Internet of Things and Big Data in Smart Logistics

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Abstract. With the rapid growth of global trade, the demand for logistics is increasing across all industries. The burgeoning demand is forcing the traditional logistics industry to transform itself into smart logistics. Among the many new technologies that have emerged in recent years, there are many that have facilitated the transformation of the logistics industry. This paper collects and integrates information on the technologies needed in the process of realising smart logistics and highlights the role of Internet of Things (IoT) and Big Data technologies in driving the smart logistics industry.

Keywords: Internet of Things · Big Data · Smart Logistics

1 Introduction

With the development of commodity variety and worldwide commerce, the logistics industry has grown to become a critical component of the global economy and a source of global firm marketing goods and expertise [1]. However, the logistics industry in the modern day continues to confront challenges such as excessive costs and inefficiency. According to the Council of Supply Chain Management Professionals' (CSCMP) 30th Annual State of Logistics Report, logistics expenditure in the United States was US$1.64 trillion in 2019, an increase of 11.4 percent over the previous year and accounting for around 8.0% of GDP [6]. Additionally, the percentage might be greater in certain less developed nations. It will be detrimental to the economy's growth.

Additionally, the COVID-19 outbreak had a significant impact on the industrial sector. Throughout the outbreak, the logistics sector performed a critical role in distributing vital household supplies to the population in a non-contact way, therefore assisting in preventing the transmission of the virus.

As a result, the logistics sector must create smart logistics. This article will discuss two emerging trends: the Internet of Things and Big Data technologies, as well as its implications for the logistics industry.

2 Smart Logistics

Dieter Uckelmann coined the term "smart logistics" in 2009. Wang et al. [2] define smart logistics as the use of technologies such as the Internet of Things, Big Data, cloud

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computing, and artificial intelligence to the logistics sector. By gathering and analysing data in real time, the system can mimic how people think and solve issues, resulting in high quality and cheap cost.

Smart logistics information technology primarily consists of technologies for sensing, disseminating, processing, analysing, and forecasting logistics information [3]. Due to a lack of knowledge in the conventional logistics paradigm, empirical conclusions are more easily accepted. A sophisticated logistics system, aided by new technology, can completely resolve this problem. The implementation of smart logistics would represent a huge disruption and innovation in the conventional logistics business, with ramifications for the traditional logistics model, operation model, industrial structure, and production ecology.

3 Internet of Things in Smart Logistics

The Internet of Things (IoT), a vital component of information and communication technology, is often regarded as having promised future possibilities for wireless communications. The Internet of Things connects people and things, things and people, via the use of sensors, controllers, mechanical devices, and people, enabling informatization, remote control administration, and network intelligence. The Internet of Things is a subset of the Internet, and the Internet remains at its heart [16].

The logistics industry's IoT architecture is composed of five distinct layers: perception, access, network, support, and application, as illustrated in Fig. 1. The perception layer collects data and acquires signals through physical devices. The access layer

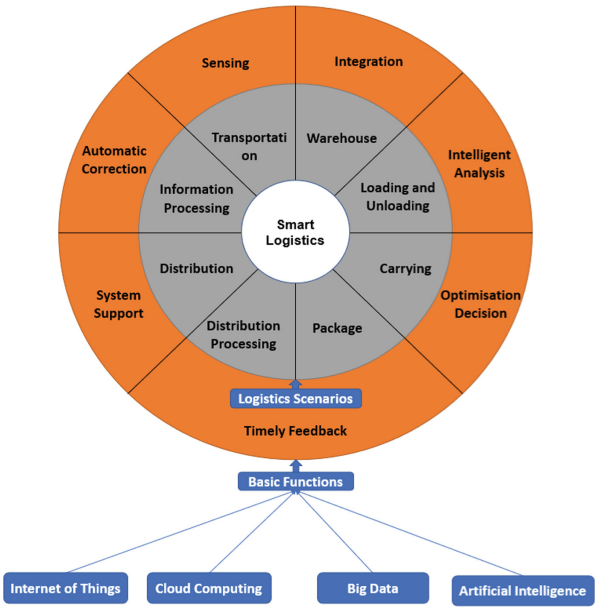

Fig. 1. Smart logistics scenarios, basic functions, and key technologies.

responds to the sensing layer's request to transfer the data acquired to transmission networks such as 3G, 4G, and WiFi. By sending the signal from the access layer to the support layer, the network layer completes the signaling process. The support layer provides data processing tools and platforms. The application layer establishes a connection between the IoT and its consumers. Additionally, it enables the industry to complete its duties [6].

Through network communication technology, smart logistics systems equipped with IoT devices such as RFID tags, sensors, actuators, and mobile phones may access all information in the smart logistics industrial chain in real time and facilitate information exchange across equipment. Intelligent logistics systems built on IoT platforms can handle and analyse massive amounts of logistical data, make choices using modern technologies such as cloud computing, big data, and artificial intelligence, and operate items intelligently. In conventional logistics, tasks such as scanning items and data input are often completed manually, which is inefficient. Meanwhile, storage rooms at logistics stations are often inadequately designated, and process monitoring is lacking.

The standard warehouse management system is combined with IoT technology to create a smart warehouse management system that can increase the efficiency of items in and out, expand the volume of storage, and reduce labour intensity and expenses. Additionally, it enables real-time management of incoming and departing items, increases delivery efficiency, and manages the collection, transfer, and picking of commodities across the system.

Through the real-time monitoring system, the logistics firm can get information on the location of trucks and cargo, the conditions of the cargo, such as temperature and humidity, and the speed, tire temperature, pressure, fuel amount, braking times, and other driving behaviours. It effectively integrates information about cargo, drivers, and vehicles while moving products, hence increasing transport efficiency, lowering transportation costs, minimising cargo losses, and providing a clear picture of everything that occurs throughout the transport process. Additionally, this strategy has the potential to decrease accidents and related injuries.

A case study conducted by (John & Paul, 2017) demonstrates how vehicle monitoring may be used to accomplish another objective: lowering exhaust emissions (Green House Gases (GHG)). The business installed sensors in trucks and provided drivers with training to help them improve their hazardous driving habits. By 2016, this firm has reduced GHG emissions by 42%, with 32% of this decrease attributed to driving behaviour modification.

The smart courier locker is built on IoT technology and is capable of detecting, storing, monitoring, and controlling things, among other tasks. When combined with a PC server, the smart courier locker comprises an intelligent courier delivery system. The PC server can analyse data acquired by smart delivery devices and make real-time updates in the background, making it easier for users to monitor couriers, deploy couriers, perform courier terminal maintenance, and perform other operations.

After the courier has put the item in the smart delivery locker, the clever system will send the user an SMS message with the verification code and the pick-up address. Users may pick up their items within 24 h at any moment, which simplifies the pick-up procedure.

4 Big Data Technology in Smart Logistics

Cox & Ellsworth [8] initially proposed the term "Big Data" as a difficulty in the computer system, referring to data sets that exceed the limit capacity of the computer's main memory, local disc, and even distant disc. However, as the Internet has developed, the concept of "Big Data" has most than likely shifted to a tool for resolving big data issues and doing analysis. Big Data technology enables us to more efficiently and effectively handle the enormous database of exploding information. Big Data may assist us in selecting and categorising data in order to solve technological challenges and accomplish our objectives, and we can also use this technology to process and merge data acquired from incompatible systems, databases, and websites.

Big Data is regarded as a crucial breakthrough in the logistics business since it enables operational capabilities, whole supply chain execution, and route optimization [9]. Additionally, it provides cost-cutting strategies, an appropriate pricing strategy, optimises logistical procedures, and significantly simplifies the decision-making process [17].

Logistics Big Data is used to describe data and information pertaining to logistics operations such as shipping, warehousing, handling, loading and unloading, packing, and delivery handling. Big data analysis can boost shipping and delivery efficiency, save logistics costs, and more efficiently meet customer service needs. All data relating to cargo distribution, logistics express firms, and customers is integrated into a massive real-time information platform, enabling rapid, efficient, and cost-effective logistics [12].

Due to the fact that transportation, storage, packing, and processing of commodities all involve a high degree of contact and information exchange. Big data technology enables the optimization of distribution routes, the rationalisation of logistics centre locations, and the optimization of warehouse storage capacity. As a result, logistics costs may be significantly reduced, and logistics efficiency increased.

The DHL delivery business presented a solution to the "last mile" issue in logistics in the article [17], which is the last step of the supply chain and the most expensive. The DHL solution is separated into two components: real-time optimization of the transportation route and a new shipping system that utilises anyone travelling along the essential road for the firm, whether they are employees or not. This solution leverages Big Data technologies such as complicated priority scheduling and location through a custom application. Additionally, it enhances operational precision when compared to a planned and dispersed workforce.

The report [18] also included another fascinating example of a DHL organisation using Big Data technology in logistics, namely "DHL Resilience 360," a risk management tool for supply chains. By informing consumers about the possible damage caused by the supply chain, and by collecting and analysing data, we can safeguard and enhance the supply chain's efficiency.

Additionally, big data technologies may aid in the improvement of customer service. With more individuals shopping online, buyers are becoming more aware of the logistical experience. Through data collection and analysis, as well as the right application of these analyses, organisations can give the finest service and operational procedures for their logistics company to their clients. Which strengthens the relationship with consumers and builds their trust, encouraging customer loyalty and preventing client turnover.

Certain commodities that need unique storage and transportation circumstances, such as certain products and medications that must be held at certain temperatures or certain delicate goods, require special transit conditions. Both the delivery business and the client rely on the items. It would be awful if items were damaged as a result of poor storage or transportation. Then, using Big Data technology in conjunction with IoT, a secure and cost-effective method of storing and delivering items may be developed.

5 Impacts on the Logistics Industry

In affluent nations such as the United States and Japan, smart logistics has progressed at a reasonably rapid pace in recent years. The advancement of smart logistics is facilitated by a strong IT infrastructure and a commitment to technology research and development.

Numerous integrated logistics firms used smart warehousing, smart logistics planning, and smart distribution years ago, including automated three-dimensional warehouses, handling robots, automated loading and unloading forklifts, drones, unmanned vehicles, and logistics storage systems. Tesco, Amazon, and other businesses began using RFID in 2015. Amazon's Tracy Operations Center, for example, utilizes the Cubiscan measurement system for inbound storage, which enables efficient scanning of inbound product form factor data and increases inbound storage efficiency; an inbound imaging system streamlines the receiving process; and a large-scale use of Kiva robots for goods picking, which significantly improves order processing efficiency. Caterpillar is a corporation based in the United States that manufactures construction and mining equipment. Caterpillar created software for total logistics planning and design based on the influence of simulation models and data on logistics expenses such as warehousing, customer service information, and warehouse management. This resulted in a large increase in sales and cost savings [14, 15].

On the one hand, the Internet of Things (IoT) and Big Data technologies enable the implementation of smart logistics by providing technological assistance and transforming logistics into really intelligent systems capable of observation, self-adaptation, and seamless connection with the outside world. On the other hand, smart logistics is the primary application area for IoT and Big Data technology, logistics firms are significant IoT and Big Data technology users, and smart logistics also serves as a demand generator and development direction for IoT and Big Data technology.

6 Conclusion

To summarise, the fast rise of the Internet and e-commerce, along with the COVID-19 outbreak, has increased global demand for logistics services, exposing some of the inefficiencies and costs associated with conventional logistics. As a result, the logistics industry's change is critical.

Nations such as the United States, Japan, and a few European countries have emerged as leaders in the development of the smart logistics sector, with a sizable domestic market, world-class technology, and a more integrated industrial chain. Smart logistics has emerged as a critical driver of the contemporary logistics industry's development, cost reduction, and industrial upgrading.

Without a question, IoT and Big Data technologies are game changers in the logistics business. The confluence of these two new developments has the potential to cut costs, increase efficiency, and enhance service quality.

Today, the majority of organisations, including logistics firms, are trying to innovate and evolve. Customers are getting more demanding; businesses are becoming more aware of the worth of their customers and concentrating their efforts on producing additional value for them. Technologies such as Big Data and the Internet of Things are also enabling businesses to improve their competitiveness and contribute to the logistics sector.

References

1. Mentzer J, Flint D, Hult G (2001) Logistics service quality as a segment-customized process. J Mark 65(4):82–104
2. Wang X, Le X, Lu Q (2020) Analysis of China's smart city upgrade and smart logistics development under the COVID-19 epidemic. J Phys Conf Ser 1570(1):012066
3. Zheng Q (2019) Development mode, problems and countermeasures of intelligent logistics in China. Res Bus Econ 18:108–111
4. Khan M, Din S, Jabbar S, Gohar M, Ghayvat H, Mukhopadhyay SC (2016) Context-aware low power intelligent SmartHome based on the Internet of things. Comput Electr Eng 52:208–222
5. Luong N, Hoang D, Wang P, Niyato D, Kim D, Han Z (2016) Data collection and wireless communication in Internet of Things (IoT) using economic analysis and pricing models: a survey. IEEE Commun Surv Tut 18(4):2546–2590
6. Song Y, Yu F, Zhou L, Yang X, He Z (2020) Applications of the Internet of things (IoT) in smart logistics: a comprehensive survey. IEEE Internet Things J
7. Hopkins J, Hawking P (2018) Big Data analytics and IoT in logistics: a case study. Int J Logist Manage
8. Cox M, Ellsworth D (1997) Application-controlled demand paging for out-of-core visualization. In: Proceedings. Visualization'97 (Cat. No. 97CB36155), pp 235–244
9. De Martino M, Errichiello L, Marasco A, Morvillo A (2013) Logistics innovation in seaports: An inter-organizational perspective. Res Transp Bus Manag 8:123–133
10. Su SII, Gammelgaard B, Yang SL (2011) Logistics innovation process revisited: insights from a hospital case study. Int J Phys Distrib Logist Manage
11. Moldagulova A, Satybaldiyeva R, Kuandykov A (2020) Application of Big Data in logistics. In: Proceedings of the 6th international conference on engineering & MIS 2020, pp 1–6
12. Yan S (2019) Study on the development strategy of smart logistics in the context of big data
13. Witkowski K (2017) Internet of things, big data, industry 4.0–innovative solutions in logistics and supply chains management. Procedia Eng 182:763–769
14. Sun T (2021) Exploring the development strategy of intelligent logistics in the era of big data - taking "Qinglong System of Jingdong Logistics" as an example
15. Shao G (2015) Study on intelligent logistics development model based on IOT
16. Tang X (2020) Research on smart logistics model based on Internet of Things technology. IEEE Access 8:151150–151159
17. Moldagulova A, Satybaldiyeva R, Kuandykov A (2020) Application of Big Data in logistics, pp 1–6. https://doi.org/10.1145/3410352.3410785
18. Witkowski K(2017) Internet of Things, Big Data, Industry 4.0 – innovative solutions in logistics and supply chains management. Procedia Eng 182:763–769. ISSN 1877-7058