Knowledge Service Model of Port Supply Chain Enterprise Based on Ontology

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Abstract. Under the background of the development of port industry and information age, with the help of the knowledge service theory system and ontology 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. Based on the analysis of the demand for knowledge service and the research status of knowledge service in port supply chain during the development and operation of port supply chain, this paper uses ontology technology to build domain ontology knowledge base, which is used to dismantle and integrate the massive digital resources in port supply chain, integrate various multi-source heterogeneous data resources, and standardize the form of knowledge sharing organization. On the basis of this, the paper carries on the calculation and reasoning experiment to the port supply chain ontology. The experiment shows that the ontology technology has good effectiveness and superiority in the knowledge representation and knowledge reasoning of constructing the port supply chain knowledge service system model.

1. Introduction
As an important core hub of international material and information exchange, port has become an important driving force to promote the development of national real economy. With the rapid development and popularization of information technology, the data resources in the field of port supply chain show explosive growth. The massive data resources contain rich, comprehensive, reliable and timely domain knowledge, which brings new development opportunities to the field of port supply chain. However, in reality, port supply chain faces many challenges in the acquisition and utilization of knowledge. On the one hand, because the port supply chain contains many subjects and circulation mechanisms at home and abroad, involving many fields, regions, disciplines and other characteristics, its complexity is easy to lead to information asymmetry, moral hazard and other problems among the port supply chain enterprises. At the same time, the problems such as the lack of transparency and asymmetry of trading information among port supply chain enterprises and the imperfect supply chain value credit system result in high technology and operation costs of port supply chain enterprises.

On the other hand, because the knowledge exchange and acquisition of upstream and downstream enterprises in the port supply chain are different from the traditional acquisition approaches and modes, many enterprises lack the effective acquisition and utilization of many data resources in the field, and it is difficult to form a long-term integrated knowledge utilization system,
and upstream enterprises in the port supply chain are difficult to obtain the required data and terminal knowledge in time.

At present, the relevant research in the field of port supply chain mainly focuses on the enterprise performance, risk identification, finance and other aspects of port supply chain. The existing literature [1-5] mainly studies the methods and risk management mechanism of port supply chain risk identification, the cooperation strategy and coordination evaluation of port supply chain, the sharing way and practical value of knowledge among the main bodies of supply chain, and the innovation driving of knowledge in the process of supply chain transmission. Literature [6-9] mainly studies supply chain operation mechanism, enterprise knowledge sharing incentive mechanism, port performance evaluation and cloud data integration, port supply chain financial model evolution and other issues. However, there are few researches on building knowledge service model by using ontology technology to provide intelligent service platform for integrated operation of port supply chain. Therefore, based on the original research, combined with the industry characteristics and demand analysis of port supply chain, the intelligent ontology database of port supply chain is established by using ontology technology. Through the ontology analysis of port supply chain subject, the case ontology of port supply chain is determined, the category attribute of different ontology is defined, the definition domain and object attribute of ontology are determined, so as to realize the self-renewal and storage of port supply chain ontology domain knowledge, a personalized, intelligent and diversified knowledge service system platform scheme is provided for port supply chain enterprises to realize information transparency and high sharing in port supply chain. Provide basic research on the intelligent operation of port supply chain structure.

2. Construction of Knowledge Service Model for Port Supply Chain
The port supply chain knowledge service system aims to provide the port supply chain with personalized, intelligent and diversified knowledge service system platform scheme, so that the port supply chain can quickly, effectively and accurately acquire the knowledge required in the operation, so as to improve the operation efficiency of the port supply chain and realize the intelligent operation of the port supply chain. To build an intelligent knowledge service system of port supply chain, so as to provide effective knowledge services for port supply chain enterprises, the following three aspects need to be considered.

(1) Collect comprehensive, rich and reliable data resources. Under the background of Internet era, the port supply chain has accumulated massive digital resources in the development process. The knowledge source formed by the collected massive data is the basis of knowledge service. Only by fully collecting rich, comprehensive, effective and high-quality knowledge resources, can it provide comprehensive, accurate and reliable knowledge service for users.

(2) An effective form of knowledge organization. At present, many port supply chain upstream and downstream enterprises are still in the traditional acquisition model and communication channels, the organization method and technology of information resources are backward, the use of information data is too limited, there is no in-depth mining and extraction of these data, lack of effective organization form, and cannot obtain the required domain information in time and effectively. Therefore, the efficient and intelligent knowledge organization form is the core and key of the knowledge service system model of port supply chain enterprises.

(3) Personalized and intelligent knowledge service. Port supply chain enterprises are easy to fall into “information maze” in the massive and complex information resources, and it is difficult to obtain the required effective knowledge. Therefore, it is an important guarantee to provide intelligent knowledge service for port supply chain enterprises quickly, accurately and efficiently. Based on the research of existing knowledge services, this paper analyzes the characteristics of port supply chain industry and operation demand, and uses ontology technology to build a port supply chain knowledge service model including knowledge acquisition module, knowledge organization module and knowledge service module, as shown in Figure 1.
2.1. Knowledge Acquisition of Port Supply Chain Knowledge Service System

Knowledge acquisition is the basis of constructing knowledge service system of port supply chain, which includes two stages: data acquisition and information extraction. With the rapid development of the port supply chain in the era of big data, the port supply chain has accumulated a large number of digital resources in the rapid development. Only by fully collecting rich, reliable and high-quality multiple information resources, can it provide comprehensive, accurate and reliable knowledge services for the relevant industries and enterprises of the port supply chain. In addition, the structure of port supply chain information resources presents multi-source and heterogeneous characteristics. These different unstructured data need to be further mined, analyzed, processed and transformed into a variety of structured data, and finally the required knowledge can be obtained. Therefore, the acquisition of knowledge not only needs to complete the information collection of all kinds of structured and non structured data at the same time, but also needs to extract the information of the collected and transformed structured information data, and extract the data and information into knowledge and store them in the database to provide data support for the construction of port supply chain knowledge base. The knowledge acquisition of port supply chain for multi-source heterogeneous data is shown in Figure 2.
2.2. Knowledge Organization of Knowledge Service System in Port Supply Chain

The knowledge organization and management module of port supply chain is a bridge to realize the demand service between port knowledge resources and port supply chain enterprises. Its main function is to collect the scattered and disordered heterogeneous knowledge resources, and to process the acquired port knowledge resources in time, store them effectively and transform them in real time according to certain rules and methods. At the same time, combined with the demand characteristics of port supply chain and the demand of problem management, new knowledge to solve the problem of port supply chain management is generated through knowledge fusion and matching, so as to form a unified and standardized knowledge base of port supply chain.

2.2.1 Ontology Knowledge Base. Knowledge organization module is a modeling method of port supply chain domain knowledge based on ontology technology. It describes the rule relationship between the knowledge objects of each layer, accurately and clearly expresses the knowledge concept system of port supply chain domain, and deeply reveals the hidden deep semantics in knowledge resource base. Port supply chain ontology base is the core of knowledge organization. Port supply chain ontology knowledge base mainly includes ontology knowledge base and rule base. It uses ontology to express, uses ontology to formally describe port supply chain, defines port supply chain ontology by concept relationship concept between ontologies and realizes port supply chain ontology by RDF, OWL and other semantic description languages to realize the ontology construction of port supply chain. After using the ontology software protege4.3 to construct and input the semantic rules of the ontology model, the new port supply chain knowledge set is obtained by reasoning engine such as fact + + and pellet, so as to realize the expansion and improvement of the ontology knowledge base. The ontology database of port supply chain includes the concept of relevant questions, the concept and structure relationship between entities, functions, axioms, etc. Port supply chain rule base is a set of rules about enterprise selection, goods definition, object selection and risk identification of port enterprises.

2.2.2 Ontology Knowledge Base Construction. In the process of building this topic, it is the first task to determine the instance ontology of ontology model. Ontology is the basic element of building ontology model, and forms the ontology structure together with the relationship between its concept and concept. In the selection of ontology, we first determine the upper ontology. As a general concept in the description domain, the upper ontology is used to represent the independent concepts and
general knowledge in different domains. It expresses the hierarchical relationship with the domain ontology. The relationship between the concept and the concept is expanded by reference. Its main function is to connect the semantic rules between the sub ontology and the supporting domain ontology [10]. Then it analyzes and selects the extended domain ontology. The port supply chain domain ontology is a form that represents the characteristic relationship and physical object of the port supply industry, including the relationship and attribute between the relevant concepts and entities in the port supply chain domain, which is used to store, evolve and disseminate the knowledge of the port supply chain domain. Domain ontology generally consists of entity set, concept set, attribute set and inference rule set.

2.2.3 Filtering Integration of Ontology. In recent years, ontology has been widely used in medicine, book management, agriculture and so on, which makes information resources well managed, shared and utilized. Although there is no extensive research on the ontology of port supply chain at home and abroad, there are also a few related researches on the knowledge service of supply chain. Due to the different creators and the different construction methods, even the ontology modeling in the same field will be very different. In order to make effective use of different ontology with different concepts and attributes in these similar fields, it is necessary to filter available ontology through ontology filtering and integration to eliminate ontology semantic heterogeneity and achieve semantic communication, so as to achieve high-level semantic integration.

After obtaining many similar domain ontologies, we use the filtering method based on ontology similarity to filter them. At present, the main similarity algorithms are vector space similarity method (VSS) and pearson correlation coefficient method (PCC) [10]. In the ontology similarity algorithm of this paper, vector space similarity method (VSS) is used to filter many heterogeneous ontologies through the vector similarity dimension and similarity coefficient between ontologies. In the process of using vector space similarity method, firstly, the similarity coefficient matrix $A$ of similar ontology and domain ontology is determined. According to the definition of similarity algorithm rules of different ontology and domain ontology, the $N \times M$ ontology similarity coefficient matrix of similar ontology and domain ontology can be obtained, where $N$ represents the number of external ontology, $M$ represents the number of domain ontology, and $a_{iM_rN}$ It represents the similarity coefficient between external ontology $I$ and domain ontology $R$. As follows.

$$A = \begin{bmatrix} a_{1r1} & a_{1r2} & \cdots & a_{1rN} \\ a_{2r1} & a_{2r2} & \cdots & a_{2rN} \\ \vdots & \vdots & \vdots & \vdots \\ a_{Mr1} & a_{Mr2} & \cdots & a_{MrN} \end{bmatrix}$$ (1)

After getting the similarity matrix of different ontology and domain ontology, the final similarity detection is carried out by calculating the recognition degree of ontology domain and combining the average coefficient of similarity coefficient of different ontology and foreign ontology in ontology domain, so as to get the similarity of foreign ontology and domain, and then determine whether it is available ontology. The specific algorithm is shown in the figure below.

$$SIM(v, r) = \frac{A_v \cdot A_r}{\|A_v\|_2 \times \|A_r\|_2} = \frac{\sum_{i=1}^{N} a_{vi} a_{ri}}{\sqrt{\sum_{i=1}^{N} a_{vi}^2} \sqrt{\sum_{i=1}^{N} a_{ri}^2}}$$ (2)

$$a_{vi} = a_{ri} + \frac{\sum_{r\in N(v)} SIM(v, r) \cdot (a_{rj} - a_{r})}{\sum_{r\in N(v)} |SIM(v, r)|}$$ (3)
Among them, SIM(v, r) in the formula represents the similarity between ontology V and ontology R in domain ontology; \( I_{vr} \) represents the set of similarity coefficients between domain ontology V and ontology R and foreign ontology; \( \bar{a}_r \), \( \bar{a}_v \) represents the average number of similarity coefficients between domain ontology and foreign ontology; \( N(v) \), \( N(r) \) represents the adjacent body set between domain ontology V and domain R; \( \bar{a}_{rl} \), \( \bar{a}_{vl} \) represents the similarity degree between foreign ontology and domain ontology V and R. Then, we extract the available ontology and knowledge resources by the similarity neighborhood standard, extract the ontology association rules and ontology concept attributes by association rule algorithm and semantic analysis technology, and extract, transform and integrate the ontology knowledge resources extracted by analysis, so as to realize the integration of multi-source ontology.

2.2.4 Semantic Annotation. Semantic annotation is to mark the knowledge resources of port supply chain for recognition in semantic network, and it is the process of mapping and association between knowledge ontology and its semantics. Semantic annotation is the basis and technical support for the analysis, recognition and extraction of ontology by using semantic web. It is also an important bridge between ontology knowledge resources and semantic description. Thus, machine learning and other technologies are used to effectively explain and understand knowledge resources. The construction of port supply chain ontology and integrated external effective ontology will mark the knowledge resources of port supply chain semantically, so that the knowledge resources in the field of port supply chain form a knowledge association network, so as to effectively obtain new examples of port supply chain, and then effectively fill and improve the knowledge base of port supply chain, and constantly enrich the knowledge resource base of port supply chain.

2.3. Knowledge Service of Port Supply Chain System

The knowledge service module of port supply chain system is the core module in the process of building the knowledge service model of port supply chain. The realization of other modules is to prepare for the module. The demand for information of enterprises in port supply chain is greatly different, but also has certain relevance. Therefore, for different knowledge demand objects in port supply chain, it is not only necessary to fully adopt different knowledge service management strategies and knowledge service management technologies, establish different targeted knowledge service systems, and realize the accurate transmission of demand knowledge. In addition, big data technologies such as knowledge navigation and knowledge map should be used to identify and real-time classify knowledge set data with the same attribute and multiple categories, so as to meet the needs of knowledge users to the maximum extent. The framework of port supply chain knowledge service system based on big data technology is shown in Figure 4.
In the process of knowledge service for knowledge users, it is not only necessary to have a huge and comprehensive knowledge repository, but also to use a large number of big data processing technologies to intelligently explore, transform, clean, extract and integrate data from different data sources, so as to form a standardized, precise, effective and orderly knowledge set. At the same time, it also needs the knowledge navigation service technology and knowledge fusion technology to form a perfect technical service system. So as to realize predictive analysis and personalized customized service for knowledge users.

3. Conclusion
The intelligence and integration of port supply chain can realize the efficient flow of various information flows, logistics and capital flows in port supply chain, and it is also the key point to realize the transformation and upgrading of port supply chain. The premise to realize the intelligent and integrated operation of port supply chain is that port supply chain enterprises can independently and effectively acquire domain data and required knowledge. Port supply chain should have a highly informationized and intelligent knowledge service platform system to provide personalized, intelligent and diversified knowledge service system platform solutions for port supply chain enterprises. Based on this, the independent ontology knowledge base of port supply chain is constructed by using ontology technology. The semantic network and ontology analysis technology are used to dismantle and integrate the massive digital resources in the field of port supply chain, integrate various kinds of multi-source heterogeneous data resources, standardize the knowledge organization form of shared port supply chain, and form the knowledge resource association network in the field of port supply chain. Through ontology filtering and ontology integration technology to obtain external ontology knowledge resources, so that the massive data knowledge resources can be maximized. Furthermore, the knowledge service model of port supply chain including knowledge collection, knowledge

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organization and knowledge service is constructed by combining knowledge fusion and matching technology, so as to realize the efficient acquisition of data in port supply chain field, the integrated sharing and utilization of knowledge resources, which has an important guiding role and practical significance for the construction of port supply chain enterprise knowledge service system by port supply chain and provide reference for port supply chain enterprises to effectively acquire and utilize massive data resources.

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5. References
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