Journal of Infrastructure, Policy and Development 2025, 9(1), 10340.
https://doi.org/10.24294/jipd10340

Article

Contents and interrelations of elements of the business development management mechanism related to intelligent supply chain innovation: China's experience

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CITATION

Sun C, Rogulenko TM. (2025). Contents and interrelations of elements of the business development management mechanism related to intelligent supply chain innovation: China's experience. Journal of Infrastructure, Policy and Development. 9(1): 10340. https://doi.org/10.24294/jipd10340

ARTICLE INFO

Received: 14 November 2024
Accepted: 11 December 2024
Available online: 7 January 2025

Abstract: Managing business development related to the innovation of intelligent supply chains is an important task for many companies in the modern world. The study of management mechanisms, their content and interrelations of elements contributes to the optimization of business processes and improvement of efficiency. This article examines the experience of China in the context of the implementation of intelligent supply chains. The study uses the methods of thematic search and systematic literature review. The purpose of the article is to analyze current views on intelligent supply chain management and identify effective business management practices in this area. The analysis included publications devoted to various aspects of supply chain management, innovation, and the implementation of digital technologies. The main findings of the article are as follows: Firstly, the key elements of intelligent supply chain management mechanisms are identified, secondly, successful experiences are summarized and the main challenges that companies face in their implementation are identified. In addition, the article focuses on the gaps in research related to the analysis of successful experiences and the reasons for achieving them.

Keywords: intelligent supply chains; business development management; innovation; Chinese experience; systematic review

1. Introduction

In the context of the global division of labor and cooperation, which is becoming the main trend of economic globalization, all countries recognize the importance of supply chains in economic development and raise them from the micro level of enterprises to the macro level of national strategies. Supply chain policies are considered by scholars and policymakers as an important tool for enhancing the competitiveness of industries and the economic power of a country (Zhang et al., 2024).

In China, although the promotion of intelligent supply chains has begun, compared with developed countries with more mature technologies and systems, there is still insufficient experience. Therefore, enterprises with strategic significance to the national economy and energy security should use intelligent technologies to promote internal and inter-firm organization, as well as national and regional cooperation, transcending business boundaries and building a global intelligent supply chain system (Kim and Lee, 2017). In addition, it is necessary to strengthen

exchanges and cooperation with other countries to combine supply chains globally, select the most competitive partners in different parts of the world, and create a global competitive advantage (Jin and Liu, 2020).

The purpose of this paper is to explore the content and relationship between intelligent supply chain innovation and business development governance mechanism in China. Compared with previous studies, this study pays more attention to the empirical analysis and policy recommendations for improving the business development governance mechanism related to intelligent supply chain innovation.

The results of the study will be used to explain the effectiveness of the business development management mechanisms related to smart supply chain innovation and summarize the success or failure of these mechanisms. This paper also found that there is still a gap in the academic literature on business development management from the perspective of smart supply chain innovation. In particular, there are few studies on successful models and innovation scenarios in this area. This is an important reason for choosing this research perspective in this paper. Therefore, one of the innovations of this paper is a detailed description of the content and relationships of the elements of the business development management mechanism related to smart supply chain innovation.

2. Literature review

With the rapid development of advanced information technology, the development of intelligent supply chains has gained new momentum, driving innovation and upgrading of traditional supply chain operations, especially in China.

Intelligent supply chains use advanced technologies such as the Internet of Things, big data, cloud computing and artificial intelligence to increase automation, efficiency and synergy across the supply chain, significantly improving company productivity and market responsiveness (Fan and Li, 2020).

Exploring the relationship between smart supply chain innovation and business development governance mechanisms in China is an important research direction. The 19th National Congress of the Communist Party of China proposed to “cultivate new growth points and form new driving forces in areas such as mid-to-high-end consumption, innovation-based economy, green and low-carbon economy, sharing economy, and modern supply chain” (Zhang, 2023). Therefore, the development of modern supply chains has become a national strategy.

As an important engine of the national economy, China’s logistics companies have significant potential to build modern supply chains. However, compared with global leading companies, there is a significant gap, which requires active implementation of supply chain innovation, accelerated construction of a modern supply chain system, and promotion of high-quality economic development (Liu, 2022; Wang, 2021).

The dependence of the parameters of supply chain business processes on the level of innovative development and digitalization is reflected in the research of Chinese scientists (Wei, 2020; Xu et al., 2021; Yin, 2020). They all agree that in order to optimize business processes in logistics, it is necessary to build a comprehensive management mechanism.

Most of the statistical data in the context of digitalization of logistics in China are presented by international analytical agencies. Thus, the Gartner report describes 5 stages of supply chain maturity in the field of logistics. As noted by Gartner consultants, most of the world's leading companies in the field of SCM consistently apply a maturity-based approach to the development and implementation of a strategy for the digitalization of logistics activities in their supply chains: 1) Reaction—autonomous operations; 2) foresight—functional scale and efficiency; 3) integration—integration of logistics in supply chains; 4) collaboration—collaboration in the value chain for the customer; 5) orchestration—a network orchestrator of profitable customer value (Gartner, 2024).

Deloitte Global analyzes the drivers and cutting-edge insights from within and outside the industry, returns to the core business logic, conducts a comprehensive and systematic study of the logistics industry, and interprets the logistics ecology in the new economy from a business model perspective (Deloitte Global, 2018).

According to a report by market research company Global Generative AI in Supply Chain Market report 2023, the global generative artificial intelligence in supply chains market size is expected to increase from US$269 million in 2022 to approximately US$10.284 billion in 2032, registering a compound annual growth rate of 45.3% during the forecast period from 2023 to 2032.

Thus, new technologies bring new changes, and large companies strive to apply advanced supply chain design technologies and use digital changes to transform and iterate supply chain operating models. On the other hand, the development, applicability, and effectiveness of new technologies in the supply chain must be constantly studied in practice to further develop more intelligent and effective application scenarios and business process transformation logic.

3. Research issues

The study of problems related to the formation and implementation of a full range of logistics support and increasing the efficiency of the implementation of the logistics potential of Chinese logistics companies has necessitated the presentation of the concept of disclosing the organizational and economic mechanism for managing business development related to innovations in intelligent supply chains. This is one of the important components of the overall process of managing the activities of organizations.

At present, many logistics companies in China have begun to use IoT technology to build intelligent supply chain systems, but most of the enterprises are small in size, unevenly distributed throughout the country, and lack effective management measures, which leads to chaos in management, hinders the free movement of production factors, does not optimize the allocation of resources, makes it difficult to form a unified, open and orderly market, and leads to the lack of leading enterprises capable of forming industrial clusters (Zhao et al., 2018).

Most small and medium enterprises experience difficulties in logistics informatization due to the lack of relevant personnel and financial resources (Chen, 2020). Enterprise managements do not pay enough attention to the application of information technology, and even if relevant intelligent logistics technologies are

introduced, the accompanying infrastructure is not developed, resulting in no significant improvement in enterprise performance (Li, 2023).

At present, the use of information technology in China for intelligent supply chain, such as barcodes, radio frequency identification, global positioning systems, geographic information systems and electronic data interchange technologies, requires a major revision of current business processes (Chen, 2021). Most enterprises use outdated information technology equipment, do not have automatic barcode identification systems, automatic vehicle guiding systems and automatic cargo tracking systems (Tang and Zhang, 2018). Compared with foreign intelligent logistics systems, there is a significant lag (Ni and Zhang, 2024).

Logistics and supply chains not only include management and functional scope of activities, but also involve effective coordination and integration of all structural divisions of the enterprise and external contractors. All this is aimed at the production of finished products, their sale and maximization of the economic benefit of the enterprise through the introduction of innovations in intelligent supply chains (Wang, 2023). Thus, the solution to the above problems lies in the plane of effective management of supply chain business processes, which implies the need to adapt the mechanism for managing business development associated with the innovation of intelligent supply chains to new conditions.

4. Research methodology

Regression analysis is used to assess the impact of digitalization on the growth of China's logistics market and to justify the need to adapt the mechanism for managing business development related to the innovation of intelligent supply chains to new conditions. This method allows us to establish the relationship between various variables and determine the impact of each of them on the result. The data required for the analysis are presented in **Table 1** and include the following indicators:

Digitalization level (D): Percentage of use of digital technologies in logistics, digitalization index or other relevant indicators.

Logistics Market Growth (G): Logistics market growth indicators such as sales volume.

Table 1. Initial data for regression analysis.

Year	China's Logistics Market Size (RMB trillion)	Level digitalization (%)
2015	219.2	9.70
2016	229.7	10.40
2017	252.8	11.90
2019	283.1	12.30
2020	300.1	13.00
2021	335.2	14.19
2022	336.2	14.30
2023	347.6	15.10

The linear model of dependence will look like this:

$$G = \alpha + \beta D + \in G \quad (1)$$

where:

G—market volume (trillion yuan);

D—level of digitalization (in %);

A and β are the model coefficients;

ϵ—random error.

The results of the model can be used to optimize business processes, increasing the efficiency and competitiveness of companies. Understanding the relationship between digitalization and market size will help to introduce innovations and improvements in technological processes.

5. Research results

Digital transformation of China's logistics companies, as a complex system project with large investment, long cycle, multiple influencing factors and unstable boundary conditions, often demonstrates its results through the improvement of core activities. The study of the cost-benefit relationship of digital transformation helps the government, industry and enterprises accurately assess the costs and benefits of digital transformation, providing a basis for decision-making. This is the key to shifting from short-term profit to value-based approach and creating new high-quality performance.

The total social logistics volume for the whole of 2023 reached 347.6 trillion yuan, an increase of 3.4% year on year, and the total profit of the logistics industry reached 12.7 trillion yuan, an increase of 4.7% year on year (**Figure 1**). The scale of logistics demand reached a new high and achieved stable growth. A total of 110.58 billion units of express delivery were completed, and the express delivery income reached 1.05667 billion yuan, the national railway freight volume was 4.98 billion tons, an increase of 4.4% year on year, and the freight throughput volume was 3.5946 billion ton-kilometers, an increase of 8.1% year on year. The country has about 8000 A-level logistics companies, more than 6 million market entities such as logistics companies and individual industrial and commercial households, and more than 50 million employees (China Logistics Yearbook, 2023).

Logistics companies are actively promoting the transformation of services into integrated supply chains, accelerating the process of industrial integration, increasing their presence in developing regions, and expanding business space. Meanwhile, the number of contract orders of key logistics companies increased by 24% in 2023 compared with 2022, and the revenue of integrated logistics business increased by nearly 30% (China Logistics Yearbook, 2023).

Digital supply chain services in the logistics sector are integrated with basic logistics services and are usually provided by third-party logistics service providers. With the diversification of consumer demand and the improvement of efficiency at the initial stage of the supply chain, the demand for logistics in China has become more diversified.

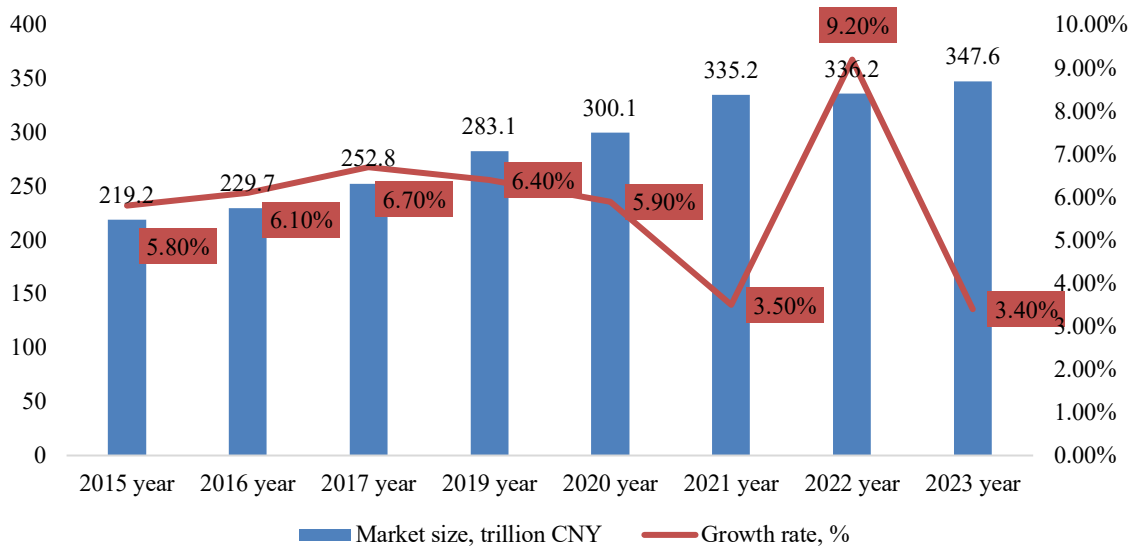

Figure 1. Dynamics of growth of the social logistics market in China in 2015–2023.
Source: China Logistics Yearbook, 2015–2023.

Regardless of the fact that third-party logistics service providers provide basic logistics services, they also use their accumulated experience to realize technical advantages, and digitalization tools are applied to all logistics services in the form of OMS, TMS, WMS, BMS, etc., providing enterprises with a foundation to cope with the ever-changing competitive environment. This is confirmed by revenue growth data. from digital supply chain services in China in the logistics sector (**Figure 2**).

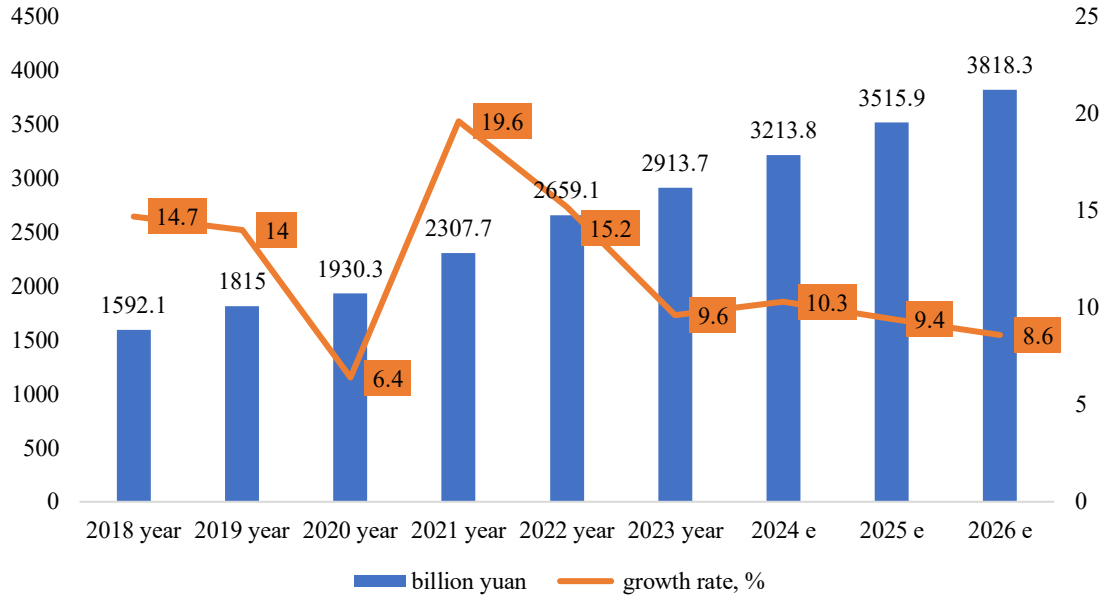

Figure 2. Scale of revenue from digital supply chain services in China from 2018 to 2026 (by logistics).
Source: China Supply Chain Digital Upgrade Industry Research Report 2022, 2024.

According to **Figure 2**, the average annual revenue growth of this segment was 13.25% from 2018 to 2023. By the end of 2023, the total revenue was 2913.7 billion yuan. At the same time, it is projected to increase to 3919.3 billion yuan by 2026.

The "2022 China Digital Logistics Development Report" shows that the total digital logistics market size was RMB 35.67 billion in 2020, and it will reach RMB 128.05 billion by 2022, with a CAGR of over 70%. This industry has more than 16,000 companies whose business scope is related to digital logistics in 2022. Among them, the number of companies established in 2022 reached more than 5000, accounting for 31.97% of the total, and the market penetration rate was about 15%. By the end of 2022, there were 2537 online freight transportation systems across the country, comprising 5.943 million scattered public transportation vehicles and 5.224 million drivers. In 2022, a total of 94.012 million waybills were uploaded in a year, an increase of 36% over the previous year (China Supply Chain Digital Upgrade Industry Research Report, 2022).

Investment in digital transformation generally shows a growth trend in 2022. Research shows that leading companies such as JD Logistics and SF Express have increased their investment in digitalization-related areas by more than 50% in recent years. Survey data shows that nearly 60% (59.7%) of enterprises have increased their investment in digital transformation, and nearly a third (33.1%) of enterprises reported that their investment remained largely the same. These two figures together account for more than 92.8%, indicating that enterprises are maintaining a positive momentum in digital transformation investment (China Logistics Yearbook, 2023).

The Internet freight platform has entered the 2.0 stage. More and more cargo owners and traditional freight companies are not only optimistic about the preferential policies of local governments, but also optimistic about the potential for cost reduction and efficiency improvement brought by opening up the transportation data chain. For example, Lenovo Group has developed a logistics and freight platform that flexibly meets the needs of multi-channel order fulfillment, and Jinguang Paper has integrated its transportation systems to open up the supply chain and meet the changing needs of the supply chain. A number of companies, such as Delin Dry Port, Tianjin Yunyou and China Chuzhiyun, accelerated the development of online services such as e-commerce and finance, and Chiwan Oriental provides digital freight platforms to small and medium-sized enterprises based on its technology (China Digital Freight Development Report, 2024).

According to the result of regression analysis, it means that with an increase in the level of digitalization by 1%, the volume of the Chinese logistics market increases by an average of 25.908 trillion yuan. The confidence interval for this coefficient (95%) is from 21.849 to 29.967, which confirms its stability and the reliability of the research results (**Table 2**).

According to the presented model, the value of the multiple correlation coefficient is 0.9879, which indicates a very strong positive relationship between the level of digitalization and the volume of the logistics market. The *F*-statistic value is 243.93 and the *F* significance is 4.36×10^{-6}, indicating that the overall model is highly significant. This means that the regression model explains the variation in the data significantly better than the random model.

Table 2. Results of the regression analysis.

Conclusion								
Regression statistics								
Multiple R	0.987923							
R-square	0.975993							
Normalized R- squared	0.971992							
Standard error	8.402454							
Observations	8							
Dispersive analysis								
	df	SS	M.S.	F	Significance of F			
Regression	1	17221.42	17,221.42	243.9252	4.36337×10^{-6}			
Remainder	6	423.6074	70.60123					
Total	7	17,645.03						
	Coeff-ty	error	t	P	Bottom 95%	Top 95%	Bottom 95.0%	Top 95.0%
Y-intersection	−38.7425	21.1298	−1.83354	0.116415	−90.445266	12.96035	−90.44527	12.96035453
Variable X1	25.90782	1.65883	15.61811	4.36×10^{-6}	21.848801	29.96683	21.84880	29.96683302

The context of the organizational and economic mechanism for managing business development in the context of innovations associated with digitalization in intelligent supply chains covers all important stages (**Figure 3**), such as the integration of new technologies, data management, efficient resource allocation and innovative strategies for interacting with partners.

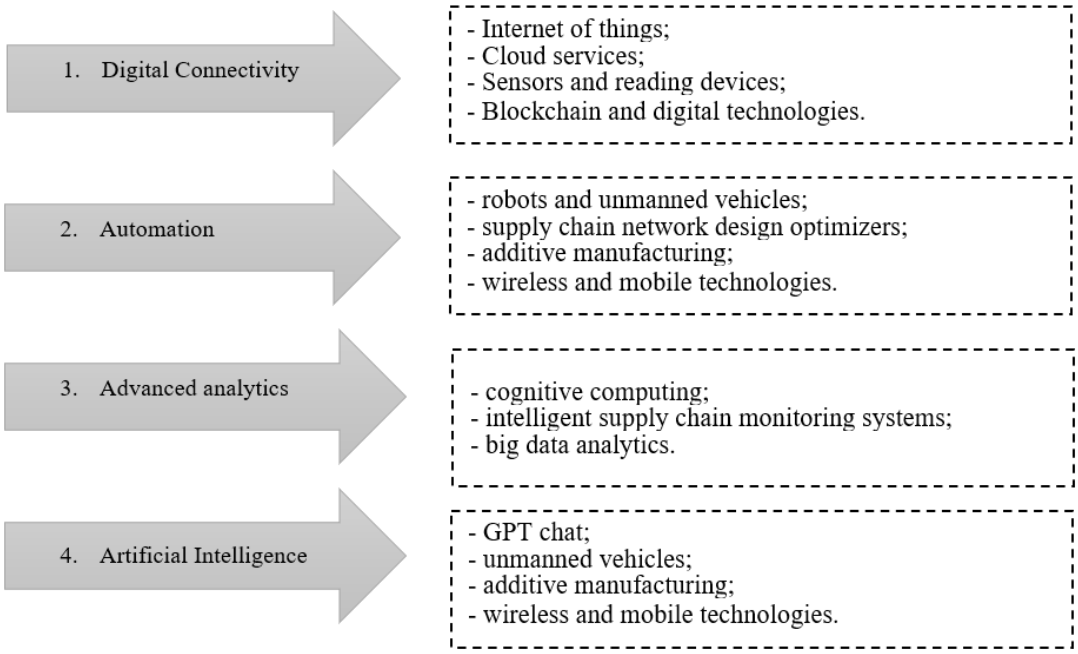

Figure 3. Stages of development of intelligent supply chains.

The main participants in supply chains are manufacturing enterprises, logistics companies, and trading enterprises. In the development process, it is necessary to optimize existing companies, implement innovative digital solutions **(Table 3**),

promote model optimization and system upgrades, clearly define the key aspects of supply chains based on resources to improve work efficiency and reduce costs.

Table 3. Digital solutions by stages of development of intelligent supply chains based on China's experience.

Stage digitalization	Tools
Digital connectivity	WeChat: A multifunctional platform for communication and payments. DingTalk: Alibaba's Collaboration and Communication Platform.
Advanced analytics	Alibaba Cloud: Data analytics and cloud computing platform. Baidu Big Data: A system for big data analysis and machine learning.
Automation	Huawei Cloud: Platform for business process automation. JD Logistics: Innovative solutions for automation of logistics processes.
Artificial intelligence	Tencent AI Lab: Research and development in the field of artificial intelligence. Baidu AI: Platform for the development and implementation of AI solutions.

Based on the concept of sharing and collaboration, intelligent logistics helps overcome enterprise boundaries and information asymmetry problems, ensuring the full utilization of resources in the supply chain. In recent years, many logistics information platforms have emerged to find suitable vehicles and warehouses, effectively reducing logistics costs and fundamentally changing the traditional logistics business model (Aihatamujiang, 2023).

Under such conditions, this mechanism can be considered as a system of actions aimed at elements of process flows, which contributes to their coordination and ordering in all links of the intelligent supply chain (**Figure 4**).

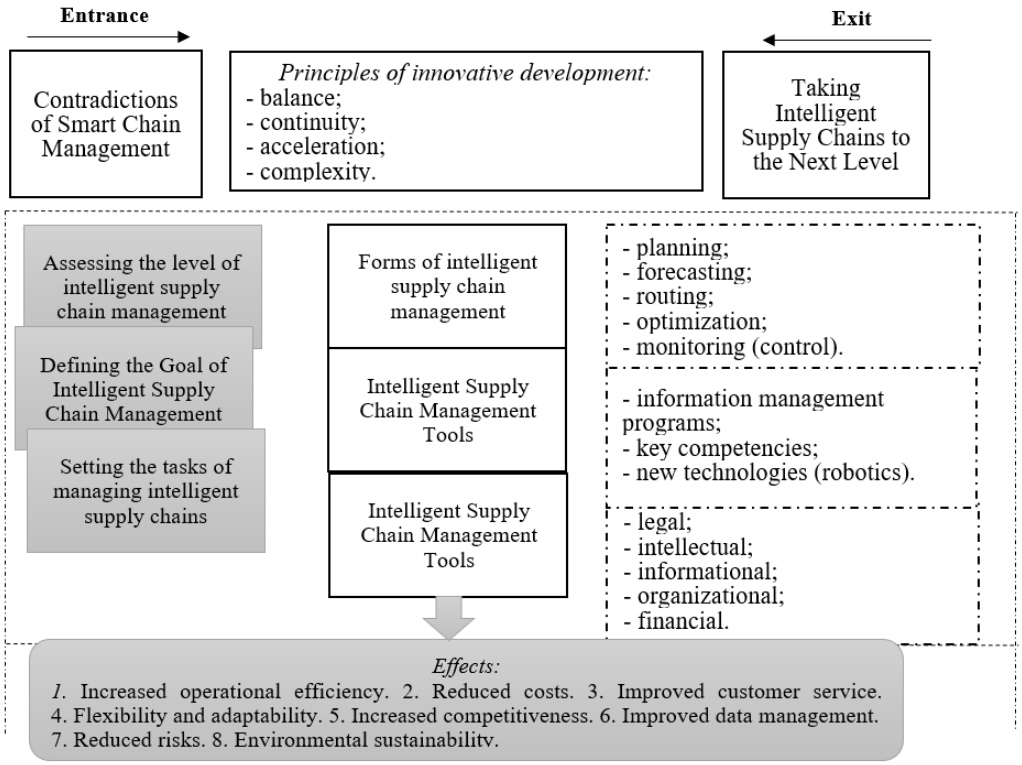

Figure 4. Schematic diagram of the business development management mechanism related to intelligent supply chain innovation in China.

Accordingly, the structure of the instruments of influence of this mechanism on material flows depends on the concept of building an intelligent supply chain chosen by enterprises: Analytical, technological, marketing, integration or combined (**Figure 5**). It should be noted that in each subsequent concept, the list of previous levers of influence on process flows is not ignored, but only supplemented with new ones, which leads to a complication of the mechanism, which must correspond to the complication of the logistics approach.

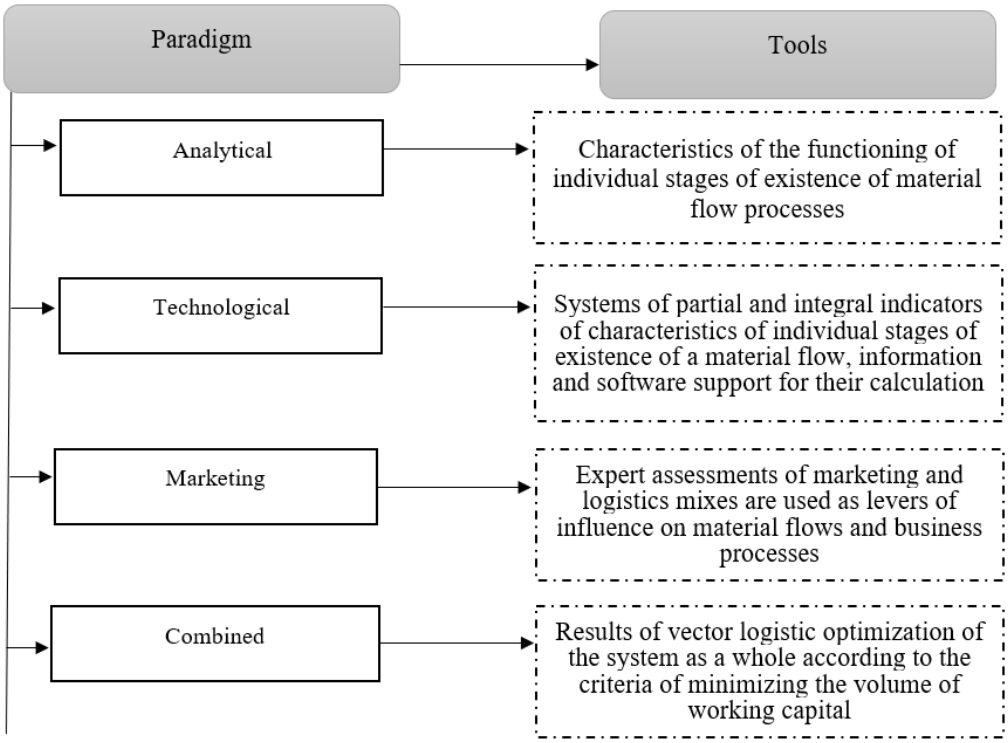

Figure 5. Structure of tools for influencing material flows and business processes in different paradigms of intelligent logistics.

Enterprises need to use digital tools to build a secure, stable, smooth, efficient and mutually beneficial digital supply chain system, effectively prevent and control potential risks in the supply chain, and further enhance the security protection capability of the digital supply chain.

6. Discussion

As an important player in the global industrial chain, China is accelerating the upgrading of its industrial structure to achieve a dominant position in the value chain. Enterprises in various industries and their upstream and downstream partners need to build advantages in core technologies, supply chain and other supporting capabilities to enhance their competitiveness in the international industrial chain. Among them, supply chain competitiveness, especially logistics cooperation and connectivity, will become a key element in the development of new-generation logistics enterprises.

The supply chain is a dynamic system with horizontal and vertical links and end-to-end integration. Different enterprises have different requirements for key

links, which leads to different development priorities and technology applications. Although external links and daily operations are often given priority, quantitative management, risk warning, and operation and maintenance of technology are still insufficient. This shows the general priority and tendency of choosing the practical path of iterative supply chain upgrading.

The main motives for the development and implementation of an organizational and economic mechanism for managing business development related to innovations in intelligent supply chains should be the following aspects (**Table 4**).

Table 4. Motives for the development and implementation of an organizational and economic mechanism for managing business development related to innovations in intelligent supply chains.

Motives	Description
Economic	Increase in profits due to growth in sales volumes. Optimization and reduction of costs for logistics processes. Creation of favorable conditions for lending and taxation. Providing sufficient resources for the implementation of logistics projects.
Management	Rationalization of management decisions in the field of logistics based on deep analytical research. Optimization of logistics flows and development of a sustainable concept for managing material, financial and information flows. Improving the system of motivation and control over the activities of logistics personnel. Improving the image of the enterprise.
Social	Realization of the personal potential of employees. Activation of the motivational component to improve logistics processes. Responsibility to consumers and society. Creation of social infrastructure.
Ecological	Improving the state of the environment. Conservation and restoration of natural resources. Improving the environmental reputation of the enterprise.

As enterprise supply chains evolve from lean to digital and intelligent, more and more new positions are emerging, such as senior planning, engineering planning, human-machine collaboration, scenario exploration, and technology application exploration. The supply chain organizational structure, operational efficiency, talent echelon, etc. will undergo corresponding changes to support the requirements of supply chain "digital intelligence" for organizational development and talent development. To this end, enterprises should pay more attention to building supply chain organizational capacity and talent iteration, formulate supply chain talent strategies and mechanisms, and introduce and retain suitable talents.

Supply chain planners can plan and optimize the supply chain system architecture in real time according to market and product changes, implement the application of related technologies, and promote the networking, digitalization and intelligent upgrading of the supply chain, which provides structural assurance and support for the future operations of the enterprise. The technical foundation ensures the feasibility of construction strategies and technologies, plays a role in enhancing the capabilities of intelligent manufacturing, and is a prerequisite for strategic elements and supply chain operations.

In recent years, China has not only implemented many logistics industries and related policies in the upstream and downstream fields, but also raised the development of logistics to the strategic level of new national infrastructure. The

policy not only provides good external conditions for logistics companies, but also points the direction of innovation and development.

First, it is necessary to consolidate the adjustment of the transportation structure, strengthen innovation in logistics service models, and promote new service models such as multimodal transportation, shared distribution, centralized distribution and carriers without vehicles.

Secondly, strengthening investment and construction of logistics hubs, integrating the "Ten Vertical and Ten Horizontal" transportation channels and the basic layout of inland logistics channels, focusing on land ports, port types, airport types, manufacturing service types, business service types and land border ports. Six different types of national hub construction.

Third, promote the transformation and upgrading of the traditional circulation industry based on technological innovation and business model innovation, stimulate the development of new sharing economy models, stimulate the entrepreneurial and innovative vitality of market entities, and encourage enterprises to use the Internet; platforms to optimize the allocation of idle social resources.

Fourth, it is necessary to strengthen informatization, data processing and intelligent logistics construction, vigorously develop intelligent logistics, use big data, the Internet of Things and other technologies to build an intelligent logistics channel network, and build an intelligent warehousing system and distribution system.

7. Conclusion

This study reviews and analyzes articles on the topic of business development management related to intelligent supply chain innovation over the past five years, taking China's experience as an example. It is found that intelligent supply chains have a significant impact on the efficiency and competitiveness of companies, and test their ability to adapt and manage new technologies.

The analysis of the content of management mechanisms, assessment of their effectiveness and identification of the causes of emerging problems form the main part of the study. The statistical results of the study characterizing the digitalization processes of the logistics industry in China in 2015–2023 show that the most frequently considered aspects are the introduction of digital technologies, automation of processes and optimization of supply chains. To a certain extent, this reflects the prospects of Chinese companies for managing business development in a high-tech environment.

Author contributions: Conceptualization, CS and TMR; methodology, TMR; software, CS; validation, CS and TMR; formal analysis, CS; investigation, CS; resources, CS; data curation, CS; writing—original draft preparation, CS; writing—review and editing, TMR; visualization, TMR; supervision, TMR; project administration, TMR; funding acquisition, CS. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

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