

Study on Coordination between Smart Port and Supply Chain

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Abstract

With the development of global economic integration, the port has developed from a single transportation node to a key node in the trade channel and logistics channel. The competition between ports also evolves into the competition between supply chains. As a link of supply chain, smart port must coordinate the relationship between port and supply chain. This paper integrates the connotation of smart port, and on this basis, discusses the overall relationship between smart port and supply chain, determines the current interaction between port and supply chain, and points out the development experience between smart port and supply chain, so as to provide reference for other developing smart ports.

Keywords

Smart Port; Supply Chain; Coordination.

1. Introduction

Ports, as the key nodes of the global comprehensive transportation network, undertake loading, unloading and transportation of more than 85% of the import and export materials, and play a pivotal role in global trade and shipping. In today's global economic integration and the Internet economy era, the port of modern information technology application ability and intelligent degree, in a certain extent reflects a country's level of science and technology development and the progress of modern logistics, also determines the sustainable development of the port capacity and the competitive position in the international market. The Internet is a wide area network that connects all the knowledge and wisdom of people in the world. At the end of the last century, the rise of Internet of Things technology represented by RFID and the highly developed application of mobile Internet make it possible to connect human wisdom with everything in the world into an all-weather and integrated "intelligent world". The smart port is the core node of the intelligent global supply chain system based on ocean transportation.

As a necessary node of international logistics and supply chain, port has always been an important position of information construction. From information port to digital port, and now to the construction of smart port, Chinese ports have entered the critical digital transformation period. At present, it is urgent to deeply integrate cloud computing, Internet of Things, big data and other information technologies with various fields of ports, so as to promote connectivity between ports and upstream and downstream supply chains, enhance port information service and business innovation capabilities, and facilitate port transformation and upgrading, as well as quality and efficiency improvement.

But the fact is that the operation of China's port supply chain is not very ideal. First, the cooperation and sharing of port and supply chain information platform is not perfect, limited to the interaction between port companies and port units, and there is no effective connection with downstream logistics enterprises, port hinterland and ports. Secondly, the fault of information system construction, low utilization rate exists in the existing relatively perfect information system; Finally, the industry is basically in a state of disordered competition. As the component units of the whole supply chain operate separately, logistics services are scattered, resulting in high average cost and fierce internal competition in the logistics industry.

At present, China has entered the new normal of economic development, and is in the critical period of accelerating the transformation and upgrading of traditional industries and comprehensively promoting the supply-side structural reform. Therefore, the space for Chinese ports to obtain sustainable growth by relying on port investment and capacity growth is very limited. The phenomenon of port transition construction exists in some coastal areas, which leads to the convergence of port functions, excess capacity and increasingly fierce homogenization competition. The development mode of port relying on large-scale construction to drive throughput growth can no longer be sustained. The connotation of development, on the basis of the achievement of information construction, port construction by wisdom to comprehensively improve the quality of supply of port logistics services and supply efficiency, then wisdom port into the supply chain system, the article will not only make the whole supply chain operation efficiency, also reduced the production cost of each node enterprises.

After entering the 21st century, China's ports develop rapidly at an extraordinary speed. Since 2002, China's port cargo throughput and container throughput have ranked first in the world for 16 consecutive years, and the port construction scale and technological equipment have also taken the lead in the world. However, China's ports are large but not strong, and are generally in the development stage of construction-oriented and resource-input ports. Compared with developed ports in Europe and The United States, there is still a considerable gap between them and informatization, intelligence, green environmental protection, supply chain and logistics service ports. In recent years, China's large coastal hub ports have been keenly aware of the global port internationalization, smart, green development trend, especially in the planning and construction of smart ports, speed up the pace. As a result, the future trend of smart ports is becoming more and more important. How to coordinate the functions of smart ports in the supply chain has gradually become the focus of research.

Based on previous studies, this paper integrates the status quo of smart ports in recent years, and focuses on the coordination between smart ports and supply chains.

The paper is divided into four parts, the overall structure is as follows: The first chapter is the introduction, the second chapter is the literature review, the third chapter studies and analyzes the cooperation mode between the smart port and the supply chain, the fourth chapter is the case analysis, empirical analysis of the coordination between the smart port and the supply chain.

2. Literature Review

As the basis of Marine transportation, ports represent the infrastructure closely related to national competitiveness [1,2]. Therefore, both developed and developing countries fully recognize the importance of smart ports, actively invest in developing smart port technologies and apply them to traditional port areas [3].

Smart port refers to making full use of the Internet of Things, cloud computing, big data and environmental protection technology, intelligent perception and other new-generation information technologies to carry out thorough perception, extensive interconnection and in-depth information mining of the port, so as to achieve seamless connection of various port resource elements and collaborative linkage of various functional modules. And finally realize the modern port form of intelligent, efficient, safe, convenient and green development [4,5]. The internet of things technology is a smart infrastructure that connects wired and wireless networks to surrounding objects, such as electronics and sensors, and exchanges collected information between them [6].

From the perspective of port positioning and demand, smart port provides pleasant and profitable services for customers and employees, involving modern port services in loading and

unloading, warehousing, logistics, commerce, finance, information and other aspects. Intelligent port has the characteristics of comprehensive perception, intelligent decision-making, independent loading and unloading, and full participation.

Big data technology is the key technology of smart port. Big data technology is used to mine massive data, discover the knowledge and rules implicit in big data, provide decision support for port management, and ultimately improve the port management level and decision level. Intelligent port uses Electronic data interchange (EDI) platform, GIS geographic information platform and RFID technology to collect and transfer information. Among them, digital twin (DT) technology can help the port industry to better realize digitalization and step into a new era, providing an important research direction for the realization of visual monitoring, visual interaction and automated living space [7].

Complete logistics service is the main function of a port. Port logistics is a term used to describe logistics and distribution services based on the arrival of goods at ports. Port logistics includes a wide range of businesses, such as cargo handling, handling, custom paperwork, monitoring, etc. Therefore, to achieve outstanding results in global trade and transactions, effective operation of port logistics is required [8]. Only when the port has enough resources, infrastructure and labor force can the port logistics run smoothly [9]. Port logistics service industry can not only meet the needs of customers, but also improve the profits of the company [10].

Service supply chain is different from traditional supply chain, its supply chain structure includes value-added flow, information flow, service flow, capital flow, etc., through sharing information, cooperation planning and operation properly, strengthen the port's response to the market, the core lies in the port. There are many versions of the concept of service supply chain. At present, a relatively complete definition is that service industry or service department applies supply chain idea to manage intangible services [11]. The ultimate goal of shipping logistics service enterprises to construct service supply chain is to pursue supply chain synergy. Shipping logistics service purpose is to realize the service integration of the supply chain collaboration, each node on the supply chain are closely linked, to better provide logistics services to the customers clearly grasp the formation and evolution of the shipping logistics service supply chain coordination mechanism and operation of the business and the allocation of resources together, can for the construction of shipping logistics service supply chain and the actual operation to provide theoretical guidance, Promote the formation of positive synergistic effect. The use of Interpretive Structural Modeling (ISM) can help overcome some obstacles of digital transformation of supply chain [12]. A clear understanding of the formation and evolution mechanism of port logistics service supply chain coordination and the coordination of business and resource allocation in operation can provide theoretical guidance for the construction and actual operation of shipping logistics service supply chain and promote the formation of positive synergies.

3. Coordinated Development of Smart Port and Supply Chain

3.1. Relationship between Port and Supply Chain

The main research contents of the relationship between port and supply chain include the process and status of port embedding into supply chain, the value created by port in supply chain and the impact of port and supply chain integration on port performance.

The relationship between port and supply chain becomes different with the development of time, from the original view that port is the center of supply chain to the view that port is a part of supply chain.

3.2. The Impact of Smart Ports on Supply Chains

3.2.1. Influence of Smart Port on Supply Chain Cost

According to the statistics of China Federation of Logistics and Purchasing, in 2018, the total social logistics cost was 13.3 trillion yuan, and the annual transportation cost was 6.9 trillion yuan, while the port cost is an important part of the cargo transportation cost. Through the implementation of reasonable loading and unloading technology or the use of advanced information technology, can reduce the unreasonable phenomenon of loading and unloading and handling, reduce the cost. The smart port adopts RFID, GPS positioning and EDI technology to realize independent loading and unloading and intelligent decision-making, effectively improving the efficiency of the port and accelerating the rapid flow of information flow, logistics and capital flow in the supply chain.

3.2.2. The Impact of Smart Ports on Supply Chain Agility

At present, the product life cycle is shortening day by day, and customers have higher and higher requirements for time. Driven by zero inventory, JIT and agile manufacturing, port operational efficiency has a great impact on the agility and responsiveness of supply chain. In order to cope with market uncertainty, unstable demand, random demand and seasonal demand, the port should be agile development. The factors affecting agility include: (1) port infrastructure, collection and distribution system and network; (2) The logistics operator's ability, including reliability, punctuality, transport frequency, information technology and security, etc. Smart port adopts big data, cloud computing and other advanced technologies, which are characterized by comprehensive perception and full participation, to achieve precise control of information transmission, information processing and personnel deployment, improve port operation efficiency, and strengthen the agility and reaction ability of supply chain.

3.2.3. The Impact of Smart Port on the Value Added of Supply Chain

Traditional ports provide loading, unloading and handling services to achieve the spatial utility of cargo; Smart ports provide value-added logistics activities such as warehousing, distribution and circulation processing to realize the time utility and improve the use value of goods. In addition, as the port participates in the supply chain, it has obvious advantages to conduct production near the port. On the one hand, the supply chain process can be shortened, and on the other hand, the radiation to the hinterland can be realized. In addition to realizing its own value-added, the port also adds value to the supply chain it serves. As the current development direction of the port, the smart port continuously introduces new technologies and reforms the management mode to carry out its own value-added, thus driving the value-added of the supply chain it serves.

3.2.4. The Influence of Smart Port on Bullwhip Effect of Supply Chain

After the smart port participates in the supply chain, the number of supply chain links increases, and the bullwhip effect intensifies with the increase of supply chain links. However, this effect can be reduced through the integration of smart port and supply chain.

Ports are usually equipped with advanced information technology and have a common information platform with customs, freight forwarders and shipping companies. They are the information intersection of the supply chain and have a good foundation to become the information center of the supply chain. Through information sharing among supply chain nodes, bullwhip effect can be reduced or restrained.

3.3. The Impact of Supply Chain on Smart Port

3.3.1. The Impact of Supply Chain Type on Port

Different types of supply chains have different requirements and choices for smart ports. Table 1 summarizes the requirements of two types of supply chains for smart ports.

Table 1. Requirements of two different types of supply chains for smart ports

Requirements for ports	Buyer-driven supply chain	Vendor-driven supply chain
type of good	Mainly for containers, part for bulk cargo and groceries	Mainly bulk cargo
volume of freight traffic	instability	relatively stable
Timeliness requirement	expect much	High requirements for consistency of supply
Choice of port or wharf	Not very stable	Relatively stable, fixed assets or long-term use of the number of facilities
Environmental factors	Limited to consider	The key to consider
Vertical integration with port-related businesses	Low degree, excluding port, wharf or ship business, more flexible choice of carrier	High degree, enterprises usually own their own docks or berths and own or charter ships or other resources
Horizontal clustering in space	May form near container ports	Due to the large scale of core enterprises, it is unlikely to form
Overall relationship with ports	And the port interactive development, mutual promotion	Synchronous development with own wharf or berth

(1) Buyer-driven supply chain. Mainly exist in the consumer goods industry, the goods are mainly containers; It is more flexible and sensitive to the availability of integrated logistics and trade services and port service quality. Enterprises in the supply chain tend to choose large hub ports.

(2) Vendor-driven supply chain. Mainly exist in half (such as petrochemical products) industry, the kind of goods is mainly bulk cargo; Focusing on bulk raw material processing activities, chain companies tend to choose ports with deep water terminals but limited container cargo volume.

3.3.2. The Influence of Supply Chain Structure on Smart Port

Transportation is a generative demand, and the demand for port freight depends largely on the direction of the supply chain of customers. As the global supply chain continues to change, shippers usually consider optimizing the supply chain process first when choosing a port. The core enterprises of supply chain are dominant in the supply chain, and their different choices of nodes lead to the change of supply chain structure, thus affecting the port selection strategy of customers. The risk of losing customers comes not only from inadequate port infrastructure, poor terminal operation or poor inland connection, but also from the rearrangement of customer supply chain network, especially the change of hub ports due to the establishment of cooperation with new logistics service providers. In addition, the last port selection strategy of customers will also affect their future port selection.

3.3.3. The Influence of Supply Chain Nodes on Smart Ports

(1) Strength of supply chain node enterprises. The supply chain node enterprises with strong strength, abundant capital and high market share, especially the core enterprises of the chain, will bring a large amount of goods to the smart port. Such customers usually have a high level of information, which is convenient for information system integration and information sharing with smart ports. However, these customers also have strong bargaining power and will put forward higher requirements for smart ports.

(2) Cooperation between smart port and supply chain node enterprises. The supply chain node enterprises that establish strategic cooperation relationship with smart port will bring long-term stable supply of goods to smart port and belong to important customers. However, the choice of smart port by chain enterprises is likely to be short-term and the freight volume is unstable.

3.3.4. The Impact of Port and Supply Chain Integration Degree on Port

The degree of integration between port and supply chain has positive influence on port performance. Through investigation and research, it is found that the higher the degree of integration and coordination with the supply chain, the higher the port operation performance. The degree of port and supply chain integration also has a positive impact on port competitiveness. The competitiveness of a port is not only affected by cargo throughput and port efficiency, but also depends on the positioning and orientation of the port in the supply chain.

4. Conclusion

Wisdom port as a link in the supply chain, is the path of the standardization and scale, using more advanced and intelligent technology and equipment, and make accurate decisions, realize its own value, brings about lots of conveniences for port operations, to reduce the port production cost, promote the supply chain on the rapid flow of logistics, information flow and cash flow. Meanwhile, other links involved in the supply chain also affect the construction of smart ports. Only with coordinated development and enhanced integration can they promote each other.

References

- [1] Chang, Y.-T., Shin, S.-H., Lee, P.T.-W: Economic impact of port sectors on South African economy:an input-output analysis, *Transp. Policy*, Vol. 35(2014), p.333-340.
- [2] Rodrigue, J.-P., Notteboom, T: The terminalization of supply chains: reassessing the role of terminals in port/hinterland logistical relationships, *Marit. Policy Manag*, Vol. 36(2009), p. 165–183.
- [3] Jun W. K., Lee M. K. and Choi J. Y: Impact of the smart port industry on the Korean national economy using input-output analysis, *Transportation Research Part A: Policy and Practice*, Vol.118(2018), p.480-493.
- [4] Botti, A., Monda, A., Pellicano, M., et al. The re-conceptualization of the port supply chain as a smart port service system: the case of the port of Salerno, *Systems*, Vol.5(2017) No. 35.
- [5] Yang, Y., Zhong, M., Yao, H., et al. Internet of things for smart ports: Technologies and challenges, *IEEE Instrum. Meas. Mag*, Vol.21(2018), p.34-43.
- [6] Ferretti, M., Schiavone, F: Internet of Things and business processes redesign in seaports: the case of Hamburg, *Journal of Bus. Process Manag*, Vol.22 (2016), p. 271–284.
- [7] Al Dakheel, J., Del Pero, C., Aste, N., et al. Smart buildings features and key performance indicators: A review, *Sustainable cities and society*. Vol.61(2020), 102328.
- [8] Sarkar B D, Shankar R: Understanding the barriers of port logistics for effective operation in the industry 4.0 era: Data-driven decision making, *International Journal of Information Management Data Insights*, Vol.1(2021) No.2, 100031.
- [9] Kim, K. H., Lee, H: Container terminal operation: current trends and future challenges, In *Handbook of ocean container transport logistics*, Vol.22 (2015), p. 43–73.
- [10] Yang, W. S., Liang, G. S., Ding, J. F. Identifying solutions for adding service value to international port logistics centers in Taiwan, *Maritime Economics & Logistics*, Vol.15(2013) No.4, p. 395–415.
- [11] Lisa M. ELLRAM, Wendy L. TATE, Corey BILLINGTON: Understanding and managing the Services Supply Chain, *Journal of Supply Chain Management*, Vol.40(2004) No.4, p. 17-32.

- [12] Agrawal, P., Narain, R., Ullah, I. Analysis of barriers in implementation of digital transformation of supply chain using interpretive structural modelling approach, Journal of Modelling in Management, Vol.15(2019) No.1, p.297-317.