Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.755108

AN INTERNET OF THINGS (IOT) ECOSYSTEM FOR A GOODS MANAGEMENT SYSTEM: DESIGN AND ANALYSIS

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ABSTRACT
The goal of the Internet of Things (IoT) is to facilitate the ubiquitous interchange of data by linking together various embedded devices, objects, and people with limited resources via the Internet protocol. With the use of ubiquitous connection to gather trustworthy and secure real-time data, logistics is seen as a pivotal role on the path to complete transparency and visibility in this vision. Furthermore, smart services and apps may be developed using the important information retrieved and translated from IoT data. These will enhance logistical activities and the overall performance of logistics operations. Modern Internet of Things (IoT) uses in logistics are the focus of this article. The logistics industry has not yet fully embraced the Internet of Things (IoT), despite the fact that doing so would have enormous benefits. Additionally, this article delves into these obstacles, which are expected to unveil a plethora of unanswered questions about the logistics domain's integration of the Internet of Things.

KEYWORDS: Internet of Things (IoT); IoT technologies; IoT building-blocks; smart logistics; green logistics; physical Internet; logistics operations; efficiency and sustainability.

INTRODUCTION
In actuality, logistics is becoming recognized as a fundamental business that supports the robust growth of the economy and related fields like transportation and education. Different perspectives and contexts have led to different definitions of logistics. Specifically, logistics is "the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from their point of origin to point of consumption for the purpose of conforming to customer requirements," according to the authors of. "Logistics involves an integrated approach with the integration of information, transportation, inventory, warehousing, material handling, packaging, and recently added security," Islam et al. said. They also made rough notes on the five main areas of logistics management: shipping, storage, inventory control, packaging, and data processing. Many scholars, like the authors of, have taken a high-level perspective of logistics and seen it as including not one but three flows: physical, informational, and financial. According to this theory, logistics management's end goal should be to bring all parties involved in logistics the activities, actors, and stakeholders into perfect harmony with one another. Whatever your point of view may be, the aforementioned ideas all boil down to one thing: logistics services exist to ensure that the correct items reach the right people at the right time in the appropriate condition. With logistics

operations becoming more complicated and dynamic owing to ever-increasing global rivalry, shorter product life-cycles, mass customization, and tougher quality standards of consumers, the information will play an increasingly important role in controlling contemporary logistics. Information and communication technologies (ICT) have improved data processing and exchange, which has led to their widespread deployment in logistics-related industries. In instance, thanks to advancements in ICT, logistics chain participants may now communicate logistics-relevant data in real time. In addition, logistics procedures may be made more efficient and effective by making full use of the communicated data to make educated decisions. A good example is how logistics service providers may enhance client experiences while reducing operating costs thanks to real-time decision-making that allows them to swiftly adapt to any changes in consumer needs. From a commercial perspective, logistics-related companies may take advantage of data analysis to forecast consumer desires and market conditions, leading to more sales and less inventory. Consequently, logistics companies are becoming more competitive as a result of the incorporation of ICT into logistics management systems. The Internet of Things (IoT) is a relatively new concept that has the potential to completely alter the way in which objects are able to communicate with one another. The Internet of Things (IoT) encompasses a wide range of concepts, from physical and virtual items to networks and systems that may be linked through integrated information and communication technologies (ICT) including GPS, Wireless Sensor Networks (WSN), and Radio Frequency Identification (RFID). Also, with this kind of integration, the things may become smart objects that can talk to each other and make well-informed judgments wherever in the world. With this future in mind, logistics systems may make use of all-encompassing connectivity to boost operational efficiency by achieving end-to-end visibility and traceability. Thus, whereas RFID and GPS systems allow for real-time tracking and tracing of logistics assets and shipments, WSNs ensure that logistics shipments remain in good condition regardless of environmental harshness thanks to their real-time sensing capacity along shipping paths. With the help of the real-time and important logistics data made possible by IoT-enabled solutions, operational efficiency may be enhanced in areas such as traffic and fleet management, inventory control, asset utilization, safety, and security. Findings from a comprehensive research by Internet of Things (IoT) technology specialists (CISCO1) and a logistics provider (DHL2) suggest that logistics systems may benefit greatly from using IoT in order to better monitor, control, manage, and optimize logistics operations. Through seamless interconnectedness across the associated logistical processes and chain stakeholders, the aforementioned viewpoints offer potential benefits that may be achieved through the application of the Internet of Things concept to logistics. For instance, logistical operations may be made more visible and transparent with the use of the Internet of Things (IoT) and its real-time data sharing capabilities. Decisions are likely also enhanced to better react to the unpredictable and ever-changing logistics-relevant environment. Logistics operations may be made more efficient and environmentally friendly by capitalizing on the Internet of Things (IoT) that is traded. Nevertheless, only a small fraction of the current literature delves deeply into the logistics sector's use of IoT for both theoretical and practical purposes. In this light, the purpose of this study is to first do a comprehensive literature review of the existing Internet of Things (IoT) applications in logistics-related domains, and then to elaborate on the opportunities and related obstacles that have been revealed by these applications.

LITERATURE REVIEW

Soonh Taj et al (2023), The term "supply chain management" (SCM) refers to the practice of organizing and improving the many links in the distribution of products and services. The rapidly expanding domain of the Internet of Things (IoT) is providing modern supply chain management with several advantages. With the use of Internet of Things (IoT) technology, supply chain operations may be digitalized and automated to achieve peak operational efficiency while cutting costs. Internet of Things (IoT) gadgets has changed the game for supply chains. Internet of Things (IoT) devices used in the supply chain process monitor shipments in real-time with cutting-edge monitoring technologies like GPS. NFC and RFID tags are also utilized by IoT devices for asset management. In general, the supply chain process makes use of IoT devices at nearly every step. Investigations into SCM that relies on the Internet of Things are still in their early stages. While there is a lot of technical writing on SCM that relies on the Internet of Things (IoT), there are just a handful of Systematic Literature Reviews (SLRs) that cover this topic. So yet, no study has presented a comprehensive assessment of IoT-based supply chain management that includes extensive analysis. To fill this informational need, this study presents an SLR on IoT-based SCM and analyses it in depth from 2018–2022. Application domains, technologies, sensors, and devices utilized to develop IoT-based supply chain management systems are covered in this overview. With their comprehensive literature review on IoT-based SCM, the SLR results will be useful to scholars and practitioners in the future who are interested in this topic. The review provides valuable insights into the pros and cons of this approach as well as its economic and commercial consequences.

Dr. C. Amali et al (2020), In real-time applications, logistics management is crucial. Logistics management has challenges in areas such as delivery delays, real-time freight vehicle identification, cargo overload, and loss or theft. Using the cargo's latitude and longitude coordinates, the Global Positioning System tracks its whereabouts. Locating the administrator is made easy with the GSM/GPRS module. Cargo can be located and positioned accurately with the help of the RFID technology. The web server's processing and organised management of commodities is made easier by the Open Source hardware. The cargo may become too heavy to carry or reach by a certain period if additional things are added to it. Using a weight sensor prevents freight from being overloaded. The technology is also utilised for security considerations, as the web server and cargo data are regularly updated in real time utilising open source hardware. Open source hardware, the Internet of Things (IoT), radio frequency identification (RFID), global positioning system (GPS), and GSM/GPRS all work together to produce reliable outcomes. In addition to preventing goods delivery delays caused by dynamic updates to cargo data, this system also guarantees the placement of goods trucks and removes the possibility of cargo overload.

RESEARCH METHODOLOGY & RESEARCH DESIGN

Logistics forms the bedrock of the IoT's development. The emergence of commodities and the rise of commodity production bring about this economic activity. Logistics must be supported for the Internet of Things to progress. One of the first sectors to use the Internet of Things was logistics. The use of informatization, digitalization, networking, integration, intelligence, agility, adaptability, visualization, and automation are all components of many logistics systems. Initially deployed in the logistics sector, the Internet of Things is formally known as the sensor network. Radio frequency identification (RFID) is a prime example of a fundamental Internet of Things (IoT) application. Manual scanning is required for data retrieval in conventional storage, which is inefficient. The phenomena of the things being stacked in a haphazard fashion is caused by the lack of clearly defined storage locations. An intelligent warehousing management system is the result of integrating the Internet of Things (IoT) with the conventional method of warehouse administration. It can simplify data querying, increase storage capacity, decrease labour effort and cost, track products delivery, and speed up scoring and delivery. You may monitor the temperature and humidity of products in addition to tracking and monitoring goods cars and items through the systematic management of logistics vehicles. Vehicles' speeds, fuel use, tyre temperatures, and other driving behaviours are tracked in real-time while items are being transported. As a result, transportation loss and costs are decreased and transportation efficiency is enhanced. Intelligent logistics industries are seeing rising demand as a result of the integration of Internet technologies with the logistics business. Logistic companies and outsourcing service providers in China primarily earn money from two types of services: basic services (transport and warehouse management) and value-added services (supply chain integration, financial services, and platform construction). Modern logistics and supply chain management in China are still in their early stages. Suppliers in the country only offer goods and do not provide any value-added services. Connecting a vast number of devices spread out across the globe, managing and extracting data from them, visualizing this data in real time, improving business agility, speeding up decision-making, and making changes to the business are all possible with Google Cloud IoT, a platform for intelligent services like fully hosted integrated services. The manufacturing industry has the potential to undergo a paradigm shift from centralized control to real-time data collecting and processing at the network edge thanks to edge computing (EC). In an effort to spur the creation of edge networking devices, Google has introduced two complementary new products since 2017: the Chip TPU hardware and the Cloud IoT Edge software. Cloud IoT edge, according to Google, "can extend the powerful data processing and machine learning capabilities of Google cloud to billions of edge devices, such as robot arms, wind turbines, and oil rigs. Therefore, they can operate the data from their sensors in real time and predict the results." at the regional level The gradual interest of large organizations in EC standardization has led to the formation of appropriate working groups to do study on the topic. According to Çakmak et al., who conducted an optimization study of the express logistics system, investigating the intelligent logistics system is important since it has greatly improved the efficiency of transportation logistics, as exemplified by express delivery. Yan and Li highlighted the use of technology in logistics information systems and provided examples of how Radio Frequency Identification (RFID) is applied. The technological foundation of supply chain management was put out by Da Silva et al., who said that logistics system and supply chain management interact and connect to each other. In both the quick response and model building processes, it has information security and transparency. In terms of the advancements in intelligent logistics system technology, Feng and Ye optimised the algorithm architecture of the logistics information system to realise intelligent transportation and warehousing operation processes. Within the framework of an intelligent logistics system, Li et al. presented a method and system for control. This thesis examines the location of intelligent logistics systems and supply chain management using the flower pollination algorithm, drawing on research on the design of these systems under the EC and IoT. In the supply chain management system, the eXtreme Gradient Boosting (XGBoost) model is employed for user information prediction. Lastly, the review delves into the inner workings of XGBoost's supply chain management prediction model, the evolution of material flow and intelligent logistics systems, and the operation of these systems. , When it comes to supply chain management and intelligent logistics systems, this thesis is a reference that is important. ,The novel aspect of this research is its application of the flower pollination algorithm to the task of intelligent logistics management placement, as well as its utilisation of the Internet of Things (IoT) and early warning systems (EC) in the development of intelligent logistics systems and supply chain management procedures. , The study is structured into four parts. In Section 1, we learn about the history of intelligent logistics systems, how they came to be, the research framework and methodology used, and how logistics has been studied in China and other countries. Theory and research methodology are presented in Section 2. The theory of edge computing is first presented. The second step is to integrate the Internet of Things and electronic commerce into the architecture of the logistics system and the process of managing the supply chain. As a last step in intelligent logistics management, the placement is executed by the flower pollination algorithm. In Section 3, we primarily examine the logistics flow and supply chain management system's and intelligent logistics system's operational modifications. The results are mostly summarized in Section 4, which also presents a concrete plan for future research and development.

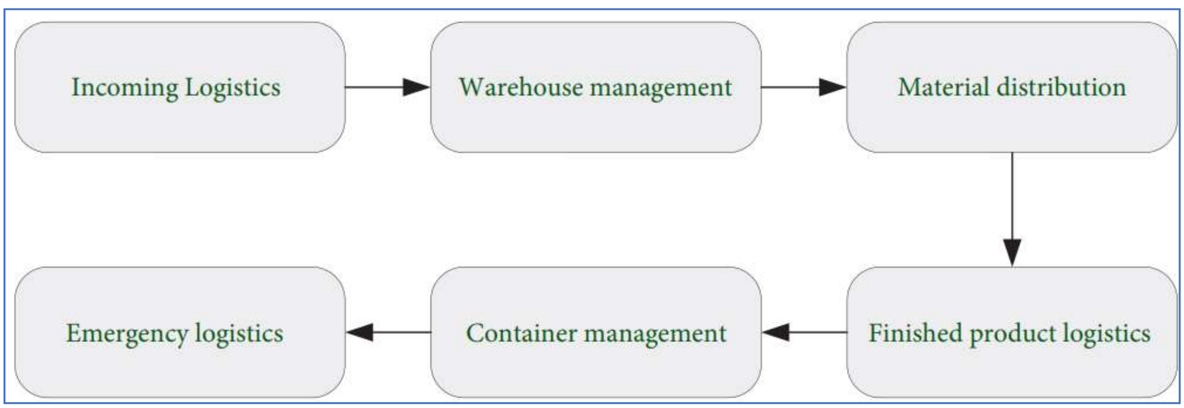

Figure 1.1 Overall Framework of the Intelligent Logistics System

Intelligent Logistics System Based on IoT

Internet of Things (IoT) integration into logistics systems has the potential to enhance automation, streamline transportation management, enhance traffic data transfer, and boost traffic efficiency. Logistics transportation can be automated, visualized, controlled, intelligent, and networked; transportation costs can be reduced; and transportation risks may be improved. Because of this, the transportation industry as a whole is able to better integrate its businesses and react to changes in the market, as well as exchange traffic data. Customers may receive up-to-date, accurate product transportation information from it, and it can also help them create the best possible transportation arrangements. Additionally, it has the potential to enhance the quality and quantity of logistics and transportation services while simultaneously providing clients with the most satisfying services possible. By integrating the IoT into SCM, managers of supply chain systems will be able to create transparent SCM and precisely trace and identify every item in the supply chain, regardless of where it is located. The Internet of Things (IoT) has greatly enhanced the management efficiency of the supply chain and allowed for a high level of integration across all supply chain components. Internet of Things (IoT) and Internet applications are foundational to intelligent logistics. It gathers, processes, manages, circulates, and analyses data using cutting-edge technology. The schematic of the ILS may be seen in Figure 1.2. Smartly completing the packing, shipping, distributing, loading, unloading, and warehousing processes is illustrated in Figure 1.2. This allows the supplier to keep tabs on the flow status of their goods in real time, which in turn allows for faster and more efficient delivery to the demander at a lower cost. Natural and social resources may be used much more sparingly as a result. A high-level overview of the ILS architecture is shown in Figure 3. Based on the intelligent logistics system's business process, Figure clarifies the general structure of the intelligent logistics system's informatization and proposes the informatization function needs for each link. Inbound logistics, material distribution, container management, completed product logistics, emergency logistics, and other linkages are mostly included. In the meanwhile, it sheds light on several aspects of each process activity node, including input, information drive, information gathering, and output. The intelligent logistics system's functionalities are displayed in Table 1. The design of the intelligent logistics system should cater to the diverse and individual demands of users, in accordance with the functions listed in Table 1. The intelligent logistics system's structure is illustrated in Figure.

Realization elements	Content	Functions
Logistics function integration	Integrating logistics services and value-added services	Meeting the personalized needs of users
Real-time tracking of users	Understanding the changes in the user's needs	Improving service levels
Information integration	Other logistics information	Providing integrated and networked services
Financial integration	Financial supervision and management of logistics businesses	Achieving financial objectives

Table 1: Functions of the Intelligent Logistics System

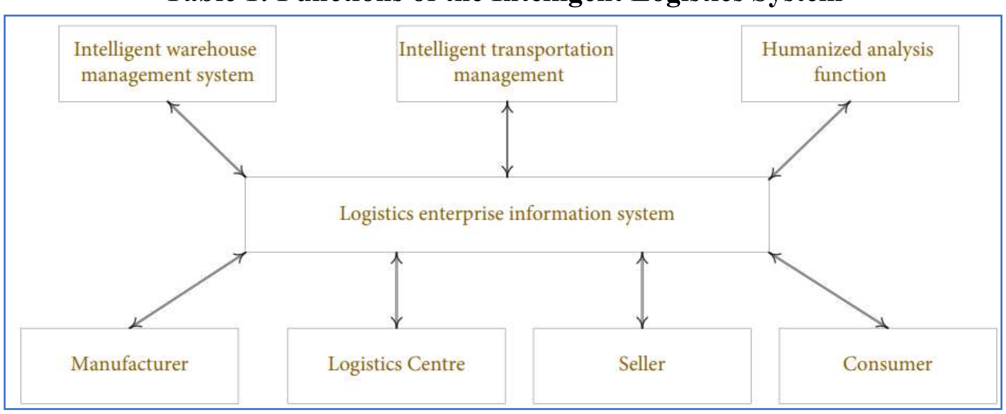

Figure 1.2 Framework of the intelligent logistics system

The electronic toll collecting system, operational truck management system, advanced traffic information service system, vehicle control system, traffic management system, and intelligent logistics system are all shown in Figure 1.2. Logistics distribution management and centralised dynamic control of vehicles are both made possible by ITS. ITS provides information about road traffic, routes to optimise transportation schemes, real-time tracking of vehicles to ensure accurate arrival times, strategies for warehouse inventory and distribution plans, and means for information sharing between logistics network nodes and the headquarters. This all contributes to an efficient logistics transportation system as a whole. ,Connecting any object to the Internet for information exchange and communication enables intelligent identification, positioning, tracking, monitoring, and management through the Internet of Things (IoT), a vast network that integrates GPS, infrared sensors, radio frequency identification (RFID) devices, laser scanners, and other devices with the Internet.

RESULT AND DISCUSSION

Positioning and Tracking of the Intelligent Logistics System and the Logistics Status in Supply Chain. After optimizing the algorithm, the intelligent logistics system compares the pre- and post-optimization distance errors of the items. This perception is based on the flower pollination algorithm. The results of comparing the distance errors of the algorithms used for flower pollination are displayed. The distance error of the optimized approach is 0.13 M, whereas that of the classic technique is 0.28 M, as shown in Figure 1.3, after 500 iterations. Distance errors will be more stable both before and after optimization as the iteration time's increase. The placement and tracking of the intelligent logistics system and the logistics status inquiry in supply chain management are made possible by the optimized algorithm, which achieves high accuracy in the distance error with increasing iteration durations before and after optimization.

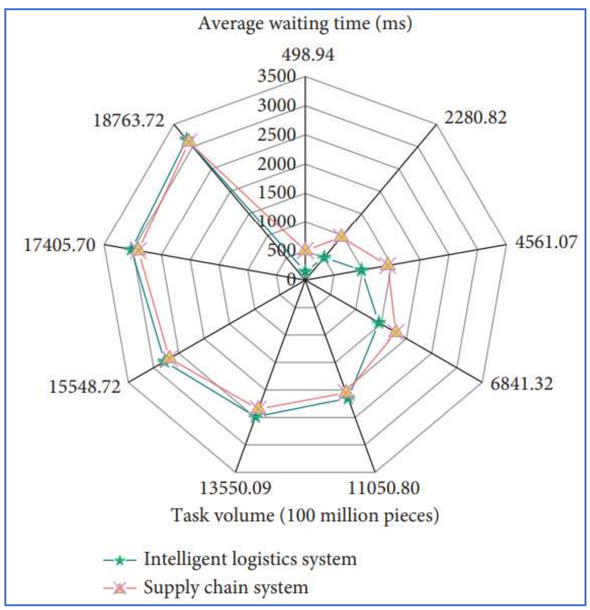

Figure 1.3 Average Waiting Time of the Intelligent Logistics System and Supply Chain Management System in Operation

Evaluation of a Supply Chain Management System Model for Forecasting and Performance. We evaluate XGBoost in comparison to SVM and random forest. In supply chain management, Figure 1.3 depicts the prediction model's inaccuracy. Figure 1.3 demonstrates that the MAE values of XGBoost and random forest are quite close, suggesting that both models have similar average fitting abilities in the supply chain management prediction model. The support vector machine model has the highest MAE score, suggesting it is unfit for use in assessing the prediction model. Because its root-mean-squared error (RMSE) is the lowest of the three models, XGBoost has the best numerical prediction ability and the supply chain prediction model's anticipated value of XGBoost t is the most accurate. The three models also have decent fitting abilities. Data stored in the cloud is subject to analysis by the intelligent logistics monitoring system. So that the state of goods transit may be known, the real route and node time are provided. It is possible to configure the alarm to go off if the goods' transportation route deviates from the predetermined path. Figure 1.3 shows the results of an analysis of the average waiting time for the operational intelligent logistics and supply chain management systems.

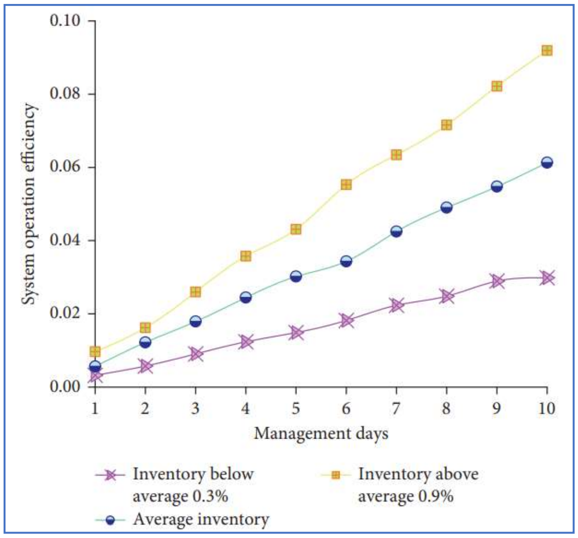

Figure 1.4 Operation efficiency of the supply chain management system.

According to Figure 1.4, the average waiting time for the intelligent logistics system is 1855.379 milliseconds while the supply chain system has an average waiting time of 1976.631. This indicates that the greater the job, the longer the waiting time for system operation will be. Intelligent logistics systems often have shorter wait times than supply chain management systems.

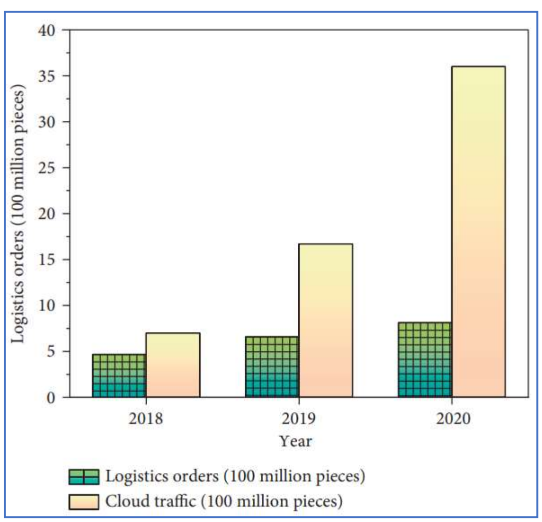

Figure 1.5 Changes of the material flow of the intelligent logistics system.

The intelligent system's and the supply chain management's operational effectiveness is evaluated over the course of ten days. In order to design and manage the intelligent logistics supply chain, an example management system is set up based on the supply chain after a thorough examination of the product's transportation, route, and quantities. The inventory system's connection to the supply chain management system is illustrated in Figure 1.5. In Figure 1.5, we can observe that when the logistics inventory is at the average, 0.3% below average, and 0.9% below average, we can compare and analyse the operational efficiency of the supply chain management system. Results show that when inventory levels are between 0.3 and 0.9% below normal, the supply chain management system's operational efficiency is worse than usual. The supply management system's operational efficiency improves as the number of system operating days increases.

CONCLUSION

Based on EC, we go over the IoT's intelligent logistics and supply chain management systems, and we utilize the flower pollination algorithm to figure out where everything fits in. The optimized approach achieves a distance error of 0.13 M after 500 iterations, while the classic technique achieves a distance error of 0.28 M. The distance error remains relatively constant both before and after optimization as the number of iterations increases. ,Both the intelligent logistics system and the supply chain system had average waiting times of 1855.379 and 1976.631 milliseconds, respectively. That the waiting time for system functioning is increased for bigger amounts of tasks is demonstrated here. XGBoost and random forest models are equally good at fitting the supply chain management prediction model on average, however support vector machine isn't a good fit for that kind of evaluation. The XGBoost model outperforms the other two models in terms of numerical prediction ability and the proximity of its forecast value to the actual value in this supply chain prediction model. The intelligent logistics system's material flow modifications from 2018 to 2020 demonstrate that supply management system operation efficiency increases with increasing system operating days. When it comes to the logistics industry's growth, the intelligent logistics system is king. This study lays the groundwork for a supply chain management and intelligent logistics system. On the other hand, the logistics industry's operating system needs updating to keep up with the new era brought about by the rapid expansion of the Internet of Things.

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