply and demand, reduce stock-outs, minimize overstocking, and lower holding costs. Machine learning-based demand forecasting can lead to a 20–50% reduction in forecasting errors, depending on data quality and model complexity. More importantly, the AI models continuously improve their accuracy as more data becomes available, enabling adaptive and self-learning systems.

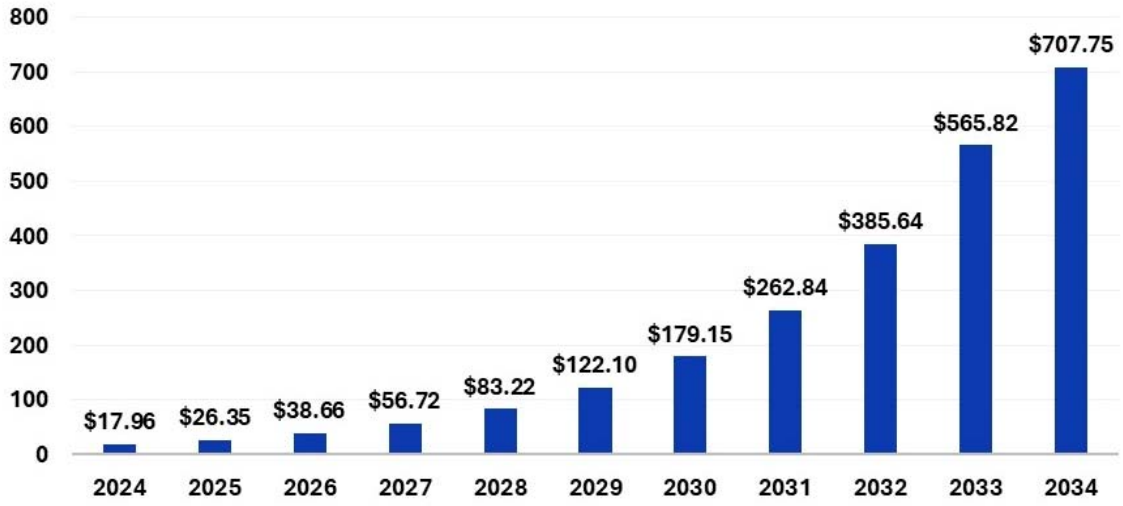
A widely cited example is Walmart, which uses deep learning and AI models across its global operations to optimize inventory. According to a case study published in *MIT Sloan Management Review* (2023), Walmart achieved a 30% improvement in forecast accuracy by deploying an AI platform that analyzes billions of data points across sales, weather, promotions, and local events

[7, p.27]. This AI system not only informs procurement decisions but also integrates with warehouse and shelf-replenishment systems, allowing near real-time responses to demand fluctuations.

Furthermore, AI-driven demand forecasting is increasingly being integrated with ERP (Enterprise Resource Planning) systems, allowing seamless information flow between sales, procurement, and logistics departments. This integration enables automated inventory replenishment, real-time alerts for stock discrepancies, and better alignment of supply chain operations with financial planning. SAP, for instance, offers an AI-enhanced module known as SAP Integrated Business Planning (IBP), which allows companies to simulate different demand scenarios and respond accordingly. As reported by SAP (2022), firms using AI-based ERP solutions have reduced excess inventory by up to 25% and improved service levels significantly [10].

The case of Walmart illustrates how AI, when correctly implemented and integrated into broader systems like ERP, can deliver measurable improvements. However, I believe small and medium enterprises (SMEs) still face challenges accessing such technology due to high implementation costs, lack of in-house data science expertise, and inadequate data infrastructure. Thus, while the technology is proven, democratizing access through scalable, cloud-based AI tools should be a priority in policy and innovation agendas.

In order to better understand the future trajectory of Artificial Intelligence within logistics, it is useful to examine market growth forecasts. Recent research highlights that the global market size of AI in logistics is expected to expand dramatically over the next decade, reflecting both the rising demand for intelligent supply chain solutions and the accelerating pace of technological adoption. The following figure illustrates these projections from 2024 to 2034.



Graph 2. Estimated market size of AI in Logistics

Source: www.precedenceresearch.com

The given chart illustrates the projected growth of the Artificial Intelligence (AI) market within the logistics sector from the year 2024 to 2034, measured in USD billions. According to the data provided by Precedence Research, the market is expected to experience a rapid and consistent expansion throughout this period.

In 2024, the AI in logistics market size is estimated to start at $17.96 billion. This figure is projected to grow to $26.35 billion in 2025 and further increase to $38.66 billion in 2026. The growth trend continues as the market is expected to reach $56.72 billion by 2027 and $83.22 billion in 2028. By 2029, the market is forecasted to expand to $122.10 billion, marking a significant growth milestone. Entering the 2030s, the pace of expansion accelerates even more rapidly. In 2030, the market size is predicted to reach $179.15 billion, and by 2031, it is projected to almost

double to $262.84 billion. The growth becomes even more pronounced in 2032 with an estimated market size of $385.64 billion. In 2033, the market is expected to jump to $565.82 billion, and by the end of the forecast period in 2034, the market size is projected to soar to an impressive $707.75 billion.

This data clearly demonstrates that the role of Artificial Intelligence in logistics is not only growing but doing so at an accelerating pace. The market is set to multiply by nearly forty times from 2024 to 2034, highlighting the increasing importance of AI-driven solutions in optimizing logistics operations, improving supply chain efficiency, and enhancing decision-making processes across the industry. The sharp rise, especially after 2029, suggests that the integration of AI technologies will become a fundamental part of logistics, shaping the future of the sector significantly.

Conclusion

Artificial Intelligence has emerged as a cornerstone of modern logistics, driving a profound transformation across the global supply chain. By integrating technologies such as machine learning, deep learning, computer vision, and natural language processing, AI is enabling logistics firms to optimize warehouse management, streamline transportation, and achieve highly accurate demand forecasting. The real-world applications showcased by industry leaders like Amazon, Alibaba, and Walmart illustrate that AI is not only a theoretical concept but a proven driver of efficiency, cost reduction, and customer satisfaction. Their experiences demonstrate how robotics, predictive analytics, and intelligent route optimization can reshape operations at scale and set new industry benchmarks.

The article also highlights that the integration of AI into logistics is not without challenges. High implementation costs, complex data integration, cybersecurity vulnerabilities, and the threat of workforce displacement create significant barriers to widespread adoption. For small and medium-sized enterprises in particular, limited financial and technical resources may slow their ability to benefit from these innovations. Addressing these obstacles will require collaboration between industry, academia, and policymakers to design inclusive strategies, scalable technologies, and effective workforce reskilling initiatives.

Looking forward, the growth trajectory of AI in logistics is remarkable, with market projections forecasting an increase from $17.96 billion in 2024 to more than $700 billion by 2034. This exponential rise reflects not only increasing demand for smarter logistics solutions but also the inevitability of AI becoming a central pillar of supply chain management. In a global economy where speed, flexibility, and resilience are critical, AI adoption is no longer optional but essential for competitiveness.

In conclusion, the future of logistics lies in embracing AI as both a technological enabler and a strategic imperative. Companies that successfully harness its potential will be better positioned to navigate uncertainty, adapt to dynamic market conditions, and deliver sustainable value to customers. However, realizing this vision requires a balanced approach that combines innovation with inclusivity, ensuring that enterprises of all sizes can participate in and benefit from this technological revolution.

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Logistika sahəsində süni intellektdən istifadə perspektivləri

Xülasə

Tədqiqatın məqsədi. Bu tədqiqatın məqsədi logistika sahəsində Süni İntellektin (Sİ) transformativ rolunu araşdırmaq və ağıllı texnologiyaların qlobal təchizat zəncirlərinin artan mürəkkəbliyini necə həll edə biləcəyini göstərməkdir. Nəzəri yanaşmalarla praktiki sübutların inteqrasiyası əsasında aparılan araşdırma, Sİ-nin anbar idarəçiliyinin optimallaşdırılması, nəqliyyat sistemlərinin səmərəliliyinin artırılması və tələbatın proqnozlaşdırılması potensialını üzə çıxarır.

Metodologiya mövcud nəzəri çərçivələrin ədəbiyyat təhlili ilə yanaşı, Amazon, Alibaba və Walmart kimi aparıcı şirkətlərin real təcrübə nümunələrinin araşdırılmasını birləşdirir. Bundan əlavə, statistik məlumatlar və bazar proqnozları logistika sahəsində Sİ-nin tətbiq miqyasını və inkişaf trayektoriyasını qiymətləndirmək üçün istifadə olunmuşdur.

Araşdırmanın nəticələri göstərir ki, Sİ-nin tətbiqi səmərəliliyin artırılmasına, xərclərin azaldılmasına və müştəri məmnuniyyətinin yüksəldilməsinə ölçülə bilən təsir göstərir. Empirik sübutlar Sİ-yə əsaslanan robot texnologiyalarının, proqnozlaşdırıcı analitikanın və marşrut optimallaşdırmasının sifarişlərin emal müddətini, yanacaq sərfiyyatını və proqnoz səhvlərini əhəmiyyətli dərəcədə azaltdığını təsdiqləyir. Bazar proqnozları isə göstərir ki, qlobal miqyasda logistika sahəsində Sİ bazarı 2024-cü ildə 17,96 milyard ABŞ dollarından 2034-cü ildə 700 milyard dollardan çox həcmdə artacaqdır.

Tədqiqatın yeniliyi və orijinallığı onun holistik yanaşmasında — nəzəri çərçivələrin, sənaye tətbiqlərinin və uzunmüddətli proqnozların əlaqələndirilməsindədir. Eyni zamanda yüksək tətbiq xərcləri, məlumat inteqrasiyası və işçi qüvvəsinin yenidən ixtisaslaşması kimi çağırışlara diqqət çəkilmişdir. Bu yanaşma göstərir ki, Sİ sadəcə dəstəkçi vasitə deyil, logistikanın gələcəyi üçün strateji zərurətdir.

Açar sözlər: Süni İntellekt (Sİ), logistikanın optimallaşdırılması, təchizat zənciri idarəçiliyi, proqnozlaşdırıcı analitika, ağıllı anbar sistemləri, avtonom nəqliyyat vasitələri, tələbatın proqnozlaşdırılması, rəqəmsal transformasiya.

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Перспективы использования искусственного интеллекта в логистике

Резюме

Цель данного исследования – изучить трансформационную роль искусственного интеллекта (ИИ) в логистике и показать, каким образом интеллектуальные технологии способны решать возрастающую сложность глобальных цепочек поставок. На основе интеграции теоретических подходов и практических доказательств исследование демонстрирует потенциал ИИ в оптимизации управления складами, повышении эффективности транспортных систем и прогнозировании спроса.

Методология включает обзор литературы по существующим теоретическим моделям, а также анализ реальных кейсов ведущих компаний, таких как Amazon, Alibaba и Walmart. Кроме того, для оценки масштабов и траектории внедрения ИИ в логистику используются статистические данные и рыночные прогнозы.

Результаты показывают, что внедрение ИИ приводит к измеримым улучшениям эффективности, сокращению затрат и повышению удовлетворенности клиентов. Практические примеры доказывают, что использование робототехники на основе ИИ, предиктивной аналитики и оптимизации маршрутов значительно снижает время обработки заказов, расход топлива и ошибки прогнозирования. Рыночные прогнозы свидетельствуют о том, что мировой рынок ИИ в логистике возрастет с 17,96 млрд долларов США в 2024 году до более чем 700 млрд долларов к 2034 году.

Новизна и оригинальность исследования заключается в его целостном подходе — соединении теоретических моделей, отраслевых приложений и долгосрочных прогнозов, а также в акценте на вызовы, связанные с высокими затратами, интеграцией данных и переподготовкой рабочей силы. Такой подход подчеркивает, что ИИ является не просто вспомогательным инструментом, а стратегической необходимостью для будущего логистики.

Ключевые слова: искусственный интеллект (ИИ), оптимизация логистики, управление цепями поставок, предиктивная аналитика, умные склады, автономный транспорт, прогнозирование спроса, цифровая трансформация.