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The Role of AI, IoT, and MIS in Facilitating the Digital Transformation of Supply Chains

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Abstract: Management Information Systems (MIS) have gradually become the technical cornerstone to help enterprises optimize the quality of decision-making. However, relying only on the data support provided by MIS is insufficient to help enterprises complete the supply chain's efficient allocation and high-frequency management. This paper aims to explore the feasibility of promoting the digital transformation of the supply chain in China's transportation industry by combining emerging technologies such as the Internet of Things (IoT), Artificial intelligence (AI), and Management Information Systems (MIS). It has been found that a strong combination of AI, IoT, and MIS technologies can effectively promote the digital transformation of the supply chain. However, there are still many challenges in practical application. Therefore, this paper proposes the interaction model of these three technologies. IoT inputs the information generated in the operation and stores it in MIS, providing data support for AI's intelligent analysis. Then, the instructions issued by AI are transmitted directly to MIS. Finally, the IoT controls the physical entity that executes these decisions. In addition, this paper summarizes the problems and reasons that may exist in applying MIS, IoT, and AI technology in the transportation industry at this stage. It is found that many problems, including low utilization efficiency of MIS, low willingness of front-line operators to use it, differences in information transmission protocols, and high cost of AI training, hinder these three technologies to promote the digital transformation of the supply chain.

Keywords: Artificial intelligence, Internet of Things, Management information system, Supply chain.

1. Introduction

Supply chain management is an effective way for enterprises to control costs. For a long time, the supply chain management of enterprises has been a difficult problem to solve. The reasons include many aspects; the most prominent are the long supply chain research time, weak links between various departments, and other problems. Combining the Internet of Things (IoT), Artificial intelligence (AI), and Management Information Systems (MIS)can solve these problems. The supply chain refers to the network structure of all enterprises involved in the product process, from production to delivery to consumers, and is arranged according to the order involved. The usual composition is suppliers, manufacturers, distributors, retailers, and consumers. IoT refers to the connection of sensors and physical devices to achieve data transmission and exchange of information

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so that the state of physical devices can be sensed through the Internet and better management and control. MIS refers to a system used by an organization to collect, process, and transmit information and data, which is intended to improve the efficiency of operations management and decision support. AI refers to the ability of computers to simulate human intelligence by systematically training them so that machines can perform tasks that normally require human intelligence.

The reasons why companies can try to use MIS, IoT, and AI in supply chain management are as follows, as shown in Figure 1. First, the theoretical construction of MIS, IoT, and AI has been completed. IoT inputs the information generated in the operation and stores it in MIS, providing data support for AI's intelligent analysis. Then, the instructions issued by AI are transmitted directly to MIS. Finally, the IoT controls the physical entity that executes these decisions. At the same time, with the deepening of the understanding of system auxiliary software, the willingness of enterprises to use it is increasing year by year. The usage rate of information systems for small and medium-sized enterprises in the Chinese market is low. However, the cloud deployment of equipment reduces the variable cost of information systems. Once the threshold of software development and design is lowered, the popularity of MIS is bound to increase. The advantages brought by the system for enterprise management include but are not limited to reducing management difficulty, enhancing management visibility, cost transparency, reducing employee corruption, optimizing internal management costs, reducing personnel costs, enhancing data security and traceability, enhancing enterprise competitive advantages and resource utilization efficiency [1]. Therefore, applying information systems is an effective way to enhance the competitiveness of enterprises. AI also provides strong help in the operation management and strategic decision-making of enterprises, especially in helping enterprises manage inventory [2]. AI manages inventory efficiently by intelligently detecting inventory numbers and analyzing past operational data to predict sales for the next stage. From the enterprise level, IoT, AI, and MIS are more like complementary relationships that build a complex system involving information input, storage, decision-making, and decision execution. Through the physical sensor-based IoT, this system uploads countless data that appear during operation to the MIS for storage and use. Then, it processes these data based on AI algorithms or performs simple decision execution and provides feasible guidance.

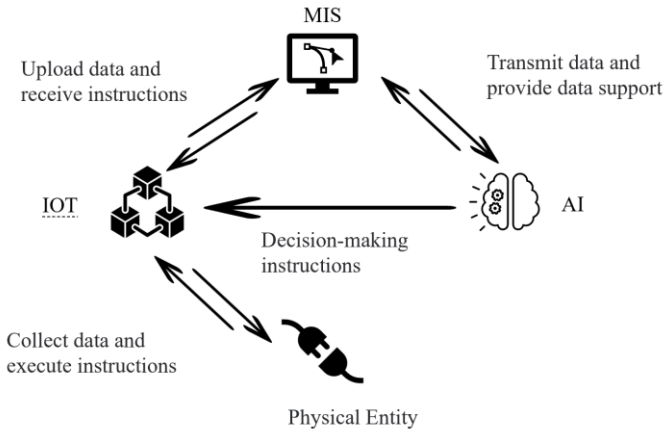

Figure 1: Supply Chain Management Model Based on MIS, IoT, and AI (Photo credit: Original)

This paper aims to explore the role of the combination of MIS, AI, and IoT in advancing the digital transformation of the supply chain. The article is mainly divided into three parts. Firstly, the constructive significance of supply chain digital transformation to enterprises is introduced. Compared with the traditional supply chain, the digital supply chain has stronger information interaction, higher controllability, and deeper visualization levels, and it also improves the

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cooperation and connectivity level of the enterprise supply chain. Secondly, this paper shows the application and challenges of relevant technologies in China's traditional transportation industry.

2. The Constructive Significance of Supply Chain Digital Transformation for Enterprises

The supply chain of an enterprise greatly affects its competitiveness and profitability. However, the efficient allocation of the supply chain has always been a significant problem plaguing enterprises. This problem has gradually been solved with improved technologies such as the Internet of Things, artificial intelligence, and management information systems. Digital transformation provides a more effective way for enterprise supply chain management. Compared with a traditional supply chain, a digital supply chain has stronger information interaction, higher controllability, and a deeper visualization level, and it also improves the cooperation and connectivity level of the enterprise supply chain [3].

In terms of visualization, IoT, the emerging technology of access, connects physical devices and related enterprises' assets to the Internet through electronic components such as sensors, allowing enterprises to get real-time information about relevant assets. At the same time, the data generated in each supply chain link is uploaded to the Internet to provide the system users with accurate and real-time data [4]. Before that, enterprises conducted supply chain investigations through personnel visits and other methods, which often took several weeks, and the results were not accurate, which had a significant impact on the strategic plan of enterprises. Compared with traditional supply chain research methods, digital supply chains can provide enterprises with real-time status of the upstream and downstream of the supply chain, which greatly improves the understanding and control of the supply chain by enterprise management. This change provides an early stage for reducing unnecessary costs in the supply chain and efficiently configuring the supply chain. The intervention of AI technology has transformed the supply chain from a concept to a tangible object. AI is expected to produce digital supply chain models that perfectly match the real supply chain situation to simulate the impact of supply chain management. The supercomputing power of computers can simulate the consumer market's response to supply chain management decisions to a great extent, enabling enterprises to try to reconstruct a more effective supply chain at almost zero cost, thus improving the efficiency of resource allocation.

Warehousing and inventory management issues are often strategic issues that enterprises need to make significant decisions, and the combination of IoT and AI has a good performance in this area. As the basic technology used in warehouse construction, IoT sensors are evenly and effectively distributed to measure inventory levels, accurately recording storage data and inventory levels on time. Data recorded by sensors has long been an important input for AI models to analyze and predict inventory levels. With access to emerging technology AI, the AI model obtained through a large number of professional training can accurately predict the future possible customer demand to predict the inventory demand level, and the prediction accuracy is even close to 100% [5]. Another embodiment of intelligence is intelligent logistics, and the transportation routes provided by IoT and related information, including but not limited to the category of goods, cargo weight, cargo price, fuel consumption, etc., are quickly analyzed and utilized by AI to optimize transportation routes and improve loading efficiency.

Another benefit of the digital transformation of the supply chain is to enhance the level of enterprise connectivity and collaboration [6]. The data interaction between IoT and AI cannot be completed directly, and MIS plays a connecting role. The management information system is equivalent to the worktable of the craftsman and plays an irreplaceable role in the process of the digital transformation of the supply chain. The data collected by the IoT-connected physical devices will be transmitted to the MIS through the transmission protocol, which the MIS receives and stores information. These collected data will be stored in the MIS database. When the AI system wants to

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call these data for analysis and decision-making, MIS will provide data support and present the results to real enterprise decision-makers after the AI system analyzes the results. On the other hand, MIS undertakes the task of communicating with the user and the system. Specifically, through the real-time task communication of MIS, the connection between various departments is closer, the problem of information island is solved, and the communication and cooperation between the upper and lower levels of the supply chain is strengthened.

3. Recent Situation and Case Analysis of China's Transportation Industry

3.1. Recent Developments

Through a literature review and industry market survey, this paper finds that the information systems research in China mainly focuses on ERP systems suitable for manufacturers. Therefore, the application of information systems in the traditional transport industry is still developing. China's logistics industry has the fastest growth rate and the largest market share in the Asia-Pacific region. Still, the actual operation efficiency of China's logistics and transportation industry is low, and the improvement potential is huge [7]. A more significant manifestation is that as of September 2024, the services provided by China's largest information system service provider "Kingdee" do not include the traditional transportation industry. Therefore, the information system targeted in the following analysis is the information system provided by "G7 Easy Flow" (hereinafter referred to as G7), an information system service provider with a large company size and a wide range of commercial applications in China's traditional transportation industry. Another object of analysis is the representative of small and medium-sized service providers, "Shiyi" software company, hereinafter referred to as Shiyi. The information system used in the traditional bulk cargo transportation industry lacks the processing and output of data, resulting in the value of data not being played out. Secondly, the system's application and human-computer interaction panel still need to be improved. The specific analysis is as follows.

First, front-line personnel have a low willingness to operate information systems. The low willingness to use information systems reduces the efficiency of management information systems. The main reason for this problem is that most transportation companies are divided into different departments according to job functions. Still, the information systems provided by service providers such as "G7" and "Shiyi" do not support the formation of new user interfaces according to department functions. As a result, front-line users need to switch the user panel repeatedly when applying this system, and the use threshold is relatively high, which hinders the application and development of MIS.

The second problem is that the system version of MIS is not updated in time, and some information systems on the market are still using code templates that are decades old. The reason may be that the complexity of the compilation system is too high, the compilation time is long, and the money cost is high. Existing service providers are still using technology that was developed years ago. Its user interface is complicated, accounting logic is confused, and it is challenging to play the real use of MIS. On the other hand, older versions of MIS are not functionally utilized efficiently by enterprises and do not support access to IoT and AI. Limited by the technical level of many years ago, the management information system built commercially using old technology at this stage does not support linking IoT and AI in function. This limits MIS's potential while hindering the supply chain's digital transformation. By updating software and connecting IoT technology to sensors deployed in the field by vehicles, ships, trains, planes, and other transport vehicles, each transport vehicle is connected to MIS so that companies can clearly understand the transport status of goods. For example, vehicle information such as the location of the vehicle, the speed of the vehicle, and the driving state

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of the driver can help the company manage the vehicle capacity more scientifically to achieve higher operating efficiency.

The third question. The current MIS system only stores the data and lacks the application of the data. The ability of MIS to process data can be used as an indicator to measure its working efficiency. The management information systems provided by Chinese MIS service providers such as G7 and Shiyi still lack relevant functions. In the traditional transportation industry, data analysis can include the analysis of past data to predict the likely volume of the next quarter. Analyzing the average cost to enhance the transportation company's in-transit management and expense reimbursement. Research data show that the gas consumption of China's transportation industry is much higher than that of other industries in terms of energy consumption and water consumption, partly due to the extensive cost management mode in this industry [8]. Therefore, strengthening cost management is also an essential function. For example, the fuel consumption management method for vehicle transportation: for the fleet of fixed-point top routes, the existing average gas consumption of the fleet is measured using multiple data storage and averaging, and the ranking of gas consumption saving is associated with high performance, so that the fuel-saving drivers have better performance, and the average gas consumption is constantly approached to a reasonable value. This is an example of the use of stored information. Through the analysis of past data, a reasonable range can be obtained, and the incentive of drivers to save gas can be enhanced using performance rewards. Finally, the optimal gas limit can be obtained. This greatly reduces shipping costs and enhances expense management and detection.

3.2. Analysis of the Application of Relevant Technologies in the Motor Transport Industry

3.2.1. Combination of IoT Technology and MIS

The main role of IoT is to provide rich input information for MIS. It has enhanced the company's understanding of the status of operating vehicles and the management and control of vehicles [9]. Secondly, IoT provides MIS with enough rich information so that management can analyze the data to make the most beneficial decision for the development of the enterprise, which replaces the emotional decision made by relying on the personal management and operation experience of entrepreneurs and improves the reliability of the company's decision. However, IoT can serve as the input end of data and the execution end of commands. The feedback information from MIS is applied to the object itself through IoT. When the AI system decides based on experience, the command is executed via IoT—for example, refreshing perfume in the car, massage components, oxygen support, when necessary, etc. IoT is an essential supporting component when AI systems implement this function through algorithms. The general path of its effect is as follows: the human eye dynamic capture device in the cab uploads the driver's current mental outlook to the MIS in real time, and the trained AI large model determines whether the driver's current mental state reaches the standard of fatigued driving by analyzing the data uploaded by the IoT. If the driver is judged to be in a state of fatigue driving, the AI system automatically issues instructions to try to relieve the driver's fatigue state or to remind the purpose. AI commands will again be applied to physical entities via IoT, such as perfume dispensers or aerators in the cockpit or massagers mounted on seats. The ultimate effect is to relieve or alleviate the driver's fatigue while driving. The combination of these technologies is expected to reduce traffic accidents caused by fatigue driving and provide protection for the personal safety of drivers and passengers, as well as the company's profit and loss costs.

3.2.2. Combination of AI and MIS

AI is used to simplify the complex data generated by IoT, perform real-time monitoring and simple decision-making, or provide decision-making guidance. The large AI model is connected to the

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management information system to improve its utilization efficiency—for example, intelligent waybill filling in the logistics industry [10]. The data identified by the photos are checked by artificial intelligence, and intelligent waybills are generated in MIS, simplifying the tedious reporting process and manual errors. In addition, training the AI based on previously stored data allows the AI to identify information in the database. Analyze possible causes for users and provide routine detection of orders and abnormal data in abnormal states [11]. The same can be said for transportation. For example, AI is connected to the MIS database to realize intelligent questions and answers. (Users can ask the AI assistant about real-time vehicle operations or accounts.) Trained AI can also access the Internet, for example, using large model analysis and database information to analyze user questions. For example, the user can ask: AI assistant, please tell me that the fuel consumption of the transport vehicle whose license plate number is ##### and waybill number is ******** is far higher than the average one day to a certain place and analyze the possible reasons. The AI can then give possible causes by combining real-time feedback on road conditions with common causes in large models.

Based on different roles in MIS, different AI programs are designed to perform tasks that need to be completed by different functions. For example, automatically create a waybill and a repair bill. Company managers can get all the information about the company's operations through intelligent interaction with AI. AI automatically monitors the operation situation 24 hours a day, reports anomalies when problems are found, and tries to solve problems with high repeatability, low difficulty, and low impact within the scope of authorization, thereby reducing the work burden of practitioners and enhancing the timeliness of unknown, unexpected handling measures. For example, when the vehicle crashes, an automatic alarm, emergency call, insurance declaration, and coordination of the company's pre-designed pre-treatment plan are used to minimize the loss caused by accidents.

4. Problems

At this stage, the amount of source code innovation is limited; most still rely on the previous construction; the advantage is low cost and low requirements for development and operation personnel. But the drawbacks include the following.

4.1. The Low Compatibility of Old and New Technologies

This problem may lead to database confusion or other issues when accessing emerging technologies such as IoT and AI.

Before IoT was linked, most of the information stored in the MIS system came from manual input data, and the input window of this part of data had been done at the beginning of the construction of MIS and was independently stored in the database. This type of data differs greatly from the data captured by IoT implementations in terms of the amount and duration of storage. In terms of storage volume, the capacity required for IoT to store data is several times that of manual upload. Second, the locations where the data is stored vary. In terms of period, manually uploaded data is intermittent, and there is no high requirement for the concurrency of the system. However, the data uploaded by IoT is real-time, which means that using IoT is in great demand for peak concurrency of MIS.

4.2. Standardization Between IoT and Components

The problem is similar to electrical sockets that are not commonly used internationally. Multiple models of sensor modules from different manufacturers are used in vehicles, significantly negatively affecting IoT access to the entire network and also bringing additional work to programmers [12].

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4.3. Differences in Transport Protocols

Due to the impact of transport protocols, many functions can only be customized, which greatly limits the commercialization of this complex system, such as text transfer protocol, image transfer protocol, and so on.

4.4. Privacy Agreement

The privacy problem has always existed, and there is no relatively perfect solution. In this system, data security should be considered for the company, drivers, and other operators due to the presence of IoT.

4.5. Training Cost of an AI Model

AI not only brings convenience but also expensive training costs. Because the AI in the system involves linking IoT to complete decision-making automatically, it has extremely high requirements for the decision-making accuracy of AI, which further increases the training cost of AI.

5. Conclusion

The combination of MIS-IoT-AI is a great boost to the digital transformation of the supply chain. At the enterprise level, IoT, AI, and MIS combine to build a complex system involving information input, storage, decision-making, and execution. Through the physical sensor-based IoT, this system uploads countless data that appear during the operation process to the MIS for storage and use. Then it processes these data based on AI algorithms or performs simple decision execution and provides feasible guidance. The more profound significance of this system is that it promotes the digital transformation of the supply chain. Compared with the traditional supply chain, the digital supply chain has stronger information interaction, higher controllability, and deeper visualization levels, and it also improves the cooperation and connectivity level of the enterprise supply chain. MIS systems also involve other broader and professional systems, such as Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems. Due to the rapid development of IoT and AI, the combination of these systems can greatly promote the digital transformation of the supply chain. Although so far, the application of these technologies in China's traditional transportation industry is still facing some challenges, combined with the market prospect, enterprises to save costs, reduce operating expenses, strengthen process control, and other behaviors are market trends, and this complex but efficient system seems to be born for this.

The article's review of existing technologies and market research is only based on data from relevant industries. It cannot reflect the overall current level of technology in China. Secondly, the explanation of the problems found in practical applications is based on samples, subject to the cost of the study, which is based on the data generated by 23 vehicles in actual operation. Due to the limited sample size, there may be differences in the studies.

References

[1] *Shang, S., & Seddon, P. B. (2002) Assessing and Managing the Benefits of Enterprise Systems: the Business Manager's Perspective. Information Systems Journal, 12(4), 271–299.*

[2] *Kitzmann, H., Strimovskaya, A., & Elena, S. (2023) Application of Artificial Intelligence Methods for Improvement of Strategic Decision-Making in Logistics. IFIP Advances in Information and Communication Technology, 132–143.*

[3] *Tran-Dang, H., & Kim, D.-S. (2021) The Physical Internet in the Era of Digital Transformation: Perspectives and Open Issues. IEEE Access, 1–1.*

DOI: 10.54254/2754-1169/143/2024.GA18962

[4] *Khan, Y., Su'ud, M. B. M., Alam, M. M., Ahmad, S. F., Ahmad (Ayassrah), A. Y. A. B., & Khan, N. (2022) Application of Internet of Things (IoT) in Sustainable Supply Chain Management. Sustainability, 15(1), 694. MDPI.*

[5] *Dash, R., McMurtrey, M., Rebman, C., & Kar, U. K. (2019) Application of Artificial Intelligence in Automation of Supply Chain Management. Journal of Strategic Innovation and Sustainability, 14(3).*

[6] *Li, B., Xu, C., Wang, Y., Zhao, Y., Zhou, Q., & Xing, X. (2024) Digital Transformation, Supply Chain Collaboration, and Eenterprise Growth: Theoretical logic and Chinese practice. European Research on Management and Business Economics, 30(2), 100249–100249.*

[7] *Lan, S., Tseng, M.-L., Yang, C., & Huisingh, D. (2020) Trends in Sustainable Logistics in Major Cities in China. Science of the Total Environment, 712, 136381.*

[8] *Pan, X., Li, M., Wang, M., Zong, T., & Song, M. (2020) The Effects of a Smart Logistics Policy on Carbon Emissions in China: A difference-in-differences analysis. Transportation Research Part E: Logistics and Transportation Review, 137, 101939.*

[9] *Gnimpieba, Z. D. R., Nait-Sidi-Moh, A., Durand, D., & Fortin, J. (2015). Using Internet of Things Technologies for a Collaborative Supply Chain: Application to Tracking of Pallets and Containers. Procedia Computer Science, 56, 550–557.*

[10] *Ferreira, P., & Reis, J. (2023). A Systematic Literature Review on the Application of Automation in Logistics. Logistics, 7(4), 80–80.*

[11] *Mohsen, B. M. (2023). Impact of Artificial Intelligence on Supply Chain Management Performance. Journal of Service Science and Management, 16(01), 44–58.*

[12] *Ding, Y., Jin, M., Li, S., & Feng, D. (2020). Smart Logistics Based on the Internet of Things Technology: an Overview. International Journal of Logistics Research and Applications, 24(4), 1–23.*