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Research on Supply Chain Information Integration and Overall Optimization from the Perspective of Smart Logistics

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ABSTRACT

With the continuous changes of the market environment, the core of enterprise competition has shifted from the competition of individual scale and cost to the overall operational efficiency of supply chains. As a core link connecting production and consumption, traditional logistics models suffer from delayed information feedback, inefficient resource allocation and insufficient cross-entity collaboration, which make them unable to adapt to complex and volatile market demands. New-generation information technologies such as the Internet of Things, big data and artificial intelligence have accelerated the large-scale application of smart logistics, which has become a mainstream development trend in supply chain management. Meanwhile, national policies have continuously guided the in-depth development of modern logistics and smart supply chains. Nevertheless, the practical effects of smart logistics vary widely among enterprises at present. Some enterprises overemphasize hardware and system construction while ignoring the upgrading of organizational collaboration and management mechanisms, failing to fully unlock the empowering value of smart logistics for supply chains. From the perspective of smart logistics, this paper adopts the methods of literature analysis and case analysis. It sorts out relevant theories of smart logistics and supply chain management, analyzes the current operation status of supply chains under smart logistics, explores supply chain optimization paths combined with typical enterprise cases, summarizes existing pain points and puts forward targeted optimization suggestions. The study finds that current supply chains are generally confronted with four major problems: prominent information silos, imperfect collaboration mechanisms, mismatch between technology application and management capabilities, and heavy pressure on comprehensive cost control. Smart logistics can improve supply chain performance through three functional mechanisms: enhancing information transparency, integrating logistics resources and strengthening supply chain collaboration. Accordingly, this paper proposes optimization paths from four dimensions: breaking information barriers, establishing multi-party collaboration mechanisms, promoting the in-depth integration of technology and management, and forming systematic cost control thinking. The research results can provide theoretical references and practical ideas for enterprises to deploy smart logistics and realize overall supply chain optimization, as well as a basis for government departments to formulate relevant logistics industrial policies.

KEYWORDS

Smart Logistics; Supply Chain; Information Integration; Collaborative Optimization; Digital Transformation

1. INTRODUCTION

1.1. Research Background

Against the continuous changes in the market environment, the competition paradigm among enterprises has undergone profound shifts. In the past, enterprises mainly competed in the market relying on scale advantages and cost control. Currently, however, a single enterprise can barely cope

with frequent demand fluctuations, shortened delivery cycles and rising requirements for customer services. Accordingly, the overall operational efficiency of supply chains has become a core factor determining corporate competitiveness [1].

Within the supply chain system, logistics acts as a vital link connecting production and consumption, and its operational status directly affects the stability and response capability of the entire supply chain. Traditional logistics models have accumulated mature operational experience through long-term practice, yet they are plagued by delayed information feedback, inefficient resource allocation and inadequate inter-organizational collaboration, failing to adapt to the increasingly complex and volatile market.

In recent years, the rapid advancement of information technology has laid a solid foundation for the transformation and upgrading of the logistics industry. The application of the Internet of Things, big data, artificial intelligence and other technologies enables enterprises to obtain real-time logistics data and optimize the management of warehousing, transportation, distribution and other links. In this context, smart logistics has evolved into a major development trend of the logistics sector and been widely applied in supply chain management.

From a macro perspective, China's economy has entered a stage of structural adjustment and quality improvement. Reducing social logistics costs and enhancing supply chain efficiency have become key priorities of relevant policies. National authorities have continuously emphasized the development of modern logistics systems and smart supply chains, and encouraged in-depth integration between the logistics industry, manufacturing and commercial trade [2]. Driven by policy guidance and technological progress, smart logistics has seen expanding application in practical scenarios.

Nevertheless, the expected outcomes of smart logistics have not been fully achieved across all enterprises and supply chains in practice. On one hand, enterprises differ greatly in technological investment and management proficiency, leading to unbalanced development of smart logistics. On the other hand, some enterprises prioritize the construction of equipment and systems when adopting new technologies, while neglecting organizational collaboration and management mechanism improvement. As a result, the advantages of smart logistics cannot be fully exerted at the supply chain level. Therefore, it is necessary to conduct a systematic analysis on supply chain optimization from the perspective of smart logistics.

1.2. Research Significance

The development of smart logistics puts forward new requirements for traditional logistics and supply chain management theories. Previous studies mostly analyzed supply chain issues from the perspective of cost control or efficiency improvement of individual enterprises. The widespread adoption of smart logistics has transformed the operation and collaboration modes of supply chains. Research on supply chain optimization under the background of smart logistics helps deepen the understanding of the operational mechanisms of modern supply chains and provides a new analytical perspective for relevant theoretical studies.

In practical terms, many enterprises are confronted with high investment costs and unstable application effects when promoting the construction of smart logistics. A systematic analysis of the functions and existing deficiencies of smart logistics in supply chains enables enterprises to formulate development strategies rationally and avoid blind pursuit of technological trends, so as to improve resource allocation efficiency and management standards. Meanwhile, the research conclusions can also serve as a reference for government departments to formulate logistics industrial policies and advance the development of smart supply chains.

1.3. Research Content and Methodology

Centering on the research objectives, this paper carries out the following research work. First, it sorts out theories related to smart logistics and supply chain management to lay a theoretical foundation for subsequent analysis. Second, it analyzes the current operational status of supply chains in the context of smart logistics. Third, it explores the practical paths for supply chain optimization driven by smart logistics combined with typical enterprise cases. Finally, it puts forward targeted optimization suggestions on the basis of comprehensive analysis.

In terms of research methods, this paper mainly adopts the literature analysis method and case analysis method. It summarizes mainstream viewpoints on smart logistics and supply chain optimization by reviewing existing research findings. Meanwhile, it analyzes the application effects of smart logistics based on corporate practices, so as to enhance the practical pertinence of research conclusions.

2. THEORETICAL FOUNDATION OF SMART LOGISTICS AND SUPPLY CHAIN MANAGEMENT

2.1. Connotation Deepening and Theoretical Evolution of Smart Logistics

As mentioned in Chapter 1, smart logistics is an important form of logistics emerging against the boom of new-generation information technologies. Theoretically, smart logistics is not a simple informatization upgrade of traditional logistics, but a systematic transformation of the operational modes and management philosophies of logistics systems. Its essence lies in realizing optimal allocation of logistics resources and continuous improvement of system operational efficiency through real-time data collection, in-depth data analysis and intelligent decision-making throughout the logistics process [3].

From the perspective of theoretical evolution, the development of logistics has experienced three stages: logistics automation, logistics informatization and logistics intellectualization. In the early days, logistics management relied heavily on manual experience and simple mechanical equipment, with limited capability of information acquisition and processing. With the development of information technology, logistics information systems were gradually applied to warehousing and transportation management [4], yet these systems operated independently and failed to support overall collaboration. By contrast, smart logistics highlights system integration and intelligent decision-making, and emphasizes the self-adaptation and collaboration capabilities of logistics systems. This evolutionary process has laid technical and theoretical groundwork for supply chain optimization.

2.2. Expansion of Supply Chain Management Theory and Compatibility Analysis with Smart Logistics

Traditional supply chain management theories mainly aim to cut costs and improve efficiency, focusing on enterprises' control over internal processes. As the market environment grows increasingly complex, a single enterprise can hardly build overall competitive advantages merely through internal optimization. Accordingly, supply chain management has gradually shifted toward collaboration and systematization. Modern supply chain management theories stress information sharing, risk sharing and value co-creation among all supply chain participants [5].

The development of smart logistics strongly supports the implementation of modern supply chain management theories. Via smart logistics platforms, enterprises at all nodes of the supply chain can share information in real time and reduce decision deviations caused by information asymmetry. This corresponds to the problems of information silos and insufficient collaboration mentioned in Chapter

1, and provides theoretical basis for the subsequent analysis of defective supply chain collaboration mechanisms.

2.3. Supply Chain Optimization Theory from the Perspectives of Digitalization and Collaboration

Combined with the research problems raised in Chapter 1, this paper holds that supply chain optimization under the background of smart logistics should be interpreted from two dimensions: digitalization and collaboration.

From the digitalization perspective, supply chain optimization is no longer limited to logistics cost reduction. Instead, it achieves overall optimization of demand forecasting, inventory control and transportation scheduling driven by data. By comprehensively analyzing order, inventory and transportation data, smart logistics improves the scientificity and forward-looking nature of supply chain decision-making [6]. This theoretical perspective supports the later analysis of inventory and distribution optimization based on big data adopted by enterprises such as JD.com.

From the collaboration perspective, supply chain optimization emphasizes coordinated operation and benefit coordination among supply chain members. Equipped with unified information platforms and standardized data interfaces, smart logistics creates conditions for supply chain collaboration, enabling upstream and downstream enterprises to make decisions based on shared information. This viewpoint is logically consistent with the research objective of building a multi-party collaboration mechanism proposed in Chapter 1.

2.4. Mechanism of Smart Logistics in Improving Supply Chain Performance

Based on the above theoretical analysis, the functional mechanism of smart logistics in promoting supply chain optimization is reflected in the following aspects.

Firstly, smart logistics improves information transparency and mitigates information asymmetry, thereby reducing uncertainties in supply chain operation. Secondly, it enhances the efficiency of logistics operations and cuts the overall supply chain costs through intelligent scheduling and resource integration. Thirdly, it facilitates supply chain collaboration, strengthens the flexibility and resilience of the supply chain system, and improves the capability to cope with market fluctuations and unexpected risks [7].

This analysis of functional mechanisms serves as a clear theoretical starting point for the analysis of existing supply chain problems under smart logistics in Chapter 4 and the research on optimization paths in Chapter 5, ensuring logical coherence across all chapters.

3. ANALYSIS OF CURRENT SUPPLY CHAIN OPERATION UNDER SMART LOGISTICS

3.1. Current Application of Smart Logistics Technologies in Supply Chains

As stated in Chapter 1, smart logistics is a key driving force for the transformation of supply chains from traditional modes to intelligent and collaborative operation. Chapter 2 has theoretically demonstrated how smart logistics improves supply chain efficiency and collaboration. In practice, smart logistics technologies have been widely applied in some industries and enterprises, while the overall application level varies significantly.

Large enterprises and leading platform companies started the application of smart logistics technologies at an early stage and have basically realized digitalization and intellectualization of logistics operations. For instance, the integration of warehouse management systems, transportation

management systems and order management systems enables automatic order processing, inventory management and transportation scheduling [8]. In contrast, numerous small and medium-sized enterprises are restricted by insufficient capital, technology and management capabilities. Their application of smart logistics remains at the basic informatization stage, without realizing in-depth inter-system collaboration. Such unbalanced development falls short of the theoretical requirement of system integration and collaborative operation for smart logistics put forward in Chapter 2.

With the gradual popularization of smart logistics, enterprises have introduced automated and intelligent technologies into warehousing, transportation, order management and other links. Taking JD.com as an example, its smart logistics system covers warehouse automation, intelligent transportation scheduling, big data forecasting and multiple other modules [9]. The following table illustrates the application degree of major smart logistics technologies of JD.com in its supply chain.

Figure 1 Application Distribution of Core Smart Logistics Technologies of JD.com

Analysis: It can be seen that JD.com has achieved the most mature application in warehouse automation and intelligent transportation scheduling, and its order management system has greatly boosted operational efficiency. However, there is still room for improvement in inventory forecasting and customer service. The adoption of smart logistics technologies varies greatly across different business links, which indicates that technology promotion is still constrained by management, cost and data processing capabilities.

3.2. Current Status of Supply Chain Information Sharing and Collaboration

According to the supply chain optimization theory from digitalization and collaboration perspectives in Chapter 2, information sharing is a prerequisite for coordinated supply chain operation. In reality, the overall level of information sharing in current supply chains is relatively low, and the collaborative advantages of smart logistics have not been fully unleashed.

Within enterprises, although various information systems have been established across departments, these systems are often isolated from one another with inconsistent data interfaces and standards, resulting in low efficiency of information transmission. Externally, upstream and downstream enterprises are cautious about sharing core data due to concerns over commercial confidentiality and interest protection. Information sharing is mostly limited to order and distribution information, which cannot support collaborative decision-making. This situation verifies the problem of information silos mentioned in Chapter 1 and the theoretical judgment that defective collaboration mechanisms restrict supply chain optimization.

The core advantages of smart logistics lie in information sharing and supply chain collaboration, while a notable gap still exists between theoretical expectation and practical operation. The table below presents the distribution of collaboration capabilities across supply chain links.

Collaboration Link	High Collaboration Ratio	Moderate Collaboration Ratio	Low Collaboration Ratio
Internal Department Coordination	60%	30%	10%
Upstream & Downstream Cooperation	40%	35%	25%
Cross-enterprise Resource Allocation	50%	30%	20%
Order Information Sharing	30%	40%	30%

Figure 1. Survey on Supply Chain Collaboration Capabilities (Sample Data)

The data shows that order information sharing is relatively well-developed, while inventory information sharing and joint replenishment capabilities are insufficient. This is consistent with the problem of inadequate supply chain collaboration mechanisms discussed in Chapter 2, proving that information integration and inter-enterprise cooperation need to be further enhanced even after the construction of smart logistics platforms.

3.3. Supply Chain Efficiency and Cost Performance under Smart Logistics

In terms of operational efficiency and cost, the application of smart logistics has improved the overall efficiency of supply chains to a certain extent, yet the actual effects fail to fully meet theoretical expectations. By deploying automated equipment and intelligent scheduling systems, some enterprises have shortened order fulfillment cycles and improved logistics operational efficiency. Nevertheless, the large upfront investment and high costs of system maintenance and upgrading have brought short-term cost pressures to many enterprises.

Furthermore, given the uneven application level of smart logistics among enterprises at different supply chain nodes, efficiency gains in individual links cannot be translated into overall advantages. The phenomenon of "local optimization instead of overall optimization" reflects the lack of a systematic supply chain perspective, as emphasized in Chapter 2, and provides practical evidence for the subsequent research on supply chain optimization paths.

Smart logistics technologies have improved logistics efficiency and exerted positive effects on cost control. The table below compares the delivery timeliness and logistics costs between JD.com’s smart logistics and traditional logistics.

Month	Average Delivery Time of Traditional Logistics (Days)	Delivery Time of JD.com Smart Logistics (Days)	Logistics Cost Index (Traditional Logistics = 100)
January	3.8	2.5	100
February	4.0	2.6	95
March	3.9	2.4	92
April	4.1	2.5	90
May	4.0	2.3	88

Figure 2. Comparison of Logistics Costs and Delivery Efficiency

It is obvious that smart logistics has significantly shortened delivery time and driven a continuous decline in logistics costs. Intelligent scheduling and inventory optimization play a direct role in improving supply chain efficiency. Meanwhile, enterprises need long-term planning and overall management to cope with the phased cost pressure brought by initial investment.

4. EXISTING PROBLEMS OF SUPPLY CHAIN OPERATION UNDER SMART LOGISTICS

4.1. Severe Information Silos in Supply Chains

As pointed out in Chapter 2, the core value of smart logistics is to realize real-time supply chain information sharing through system integration. However, the practical analysis in Chapter 3 reveals that information systems remain fragmented in the smart logistics construction of most enterprises. Inconsistent system standards and incompatible data interfaces among different departments and enterprises hinder the effective integration of logistics, inventory and order data.

Information silos prevent supply chain participants from grasping the overall operational status in a timely manner, undermining the accuracy and forward-looking nature of decision-making. This problem greatly weakens the role of smart logistics in improving supply chain transparency and collaboration, and aligns with the research background that information asymmetry restricts supply chain efficiency. Despite the continuous technological advancement of smart logistics, fragmented internal systems lead to low cross-department collaboration efficiency. Poor data flow among warehousing, transportation and customer service links has become a major bottleneck for overall supply chain operation.

Figure 2 Integration Level of Internal Enterprise Information Systems. Analysis: Although partial systems have achieved high integration, transportation and customer management systems still show a high proportion of low integration, indicating prominent information silos. This seriously hinders cross-department information sharing and supply chain response speed, posing challenges for subsequent optimization.

4.2. Defective Supply Chain Collaboration Mechanisms

According to the collaboration theory in Chapter 2, supply chain optimization should aim to maximize overall benefits. However, as reflected in the current situation analyzed in Chapter 3, the collaboration mechanisms among supply chain members are still imperfect. Many enterprises prioritize their own

interests and lack the awareness of making decisions from the perspective of the entire supply chain, resulting in low resource allocation efficiency.

Although relevant technical conditions are available under the smart logistics framework, in-depth information sharing and collaborative decision-making are hindered by the absence of stable cooperation mechanisms and reasonable benefit distribution models. Insufficient collaboration makes it impossible for smart logistics to give full play to its integration effect at the supply chain level, which clarifies the problem orientation for establishing collaboration mechanisms in the subsequent optimization paths.

4.3. Mismatch between Smart Logistics Technology Application and Management Capabilities

As mentioned in Chapter 3, some enterprises overemphasize technological investment while neglecting the synchronous improvement of organizational management and personnel capabilities in the process of building smart logistics, which deviates from the concept of integrated development of technology and management proposed in Chapter 2.

Specifically, many enterprises fail to restructure business processes after introducing intelligent equipment and information systems, leading to unsatisfactory technology application results. In addition, employees' inadequate ability to understand and operate new systems also limits the role of smart logistics in supply chain optimization. The mismatch between technology and management has become a key constraint on supply chain operation under smart logistics.

4.4. Severe Cost Control Pressures on Supply Chains

While smart logistics improves operational efficiency in individual links, the analysis in Chapter 3 shows that many enterprises face short-term cost increases. High expenditure on technology investment, system maintenance and management adjustment makes it difficult for enterprises to gain cost advantages in the short run.

From the overall supply chain perspective, uneven adoption of smart logistics technologies among node enterprises makes it hard to convert local efficiency improvements into overall cost advantages. This problem reflects the lack of systematic optimization thinking in supply chains, which contradicts the theoretical requirement that overall optimization outweighs local optimization. While improving efficiency, smart logistics also brings substantial cost pressures, especially in warehousing, transportation and system investment. Figure 3 Proportion of Logistics Cost Components

Analysis: Warehousing and transportation account for the largest share of total logistics costs, and the proportion of IT system investment is also considerable. Despite efficiency gains brought by smart logistics, cost pressures remain prominent, and cost control is still a core priority for enterprise optimization.

5. RESEARCH ON SUPPLY CHAIN OPTIMIZATION PATHS UNDER SMART LOGISTICS

5.1. Integrate Supply Chain Information Systems to Break Information Silos

Based on the systematic analysis of supply chain problems under smart logistics in Chapter 4, this paper proposes that supply chain optimization should be promoted collaboratively from multiple dimensions including information integration, collaboration mechanism improvement, integration of technology and management, cost control and risk prevention, so as to build a systematic, intelligent and collaborative modern supply chain system.

To address fragmented information systems and information silos, enterprises should accelerate the integration of supply chain information systems. Centering on smart logistics platforms, enterprises shall integrate warehouse management systems, transportation management systems and order management systems, unify data standards and interface specifications, and realize real-time information sharing across all supply chain links.

Meanwhile, enterprises should leverage big data and cloud computing technologies to realize centralized management and in-depth analysis of supply chain operational data, so as to improve information utilization efficiency and decision-making quality. The integration of information systems enhances supply chain transparency and lays a solid data foundation for collaborative operation and overall optimization.

5.2. Establish Multi-party Collaborative Supply Chain Operation Mechanisms

To solve the problem of inadequate supply chain collaboration, in-depth cooperation between upstream and downstream enterprises should be promoted at the institutional level. Enterprises can consolidate mutual trust by establishing long-term strategic partnerships, improving contractual constraints and optimizing benefit distribution mechanisms.

In the context of smart logistics, full use should be made of collaborative platforms to share order, inventory and logistics information, and promote collaborative modes such as joint forecasting, joint replenishment and joint distribution, so as to improve the overall efficiency of the supply chain. This countermeasure is closely aligned with the collaborative optimization theory in Chapter 2.

5.3. Promote In-depth Integration of Smart Logistics Technologies and Supply Chain Management

To resolve the mismatch between technology application and management capabilities, enterprises shall adjust organizational structures and restructure business processes while introducing smart logistics technologies. Optimized process design enables smart logistics technologies to be embedded into supply chain management and decision-making procedures, rather than merely applied in basic operational links.

In addition, enterprises need to strengthen informatization training for employees to improve their ability to understand and operate smart logistics systems, and avoid the dilemma of "advanced technology with low utilization efficiency". The in-depth integration of technology and management can fully tap the potential value of smart logistics in supply chain optimization.

5.4. Adopt a Systematic Supply Chain Perspective and Enhance Cost Control Capabilities

To address the issue that local optimization cannot generate overall advantages, enterprises should establish the philosophy of systematic supply chain optimization and implement cost control from a holistic perspective. Relying on smart logistics platforms, enterprises shall conduct overall planning for inventory, transportation and distribution to avoid redundant construction and resource waste.

Furthermore, enterprises can reduce unit logistics costs and improve overall supply chain efficiency through large-scale operation, resource sharing and process collaboration. This approach helps alleviate the short-term cost pressures of smart logistics construction and achieve long-term cost advantages for the supply chain.

6. CONCLUSION AND PROSPECT

6.1. Research Conclusions

From the perspective of smart logistics, this paper systematically analyzes the current status, existing problems and optimization paths of supply chain operation. The research concludes that smart logistics is a crucial pillar for supply chain optimization and high-quality development. To give full play to its value, it is essential to realize integrated information systems, sound collaboration mechanisms and in-depth integration of technology and management.

Combining theoretical research and empirical analysis, this paper finds that the application of smart logistics in current supply chains is hindered by information silos, insufficient collaboration, lagging management capabilities and inadequate risk prevention. Targeted at the above problems, this paper puts forward a set of systematic optimization paths, providing theoretical reference and practical enlightenment for enterprises to develop smart logistics and optimize supply chains.

6.2. Research Prospects for the Future

Future research can be further deepened in the following aspects. First, adopt empirical research methods to construct evaluation indicator systems and models, so as to conduct quantitative analysis on the impact of smart logistics on supply chain performance. Second, carry out comparative research on multiple cases covering specific industries or typical enterprises to enhance the pertinence of research conclusions. Third, explore the collaborative development paths of smart logistics and modern supply chain systems from the policy perspective, to provide references for macro policy-making.

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