Research on the Construction of Knowledge Service Model of Port Supply Chain Enterprise in Big Data Environment

Yang Bo¹, Mao Junqing²
¹,²School of Information Management, Jiangxi University of Finance and Economics, Nanchang, Jiangxi, 330013, China
e-mail: yangbo@jxufe.edu.cn

Abstract: In the context of the rapid development of big data and artificial intelligence, with the help of the knowledge service theory system and big data technology to build a smart port supply chain knowledge service model to provide a personalized, intelligent, and diversified knowledge-based service system platform solution to port supply chain enterprises, which is of great significance to realization of port supply chain transformation and upgrading and intelligent integrated operation. This paper analyzes and summarizes the research status of knowledge service demand and port supply chain knowledge service during the development and operation of port supply chain, and applies big data and artificial intelligence technologies such as knowledge matching, knowledge fusion, and natural language processing. The port supply chain knowledge service model including knowledge acquisition, knowledge organization and knowledge service modules is constructed. Ontology method is used to construct the ontology knowledge base of port supply chain, and based on this, computational reasoning experiments are performed. The experiments show that the ontology technology shows good effectiveness and superiority in constructing the knowledge service system model of the port supply chain in terms of knowledge representation and knowledge reasoning.

1. Introduction
With the continuous development of economic globalization, big data and artificial intelligence technology, the interdependence and integration of the world economy have become an inevitable trend[1]. As an important carrier for material exchange at home and abroad, and an important bridge for international information communication and data exchange, ports have become an important driving force for the development of the country's real economy[2]. Through the search of domestic literature, the current domestic research in the field of port supply chain mainly focuses on the research of port supply chain's enterprise performance, risk identification, finance and son on. However, few papers have showed the research results on intelligent, integrated operation service intelligent platform for port supply chain operations via big data and artificial intelligence. In this paper, under the background of big data environment, the construction of knowledge service model framework of port supply chain is discussed, which provides basic research for the realization of intelligent integrated operation of port supply chain.

2. Demand analysis and literature review
2.1. Demand analysis
Port supply chain is a chain like organic network structure formed by integrating the upstream and
downstream member enterprises through establishing appropriate mechanism and structure with port enterprises as the core, in order to quickly and accurately deliver goods to customers and maximize various benefit values in the supply chain[9]. However, in the real port supply chain, information asymmetry and information island are easy to form on the nodes of the supply chain, which makes it difficult to maximize the benefits of enterprises in the supply chain. Therefore, in China, on the one hand, large-scale port and waterway enterprises take measures such as horizontal resource integration, merger and reorganization to achieve large-scale operation; On the other hand, they broaden and improve the port supply chain structure through strengthening the vertical cooperation between enterprises, deepening business collaboration, project linkage, etc[10]. The government documents "several opinions of the Ministry of transport on promoting the scientific development of Yangtze River shipping" propose to integrate port development, strengthen port linkage, promote the deepening cooperation between port enterprises and railway, highway and air transportation enterprises, and promote the effective connection between port areas and various transportation modes[5]. Taking China Merchants Group as an example, by the end of 2018, the business of China Merchants port group has covered 38 ports in 18 countries and regions on 6 continents. with service network covering the whole country and the main economic zone of globe, Sinotrans vigorously promotes the integration of professional companies, so as to realize the unified operation of contract logistics and cold chain logistics, and realize the whole industrial layout of port supply chain through a series of merger and reorganization.[6]

Although China is constantly promoting the development of port logistics, there is still a certain gap between the operation mode and knowledge management of port supply chain in China compared with the advanced port supply chain logistics services in foreign countries, especially in the context of the Internet economy era, the integrated knowledge service level of port supply chain enterprises still has a large space to improve[11]. Due to the lack of transparency and asymmetry of transaction information and other imperfect supply chain value credit system problems, port supply chain enterprises have high related operating costs. At the same time, due to the lack of adaptability of China's ports to social and economic development and prominent structural contradictions, most ports can only provide single or segmented logistics services, which cannot form a complete logistics service supply chain and provide multi-faceted high-quality logistics services[6]. Therefore, based on the current development trend of port supply chain, it is inevitable trend in the development of port supply chain system by using big data technology to build the knowledge service platform of port supply chain to improve the overall benefits of port supply chain enterprises and realize the highly integrated and intelligent port supply chain.

2.2. Literature review
The rapid development of new technologies such as big data, Internet and artificial intelligence has brought new opportunities to port supply chain[9]. At present, the research on knowledge service of port supply chain is still in the initial stage at home and abroad. In the current research, scholars at home and abroad have applied big data, artificial intelligence and other technologies to the supply chain for many explorations. Niu Xiaoge (2014), a domestic scholar, believes that knowledge sharing in supply chain refers to the process from knowledge flow to organizational learning to knowledge application, in which supply chain members exchange their own knowledge and relevant experience with each other [10]. Zhang Mujia (2017), a domestic scholar, believes that knowledge sharing refers to the interactive process of knowledge innovation and appreciation, in which the subjects of knowledge sharing voluntarily carry out knowledge sharing, through various means of knowledge sharing to make the shared knowledge circulate, exchange, learn and transform among the subjects, and jointly create new knowledge [11]. Koskinen (2014), a foreign scholar, put forward that knowledge sharing is an important business activity of supply chain management based on the theory of self creation, in which knowledge flow and learning have strong autonomy, each supply chain node enterprise has its own organizational memory, forming a self creation knowledge system is an important way to promote knowledge sharing among supply chain enterprises [12]. Chen (2016), a foreign scholar, generalized the
definition of knowledge sharing, and believed that the process of knowledge sharing not only includes knowledge transmission, but also mutual learning. [13]

This paper considers that port supply chain system is a complex service ecosystem, which is determined by the complexity of port supply chain. The complexity of port supply chain system stems from its many participants as well as the intersection and integration of many disciplines involved in its operation. The knowledge service system of port supply chain uses big data and artificial intelligence technology to provide intelligent, integrated and diversified knowledge services for each node enterprise of the whole port supply chain, so as to realize the efficient operation and maximum benefit operation of port supply chain.

3. Research on knowledge service model of port supply chain

Deeply understand and analyze the development status of port supply chain under the background of big data, and analyze the existing problems of port supply chain. In order to give full play to the port's unique industrial chain advantages, build the knowledge service model of port supply chain with the help of big data and artificial intelligence technology and the aggregation of many heterogeneous themes and heterogeneous data to realize the resource sharing and value coordination of port supply chain enterprises. So as to realize the intelligent operation of port supply chain. This model framework is mainly composed of knowledge acquisition module, knowledge organization module and knowledge service module. The knowledge service model is shown in Figure 1.

Figure 1. knowledge service framework model of port supply chain is based on big data

The port supply chain knowledge service platform is to provide intelligent knowledge services for the port centered supply chain network structure by using big data and artificial intelligence and other technologies. The knowledge service model can effectively integrate resources to achieve complementary advantages and grasp the authenticity of goods transactions to achieve information
symmetry and value synergy, In addition, break the traditional straight-line business transaction mode and control the business transaction information of each node, making the transaction process open and transparent, and data real-time sharing[13]. At the same time, improve the credit value system to provide security for diversified knowledge sharing. Information transparency and knowledge sharing are easy to form strong cohesion and improve the operation efficiency of supply chain knowledge for dynamic supply chain network structure, so as to make better use of relevant resources.

The knowledge service system of port supply chain needs to widely obtain the relevant data of port supply chain and uses the big data technology to collect, clean, and extract the widely available disorderly, complex and decentralized port supply chain data into processable knowledge. Then based on big data technology, through knowledge map, knowledge navigation, knowledge matching, knowledge fusion and other methods to provide convenient and reliable intelligent knowledge services for port supply chain enterprises.

4. Construction and reasoning of port supply chain ontology knowledge base
In this paper, a port supply chain ontology knowledge base is constructed by using the ontology building software protege 4.3. Based on this ontology knowledge base, the reasoning and calculation experiments of port supply chain ontology are carried out. The construction of port ontology knowledge base mainly includes the construction of port supply chain ontology base and port supply chain rule base. Ontology base is built on the basis of knowledge elements extracted from port supply chain knowledge, and rule base is the collection of management mode and operation mode rules of port supply chain.

4.1 Construction of port supply chain knowledge service system ontology
This paper uses the seven-step method of domain ontology construction proposed by Stanford University researchers Noy and McGuinness to build the ontology library. The process is based on the Java-based graphical editing tool Protege to build the ontology library. Protege software has the same friendly user interface as ordinary windows applications, which is easy to learn and use, and can easily realize the creation and visualization of ontology. This paper uses Protege 4.3 to build the port supply chain ontology library[14].

In the construction of the port supply chain ontology, it is necessary to analyze the port supply chain ontology. Because there is no reusable ontology related to the port supply chain, it is necessary to redefine the port supply chain ontology library independently. Analyze and summarize the knowledge in the field of port supply chain, determine the relevant ontology, define the relevant classes and attributes, and determine the definition domain and object attributes of the attributes. The attributes of some ontologies in the ontology database of port supply chain are shown in the table below.

| Ontology                  | Attribute types | Domain of definition | Object attribute            |
|---------------------------|-----------------|----------------------|----------------------------|
| semi-manufactures         | Data attribute  | Supplier             | by handing, be transported  |
| Railway transportation    | Object attribute| Land transportation company | transport                   |
| Freight forwarding enterprises | Object attribute | Port supply chain | agent, declare             |
| Port processing Department | Object attribute | Port enterprise | machining                  |
| Boats and ships            | Object attribute | The shipping company | transport                  |
| Tanker                    | Data attribute  | Boats and ships      | transport                  |
| Storage repository         | Object attribute | Storage enterprise | save                      |
| Customs agencies           | Object attribute | Port supply chain | audit                      |
| Ordinary freight car       | Data attribute  | Road transport       | transport                  |
| Unified credit granting    | Object attribute | Financial institution | lending                    |
Figure 2. port supply chain knowledge service part ontology knowledge base

The ontology instance needs to be filled in after the definition of class and attribute of ontology is completed. In this paper, some instances needed for later reasoning experiments are filled in the ontology database. The ontology database of port supply chain after construction is shown in Figure 2.

4.2 rule base reasoning of port supply chain knowledge service system

4.2.1 Ontology based reasoning

In the definition of relevant rules of ontology database, such as storage enterprises, port enterprises and land transportation enterprises all involve loading and unloading during operation, so the definition of loading and unloading in ontology belongs to a part of storage, port, transportation and other enterprises. The operation of goods in the port supply chain may involve the needs of processing, storage and other operations. The enterprises that can store goods in the port supply chain are not only specialized storage companies, but also port enterprises and some third-party logistics enterprises. The enterprises that can process goods in the port supply chain also include storage enterprises and port enterprises. Therefore, the new knowledge can be obtained by loading the FaCT ++ inference engine for inference as shown below.

Figure 3. before part of ontology reasoning  Figure 4. after part of ontology reasoning
Through reasoning, it can be seen that different enterprises in the port supply chain have the same cross functions, so that the goods can be selected to maximize the benefits according to the actual needs and the attributes of the goods in the process of transportation. At the same time, the logic of the ontology knowledge can be tested to ensure the effectiveness of the port supply chain ontology knowledge.

4.2.2 Ontology rule reasoning
This paper analyzes and summarizes some ontology rules based on the operating mode of the port supply chain, the different attributes of goods, the requirements of customers for goods transportation and other characteristics, combined with the characteristics and processes of goods in real transportation. These rules are the accumulation of cargo transportation experience in reality or the requirements of national standards. Some rules of extraction are as follows:

Rule 1: if the transported goods meet the national dangerous goods index attribute, they are defined as dangerous goods.

Rule 2: if the customer requests to deliver the goods to the customer as soon as possible, the land transportation shall choose the special transportation in the air transportation.

Rule 3: select special warehouse for storage.

Rule 4: shipping companies choose container ships to transport dangerous goods.

The rules are presented in a Semantic Web Rule Language (SWRL) semantic manner, and users are allowed to write rules according to OWL concepts and relationships to provide more powerful deductive reasoning ability than using OWL alone, so as to better dig out the implicit knowledge in ontology knowledge base[14]. The following figure is shown abefore and after reasoning.

Figure 5. before reasoning of dangerous goods transportation

Figure 6. after reasoning of dangerous goods transportation

In the transportation of dangerous goods, the above four SWRL rules are used to infer with the help of the fact + + inference engine to obtain new knowledge: the dangerous goods shall be stored in the special warehouse of the storage enterprise in the process of storage, special transportation of air transportation shall be selected in the land transportation to meet the time requirements of users, in the shipping, container ships shall be selected in the transportation. The comparison between the results before and after reasoning of dangerous goods transportation is shown in Figure. 5 and Figure. 6.

5. concluding remarks
The intelligence and integration of port supply chain can promote the close cooperation among many enterprises in the port supply chain, establishing a partnership of mutual benefit, value coordination, integrity and transparency to realize the smooth flow of information flow, logistics and capital flow in the supply chain, which is also the key point to realize the transformation and upgrading of port supply
In this paper, knowledge fusion, knowledge matching, natural language processing and other big data and artificial intelligence technologies are applied to port supply chain knowledge services to build a port supply chain knowledge service model, so as to effectively explore and process port supply chain data resources, and realize the integration and sharing of various data resources of port supply chain enterprises. It is of great practical significance for the development of port supply chain enterprises to provide personalized, intelligent and diversified knowledge service system platform scheme for port supply chain enterprises and realize the transformation from traditional operation to intelligent operation of port supply chain.

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