



Development of Logistics Technology: An Analysis based on the 4.0 Era

Mohammad Shahparan^{1*}, Artem Klykov², Elena Salnikova³, Shokirov Firdavsbek⁴

Lecturer, Department of Tourism, Silk Road International University of Tourism and Cultural Heritage, Samarkand, Uzbekistan-140104.¹

Professor, Department of Tourism, Silk Road International University of Tourism and Cultural Heritage, Samarkand, Uzbekistan-140104.²

Lecturer, Department of Tourism, Silk Road International University of Tourism and Cultural Heritage, Samarkand, Uzbekistan-140104.^{3,4}

Corresponding Email: mohammad.shahparan@univ-silkroad.uz*

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Abstract

The paper explores the concept of the development of logistics technology based on 4.0 and how logistics is driven by technology. It aims to guide future research and assist managers in implementing the development of technology logistics 4.0 concepts. Qualitative methods are used in this paper. Data related to logistics technology was collected from different online sources. The evolution of logistics technology in the era of Industry 4.0 has been significant. Logistics 4.0, a concept emerging from Industry 4.0, focuses on the digital transformation of logistics management. Logistics technology like Artificial Intelligence, Machine Learning, and Big Data in logistics management to enhance and optimize processes and communication between different systems in logistics operations. The rapid advancement of Information Technology has played an essential role in promoting modern logistics information technologies.

Keywords: Modern Technology, Logistics, Advancements, Information, Development

Introduction:

Technologies are transforming logistics systems and processes by this technology logistics, leading to greater efficiency and automation. In innovative warehousing, technology influences the logistics industry because smart warehouse helps save time and error-free operation and is a cost-consuming process. Using modern technology in the logistics sector ensures the sustainability of environmental issues. In the logistics sector, the rapid advancement of information technology has led to the discovery of a dynamic logistics world that promotes modern logistics with modern information technology. Many logistics service providers are

Development of Logistics Technology: An Analysis based on the 4.0 Era

now involved with modern information technology but are not involved with information technology; they are now thinking of involving IT. Those not involved in this are not fulfilling their fullest competitiveness and financial success.

The primary role of modern information technology in the logistics operations sector is to investigate the degree to which information technology, its proper usage, and its capabilities can affect logistics service providers. It influences logistics companies and run their activities smoothly with information technology. The modern Logistics industry has developed by involving Information Technology (IT) to increase performance and competitiveness. Key advancements include IT usage and capability influencing firm success through new service inventions (Nour, 2022).

Due to the technological improvement in the global productive system caused by the 4.0 revolution, building a new dimension of the logistics sector using information technology has become necessary. It helps to increase performance and timely response.

Many developed countries have implemented modern information technology in the logistics sector but still lack it because of proper application and research—the challenges and trends in implementing information technology in Logistics 4.0. Adopting information technologies and concepts of industry 4.0 in the field of logistics can be fruitful. Modern logistics technologies like blockchain, IoT, and Big Data enhance their performance worldwide and face challenges in adoption due to a lack of common frameworks, especially in developing countries (Camila Patricia Malagón-Suárez, 2023). There are benefits of integrated networks, such as cost reduction and customer satisfaction; There are also some disadvantages of integrated networks, such as initial implementation cost and technological error. (Loso Judijanto, 2024).

Technology factors are necessary for logistics process improvement and optimizations, the Internet of Things, Big Data, cloud computing, and artificial intelligence. These kinds of technology also help to achieve real-time data. 5G networking systems can meet these requirements in the logistics sector. They can turn into intelligent logistics instead of conventional logistics (Alexandra Lagorio, 2023). PI-based logistics performs activities to monitor and manage data, product characteristics, financial flows, and product traces. PI-based logistics also helps with data collection and data use. Blockchain technology increases product and customer service (Michele Acciaro, 2020).

The new information technology application in the logistics sector creates the emergence and development of the logistics sector. Many modern information technologies are used in logistics, which has turned into logistics 4.0. Due to the technological solutions and different modern tools that have updated the logistics sector, the Logistics Center (LC) is involved in technology. Through the 4th industrial revolution, logistics became available today, and logistics companies can control the whole logistics process without any problem. It is controlled automatically by the power of technology. For economic attraction, logistics is growing daily with the help of information technology. Modern technology like IoT, big data and CC are crucial advantages for the logistics sector because they enhance efficiency and operation activities (Smiljka Mišić, 2023). Intelligent logistics highlights the perception of modern logistics with big data, automation, the internet and AI. The development of the logistics sector depends on technology. Innovation technology and the application of technology are the central part of being a perfect logistics activity. Logistics 4.0 has advanced

with the invention of critical technology that enhances the efficiency and operations of the logistics sector (MeiE Xie, 2022).

Literature Review:

The application of modern technology is essential for sustainable development in the logistics sector. There is proof that modern technology helps achieve sustainability in the logistics sector. Information technology helps establish sustainability processes and the business model for the logistics services company.

Modern technology helps improve cargo handling and operations processes through identification systems and order-picking technologies. The current logistics sector is connected with information technology and data transfer systems. In the competitive market, logistics and supply chains face problems with customers' requirements. Such a problem can be solved only by using technological solutions and improving the quality of their services (Mariusz Kostrzewskia, 2021). According to the research and market, logistics will have a market value of \$ 9407.5 billion in 2023. It is expected to increase \$15978.2 billion by 2032, amounting to a CAGR of 6.45%. Technological innovations in the logistics sector are changing consumer behavior (Spector, 2024). Using automation, artificial intelligence, blockchain, and Internet of Things operators cutting-edge technology. The main aim of using this technology in the logistics sector is to optimize their process and improve efficiency and customer satisfaction (Tymoshchenko, 2024). Goods are transported, stored, and managed by technology in the logistics sector. The automation system handles sorting, packaging, loading and unloading (Patel, 2023). The main technology sectors, such as big data, cloud computing and networking, business intelligence, IoT, and hardware, refer to logistics 4.0. These are the critical components of Logistics 4.0. More development of technology means the development of the logistics sector. Developed countries implemented this technology sector wisely in logistics (KANSY, 2023). Logistics 4.0, with the support of information technology, focuses on the sustainability process and the business model for the logistics sector. Information technology highlights the benefits of logistics companies, such as energy efficiency and reduced error. The role of technology in the logistics sector is to run the logistics service process smoothly (Nayra Vasiulis Ferreira Rodrigues, 2022).

In the modern age, technology has transformed logistics 1.0 into logistics 4.0. Logistics 4.0 aims to achieve excellent efficiency in the logistics process. It impacts various sectors. Only Logistics 4.0 can enhance service quality with the application of technologies. (Mladen Krstić, 2021). The new technologies provide economic efficiency, environmental performance, and social impact on the logistics industry. Technology is the new landscape of sustainable logistics. It helps to perform smoothly in logistics (Xu Sun, 2022). One of the most modern technologies is automation. Automating can increase the efficiency of internal transport, transmission, and storage processes. It is essential for the logistics sector's automation process, which helps improve efficiency, service level, and competitiveness (Helmut Zsifkovits, 2020).

An intelligent warehouse in the logistics area plays a crucial role. The digitization of warehouse intralogistics implies changing the roles and tasks of workers who are operating fooled. Eware can be improved by the modern science and technology system(Domański, 2019).

Development of Logistics Technology: An Analysis based on the 4.0 Era

In the 21st century, digital technology is an urgent need in logistics. Technology helps to improve the logistics sector. Logistics improvement helps to increase the digital economy. The development of the theory and methodology of logistics transformation in modern conditions helps to identify the business activity in the logistics area (T. E. Evtodieva, 2019). The logistics process's technological conditions, opportunities, and challenges depend on the service provider. The main target of logistics service providers should be reliability and quality (Róbert Skapinyecz, 2018). Proper quality, quantity, time, place, conditions, suitable goods, and price are the 7R of the logistics sector. To fulfill this 7R, there is no alternative to applying modern technology. Without the application of modern technology, it is tough to compete in the market. Logistics is the central pillar of the value chain for the industries. Application of advanced technology, supply chain analysis, disruption management, environmental adaptation and climate change are the critical factors to highlight the logistics sector (Wang, 2016).

The logistics sector has developed with technological advancements like artificial intelligence (AI), machine learning (ML), intelligent warehouses, robotics, cyber-physical systems, big data, digital procurement tools, etc. The logistics sector now involves WMS and PLC through OPC UA for service quality. Due to the application of digital transformation, the logistics sector enhances efficiency, flexibility, and connectivity, which are the advancement tools for logistics sector automation, data exchange, and IoT integration.

Research Method

In this paper, qualitative methods are used. Data was collected from recent research papers on the logistics development field using technology. It also describes the link between technology and logistics in the 4.0 era and how technology developed the logistics sector. The methodology involves analyzing the relationship between modern technology and logistics and how new technology is applied in the logistics sectors. Discuss the potential of logistics operations with technologies based on secondary data.

Result and Discussion:

Modern technology is crucial for the development of logistics. When combined with information technology, cyber-physical systems (CPS), big data, and cloud computing, logistics development can revolutionize logistics processes and ensure consumer demand quickly without extra cost or time.

A world where nothing would be transported or delivered seems absurd. Thanks to logistics, distribution is now prompt and efficient. Logistics play a crucial role in a nation's economy by providing employment and contributing to its GDP. The global logistics market is estimated to reach 15.5 Trillion USD by 2023 in revenue. Today, logistics and technology are integrated to enhance the growth and efficiency of the logistics industry. The changing customer requirements are a critical factor in shaping the technologies used by the industry. Hence, the integration of logistics and technology. Here's a brief evaluation of a few emerging technologies bound to influence the future of logistics. Since IoT can transfer data over any network, it can monitor people, employees, and equipment while ensuring security and safety.

It enables managers to examine and understand ongoing activities in a factory or company, such as the performance of machines and equipment, energy consumption, ambient conditions, the status of inventory, and the flow of materials at any given time. It also enhances in-transit visibility, thus bringing more orders to industries. Besides, IoT can also predict imminent problems and hurdles that may inhibit the development of any or all aspects of the logistics industry. The world now consists of 1.1 million working and functional robots. They are efficient and reliable in manufacturing, production, and delivery. Moreover, they can work alongside human workers in factories. Japan and the USA are countries that have already implemented robotic services and artificial intelligence in several of their logistics processes. Shortly, we will witness a shift where robots will replace blue-collar jobs, and customer service will be less frustrating with the assistance of chatbots. Drone delivery is an actual possibility in the next few years. An uncrewed aerial vehicle can relieve city traffic by facilitating delivery service through the skies. It also has the potential to challenge geographical conditions and poor infrastructure, especially in rural areas. Google is already testing UAVs for rural deliveries in Queensland, Australia. At some point, drones will also be used to track. Equipped with electronic eyes, ears, and sensors, their application in logistics can enormously reduce costs and lower the burden of human effort. However, implementation is still challenging since only 12.78% of logistics companies have any knowledge or expertise in this area. Assists, monitors and flags high-risk areas or roads, and searches and locates missing employees.

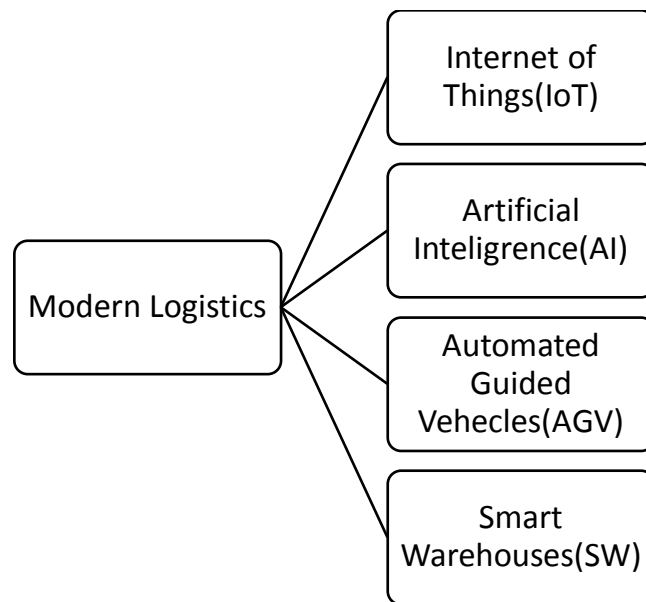
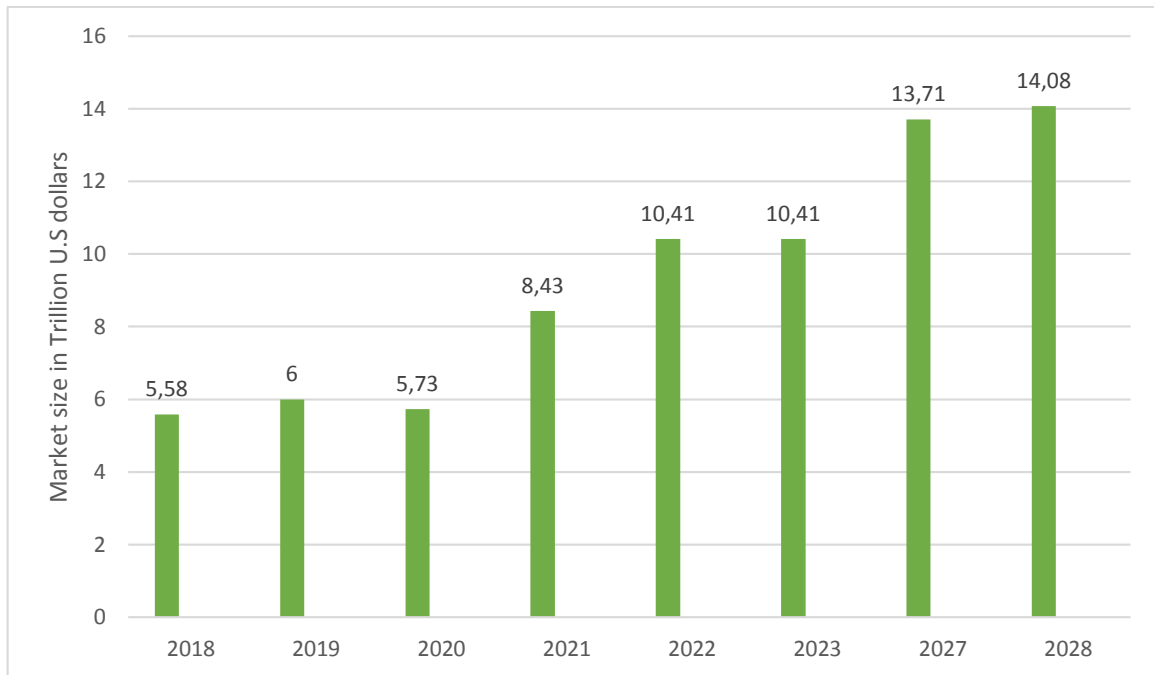


Figure 01: Modern Logistics Technology

The use of automation and robotics in the logist8cs sector has transformed into the modern era. Different kinds of automation tools, like robotics and AI, are the key technologies that enhance competitiveness in the logistics sector. Modern technology reduces the manual task in the logistics sector. Although it has challenges, it is easy to use in logistics. 2022 the worldwide logistics industry will hold a 10.41 trillion U.S. dollar market size. It is expected in the future, it will be 1408 trillion U.S dollars (table-01).

Development of Logistics Technology: An Analysis based on the 4.0 Era

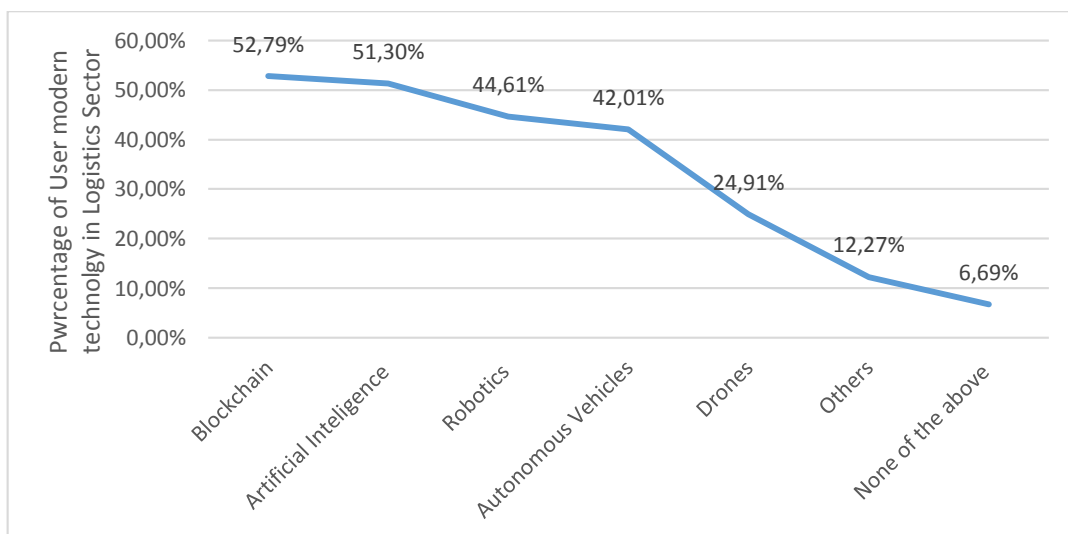
Table 01: Size of the global logistics industry from 2018 to 2022 with future forecast until 2028



Source: Statista

Due to modern technology, the logistics sector includes autonomous vehicles, artificial intelligence, and drones. These technologies may impact job stability because they streamline operations. In the future, technological advancements in the logistics sector will include autonomous systems, sustainable practices, and potential job transformations. Digitalization will enhance resource management. There was a significant change in the logistics industry worldwide in 2018. During the survey by Statista, almost 53% of the respondents said they expected that blockchain would change the logistics industry.

Table 02: According to Statista report in 2018 worldwide, the technology users in the logistics sector.



Conclusion

90% of logistics companies reported that they will implement new technology to ensure their operations. They need advanced technology solutions to grow their industry. According to the latest data insight, the SCM software market will grow by US\$20.27 billion this year. The synthesis of results and discussions underscores the multifaceted nature of information technology in the logistics sector.

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Development of Logistics Technology: An Analysis based on the 4.0 Era

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