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Coordinated Development of Supply Chain Management and Urban Transportation Planning

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Abstract: In the era of economic globalization, the harmonious integration of regional supply chain management and urban traffic planning is of paramount significance. This research meticulously dissects the intricate interplay between these two domains, with a particular emphasis on the detrimental impact of traffic congestion on the efficiency of supply chains, the strain that supplies chain expansion places on transportation infrastructures, and the conspicuous absence of effective information-sharing mechanisms. The study delves into a spectrum of strategic approaches, including integrated planning, traffic optimization, reengineering of supply chain processes, leveraging information sharing and technological advancements, as well as policy guidance and collaborative governance. These strategies collectively form a robust theoretical framework aimed at bolstering regional competitiveness and fostering sustainable development. Moreover, the research underscores the imperative need for future endeavors to concentrate on the integration of emerging technologies and the facilitation of cross-regional cooperation, both of which are pivotal in guiding regional economic prosperity and urban advancement.

Keywords: Supply Chain Management, Urban Traffic Planning, Collaborative Development, Information Sharing.

1. Introduction

In today's globalized economic landscape, competition among enterprises has become increasingly fierce. Supply chain management, as a core component of business operations, has become a crucial element for the survival and development of enterprises [1]. An optimized supply chain ensures the timely supply of raw materials, the smooth operation of the production process, and the efficient distribution of products. Meanwhile, with the acceleration of urbanization, urban traffic planning, as an important part of urban infrastructure construction, has become indispensable [2]. Urban traffic systems are not only required to meet the daily travel needs of residents but also to adapt to the growing demand for freight transportation. However, the rapid development of the logistics industry has led to a sharp increase in logistics transportation demands, placing immense pressure on urban traffic networks. Traffic congestion has become increasingly severe, thereby restricting the efficiency of supply chains. Therefore, studying the interactive relationship between supply chain management and urban traffic planning, as well as how to achieve coordinated development, is of significant practical necessity.

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Supply chain management encompasses the entire process from the procurement of raw materials to the delivery of the final product to consumers, involving multiple stages including suppliers, manufacturers, distributors, retailers, and end-users. It enhances efficiency and reduces costs through the integration of resources, optimization of processes, and information sharing [3]. Urban traffic planning, on the other hand, involves the planning and design of the future development of urban traffic systems, including the planning of road networks, public transportation, and transportation hubs, with the aim of improving the operational efficiency and service quality of urban traffic.

This research employs a combination of literature review and empirical research methodologies. Initially, by examining relevant literature, the study ascertains the current state and prevailing issues in supply chain management and urban traffic planning. Subsequently, empirical research is utilized to substantiate the efficacy of the proposed strategies for coordinated development. The significance of this study is to offer economically advanced regions a scientific approach to address the conflicts between supply chain management and urban traffic planning. It aims to dismantle information silos, optimize the allocation of resources, reduce logistics costs, and enhance the regional competitiveness and sustainable development capabilities within the logistics domain.

2. Traffic and Supply Chain Bottleneck Analysis

2.1. Traffic Congestion as a Hindrance to Supply Chains

2.1.1. Reduction in Delivery Timeliness

Traffic congestion around ports, especially during peak hours, has become a significant issue. The congestion leads to a substantial increase in the transportation time for container trucks, thereby compromising delivery timeliness. For instance, during periods of severe congestion, the transportation time for goods at the Port of Shanghai may increase by 30% to 50% compared to normal conditions [4]. This not only increases logistics costs but also potentially affects the production schedules and customer satisfaction of enterprises. Specifically, when goods fail to arrive on time, companies may face the risk of production line shutdowns due to a lack of materials, increasing the likelihood of production delays and thereby affecting the continuity and stability of the entire production process. For customers, delayed deliveries can lead to customer attrition, damaging the company's market reputation and having an adverse impact on the long-term development of the enterprise.

2.1.2. Increase in Logistics Costs

Traffic congestion prolongs the travel time of logistics vehicles, increases fuel consumption, and may also necessitate the payment of additional congestion fees. These factors significantly increase logistics costs, adversely affecting the economic benefits of enterprises. Further analysis reveals that vehicles idling or driving at low speeds for extended periods in congested areas consume much more fuel than when driving under normal conditions [4]. Moreover, congestion may force vehicles to take detours, increasing the mileage and thereby further escalating fuel costs. Additionally, some regions may impose congestion charges on congested routes, directly increasing the operational costs of logistics companies. In the long run, the increase in logistics costs may squeeze the profit margins of enterprises, affect their competitiveness, and may even lead to the insolvency of some small logistics companies [5].

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2.2. Traffic Pressure Brought by Supply Chain Development

2.2.1. Change in Traffic Flow Distribution

With economic growth, new logistics parks and warehouses are continuously being built, and the throughput of port goods keeps increasing. These changes have led to significant alterations in the distribution and intensity of traffic flow, making the existing traffic planning insufficient to meet new demands. For example, roads around new logistics facilities may experience overloading, and traffic management measures have not been able to keep pace with the adjustments [6]. Specifically, the construction of new logistics parks and warehouses attracts a large number of logistics vehicles, leading to a rapid increase in traffic volume in the surrounding areas within a short period. Roads originally planned to accommodate the travel of residents and a small amount of cargo transportation may become severely congested during certain periods after the new logistics facilities are built. This change in traffic flow distribution not only affects the travel of residents in the surrounding areas but also poses difficulties for cargo transportation itself, as congestion leads to extended transportation times and reduced logistics efficiency.

2.2.2. Overburdened Transportation Infrastructure

The growth of supply chains leads to an increase in cargo transportation volumes, placing greater stress on urban transportation facilities such as roads and bridges. In the long term, this can accelerate the deterioration and aging of these facilities, affecting the normal operation of urban traffic. Additionally, the frequent travel of heavy logistics vehicles on the roads causes greater wear and tear on the road surfaces, shortening their lifespan. For bridges, vehicles that exceed their designed load capacity can pose long-term safety risks to the bridge structures. Moreover, with the increase in cargo transportation, the costs for maintenance and renewal of transportation facilities also rise [6]. If sufficient funds are not promptly invested in maintenance, the condition of the transportation infrastructure will further deteriorate, ultimately impacting the normal functioning of the entire urban traffic system.

2.3. The Absence of Data Information Sharing and Coordination Mechanisms

2.3.1. Difficulties in Information Acquisition for Logistics Enterprises

There is a lack of effective data sharing mechanisms and information platforms among logistics enterprises in the supply chain, port operators, and urban traffic management departments. Logistics enterprises struggle to obtain real-time and accurate traffic condition information, making it difficult to adjust delivery routes and plans in a timely manner. To elaborate, when logistics enterprises schedule delivery tasks, they may choose congested routes due to the inability to access real-time traffic congestion information, leading to increased transportation times. Moreover, in the event of sudden traffic incidents, such as traffic accidents or road construction, logistics enterprises are unable to promptly obtain relevant information and adjust their routes, thereby affecting the timeliness of deliveries. These difficulties in information acquisition lead to low operational efficiency for logistics enterprises and increased logistics costs.

2.3.2. Decision-making Difficulties for Traffic Management Departments

Traffic management departments also lack sufficient understanding of the changing logistics transportation demands within the supply chain, making it difficult to formulate targeted traffic guidance and management strategies in advance. This results in the often ineffective adoption of temporary measures when dealing with traffic congestion and peaks in cargo transportation.

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Specifically, due to the lack of knowledge about the transportation plans and needs of logistics enterprises, traffic management departments are unable to accurately predict which sections will experience congestion at specific times, nor can they arrange appropriate traffic control measures in advance. For example, during peak cargo transportation periods, if traffic management departments cannot plan vehicle routes and schedules in advance, it is easy for traffic congestion to worsen. Moreover, temporary measures often cannot fundamentally solve the problem; they can only alleviate congestion in the short term and do not meet the long-term needs of traffic management.

3. Recommendations and Optimization Strategies

3.1. Integrated Planning Strategies

3.1.1. Regional Coordinated Planning

In urban development planning, it is crucial to consider the layout of supply chain facilities and transportation infrastructure from a regional perspective. This requires a comprehensive analysis of factors such as industrial distribution, logistics demand, and traffic flow within the region. The location of logistics parks should be planned rationally to be closely connected with transportation hubs (such as ports, railway freight stations, airports, etc.), forming efficient logistics transportation corridors. For example, in cities that rely on port development, logistics parks should be located near the port and connected with the port's collection and distribution channels, facilitating the rapid loading and unloading of goods and reducing the number of transfer links, thereby improving logistics efficiency [1]. At the same time, the synergistic development of logistics parks with surrounding industrial parks should also be considered to ensure that logistics services can meet the needs of industries.

3.1.2. Reserving Construction Space

Reserving construction space for transportation infrastructure according to the forecast of logistics transportation demand is key to ensuring smooth future logistics transportation. This requires the use of scientific forecasting methods to predict logistics transportation volumes, vehicle growth numbers, and other factors over a certain period in the future. For example, predictions can be made based on historical data and economic development trends. The reserved space includes widening the main roads leading to transportation hubs such as ports, railway freight stations, and airports, increasing the number of lanes or widening the road width to meet the growing traffic flow demands. In addition, consideration should be given to increasing railway branches and improving the railway network to enhance railway transportation capacity [7], providing a guarantee for the large-volume transportation of goods. At the same time, the road network around logistics parks should also be planned rationally, with sufficient space reserved for future expansion and upgrades [8].

3.2. Traffic Optimization Strategies

3.2.1. Development of Intelligent Transportation Systems

Utilizing intelligent transportation technologies to optimize urban traffic is a crucial means of alleviating traffic congestion and enhancing logistics efficiency [9]. Intelligent traffic signal control is a key component of this approach. By installing intelligent traffic signal systems, the duration of traffic lights can be automatically adjusted based on real-time traffic flow. For instance, on sections where logistics vehicles frequently travel, when a higher number of logistics vehicles are detected waiting, the green light duration can be appropriately extended to reduce waiting times, thereby increasing the passage efficiency of logistics vehicles. Moreover, intelligent traffic signal systems

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can also achieve regional coordinated control, with interlinked control of traffic lights at adjacent intersections, preventing vehicles from frequently stopping and starting between intersections, thereby alleviating traffic congestion.

Furthermore, the widespread application of vehicle navigation systems provides logistics vehicles with real-time traffic information and optimal route suggestions. Logistics vehicle drivers can avoid congested routes and choose smoother paths based on the prompts from the navigation system, thereby improving transportation efficiency. Vehicle navigation systems can also be connected to the information systems of traffic management departments, providing real-time feedback on the vehicle's location and driving status. This offers data support to traffic management authorities, facilitating better traffic control.

3.2.2. Optimizing Transportation Facilities

Optimizing transportation facilities is a necessary measure to enhance their load-bearing capacity and service life. Firstly, improving the condition of road surfaces is crucial. By regularly inspecting and maintaining roads, and promptly repairing damages and defects, the further expansion of cracks and potholes can be prevented, thereby ensuring the safety and comfort of vehicle travel. At the same time, adopting advanced pavement materials and construction techniques can increase the strength and durability of the road surface, extending the lifespan of the road. Secondly, increasing the load-bearing capacity of bridges is an essential measure. For bridges with insufficient load-bearing capacity, reinforcement and modification should be carried out. Methods such as increasing the strength of bridge structures or replacing bridge components can be used to enhance the load-bearing capacity of bridges, ensuring their safe operation under the increasing traffic volume and heavy vehicle loads. Additionally, during the bridge modification process, the aesthetic appeal of the bridge and its coordination with the surrounding environment should also be fully considered, ensuring that facility modifications are in harmony with the surrounding landscape [9].

3.3. Supply Chain Process Transformation Strategies

3.3.1. Promoting Multimodal Transport

Promoting the shift of supply chain transportation modes towards multimodal transport is key to enhancing the coherence and efficiency of cargo transportation. Firstly, collaboration and connection should be strengthened. For example, good transfer facilities and processes should be established between ports and railways to ensure that goods can be smoothly loaded from ports onto railway vehicles, reducing the number and time of cargo handling. Corresponding connection mechanisms should also be established between roads and air transport to facilitate the conversion of goods between different modes of transportation. Secondly, establishing standardized multimodal transport processes and rules is the foundation for ensuring the smooth operation of multimodal transport. Unified standards for cargo packaging, loading and unloading, and transport documents can ensure that different modes of transport handle goods according to the same standards, reducing problems caused by inconsistent standards. Moreover, encouraging logistics enterprises to adopt container multimodal transport is beneficial because containers are standardized, and easy to load and transport, which can improve the coherence and efficiency of cargo transportation, reduce the number of cargo handling and transportation time, and further enhance overall logistics performance.

3.3.2. Introducing Inventory Management Concepts

Introducing advanced inventory management concepts and technologies is an effective way to reduce the overall inventory levels in the supply chain. Firstly, adopting advanced management methods can

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improve inventory management efficiency, such as Vendor Managed Inventory (VMI) and Joint Managed Inventory (JMI). Taking VMI as an example, suppliers can proactively arrange replenishment of goods based on the customer's inventory levels and demand forecasts; customers do not need to manage their own inventory, thereby reducing the possibility of inventory backlog. For JMI, multiple suppliers and customers can jointly manage inventory, increasing inventory turnover rates and reducing inventory costs through information sharing and collaborative replenishment [10]. Secondly, utilizing data analysis and forecasting technologies can accurately predict market demand, helping enterprises to reasonably arrange production and distribution plans, thereby increasing inventory turnover rates and reducing logistics costs. By analyzing various data such as historical sales data, market trends, and consumer behavior [10], enterprises can more accurately predict future market demands, and arrange production and distribution plans in advance, avoiding fluctuations in logistics transportation demands caused by inventory backlog or stockouts.

3.4. Information Sharing and Technology Application Strategies

3.4.1. Establishing a Data Sharing Platform

Establishing a data sharing platform is crucial for the real-time sharing of cargo transportation and traffic flow information. Firstly, integrating data resources is the foundation of platform construction: integrating data resources from logistics enterprises, ports, and traffic management departments is the basis for establishing a data sharing platform. For example, logistics enterprises' cargo order information, transportation vehicle information, ports' vessel operation information, cargo throughput information [2], and traffic management departments' traffic condition information, traffic control information, etc., should all be integrated into a single platform. By integrating these data resources, comprehensive information sharing can be achieved, providing logistics enterprises and traffic management departments with a more complete basis for decision-making.

Secondly, real-time sharing is the key to the effective operation of the platform. Through the data sharing platform, the real-time sharing of cargo transportation and traffic flow information can be effectively realized. Logistics enterprises can also use the platform to obtain real-time traffic conditions and adjust their delivery plans accordingly. For example, if the platform indicates that a certain section is congested, logistics enterprises can immediately adjust the vehicle's route to avoid the congested area, thereby improving delivery efficiency. Traffic management departments can also use the platform to obtain real-time cargo transportation information and prepare traffic control plans in advance. For instance, during peak cargo transportation periods, they can arrange vehicle routes and schedules ahead of time to prevent traffic congestion.

3.4.2. Applying IoT and Big Data Technologies

The application of IoT and big data technologies is an important means of mining data value and providing support for collaborative decision-making. Firstly, installing sensors on logistics transportation equipment and traffic infrastructure is the basis for data collection. For example, installing GPS positioning sensors and cargo status sensors on logistics vehicles, vehicle flow sensors and road condition sensors on roads, and structural health sensors on bridges. Through these sensors, a large amount of transportation and traffic condition data can be collected.

Secondly, mining data value is key to achieving intelligent decision-making. Through big data analysis techniques, valuable information can be extracted from vast amounts of data to support collaborative decision-making. For example, by analyzing data collected from vehicle flow sensors, traffic congestion points and peak logistics transportation times can be predicted. By analyzing data collected from cargo status sensors, the transportation condition of goods can be understood, such as

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whether there is any damage or if they meet requirements, providing a basis for decision-making for logistics enterprises, and facilitating them to take corresponding measures [11].

3.5. Policy Guidance and Collaborative Management Strategies

3.5.1. Introduction of Incentive Policies

The introduction of incentive policies by the government is an important safeguard for promoting the coordinated development of supply chain management and urban traffic planning. Firstly, regulating the construction and operation of logistics parks is a key measure to achieve coordinated development between the two.

Decision-making departments should establish clear regulations for the construction and operation of logistics parks to ensure that their location, scale, and functional layout are coordinated with urban traffic planning. For example, it should be stipulated that logistics parks should be located in areas with convenient transportation and have good connections with transportation hubs. The scale of the park should be determined based on local logistics demand and land resource conditions, and the functional layout should be rational, including the reasonable division of different functional areas such as storage areas, loading and unloading areas, and distribution areas.

Secondly, managing the passage of freight vehicles is also one of the important policies for the government to promote coordinated development. Depending on the traffic conditions in different areas and at different times, the government can introduce policies for the management of freight vehicle passage, reasonably formulating regulations on restrictions, passage times, and route specifications for freight vehicles to ensure a balance between logistics transportation needs and the travel needs of urban residents.

In areas with severe traffic congestion, such as city center districts, freight vehicles can be restricted during peak hours. At the same time, the routes for freight vehicles during other periods can be specified to avoid causing excessive impact on residents' travel, while also ensuring the needs of logistics transportation.

3.5.2. Establishing a Collaborative Management Mechanism

Establishing a collaborative management mechanism is key to strengthening the coordinated management of the development between supply chain management and urban traffic planning. Firstly, a collaborative management institution can be established, composed of relevant government departments, logistics industry associations, port operators, etc. For example, it could be jointly formed by traffic management departments, planning departments, economic development departments, logistics industry associations, port operators, etc. The responsibility of the collaborative management institution is to coordinate the interests of all parties, formulate unified development strategies and action plans, and strengthen the coordinated management of the development between supply chain management and urban traffic planning.

Secondly, formulating unified strategies and plans is a crucial step in achieving coordinated development [12]. The collaborative management institution should develop unified development strategies and action plans based on different actual needs. For instance, formulating unified strategies and action plans regarding the construction of logistics parks, the development of traffic infrastructure, the transformation of supply chain processes, and information sharing, ensuring that all work proceeds in a unified direction and towards common goals, thereby promoting the coordinated development of supply chain management and urban traffic planning.

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4. Conclusion

This study conducts an in-depth analysis of the interactive relationship and synergistic effects between supply chain management and urban traffic planning in economically developed areas. By researching relevant literature and conducting case studies, the complex mechanisms of interaction between the two are revealed. Furthermore, this study analyzes issues such as the negative impact of traffic congestion on supply chain efficiency, the pressure that supply chain development places on traffic systems, and the insufficiencies of data sharing and coordination mechanisms. By implementing strategies such as integrated planning, traffic system optimization, information sharing and technological application, policy guidance, and collaborative management, the coordinated development of supply chain management and urban traffic planning can be effectively promoted, thereby enhancing the competitiveness and sustainable development capabilities of the regional economy.

Given the continuous advancement of technology and the constant economic growth, there is a broad prospect for research and practice in the coordinated development of supply chain management and urban traffic planning in the future. For example, further research on how to use 5G technology, autonomous driving technology, and other means to improve logistics transportation efficiency and traffic management levels, as well as how to strengthen the coordinated work of supply chains and traffic planning across cities and regions under the background of regional integrated development, is needed. These studies will help to further improve the coordinated development mechanism of supply chain management and urban traffic planning, providing stronger support for the economic development and urban construction of economically developed areas.

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