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ARTIFICIAL INTELLIGENCE IN LOGISTICS: OPPORTUNITIES AND CHALLENGES

Yevhen Burov[1], Andrii Kuliavets[2]

[1, 2] Lviv polytechnic National University,
Information Systems and Networks Department, Lviv, Ukraine
[1] E-mail: yevhen.v.burov@lpnu.ua, ORCID: 0000-0001-8653-1520
[2] E-mail: andrii.m.kuliavets@lpnu.ua, ORCID: 0009-0006-4946-1416

The integration of artificial intelligence into the logistics industry is a rapidly evolving field with the potential to revolutionize the way goods are transported and managed. Artificial intelligence can be used to optimize a wide range of logistics processes, from demand forecasting and route planning to warehouse management and customer service. However, the integration of artificial intelligence also raises a number of technical and ethical issues that need to be addressed to ensure its successful implementation.

Choosing the right artificial intelligence algorithms for specific logistics tasks is crucial to ensure their efficiency and accuracy. This requires careful consideration of factors such as data type, task complexity, and desired performance metrics.

The growing amount of data collected and processed by artificial intelligence systems raises concerns about data security and privacy. Companies need to implement robust security measures to protect sensitive data from unauthorized access, breaches, and misuse.

The use of artificial intelligence in logistics raises ethical issues related to bias, transparency, and accountability. Artificial intelligence algorithms should be developed and used fairly, transparently, and with respect for the right to privacy and in compliance with all relevant laws and regulations.

In order to eliminate or prevent these problems, recommendations for the effective implementation of artificial intelligence in the logistics sector have been developed and formulated. They include aspects that need to be addressed in the first place when developing mechanisms for automating logistics processes.

The integration of artificial intelligence into logistics offers significant opportunities to increase efficiency, reduce costs and improve customer service. However, it is crucial to address the technical and ethical challenges associated with artificial intelligence integration to ensure that it is used responsibly and beneficially. By following the recommendations, logistics companies can successfully use artificial intelligence to transform their operations and achieve their strategic goals.

Keywords: artificial intelligence; logistics; logistics systems; automation; innovative technologies.

Introduction

The logistics industry in the modern world is facing the challenges of rapid globalisation, growing traffic volumes and the constant need to optimise processes. In this context, artificial intelligence (AI) is gaining in importance as a key tool for solving many of the problems faced by modern logistics.

AI can transform traditional approaches to managing logistics processes by automating routine tasks, analysing large amounts of data in real time, and improving insights for decision-making. The introduction of AI can increase productivity, reduce costs, and improve customer service, creating a competitive advantage for companies in the market.

However, along with the opportunities, the integration of AI into the logistics industry also brings its own challenges. It raises questions about data security, ethical standards, and regulatory aspects of using artificial intelligence. It is also important to understand the potential social and economic impact of AI in logistics, particularly in the context of changes in the labour market and interaction with human resources.

This article reviews the current state of research and literature on the integration of artificial intelligence into the logistics sector, identifies key issues and challenges facing this process, and formulates recommendations for the effective implementation of AI in logistics.

Problem statement

The introduction of artificial intelligence in the logistics sector is a relevant and promising area of development. However, this process is accompanied by a number of technical and software challenges that require careful analysis and a balanced approach.

One of the key issues is data security. As the amount of data processed and analysed by AI increases, the risk of unauthorised access, loss, or misuse of this data increases. Developing effective data protection strategies is critical to ensuring data confidentiality and integrity.

Another important issue is the selection and optimisation of algorithms. Choosing the right machine learning algorithm or deep learning technique can affect the efficiency and accuracy of the system. The approaches used for demand forecasting, transport routing, or inventory management should be carefully studied and optimised for specific logistics tasks.

Another important aspect is the integration of AI with existing logistics systems. This can include developing APIs, creating interfaces to interact between different systems, and adapting existing data to formats that AI can understand.

Scalability issues are another area of concern. As the amount of data and tasks to be processed grows, it may become necessary to optimise the system architecture, use distributed computing, and process large amounts of data in real time.

The successful integration of artificial intelligence into the logistics sector requires a comprehensive approach and a deep understanding of both the logistics and technological aspects of the process.

Analysis of recent researches and publications

Recent research and publications on the integration of artificial intelligence into the logistics sector focus on several key areas.

First of all, the development of the latest technological solutions for optimising logistics processes is becoming important. Works [11, 12] analyse the possibilities and advantages of using artificial intelligence algorithms in logistics to optimise logistics processes. It identifies the key aspects and future directions of development related to the integration of artificial intelligence into the logistics sector. The authors argue that artificial intelligence can be used to improve forecasting and planning, automate operations, optimise routes and vehicles, and ensure transparency and tracking of operations in supply chains. Ultimately, research indicates that the role of artificial intelligence in logistics is to improve order processing, inventory management, supply chain, and distribution operations in order to provide an enhanced customer experience.

Also noteworthy is the study [4], which focuses on data security and privacy when integrating AI into logistics processes due to the growing amount of data stored and processed in logistics systems. It is

based on actual examples of incidents and threats to data security that may arise when using artificial intelligence in logistics and supply chain management. The author of the study identifies risk factors such as insufficiently secure databases or networks, phishing schemes targeting weak links in the supply chain, and insufficiently secure APIs.

In addition, it is important to note the growing interest in the ethical and regulatory aspects of the use of artificial intelligence in logistics, as they directly affect the speed of development of this industry. Studies in this area consider the impact of automated systems on society, the legal framework for regulation and responsibility for AI decision-making. In particular, studies [9, 10] highlight the importance of analysing the ethical aspects of using artificial intelligence in logistics systems. They are based on the understanding that the widespread use of artificial intelligence requires attention to ethical issues, in particular, the use of personal data of staff and customers, as well as the validity of management decisions made using artificial intelligence. Studies have shown that it is necessary to carefully consider the ethical aspects of introducing artificial intelligence into logistics systems to ensure the fair and ethical use of this technology.

Current research focuses on the potential benefits and challenges of introducing innovative artificial intelligence technologies into enterprise logistics management. It is noted that the implementation of artificial intelligence in the logistics sector requires an integrated approach and a deep understanding of various aspects, such as technological innovation, data security, ethical and regulatory requirements, and social ones. This suggests the need to continue and deepen research in this area, as its relevance and importance for the further development of logistics in the modern world is extremely important.

Formulation of article objectives

The purpose of this article is to analyse the problems and challenges associated with the integration of artificial intelligence into the logistics sector, as well as to develop recommendations for the effective implementation of AI, taking into account data security, ethical standards and regulatory aspects. The analysis will identify potential risks and propose strategies and approaches to overcome them in order to create sustainable and efficient logistics systems that take advantage of artificial intelligence to achieve high results.

Presentation of the main material

Artificial intelligence algorithms are used in various areas of logistics to optimise processes and increase efficiency.

Without AI, logistics companies have to manually plan routes on their own, which does not allow them to adapt to changes in traffic or weather conditions in time [8]. This can lead to longer delivery times and higher fuel expenses. In fact, traffic congestion alone adds $74.5 billion in operating costs to the industry annually in the US [6]. Machine learning algorithms allow analysing large amounts of data in real time, which in turn makes it possible to respond to changes and anomalies and thus optimise logistics routes, track the location of goods and manage their movement, reducing delivery time and costs. This increases the accuracy and speed of delivery, and allows you to keep customers informed about the status of their orders.

AI can be used to forecast demand, which allows for optimised procurement and warehouse management. This allows companies to efficiently plan inventory and reduce warehouse maintenance costs. AI allows automating processes related to warehouse management, including tracking goods in warehouses and their movement, inventory, etc. This increases the efficiency of workflows and reduces labour costs. In general, logistics tasks involving AI can be divided into 3 groups. The classification of logistics tasks is shown in Fig. 1.

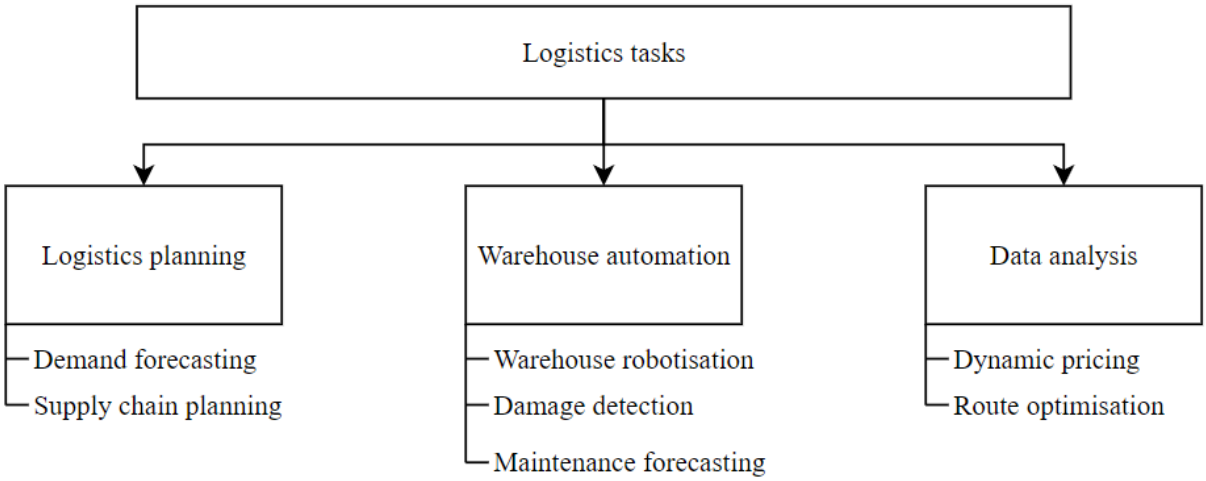

Fig. 1. Classification of logistics tasks

One of the key challenges that arise in the process of integrating artificial intelligence into the logistics sector is the selection and optimisation of algorithms that are best suited to solve specific tasks. This problem is not only complex but also critical, as the efficiency and accuracy of the system as a whole may depend on the choice of algorithm.

To demonstrate the importance of choosing the right machine learning algorithm and to identify the main selection criteria, it was conducted a comparison of the effectiveness of different algorithms on the route optimisation task to minimise delivery time, taking into account several factors such as data type, data volume, and prediction accuracy.

In the course of the experiment, three algorithms were used to predict the delivery time: linear regression, extreme gradient boosting (XGBoost), and recurrent neural networks (RNN). To evaluate the accuracy of the models, we used the mean absolute error metric.

Linear regression showed an average absolute error of 12.83, which indicates a certain inaccuracy of predictions on a dataset with nonlinear dependencies. This algorithm works well on simple data, but is unable to effectively handle complex dependencies.

XGBoost proved to be the most efficient algorithm with an average absolute error of 1.13, demonstrating the algorithm's ability to accurately model complex relationships between variables.

RNN had the highest error among the models at 37.70, which may be due to insufficient data to train the model or the fact that the dataset did not contain enough time dependencies based on previous events.

The task of predicting delivery times is quite complex due to factors such as traffic, weather, and time of day. That is, the type, volume, and complexity of the data directly affect the efficiency of the algorithm. XGBoost was 91.2 % more accurate than linear regression and 97 % more accurate than recurrent neural networks

Fig. 2 and Fig. 3 show a comparison of actual and predicted delivery times obtained from the three algorithms.

The choice of a machine learning algorithm or deep learning technique requires in-depth analysis and careful consideration of various factors. For example, it is necessary to take into account the type of data used to train the model, the amount of available data, the complexity of the problem, and the speed and accuracy required to solve a specific logistics task [13].

In addition, algorithm optimisation involves selecting the optimal model parameters to achieve maximum efficiency. This process can be quite complex and require a large number of experiments and analysis of results.

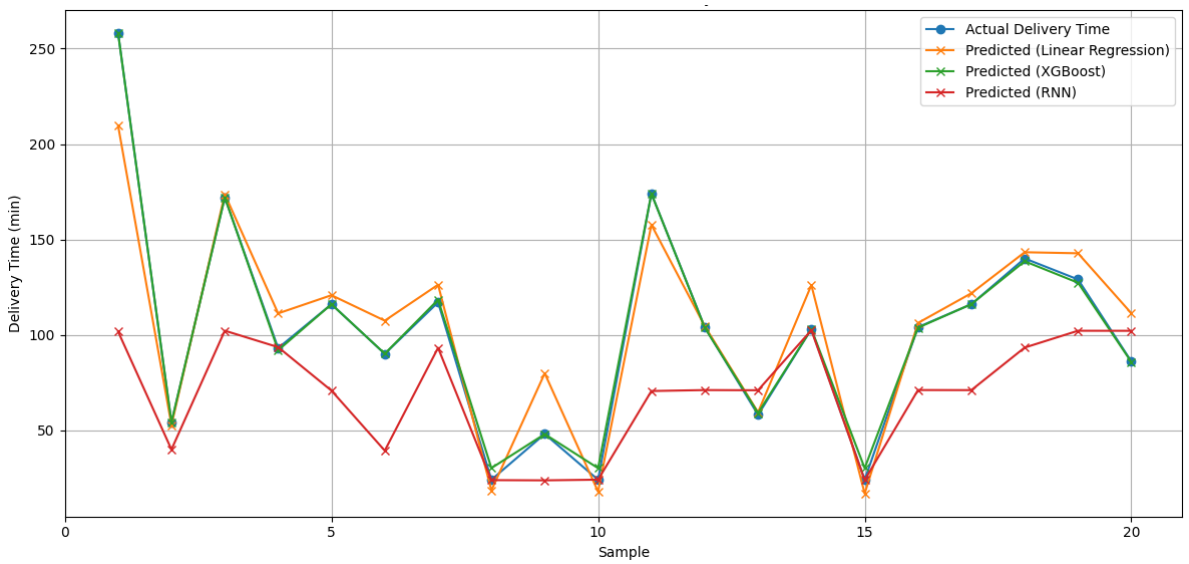

Fig. 2. Delivery time prediction results

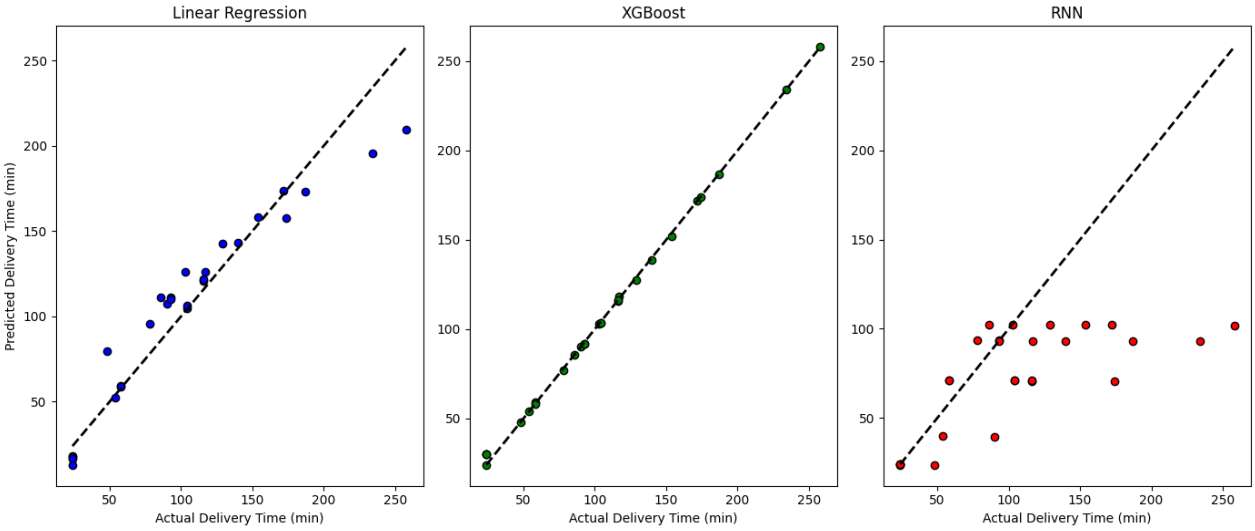

Fig. 3. Comparison of actual and predicted delivery times

The problem of choosing algorithms becomes especially relevant in the context of rapid technological development and constant replenishment of the set of available methods. This creates the need to constantly evaluate and rethink the choice of algorithms in the context of changing conditions and tasks. Fig. 4 shows the main criteria for selecting algorithms.

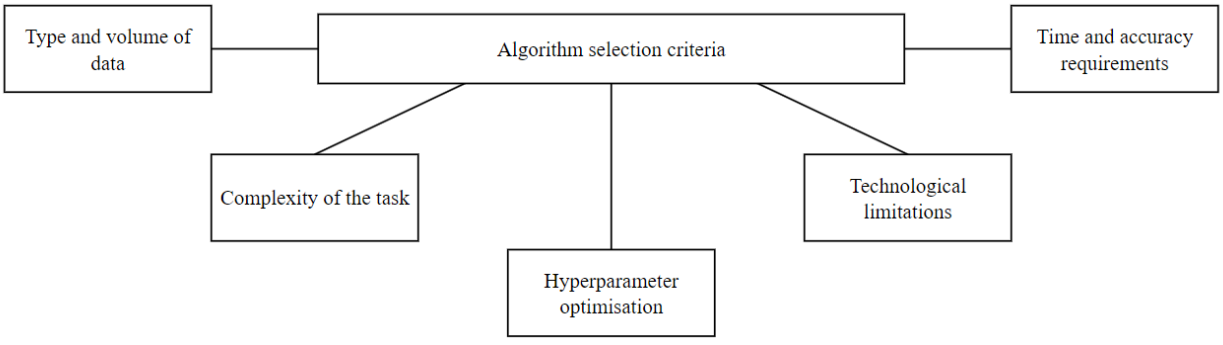

Fig. 4. Criteria for choosing AI algorithms

Also, the configuration of data and its quality directly affect the efficiency of algorithms. There is a possibility that AI can make biased decisions based on historical data.

Biased AI decisions in logistics can occur for several reasons and have serious consequences for businesses and customers. One of the main reasons is that many AI algorithms are trained on historical data, which may contain bias or partiality. For example, if a logistics company's historical data shows that certain types of work are more often performed by men than women, an AI algorithm may decide to automatically assign these jobs to men, which can lead to biased decisions and inequality in the performance of tasks [1, 5].

In addition, another reason for biased decisions may be the lack of representativeness of the data on which the algorithm is trained. If certain groups or aspects of data are underrepresented, this can lead to distorted results and biased decisions.

In logistics, biased AI decisions can lead to underestimating or overestimating certain important factors, such as delivery times, customer needs, or the optimal route. This can lead to business losses due to stock outs or overstocks, delivery delays, customer dissatisfaction, and reduced service levels.

The use of artificial intelligence in logistics requires careful selection and optimisation of algorithms, as well as avoiding biased decisions. To solve the problems of selecting and optimising artificial intelligence algorithms and eliminating biased decisions in the logistics sector, the article develops recommendations for implementing AI in logistics information systems.

Before using AI algorithms, it is necessary to conduct a thorough analysis of the source data to identify and eliminate bias or lack of representativeness. This may involve collecting additional data or applying bias reduction techniques.

It is important to develop objective metrics to evaluate the effectiveness and objectivity of AI algorithms. This will help identify potential biased decisions and ensure continuous improvement of algorithms.

In addition, experts from various fields, including logistics, ethics, and social sciences, should be involved in the process of developing and improving AI algorithms. Their knowledge and experience can help identify and address potential bias issues.

It is important to constantly train and improve AI algorithms using new data and methods. This will help to increase the objectivity and accuracy of decisions.

The issue of data security in the context of integrating artificial intelligence into the logistics sector is a serious challenge for companies that use artificial intelligence to optimise their logistics processes. As the amount of data processed and analysed increases, so does the risk of unauthorised access, loss or misuse of this data.

One of the key threats is the possibility of cyber-attacks. Insufficiently protected databases or networks can become the target of cyberattacks, during which attackers can gain unauthorised access to confidential information. This can lead to confidential data leakage, breach of trust of customers and partners, and significant financial losses for the company.

Another threat is phishing attacks. Attackers can use phishing schemes to gain access to logistics systems through weak points in the supply chain, such as less secure suppliers. This can lead to the leakage of confidential information or even the theft of goods.

Poorly secured application programming interfaces (APIs) used to collect data, submit it to the AI model, and obtain results can also be targeted by attackers. This can lead to data leaks or malicious code being injected into the AI system, which in turn can lead to further cyberattacks or disruption of logistics processes.

Recently, some incidents, such as the cyberattack on SolarWinds in 2020 or the technical error of ChatGPT developers in 2023, demonstrate how serious the consequences of a data security breach can be [2]. Therefore, it is necessary to take appropriate measures to ensure data security in the context of AI in logistics.

It is not possible to make the system absolutely secure or reduce the level of cyber threats to zero, but certain measures can be taken to significantly reduce the risks associated with the security of logistics systems.

To effectively mitigate cyber risks in complex supply chains, companies need to regularly conduct vulnerability assessments and implement security measures. This includes identifying potential weaknesses in hardware, software, network infrastructure and human factors, and prioritising remediation based on their importance and potential impact.

Effective vulnerability management involves ongoing monitoring, remediation, testing and training to ensure that all components of an organisation's supply chain are secure and up-to-date.

Protecting data at rest and in transit is important to prevent leakage and ensure compliance with privacy regulations. It is recommended to use encryption standards such as AES-256, TLS/SSL or SSH, depending on the type of data and communication channels. In addition, organisations should implement a data classification and retention strategy to minimise the amount of sensitive information stored and processed, and create backup and disaster recovery plans to protect against loss.

AI algorithms are able to analyse information from a variety of sources, such as network logs, sensor data and user behaviour, to identify irregularities that may indicate a cyber-attack. In addition, AI systems can continuously learn from experience, allowing them to improve their detection capabilities over time.

One of the well-known artificial intelligence methods used in cybersecurity is supervised learning. In this approach, an algorithm is trained on a dataset of known cyber threats, allowing it to recognise similar patterns in new data. Supervised learning can be effective in detecting known threats, but may have difficulty recognising previously unknown attacks. To detect new and unknown threats, unsupervised learning technology should be used. This method allows the algorithm to find hidden patterns or anomalies in the data without prior knowledge of the threats [7].

In addition, artificial intelligence systems can help with incident response and threat tracking. When combined with automated recovery tools, AI can speed up the containment and remediation process, reducing the overall impact of a cyber-attack.

The introduction of artificial intelligence into logistics information systems can be a complex and multifaceted task. Therefore, such technological transformations inevitably lead to a number of ethical issues that require careful study and resolution.

The bias of AI algorithms, which was described in the problem of algorithm selection and development, is also one of the most pressing ethical issues in modern logistics. Data-driven algorithms may contain biases that lead to discrimination against certain groups of people or companies. For example, an algorithm that optimises delivery routes may favour companies located in affluent areas or refuse to serve remote or poor regions. This can have a negative impact on access to goods and services, as well as on the economic development of these regions.

The opacity and complexity of AI algorithms make them 'black boxes', which makes it difficult to understand how they work and how they make decisions. This can lead to situations where algorithms make discriminatory or unfair decisions, but it is impossible to clearly identify the reasons and challenge them. This issue is particularly acute when AI is used to make important decisions that affect people's lives.

The collection and use of data by logistics companies also raises a number of ethical issues related to privacy and confidentiality. Logistics companies collect huge amounts of data about their customers, suppliers and employees. This data can be used to create personalised services or to improve AI algorithms. However, it is important to ensure that data collection and use is done ethically, with due regard for the right to privacy and in compliance with all relevant laws [3].

To overcome these dilemmas, comprehensive measures are needed. First, clear ethical guidelines for the use of AI based on fairness, transparency, accountability, respect for privacy and human rights need to be developed. Ethics committees should be established with the participation of representatives of logistics companies, academics, ethics experts, the public, and the government to monitor and evaluate the ethical use of AI.

Secondly, it is important to ensure transparency and accountability of AI algorithms. Their work should be clearly documented so that people understand how they make decisions. Auditing and verification methods are needed to ensure that algorithms are ethically compliant. Companies that use AI should inform about its use and the measures taken to protect data privacy.

Third, bias in AI algorithms needs to be reduced. Thorough testing on a variety of data sets will help identify and eliminate bias. In addition, correction methods are needed to ensure that algorithms do not discriminate against certain groups. It is also important to raise awareness of the problem of bias in AI and how to avoid it.

The fourth point is data protection. Clear rules should be developed for the collection, storage, and use of data in AI algorithms. People should have the right to access their data and control its use.

Conclusions

Thus, after analysing the integration of artificial intelligence into the logistics sector, we can see that the impact of AI is quite significant. The use of AI in logistics information systems can reduce costs, increase efficiency and competitiveness of logistics companies by optimising and automating a large number of processes, such as demand forecasting, supply route planning, warehouse management, and improving customer interaction.

However, in addition to the positive effects, AI integration raises a number of technical and ethical issues. There are problems of choosing and optimising algorithms. The results of the experiment demonstrate that the choice of algorithm has a critical impact on the accuracy and efficiency of solving logistics tasks. XGBoost was 91.2 % and 97 % more accurate than linear regression and recurrent neural networks, respectively. This helped to define the criteria for selecting machine learning algorithms and optimising them for specific logistics tasks, which can significantly improve forecasting accuracy.

Security and ethical issues also arise. Most of these issues have been considered in detail and a number of recommendations have been made to avoid or reduce their effect. The successful implementation of AI in logistics requires a comprehensive approach that includes the development of a clear AI implementation strategy that takes into account goals, resources, and potential risks, continuous training and improvement of AI algorithms that meet specific logistics tasks, ensuring data security and protection of confidential information, and the development of ethical principles for the use of AI that guarantee fairness, transparency, and accountability.

In view of this, further research, improvement and updating of strategies for the implementation of automated technologies are becoming a priority for the effective development of AI integration into logistics processes and achievement of the set goals.

Список літератури

1. Fuel Transport. *Challenging an Unconscious Bias in Logistics*. https://fueltransport.com/challenging-unconscious-bias/

2. Oladimeji, S., & Kerner, S. M. (2023, November 3). *SolarWinds hack explained: Everything you need to know*. TechTarget. https://www.techtarget.com/whatis/feature/SolarWinds-hack-explained-Everything-you-need-to-know

3. OmneelabWMS (2023, August 9). *Ethical Considerations in AI-Enabled Supply Chain Decision-Making*. Medium. https://medium.com/@omneelabWMS/ethical-considerations-in-ai-enabled-supply-chain-decision-making-4e9575c036c3

4. Richey Jr, R. G., Chowdhury, S., Davis-Sramek, B., Giannakis, M., & Dwivedi, Y. K. (2023). Artificial intelligence in logistics and supply chain management: A primer and roadmap for research. *The Journal of Business Logistics*, *44*(4), 532–549. https://doi.org/10.1111/jbl.12364

5. Silberg, J., & Manyika, J. (2019). Notes from the AI frontier: Tackling bias in AI (and in humans). *McKinsey Global Institute*.

6. The American Transportation Research Institute (2018, October 18). *Trucking Industry Congestion Costs Now Top $74 Billion Annually*. ATRI. https://truckingresearch.org/2018/10/trucking-industry-congestion-costs-now-top-74-billion-annually/

7. Vernall, M. (2023, December 16). *How To Keep Supply Chains More Secure by Leveraging AI & ML*. Linkedin. https://www.linkedin.com/pulse/how-keep-supply-chains-secure-leveraging-ai-ml-mark-vernall-az3kc

8. Voitsekhivska, I. (2024, January 11). *AI in Logistics: How Does It Truly Transform The Field?* Eliftech. https://www.eliftech.com/insights/ai-in-logistics-explained/

9. Медведєв, Є., Попова, Ю., & Коваленко, М. (2023). Інноваційні технології штучного інтелекту в управлінні логістикою соціальних підприємств. *Економіка та суспільство*, (56). https://doi.org/10.32782/2524-0072/2023-56-53

10. Музиченко, Т., Скорба, О., & Шевчук, А. (2023). Штучний інтелект як засіб оптимізації бізнес процесів в електронній комерції. *Академічні візії*, (25). https://doi.org/10.5281/zenodo.10081884

11. Позняк, О., & Мельник, К. (2020). Логістичні аспекти штучного інтелекту в управлінні товарами стратегічного призначення. *Науковий погляд: економіка та управління*, *3*(69), 153–158. https://doi.org/10.32836/2521-666X/2020-69-25

12. Фалович, Н., & Дубчак, О. (2023). Впровадження штучного інтелекту в логістиці: майбутнє логістичної галузі. *Матеріали Всеукраїнської науково-практичної Інтернет-конференції "Маркетингові технології підприємств в сучасному науково-технічному середовищі"*, 143–144.

13. Шматковська, Т., Стащук, О., & Дзямулич, М. (2021). Великі дані та бізнес-моделювання економічних систем. *Ефективна економіка*, *5*. https://doi.org/10.32702/2307-2105-2021.5.96

References

1. Fuel Transport. *Challenging an Unconscious Bias in Logistics*. https://fueltransport.com/challenging-unconscious-bias/

2. Oladimeji, S., & Kerner, S. M. (2023, November 3). *SolarWinds hack explained: Everything you need to know*. TechTarget. https://www.techtarget.com/whatis/feature/SolarWinds-hack-explained-Everything-you-need-to-know

3. OmneelabWMS (2023, August 9). *Ethical Considerations in AI-Enabled Supply Chain Decision-Making*. Medium. https://medium.com/@omneelabWMS/ethical-considerations-in-ai-enabled-supply-chain-decision-making-4e9575c036c3

4. Richey Jr, R. G., Chowdhury, S., Davis-Sramek, B., Giannakis, M., & Dwivedi, Y. K. (2023). Artificial intelligence in logistics and supply chain management: A primer and roadmap for research. *The Journal of Business Logistics*, *44*(4), 532–549. https://doi.org/10.1111/jbl.12364

5. Silberg, J., & Manyika, J. (2019). Notes from the AI frontier: Tackling bias in AI (and in humans). *McKinsey Global Institute*.

6. The American Transportation Research Institute (2018, October 18). *Trucking Industry Congestion Costs Now Top $74 Billion Annually*. ATRI. https://truckingresearch.org/2018/10/trucking-industry-congestion-costs-now-top-74-billion-annually/

7. Vernall, M. (2023, December 16). *How To Keep Supply Chains More Secure by Leveraging AI & ML*. Linkedin. https://www.linkedin.com/pulse/how-keep-supply-chains-secure-leveraging-ai-ml-mark-vernall-az3kc

8. Voitsekhivska, I. (2024, January 11). *AI in Logistics: How Does It Truly Transform The Field?* Eliftech. https://www.eliftech.com/insights/ai-in-logistics-explained/

9. Medvedev, E., Popova, Y., & Kovalenko, M. (2023). Innovative technologies of artificial intelligence in the logistics management of social enterprises. *Economy and Society*, (56). https://doi.org/10.32782/2524-0072/2023-56-53

10. Muzychenko, T., Skorba, O., & Shevchuk, A. (2023). Artificial intelligence as a means of optimizing business processes in e-commerce. *Academic Visions*, (25). https://doi.org/10.5281/zenodo.10081884

11. Pozniak, O., & Melnyk, K. (2020). Logistics aspects of artificial intelligence in the management of strategic goods. *Scientific view: economics and management*, 3(69), 153–158. https://doi.org/10.32836/2521-666X/2020-69-25

12. Falovych, N., & Dubchak, O. (2023). Implementation of artificial intelligence in logistics: the future of the logistics industry. *Materials of the All-Ukrainian scientific and practical Internet conference „Marketing technologies of enterprises in the modern scientific and technical environment"*, 143–144.

13. Shmatkovska, T., Stashchuk, O., & Dziamulych, M. (2021). Big data and business modelling of economic systems. *Effective Economy*, 5. https://doi.org/10.32702/2307-2105-2021.5.96

ШТУЧНИЙ ІНТЕЛЕКТ У ЛОГІСТИЦІ: МОЖЛИВОСТІ ТА ВИКЛИКИ

Євген Буров[1], Андрій Кулявець[2]

[1,2] Національний університет "Львівська політехніка",
кафедра інформаційних систем та мереж, Львів, Україна
[1] E-mail: yevhen.v.burov@lpnu.ua, ORCID: 0000-0001-8653-1520
[2] E-mail: andrii.m.kuliavets@lpnu.ua, ORCID: 0009-0006-4946-1416

Інтеграція штучного інтелекту в логістичну галузь – це сфера, що швидко розвивається і має потенціал докорінно змінити способи транспортування та управління товарами. Штучний інтелект можна використовувати для оптимізації широкого спектру логістичних процесів – від прогнозування попиту і планування маршрутів до управління складом і обслуговування клієнтів. Однак інтеграція штучного інтелекту також викликає низку технічних та етичних проблем, які необхідно вирішити для забезпечення його успішного впровадження.

Вибір правильних алгоритмів штучного інтелекту для конкретних логістичних завдань має вирішальне значення для забезпечення їхньої ефективності та точності. Це вимагає ретельного врахування таких факторів, як тип даних, складність завдання і бажані показники ефективності.

Зростаючий обсяг даних, зібраних і опрацьованих системами штучного інтелекту, викликає занепокоєння щодо безпеки та конфіденційності даних. Компаніям необхідно впроваджувати надійні заходи безпеки, щоб захистити конфіденційні дані від несанкціонованого доступу, порушень і зловживань.

Використання штучного інтелекту в логістиці викликає етичні проблеми, пов'язані з упередженістю, прозорістю та підзвітністю. Алгоритми штучного інтелекту повинні розроблятися і використовуватися чесно, прозоро і з врахуванням права на приватність та з дотриманням усіх необхідних норм законодавства.

Для усунення чи запобігання цих проблем розроблено та сформульовано рекомендації для ефективного впровадження штучного інтелекту в логістичну сферу. Вони включають в себе аспекти, на які потрібно першочергово звернути увагу при розробленні механізмів автоматизації логістичних процесів.

Інтеграція штучного інтелекту в логістику відкриває значні можливості для підвищення ефективності, зниження витрат і поліпшення обслуговування клієнтів. Однак для забезпечення відповідального і корисного впровадження штучного інтелекту вкрай важливо вирішити технічні та етичні проблеми, пов'язані з інтеграцією штучного інтелекту, щоб забезпечити його відповідальне і корисне використання. Дотримуючись рекомендацій, логістичні компанії можуть успішно використовувати штучний інтелект для трансформації своїх операцій і досягнення стратегічних цілей.

Ключові слова: штучний інтелект, логістика, логістичні системи, автоматизація, інноваційні технології.