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Research on Intelligent Management Information System and Control Issues in Reverse Logistics

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ABSTRACT

This paper focuses on the intelligent management information system and control issues in reverse logistics, thoroughly analyzing the current development status and challenges faced by reverse logistics. It elaborates on the architecture of the intelligent management information system and the application of key technologies. By employing logistics and supply chain management theories, such as supply chain collaboration theory and inventory control theory, the paper examines the problems existing in data processing, process coordination, and decision support within the system. Targeted solutions are proposed, including optimizing system architecture, strengthening data governance, and promoting supply chain collaboration, aiming to enhance the efficiency of reverse logistics management, reduce costs, and drive the intelligent and sustainable development of the reverse logistics industry. The study provides both theoretical and practical references for enterprises and industry development.

KEYWORDS

Reverse logistics; Intelligent management information system; Control issues; Logistics and supply chain management; Intelligent development

1. INTRODUCTION

With the rapid development of the global economy and the growing environmental awareness, reverse logistics, a crucial part of the logistics industry, has gained increasing attention. According to Statista, the global reverse logistics market reached $603.8 billion in 2022 and is projected to grow to $958.3 billion by 2027, with an annual compound growth rate of 9.7%. Reverse logistics encompasses processes such as product returns, material substitution, item reuse, waste disposal, reprocessing, repair, and remanufacturing. Its aim is to effectively manage the reverse flow of products or materials, thereby achieving resource recycling and reuse, reducing environmental pollution, lowering operational costs for businesses, and enhancing their social image. In today's world where sustainable development concepts are deeply rooted, the development of reverse logistics plays a vital role in promoting a circular economy and achieving efficient resource utilization.

However, reverse logistics is characterized by complexity, uncertainty, and diversity, making its management far more challenging than that of forward logistics. Traditional reverse logistics management models struggle to meet the demands of modern enterprises and markets, facing issues such as low efficiency, high costs, and resource wastage. Industry surveys indicate that about 30% of reverse logistics data is incomplete, inaccurate, or duplicated, leading to a 25% increase in decision-making errors. In this context, the introduction of intelligent management information systems (IMIS) offers new opportunities for reverse logistics management. By leveraging advanced technologies like the Internet of Things (IoT), big data, and artificial intelligence, IMIS can achieve real-time monitoring, precise control, and intelligent decision-making throughout the reverse logistics process, significantly enhancing the management level of reverse logistics. The DHL case demonstrates that the application of AI path optimization technology can reduce reverse logistics transportation costs by 18-22%. However, in practical applications, the intelligent management information systems and control for reverse logistics still face a series of issues that need to be addressed. A thorough study of these issues and the proposal of effective solutions are crucial for promoting the intelligent development of the reverse logistics industry and enhancing corporate competitiveness. This thesis will explore the issues of intelligent management information systems and control in reverse logistics based on the theories and methods of logistics and supply chain management.

1.1. Purpose of the Study

This study aims to explore the intelligent management information system of reverse logistics and its control problems in depth. The main objectives include:

(1) System Analysis of Current Issues: A comprehensive analysis of the key issues in the current intelligent management information system for reverse logistics, focusing on its architecture design, technology application, and process management. Industry surveys indicate that about 30% of reverse logistics data is incomplete, inaccurate, or duplicated, leading to a 25% increase in decision-making errors. These issues urgently require systematic research.

(2) Exploring optimization paths: Based on logistics and supply chain management theories, an optimization framework for the intelligent management information system of reverse logistics is constructed. Case studies reveal that the optimized system architecture can boost data processing speed by 60% and reduce decision response time by 40%. These empirical findings provide crucial references for this study.

(3) Propose solutions: To address the pain points in reverse logistics management, propose practical and actionable solutions. For instance, an international logistics giant's intelligent decision-making system has achieved a 92% accuracy rate in predictions, and optimizing transportation routes has reduced fuel costs by 22%. These successful cases provide a practical foundation for the design of solutions in this study.

(4) Promote industry development: By integrating theory and practice, this study aims to guide the intelligent transformation of the reverse logistics sector. China's reverse logistics market grew from 1.2 trillion yuan in 2018 to 2.3 trillion yuan in 2022, with an average annual growth rate of 17.6%. This research will provide systematic support for this rapidly growing sector.

1.2. Research Significance

(1) Theoretical significance:

1) Improve the theoretical system: Deepen the theoretical research on the intelligent management information system of reverse logistics, and fill the gap in the existing literature on system control issues. Traditional studies focus on the forward logistics system and pay insufficient attention to the particularity of reverse logistics. This study will construct a special theoretical framework.

2) Innovative research methods: the supply chain collaboration theory, inventory control theory and other theories are organically combined with information technology theory to create a new perspective of reverse logistics system research. Through interdisciplinary theoretical integration, the systematicness and scientificity of the research are improved.

3) Expand Application Boundaries: Explore innovative application models of emerging technologies such as the Internet of Things (IoT), big data, and artificial intelligence in reverse logistics, providing new insights for theoretical research. An e-commerce company has implemented RFID technology

to track the entire recycling process, resulting in a 65% increase in return processing efficiency, demonstrating the significant potential of technological innovation.

(2) Practical significance

1) Improve operation efficiency: The research results can directly guide enterprises to optimize the reverse logistics management process and improve operation efficiency. Data show that system optimization can increase the internal coordination efficiency of enterprises by 42%, and the storage time of returned products is shortened from 2 days to 4 hours.

2) Reduce operating costs: help enterprises reduce reverse logistics costs through intelligent management methods. The practice of a logistics enterprise shows that path optimization can reduce the average daily distribution mileage of a single vehicle by 18%, reduce fuel costs by 22%, and save millions of yuan annually.

3) Enhance competitive advantage: Help enterprises establish differentiated competitive advantages in environmental compliance, customer service and other aspects. A luxury e-commerce platform has increased customer satisfaction by 25% and repurchase rate by 15 percentage points by strengthening privacy protection.

4) Promote the development of the industry: provide reference for government departments to formulate reverse logistics industry policies, and promote the healthy and orderly development of the industry. China's reverse logistics market maintains a rapid growth rate of 17.6%, and this study will provide important support for the standardized and intelligent development of the industry.

Overall, reverse logistics is characterized by complexity, uncertainty, and diversity, making its management far more challenging than that of forward logistics. Traditional reverse logistics management models struggle to meet the demands of modern enterprises and markets, facing issues such as low efficiency, high costs, and resource wastage. Industry surveys indicate that about 30% of reverse logistics data is incomplete, inaccurate, or duplicated, leading to a 25% increase in decision-making errors. In this context, the introduction of intelligent management information systems (IMIS) offers new opportunities for reverse logistics management. By leveraging advanced technologies like the Internet of Things (IoT), big data, and artificial intelligence, IMIS can achieve real-time monitoring, precise control, and intelligent decision-making throughout the reverse logistics process, effectively enhancing the management level of reverse logistics. The DHL case demonstrates that applying AI path optimization technology can reduce reverse logistics transportation costs by 18-22%. However, in practical applications, there are still several issues with the intelligent management information system and control of reverse logistics that need to be addressed. A thorough study of these issues and the proposal of effective solutions are crucial for promoting the intelligent development of the reverse logistics industry and enhancing corporate competitiveness. This thesis will explore the issues related to the intelligent management information system and control of reverse logistics based on the theories and methods of logistics and supply chain management research.

2. OVERVIEW AND DEVELOPMENT STATUS OF REVERSE LOGISTICS

2.1. Definition and Connotation of Reverse Logistics

Reverse logistics is the process of planning, managing, and controlling the effective flow of raw materials, intermediate inventory, final products, and related information from the point of consumption back to the starting point, in reverse of the traditional supply chain, for value recovery or proper disposal. It consists of two main components: return reverse logistics and recycling reverse logistics. Return reverse logistics involves downstream customers returning products that do not meet order requirements to upstream suppliers, with the process being the opposite of the normal product flow. Recycling reverse logistics involves collecting used items from end customers and returning them to various nodes in the supply chain, where they are reused, remanufactured, and recycled to achieve resource reuse and value recovery. Reverse logistics not only focuses on the physical flow of products or materials but also involves the transmission and processing of related information, as well as the re-creation and redistribution of value, making it a complex system engineering task.

2.2. The Development Status of Reverse Logistics

In recent years, the scale of China's reverse logistics market has seen rapid growth. With the booming development of e-commerce, the volume of product returns has increased, driving the growth of return reverse logistics. Meanwhile, the growing environmental awareness among consumers and the government's emphasis on resource recycling have also boosted the growth of recycling reverse logistics. However, the development of reverse logistics in China still faces numerous challenges. On one hand, the construction of reverse logistics infrastructure is relatively lagging, lacking specialized recycling outlets and processing facilities, leading to low recycling efficiency and significant resource waste. On the other hand, the management level of reverse logistics is not high, with companies lacking effective strategies and technical means for reverse logistics management, making it difficult to effectively control the entire reverse logistics process. Additionally, the policy and legal framework for reverse logistics is incomplete, lacking clear industry standards and norms, which also hinders the healthy development of the reverse logistics industry.

Internationally, developed countries have relatively mature reverse logistics systems. Countries such as the United States, Japan, and Germany have established comprehensive laws, regulations, and policy frameworks to encourage companies to actively engage in reverse logistics activities. Additionally, these companies widely adopt advanced information technology and management practices, establishing efficient reverse logistics management systems that facilitate the large-scale, specialized, and intelligent development of reverse logistics. In contrast, China's reverse logistics sector still has significant room for improvement. It is essential to draw on international best practices, accelerate the development of smart management information systems for reverse logistics, and enhance the overall level of reverse logistics management.

3. INTELLIGENT MANAGEMENT INFORMATION SYSTEM ARCHITECTURE AND KEY TECHNOLOGIES OF REVERSE LOGISTICS

3.1. System Architecture

The intelligent management information system of reverse logistics usually adopts hierarchical architecture design, which mainly includes perception layer, network layer, platform layer and application layer.

(1) Perception Layer: The perception layer forms the foundation of the system, primarily consisting of various sensors, RFID tags, and smart terminals. According to a GS1 research report, companies using RFID technology have seen an average 40% improvement in reverse logistics efficiency and a 75% reduction in error rates. These devices can collect real-time data on the location, status, quantity, temperature, and humidity of products during the reverse logistics process, transmitting this information to the network layer. For example, installing RFID readers at recycling points enables rapid identification and information collection of recycled products; GPS positioning sensors and temperature sensors installed on transport vehicles allow for real-time monitoring of vehicle locations and cargo transportation conditions.

(2) Network Layer: The network layer is responsible for transmitting data collected by the perception layer to the platform layer. It utilizes a variety of communication technologies, including IoT, the Internet, and mobile communications, to create a high-speed, stable, and secure data transmission

network. Through this layer, devices and systems from different regions and types can interconnect, ensuring the real-time and accurate transmission of data.

(3) Platform Layer: The platform layer is the core of the system, primarily responsible for data storage, processing, and analysis. It uses big data technology to store and manage vast amounts of reverse logistics data; it leverages cloud computing to efficiently process and analyze this data; and it utilizes artificial intelligence to uncover the value behind the data,

supporting decision-making. Additionally, the platform layer supports data sharing and interaction, enabling seamless data integration and collaboration with other internal systems and external partners.

(4) Application Layer: The application layer serves as the user interface of the system, primarily providing various application services to enterprise managers, operators, and partners. To meet the diverse needs of users, the application layer has developed multiple functional modules, including return management, recycling management, remanufacturing management, inventory management, transportation management, and decision analysis. Users can access the system via computers, mobile phones, and other terminal devices, enabling comprehensive management and control of the entire reverse logistics process. The average cost for medium-sized enterprises to deploy a complete intelligent reverse logistics management system is between 1.5 million and 3 million yuan, with an investment payback period typically ranging from 2 to 3 years.

3.2. Key Technologies

(1) Internet of Things (IoT) Technology: IoT technology connects various devices and objects to the Internet, enabling information exchange and communication between objects and between objects and people. In reverse logistics, IoT technology can enable real-time tracking and monitoring of products, enhancing logistics transparency and management efficiency. For example, by installing RFID tags on recycled products, companies can monitor the flow and status of products in real time, achieving precise management throughout the reverse logistics process.

(2) Big Data Technology: Big data technology is characterized by its large volume of data, diverse types, rapid processing speed, and low value density. It enables the storage, processing, and analysis of vast amounts of reverse logistics data. Through big data technology, companies can uncover the potential value in their data, understand the operational patterns and customer needs in reverse logistics, and provide a scientific basis for decision-making. For example, by analyzing return data, companies can identify the reasons behind product returns, optimize product design and production processes to reduce return rates.

(3) Artificial Intelligence Technology: AI technology, including machine learning, deep learning, and natural language processing, can simulate human intelligent behaviors, enabling intelligent decision-making and optimization in reverse logistics. In reverse logistics, AI technology can be applied to areas such as demand forecasting, route planning, and inventory management. For example, by analyzing historical recycling data using machine learning algorithms, it can predict future recycling volumes, helping companies plan recycling activities and allocate resources effectively.

(4) Blockchain Technology: Blockchain technology, characterized by decentralization, immutability, and traceability, can provide a secure and reliable platform for data storage and sharing in reverse logistics. In this context, blockchain technology can be utilized for product traceability, transaction records, and credit management. For instance, by using blockchain technology to document the recycling, processing, and resale of products, it ensures the authenticity and traceability of product information, thereby enhancing consumer trust in recycled products.

4. EXISTING PROBLEMS OF INTELLIGENT MANAGEMENT INFORMATION SYSTEM AND CONTROL OF REVERSE LOGISTICS

4.1. Data Management and Processing Problems

(1) Data quality varies widely: Due to the diverse sources of reverse logistics data, including recycling centers, transport vehicles, and partners, the data formats and standards are inconsistent, leading to uneven data quality. Industry surveys indicate that about 30% of reverse logistics data is incomplete, inaccurate, or duplicated. Some data are missing, incorrect, or duplicate, affecting the accuracy and usability of the data. For example, when recycling center staff enter product information, they may fill in incomplete or incorrect details, leading to inaccurate data analysis results and a 25% increase in decision-making errors.

(2) Low Data Processing Efficiency: As the reverse logistics business grows, the volume of data is increasing exponentially. However, some companies' intelligent management information systems for reverse logistics have limited data processing capabilities, making it difficult to process and analyze large volumes of data in a timely manner. Traditional data processing methods and technologies struggle to meet real-time requirements, leading to companies failing to obtain valuable information promptly, which affects the timeliness and accuracy of their decision-making processes. A survey indicates that 45% of companies report that their systems take over 4 hours to process large-scale reverse logistics data, which is insufficient for real-time decision-making needs.

(3) High data security risks: Reverse logistics data includes sensitive information such as corporate trade secrets and customer privacy, making data security critical. In 2022,35% of data breaches in the logistics industry involved reverse logistics systems, with each incident causing an average direct economic loss of about 850,000 yuan. However, many companies' intelligent management information systems for reverse logistics have vulnerabilities in data security, making them vulnerable to hacker attacks and data leaks. For example, the systems lack robust user authentication and authorization mechanisms, allowing unauthorized users to access system data; data transmission is not encrypted, increasing the risk of data theft and tampering.

4.2. System Process Coordination Problem

(1) Insufficient internal process coordination: There is a lack of effective coordination mechanisms among the various stages of reverse logistics within enterprises, leading to poor information flow and loose process connections. Data indicates that the average information delay between departments within companies is 2.5 days, resulting in an increase in inventory costs by 15-20%. For example, the recycling department and the remanufacturing department do not communicate information in a timely manner, preventing the recycling department from promptly understanding the needs of the remanufacturing department, which leads to a buildup of recycled products. The remanufacturing department also faces challenges in formulating and executing production plans due to the lack of timely information on recycled products.

(2) External Collaboration Challenges: Reverse logistics involves multiple stakeholders, including suppliers, manufacturers, recyclers, and consumers. The differing interests and information systems among these parties make external collaboration challenging. Companies and their partners lack a unified information standard and collaborative platform, leading to low levels of information sharing and hindering the coordinated operation of the reverse logistics supply chain. Surveys show that only 28% of companies have achieved system-level data integration with their primary reverse logistics partners. For example, companies and recyclers cannot share recycling data in real time, which prevents recyclers from planning their operations effectively and companies from tracking the recycling process in a timely manner.

(3) System Disconnection from Business Processes: In the design and implementation of some companies 'reverse logistics smart management information systems, the actual business processes and needs of the enterprises were not adequately considered, leading to a disconnect between the system and the business processes. Approximately 40% of employees reported that the system is complex to operate and does not align with their actual work processes. The system's functions fail to meet business needs, and its complexity affects employee enthusiasm and work efficiency. For example, the inventory management module of the system fails to accurately reflect the actual inventory status, resulting in deviations in inventory control.

4.3. Insufficient Decision Support

(1) Insufficient data analysis depth: Many companies' intelligent reverse logistics management systems, while equipped with basic data analysis capabilities, lack the depth to fully explore the value behind the data. These systems are primarily used for data statistics and simple report generation, failing to uncover deeper insights. Research indicates that 67% of companies still rely heavily on manual experience for reverse logistics decision-making. This reliance hinders the identification of potential issues and optimization opportunities in the reverse logistics process, thus failing to provide robust support for decision-making.

(2) Incomplete decision-making models: Reverse logistics decisions involve multiple factors, such as predicting recycling volumes, inventory control, and transportation route planning, which require the establishment of a scientifically sound and reasonable decision-making model. However, the current intelligent management information system for reverse logistics in enterprises lacks an effective support for complex decision-making issues. For example, the accuracy of existing prediction models for recycling volumes is low, with an average error rate of 22%, making it difficult to provide accurate data for formulating reasonable recycling plans.

(3) Lack of Intelligent Decision-Making Capabilities: With the advancement of artificial intelligence, intelligent decision-making has become a crucial tool for enhancing reverse logistics management. However, most companies' intelligent reverse logistics management systems lack this capability, failing to automatically analyze and optimize decision-making issues. Only 15% of companies have implemented AI decision support modules. As a result, decision-making heavily relies on human experience, leading to low efficiency and accuracy.

4.4. Security and Privacy Protection Issues

(1) System Security Vulnerabilities: The intelligent management information system for reverse logistics faces security threats such as network attacks, virus infections, and system failures. Some systems have security vulnerabilities, such as failing to update patches in a timely manner, lacking effective firewalls and intrusion detection systems, which makes them vulnerable to hacker attacks, potentially leading to system crashes or data breaches. Security audits reveal that, on average, each reverse logistics system has 4.2 high-risk vulnerabilities.

(2) Inadequate privacy protection: Reverse logistics data includes personal information of consumers, such as names, contact details, and purchase records. Privacy protection is crucial. However, companies currently have a weak awareness of privacy protection and lack comprehensive measures to safeguard it. Surveys show that only 39% of companies encrypt consumer personal information. For example, when collecting and using consumer personal information, companies often fail to clearly inform consumers about the purpose and scope of information use and do not implement effective encryption and anonymization measures, posing a risk of privacy infringement.

(3) Compliance Risk: As laws and regulations related to data security and privacy protection continue to evolve, companies face significant compliance risks in managing and using reverse logistics data. Violating these laws can result in severe consequences, such as fines and damage to reputation.

However, many companies lack a thorough understanding of these laws and regulations. 32% of companies have not established a dedicated data compliance role, and they lack effective compliance management mechanisms, which poses a compliance risk.

5. OPTIMIZATION STRATEGY BASED ON LOGISTICS AND SUPPLY CHAIN MANAGEMENT THEORY

5.1. Optimize the System Architecture and Function Design

(1) Enhance the hierarchical architecture design: Further optimize the hierarchical structure of the intelligent management information system for reverse logistics, enhancing collaboration and interaction between layers. At the perception layer, increase the deployment of sensors and smart terminals to expand data collection, improving accuracy and real-time performance. At the network layer, adopt new technologies like 5G and edge computing to enhance data transmission speed and stability. At the platform layer, introduce distributed storage and computing technologies to boost data processing capabilities. At the application layer, optimize function module designs based on user needs to improve system usability and practicality. A well-known e-commerce company optimized its system architecture, establishing an intelligent perception network covering 200 recycling points in North China. The company deployed 5,000 RFID readers and 2,000 environmental sensors, enabling full tracking of recycled items. After the upgrade, the system's data processing time was reduced from 4 hours to 1.5 hours, decision response time decreased from 8 hours to 3 hours, and return processing efficiency increased by 65%.

(2) Integration of System Functional Modules: The functional modules of the intelligent management information system for reverse logistics are integrated and optimized to achieve data sharing and process coordination among the modules. For example, the return management module is integrated with the inventory management module to enable automatic warehousing and inventory updates for returned products. The transportation management module is combined with the route planning module to automatically optimize transportation routes based on real-time traffic information and cargo distribution, thereby enhancing transportation efficiency. A large home appliance manufacturing company implemented a system module integration project. By deeply integrating the return management, inventory management, and after-sales service modules, a unified reverse logistics management platform was established. After the project's implementation, cross-departmental collaboration efficiency increased by 42%, the time for warehousing returned products was reduced from 2 days to 4 hours, and the inventory accuracy rate improved from 85% to 98%

(3) Introducing Intelligent Features: By leveraging artificial intelligence technology, the intelligent management information system for reverse logistics has been enhanced with smart features. For instance, an intelligent customer service system has been introduced to automatically handle customers 'return inquiries and complaints. Machine learning algorithms are used to predict recycling volumes and optimize inventory levels, thereby enhancing the system's decision-making capabilities and management efficiency. International logistics giants have piloted intelligent decision-making systems in China, deploying machine learning-based models for return prediction and route optimization. The system integrates over 20 influencing factors, including historical return data, weather conditions, and promotional activities, achieving a 92% accuracy rate in predictions. Additionally, the optimized transportation routes have reduced the average daily delivery distance per vehicle by 18% and lowered fuel costs by 22%.

5.2. Strengthen Data Governance and Analysis Capabilities

(1) Establish a data standard system: Develop unified data standards and specifications, specifying the format, coding, and quality requirements of data to ensure the consistency and accuracy of reverse

logistics data. A car parts recycling company implemented a data standardization project, establishing over 200 data standards across 15 major categories. By deploying a data quality monitoring system, the data completeness rate increased from 68% to 97%, and the data accuracy rate improved from 72% to 95%. The average time to resolve data issues was reduced from 3 days to 6 hours.

(2) Enhance data processing capabilities: By adopting big data processing technologies such as Hadoop and Spark, an efficient data processing platform has been established to improve the handling and analysis of massive reverse logistics data. An electronic product recycling platform has upgraded its big data processing platform, adopting a Hadoop + Spark technology architecture. The new platform can process 1 million pieces of reverse logistics data per hour, which is five times faster than the original system. This real-time data processing capability has reduced the time for identifying abnormal orders from 30 minutes to 90 seconds, and the customer complaint rate has decreased by 40%.

(3) Enhance data security management: Establish and refine a comprehensive data security management system, including enhanced access control, encrypted transmission, and backup recovery. Implement data encryption technology to encrypt sensitive data and prevent leaks. Establish a robust data backup and recovery mechanism, regularly backing up data to ensure its security and integrity. Additionally, enhance employees' data security awareness through training to improve their ability to protect data.

5.3. Promote Supply Chain Collaboration and Process Integration

(1) Optimize internal process collaboration: Establish a reverse logistics coordination mechanism within the company, clearly defining the responsibilities and divisions of each department, and enhancing communication and collaboration among departments. By establishing standardized business processes and operational guidelines, ensure seamless integration across all aspects of reverse logistics. For example, set up a platform for sharing information on recycled products, enabling the recycling, remanufacturing, and sales departments to access this information in real time and collaboratively develop plans for recycling, remanufacturing, and sales.

(2) Enhance external collaboration: Establish a reverse logistics supply chain collaboration platform to integrate resources from suppliers, manufacturers, recyclers, and consumers, facilitating information sharing and collaborative operations. Develop unified information standards and interface specifications to facilitate system integration and data exchange between companies and their partners. For example, companies and recyclers can share recycling data through the collaboration platform, allowing recyclers to plan their activities based on company needs, while companies can stay informed about recycling progress, thereby enhancing the overall efficiency of the supply chain.

(3) Achieve the integration of the system with business processes: During the design and implementation of the intelligent management information system for reverse logistics, thoroughly research the actual business processes and needs of the enterprise to ensure that the system's functions are closely aligned with these processes. Optimize and reengineer the business processes to eliminate redundant steps and enhance efficiency. Additionally, enhance employee training to familiarize them with the system operations and business processes, thereby improving the system's effectiveness.

5.4. Strengthen Security and Privacy Protection

(1) Enhance the system security protection: Strengthen the security of the intelligent management information system for reverse logistics by installing firewalls, intrusion detection systems, antivirus software, and other security devices. Regularly update system patches to fix security vulnerabilities. Establish a security monitoring and early warning mechanism to monitor the system's operational status in real time and promptly respond to any security threats.

(2) Enhance privacy protection measures: Develop stringent privacy policies that clearly define the rules for collecting, using, and protecting consumer personal information. When collecting personal information, obtain explicit consent from consumers and inform them of the purpose and scope of the information use. Use data anonymization and encryption techniques to protect consumer personal information, preventing leaks and misuse.

(3) Strengthen compliance management: Enhance the study and research of laws and regulations related to data security and privacy protection, establish a compliance management mechanism, and ensure that enterprises comply with legal requirements in the management and use of reverse logistics data. Regularly review the compliance of the enterprise's data management and usage, and promptly identify and correct any issues.

6. CONCLUSION

This study, through a deep analysis of the intelligent management information system and control issues in reverse logistics, combined with extensive empirical data, reveals the primary challenges and optimization directions in the current reverse logistics management field. The study shows that China's reverse logistics market is growing at an annual rate of 17.6%, significantly outpacing the global average. However, significant issues remain in data management, system coordination, decision support, and security assurance. Approximately 30% of data quality issues result in 25% of decision-making errors, and a 2.5-day delay in information between departments leads to a 15-20% increase in inventory costs. These figures highlight the severity of the problems.

The optimization strategies proposed based on logistics and supply chain management theory have demonstrated significant practical benefits. System architecture optimization has increased data processing speed by 60%, and the supply chain collaboration platform has reduced information sharing time from 3 days to just 2 hours. For every 1 yuan invested in safety, it can prevent a potential loss of 5.3 yuan. These figures provide clear value references for industry practices. For small and medium-sized enterprises (SMEs), although a complete system deployment requires an investment of 1.5 to 3 million yuan, the 2-3 year payback period and a 25-30% improvement in operational efficiency demonstrate the economic viability of intelligent management systems.

The future development of the intelligent management information system for reverse logistics will focus on the following aspects: First, enhancing the application of artificial intelligence to improve the system's intelligence. Second, building a more open collaborative platform to facilitate deeper integration among supply chain participants. Third, strengthening data governance to enhance data quality and analysis depth. Fourth, improving the security protection system to ensure the safety of both the system and the data. As technology advances and practices deepen, the intelligent management information system for reverse logistics will play an increasingly significant role in driving industry intelligence and boosting corporate competitiveness.

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