

Artificial Intelligence in Risk Prediction and Management of E-commerce Supply Chains

Wanxin Feng

*Department of Operations Management, Fisher College of Business, The Ohio State University,
Columbus, USA*

Feng.1350@buckeyemail.osu.edu

Abstract. In the face of the growing complexity and vulnerability of the e-commerce supply chain, artificial intelligence (AI) is used to improve risk prediction and decision-making greatly. This paper explores how AI-driven solutions have improved demand forecasting, logistics scheduling, and supplier risk management, as well as created new challenges, such as algorithmic bias, overreliance, and data privacy issues. The study also delves into the analysis of benefits and potential risks, supported by recent literature and industry case studies. To tackle these issues, this study offers suggestions about making the best use of AI in this situation, like improving data management, using both people and AI to watch over things, making sure computer stuff is safe from bad people who might want to mess with it, and following rules for being a good friend to AI. As shown in the result, with transparency in data governance and the addition of good technical protection, AI could help with supply chain resiliency and efficiency. The findings show that for these e-commerce businesses to do more than operate well, but actually have sustainable, resilient supply chains, they need to strategically and ethically embrace AI.

Keywords: Supply Chain Risk Management, Artificial Intelligence, E-Commerce, Decision-Making, Ethical AI

1. Introduction

1.1. Research background

The swift development of the globe's digital economy has made it so that e-commerce is right up there, completely changing how businesses used to work. The outstanding feature is the logistics operation mode. Statistics from Statista forecast that the world's e-commerce sales volume will be over \$5.8 trillion by 2023, and it will be over \$8 trillion by 2027 [1]. It is a type of growth that requires much more complex interrelated supply chains that will react quickly to consumer demands. Logistics operations in the past were mostly based on human manual planning and scheduling, and human and operational factors can easily interrupt them. The e-commerce supply chain depends greatly on real-time logistics as well as cross-border transactions, so there would be a greater risk. For example, risk of logistics delays, demand fluctuations, and missing data security issues [2].

Some more advanced computing techniques are being used in an attempt to reduce these. Artificial intelligence has become an effective solution to these problems. Using machine learning and deep learning algorithms, artificial intelligence can analyze the massive amount of market data and get more accurate demand forecasting results. AI can reduce over-/and undersupply with demand prediction models, and intelligent logistics algorithms can predict delays and optimize routes [3]. In the same way, there is an increasing amount of practical instances where AI is being used for supply chain management, giving businesses better and more accurate management as well as strategic help. In this case, the question of how to apply artificial intelligence technology to predict and warn against risks of the supply chain is now the most popular discussion point in the academic circle as well as in the industry.

1.2. Literature review

As artificial intelligence technology is developing along with its wider application, research for smart supply chain management is also making some new developments. Min studied how AI gets used for predicting demand; Min saw that AI greatly helped in accurately predicting demand and made customers happier while also lowering the cost of having products on hand [4]. Mehrotra et al., how Walmart could lessen its transportation fees and greatly cut down on its carbon emissions by planning routes with AI [3]. It has been shown that algorithms based on AI can better find supplier risk than traditional methods. Moreover, these algorithms are more suited for global supply chains [5].

Other scholars also consider the limitations and risks of AI in the supply chain. Mehrabi et al. talked about the problems of Algorithmic bias and fairness in AI and said that over-reliance on customer data to analyze, predict, and make predictions would introduce new cybersecurity and model reliability problems [6]. The above studies point out the benefits that AI brings, while highlighting the difficulties and problems caused by AI. People can get a much better idea of what my kind of AI can do for a supply chain situation.

1.3. Research gap

Academics are now starting to look at how artificial intelligence is impacting e-commerce supply chains; however, there are still some issues with what scholars have found already, such as. First, many existing studies focus on one single aspect of e-commerce, such as demand forecasting or logistics improvement, and have yet to systematically explore the applications of AI to risk prediction and decision making across the entire e-commerce supply chain. This entails integrating risk assessment from procurement and demand forecasting to last-mile delivery and returns, all within the unique context of digital platforms and global logistics. Secondly, the research on the application of AI in traditional retail supply chains has been relatively extensive, while the specific situation of e-commerce supply chains (digital platform and cross-border logistics) is relatively less involved. Consequently, there remains a limited understanding of the potential risks of applying AI to e-commerce supply chains, including both operational risks (logistics delays, supplier disruptions) and digital risks (privacy of consumer data, system dependencies).

1.4. Research framework

This study aims to bridge these gaps by developing a comprehensive framework for understanding AI's role in predicting and managing risks within e-commerce supply chains. The structure of this

research is as follows: First, the research is about the background and current status of AI applications in e-commerce supply chains, such as demand forecasting, logistics optimization, and supplier evaluation. Second, this paper analyzes the positive impact of AI, including but not limited to the more accurate forecasting of demand, logistics scheduling optimization, and supplier risk management. Third, this paper also points out the key problems that need to be addressed in the process of applying AI, such as algorithm bias, overreliance on AI systems, and data privacy. Finally, this paper proposes some improvement strategies in response to the above problems to improve the reliability of the AI.

The object of this paper is the supply chain of e-commerce. Not only highlight the opportunities of AI in risk prediction and management, but also emphasize its potential limitations and risks. The end goal is to provide useful know-how for creating much stronger, more powerful, and safer AI, based supply chains for e-commerce businesses.

2. Case description

2.1. Overview of e-commerce supply chains

E-commerce is different from traditional supply chain with respect to Speed Dimension, Size Dimension, and Complexity Dimension. But it could be disrupted by this very nature. Global online retail is booming as a result of Amazon, Alibaba, and JD. They have highly digitized, global, around-the-clock supply chains, with international logistics and multiple tiers of supplier ecosystems - all much more likely to suffer from sudden demand spikes, logistics snafus, and stock shortages [6]. Take any e-commerce company prepping for shopping festivals like Singles' Day in China or Black Friday in the US. Order volume can skyrocket by an order of magnitude in just a week [7].

2.2. Role of artificial intelligence in e-commerce supply chains

The use of artificial intelligence in online commerce supply chains have been widely applied to fight against these kinds of dangers: the first one is by AI-driven demand forecasting system for both nonlinear patterns and dynamics in data from sales trends of past times along with seasonality impacts customer analysis to provide more predictable results compared to just statistics do; Moreover, for example, Amazon uses machine learning to predict demand in a region and pre-stores goods in warehouses close to customers to provide fast delivery services [4].

Second is logistics and transportation management, which uses AI Exist algorithms that can predict delays as well as suggest the best delivery routes according to the real-time analysis of the current traffic, weather, and congestion at ports. Alibaba's logistics network partner, Cainiao, makes an AI-based scheduling system that reduces the average delivery time by 30% [8].

The manager uses third-party supplier risk and AI Technology. Scholars use predictive models to analyze supplier performance and financial health as well as geopolitical hazard. It's used to warn of possible disruptions early and modify the sourcing strategy for the supply chain so that continuity is maintained. Powered by an AI risk evaluation tool, it could identify a high chance of bankruptcy, product defects, or transportation bottlenecks in suppliers, and e-commerce companies could switch to other suppliers right away [5].

These apps together show users how AI makes the e-commerce supply chain more able to both fight (resist problems) and work.

2.3. Development status and emerging challenges

Though some advances have been made, integrating AI into the supply chain of e-commerce is not as easy. From one viewpoint, AI application in the e-commerce supply chain generates perceptible profit, such as inventory cost cuts, quicker arrival speed, and improved customer satisfaction [4,8]. On the contrary is the black box of AI algorithms, AI system trustworthiness, and data security obstacles [5]. It can show what balanced views are necessary, that Scholars have to find those good things, and yet also have to carefully inspect the connected dangers so as to build real means to cut down such dangers.

3. Analysis of the problem

3.1. Positive influence identified

3.1.1. Improved demand forecasting accuracy

Artificial Intelligence (AI) greatly improves supply chain management, as most improvements can be achieved by improving supply chain demand prediction. E-commerce companies use AI's machine learning, which uses consumer browsing activity, real-time sales, and social media rather than using linear regression models based on previous sales of past trends for predicting consumers' demand [9]. These kinds of models can predict things like demand going up because of seasons changing or new products coming out, which can help companies make changes to their supply on the spot, like the situation where an AI aids in exacting demand predictions so Amazon could ship stock to each local warehouse to complete online orders instead of a sole fulfillment center [4]. In this situation, accurate forecasts of consumer demand by AI cut stockout and overstock costs, and increase the power of the supply chain. Enhanced demand forecasting allows e-commerce businesses to foresee order volume during Black Friday and the Singles Day promotional period, where order numbers could double or even triple within hours. It is important to build a more responsive and resilient e-commerce supply chain.

3.1.2. Optimized logistics and transportation scheduling

AI positively influences the scheduling of e-commerce supply chain logistics, transportation, and delivery management. AI systems integrated with real-time traffic data, weather conditions, and shipping port congestion rates can alert managers to potential delays and bottlenecks, allowing them to adjust their schedules and routes [10]. Alibaba logistics company, Cainiao, has developed AI logistics scheduling. Improve warehouse operations and route algorithms, and shorten the average shipping time by more than 30% [11]. In addition, AI has enabled the use of autonomous delivery vehicles and drones for last-mile delivery in the e-commerce industry. For example, some companies in China use drones equipped with AI-based routing and scheduling to deliver products to consumers within cities. Overall, better management of logistics scheduling and transportation routes through AI increases the speed of e-commerce deliveries, reducing transportation delay risks and improving supply chain reliability in the rapidly growing global e-commerce market.

3.1.3. Enhanced supplier risk management

AI positively impacts supplier risk management in the global e-commerce industry. E-commerce suppliers are usually multi-tier networks that are at risk of disruption by events such as financial

distress, quality failures, or geopolitical conflicts. E-commerce companies use AI-based predictive models to analyze supplier performance data, financial stability indicators, and other external risk factors to identify patterns that indicate disruption risks [5]. Firms can then plan to mitigate the potential impact of supplier disruption and reduce reliance on high-risk suppliers. For example, suppliers can use AI-powered predictive models to assign scores to suppliers that indicate their performance and risk of disruption to help procurement managers identify alternative and reliable sources.

3.2. Problems identified analysis

3.2.1. Algorithm bias and accuracy limitations

A primary concern regarding AI adoption is the inherent limitation in the accuracy and potential bias of its algorithms. The reliability of machine learning models and algorithms largely depends on the quality and availability of the data used to train them. For example, there are many cases where datasets used for AI in e-commerce systems have been outdated or biased. When training data is outdated, model forecasts will not be accurate enough for supply chain planning. For example, at the start of the COVID-19 pandemic, when there were widespread shortages of consumer essentials like toilet paper, the existing AI-based demand forecasting models could not be applied to predict demand for the affected goods [12]. This underscores a fundamental limitation of many AI models: their inability to extrapolate beyond the historical patterns present in their training data, making them vulnerable to structural breaks or 'black swan' events. Another problem with using AI in supply chain management is that machine learning algorithms may be biased due to incomplete data. The problem arises when the training data of the machine learning model cannot truly represent the majority of consumers or market regions effectively [6]. When there are inaccurate predictions, the supply chains will be disrupted, incorrect orders of stocks in warehouses, and a shortage of products in physical stores will cause huge losses for e-commerce businesses.

3.2.2. Over-dependence on AI systems

AI dependence and over-reliance on AI in the e-commerce supply chain are other problems, such as the use of AI in e-commerce. AI-based demand forecasting, Logistics management, Warehouse management, and Inventory Optimization systems are installed and adopted in the majority of e-commerce businesses. This results in over-reliance on automation and more or less human intervention and supervision. E-commerce companies have no extra plan for AI systems going offline. In one case of the failure of automated forecasting and order allocation among e-commerce companies, when a warehouse management system that uses AI was launched, the company's products were not delivered on time for several hours, even during the event of product launch, resulting in huge losses as well as customer dissatisfaction for the business [13]. Automation eliminates manual oversight, and over-reliance on the automated AI system can also create new risks and make supply chains less robust and less adaptive.

3.2.3. Data security and privacy concerns

The increased use of AI in e-commerce supply chains is likely to increase cybersecurity risks, including data privacy breaches. E-commerce AI systems use consumer purchase history, search and browsing records, and payment and supplier contract data for optimization. However, using AI systems to process sensitive consumer data raises data security and privacy concerns that may not be

fully addressed or appreciated by firms adopting AI in their supply chains. In recent years, some e-commerce firms have been hacked by organized cybercrime groups. In many reported cases, e-commerce sites were exploited by using AI to find and exploit software vulnerabilities that allowed hackers to gain unauthorized access to databases containing sensitive user data [14]. In addition, the increased use of AI in e-commerce supply chain management can have privacy-related consequences when firms operating in multiple countries face new data protection requirements that differ by region. For example, using AI to process customer data collected in the European Union would need to comply with the EU General Data Protection Regulation (GDPR), which would be a challenge for a firm with e-commerce sites in many countries. Consequently, robust data governance frameworks are imperative to mitigate the significant cybersecurity and privacy risks exacerbated by AI adoption.

3.3. Summary of analysis

In terms of problem analysis, it can be concluded that AI has a positive impact on certain supply chain operations and e-commerce, which involves demand forecasting, logistics, and risk assessment of suppliers [4,5,8,9]. And it is also stated that AI has negative impacts on the industry because of the AI accuracy and bias problems [6,12]. It is most probable that using AI with e-commerce increases the chances of cybersecurity and data privacy [14]. From the research, I can see that relying too much on AI managing all companies' supply chains is an issue as well. If these AI systems break down or get hacked, then it is going to be a whole new kind of disruption for the entire e-commerce industry in the world [13]. Conclusion: The growth of AI gives many chances for improvement in terms of effectiveness and fortitude. But Scholars let AI loose without robust data governance, without human oversight and regulatory compliance, and AI will do what it must and can inadvertently amplify system risk by default.

4. Proposed framework for mitigating AI-related risks

To fight the threats that were found in the analysis and take advantage of the benefits that would come from AI, we'd need a multi-sided plan. Also, here are some recommendations for an e-commerce company to have AI more strategically and resilient in the supply chain.

4.1. Establish a governance framework for responsible AI

In the long run, e-commerce companies have to figure out a way to make it so that responsible AI becomes part of what a company stands for and how it works with people who trust it. Create and communicate internal guidelines, policies, or standards on fairness, explanation, accountability, and safety for AI systems and projects. Like making up and letting out their ethical principles, decision standards, or yardsticks for artificial intelligence systems, and designating certain persons or squads to watch over and report on how much they conform to and how they do. Responsible-AI committees or councils for supply-chain AI might be set up too to make the control and supervision of algorithm setup, information gathering, use, and sharing more official. And also, the e-commerce companies could attempt to work together with industry associations, tech-providing companies, government departments, educational institutions, etc., to create and advertise industry-wide best practices and standards for AI use in supply chain risk management. This might be a benchmark study, open source toolkit or platform concerning bias detection or data privacy concerns, or multi-stakeholder framework/ initiative concerning cybersecurity or ethical AI. By all means, e-commerce

enterprises can collaborate to form a trustworthy and accountable AI ecosystem that benefits the whole supply-chain community.

4.2. Improve data quality and algorithm fairness

One of the main obstacles for AI applications in the e-commerce supply chain is poor data quality & data bias. Algorithms need good data to learn from, but datasets might be messy, old, missing stuff, or have problems. In order to protect the integrity and fairness of data, e-commerce companies need to build a data governance system that covers the whole data lifecycle process. It must include data gathering, cleaning, labeling, storage, and training. Data source should be timely, regular, supplemented, and perfect. Bias detection and mitigation tools and methods should be utilized both before and after training and deploying the algorithms to detect and fix any gap or oversight in the different customer segments, geographic areas, product categories, and scenarios. Take a firm that mixes its own inside transactional facts and information from its clients with outer signals like search trends or numbers about how the economy is going or what the competition is pricing things at, and use all those to help train up a prediction model that can better tell what's happening out there in the marketplace and what people actually prefer. Also, the analytics team should have specific people or groups to be "data stewards" and to constantly look at and make sure the data is of good quality and has lots of different examples over time.

Moreover, the explainable models or model explanation layer can increase visibility and answerability when making the forecast/replenishment choice. Take something like SHAP or LIME, the manager can see which variables contribute what to a particular prediction. The manager can easily spot any surprises or unreasonable biases/mistakes and fix them before they make it into the SC. To make up for that, e-commerce companies will probably come up with a corporate-level board that relies on each other for an 'AI review board' that includes supply chain experts, data analysts, and compliance workers, and their task is to examine and verify how the model performs and outputs in accordance with the company's ethical and benchmark standards of operation.

4.3. Balance automation with human oversight

AI can make e-commerce supply chains work better and cover a bigger area, but using algorithms too much will lead to troubles when things get complex or change quickly, when something extremely rare or unforeseen occurs, or when ethics and rules need consideration; to prevent excessive automation and ensure human supervision and interference is guaranteed for AI application, e-commerce companies must implement a "human-in-the-loop" approach for adopting AI. In this scenario, automation backs up the judgment and choice of a manager in the case of being critical or high-risk. Think about a scenario where a company makes order allocations/routing decisions in their fulfillment centers and does not just automate them with the output of a forecast. That company would make a control hierarchy based on a layering algorithm, which could give guidance; people can choose to say yes or override on certain criteria/thresholds.

It could also mean creating a failover mechanism and escalation protocols if there's a forecast failure from the forecasting platform or the warehouse management system, like doing these periodic scenario tests and "red team" drills so that scholars can mimic and practice all sorts of outage and anomaly situations and feel confident about the business continuity when a situation like that comes around, such as Black Friday or Singles' Day. Model the responsibility for the monitoring and escalation accountability, which could also be delegated to operational crews. This would give a feeling of control and responsibility for the AIP.

4.4. Strengthen cybersecurity and data privacy protections

Cyber attacks and data breaches can be conducted on AI systems for e-commerce supply chain risk management in order to obtain or steal information. As such, cybersecurity and data privacy should inform the design and the operation of AI solutions from an in-depth defence, least privilege, and privacy-by-design perspective. Just take the AI-powered app on supply chain as an example: It's gotta be secure with different levels, a network split in parts, data locked up and hidden away, who can enter and leave the area, along with AI trained to watch out for strange people who don't belong – clearly say what the Supplier Contracts and Agreements should contain about info protection and what is expected for security. Often, check to make sure companies' artificial intelligence systems are safe by doing tests like audits or poking around to find any holes where bad guys might sneak in. E-commerce businesses must follow all kinds of laws about protecting private information, like the EU's big privacy rule or the one in California that talks about consumer privacy rights. Privacy-by-design techniques such as anonymisation and pseudonymisation of data, as well as consent management and data retention policies, need to be taken into account for protecting customer and supplier data where necessary. Employees' teaching and learning programs also have to cover stopping common cyber dangers like tricks, companies' accounts controlled by others, and changing software without permission, which also affects AI systems.

5. Conclusion

5.1. Key findings

This paper studied the effect of artificial intelligence on e-commerce supply chain risk. Scholars focus on prediction, as well as the advantages/disadvantages of integrating AI by companies. From the research, it was found that AI improves operations a lot. And permits more accurate demand prediction. Efficient logistics planning. Strong supplier risk management. Helping the company predict when their product will be most in-demand, reduce the time it takes for them to get products to customers, evaluate how trustworthy a supplier is, and improve a firm's ability to handle supply issues and improve customer satisfaction.

But there were some problems, too. The information might not be very good, or the computer's decision-making might have unfair prejudices. Using machines too much could make people stop working and not look at how things work. It would be easier to do bad things, like making sure the internet is safe and stopping people's private info from being seen by others. The suggestions in this paper directly answer the three gaps. Forming up robust data-governing and discrimination-seeking institutions, conserving mixed decision-making structures, and bettering the management of cyber and privacy, and additionally proposing that AI responsibility concepts are incorporated into company routines and processes, and working alongside other industry parties and regulatory organizations.

5.2. Theoretical and practical implications

The results of this paper have practical value and guidance on how to run a business and research methodology for managers and scholars in e-commerce and the digital economy. On the other hand, the paper is helpful for the business; it can be a guide to adopting AI into their company and help them solve problems and dangers for business, technology, and ethical problems. The paper thinks that managers can adopt a holistic view to AI-powered supply-chain design, without making things

less clear, answerable to others, or customers trusting it. On the other side, the study also contributes to the sustainable development in online retail and other sectors of logistics by making clear how technological innovation and risk governance can move forward at the same time. The paper offers “a key contribution of this study is providing a balanced view of the opportunity and risk of AI that policymakers, technology providers, and other players in the e-commerce value chain can use to build norms and standards.

5.3. Limitations and future studies

The main research limitation of this paper is that it depends mainly on secondary data, case studies, and a review of the literature. Although it can give scholars a few useful ideas, it doesn't really describe what's happening quite fast for different online stores using AI. Here, some further research would be good, such as doing the kind of original data collection myself, like taking surveys, doing interviews, or getting involved in pilot experiments with people who work on supply chains. And maybe do more research that could show scholars if those things really make the research questions true, and if they work for a long time. An example of being in a certain research area would be the risk of each specific sector, like in green logistics, AI's involvement in sustainability, and then look at the actual use of AI, how does the green logistics use affect sustainability? Another one could be new technologies, such as generative AI and blockchain, and their possible complementarity to existing solutions.

References

- [1] Statista. (2023, July 27). E-commerce worldwide – statistics & facts. Statista. <https://www.statista.com/topics/871/online-shopping/?srsltid=AfmBOorKJvcT-rm55E8w9Oyx66yIoY2ERgZg-7pPWH-iIUEnlIKXCkpK#topicOverview>.
- [2] Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: Extending the supply chain resilience angles towards survivability. *International Journal of Production Research*, 58(10), 2904–2915. <https://doi.org/10.1080/00207543.2020.1750727>.
- [3] Mehrotra, P., Fu, M., Huang, J., Mahabhashyam, S. R., Liu, M., Yang, M. (A.), Wang, X., Hendricks, J., Moola, R., Morland, D., Krozier, K., Nie, T., Sun, O., Adbesh, F., Zhang, T., Shrivastav, M., Xu, J., Rajan, S., Turner, M., Tucker, S., Jones, M. D., Xiao, F., Bhargava, A., Deshpande, D., Mokashi, S., Johnson, T., Raman, C., Ferguson, M., Keller, M., Donahue, S., Bhutta, R., Akella, M., Musani, P., Venkatesan, S., Guggina, D., & Furner, J. (2024). Optimizing Walmart's supply chain from strategy to execution. *INFORMS Journal on Applied Analytics*, 54(1), 5–19. <https://doi.org/10.1287/inte.2023.0093>.
- [4] Raman, S., Patwa, N., Niranjana, I., Ranjan, U., Moorthy, K., & Mehta, A. (2018). Impact of big data on supply chain management. *International Journal of Logistics Research and Applications*, 21(6), 579–596. <https://doi.org/10.1080/13675567.2018.1459523>.
- [5] Yang, M., Zhao, L., Chen, J., & Xu, X. (2023). Supply chain risk management with machine learning during the COVID-19 pandemic. *Transportation Research Part E: Logistics and Transportation Review*, 174, 102947. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9715461/>.
- [6] Mehrabi, N., Morstatter, F., Saxena, N., Lerman, K., & Galstyan, A. (2021). A survey on bias and fairness in machine learning. *ACM Computing Surveys*, 54(6), 1–35. <https://doi.org/10.1145/3457607>.
- [7] National Bureau of Statistics of China. (2023, July 30). Operation of China's Purchasing Manager Index in July 2023. National Bureau of Statistics of China. http://www.stats.gov.cn/sj/zxfb/202307/t20230731_1941624.html.
- [8] Zhang, D., Pee, L. G., & Cui, L. (2021). Artificial intelligence in E-commerce fulfillment: A case study of resource orchestration at Alibaba's Smart Warehouse. *International Journal of Information Management*, 57, Article 102304. <https://doi.org/10.1016/j.ijinfomgt.2020.102304>.
- [9] Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S. F., Childe, S. J., Hazen, B., & Akter, S. (2017). Big data and predictive analytics for supply chain and organizational performance. *Journal of Business Research*, 70, 308–317. <https://doi.org/10.1016/j.jbusres.2016.08.004>.

- [10] Choi, T. M. (2021). Risk analysis in logistics systems: A research agenda and future directions. *Transportation Research Part E: Logistics and Transportation Review*, 145, 102170. <https://doi.org/10.1016/j.tre.2020.102170>.
- [11] Gölzer, P., & Fritzsche, A. (2017). Data-driven operations management: Organizational implications of the digital transformation in industrial practice. *Production Planning & Control*, 28(16), 1332–1343. <https://doi.org/10.1080/09537287.2017.1375148>.
- [12] Ivanov D. (2021). Exiting the COVID-19 pandemic: after-shock risks and avoidance of disruption tails in supply chains. *Annals of operations research*, 1–18. Advance online publication. <https://doi.org/10.1007/s10479-021-04047-7>.
- [13] Baharudin, H. (2023). AI in e-commerce warehouse management: Enhancing operational efficiency, ensuring inventory precision, and strengthening security measures. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.5050072>.
- [14] Kshetri, N. (2018). The economics of AI-driven cybersecurity in e-commerce. *IT Professional*, 20(6), 73–77. <https://ieeexplore.ieee.org/document/8617758>.