Study on 4PL Information Platform Based on Web Services

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Abstract

The forth party logistics (4PL) information Platform is an information platform for comprehensive supply chain solutions for the customers in modern logistics environment. This paper put forward a web services based information platform for 4PL based on the analysis of information management requirements for regional logistics management and operation, and analysis the operation process of 4PL information platform. Furthermore, some key enable technologies supporting for 4PL information platform are studied, which including Web services encapsulation technology for logistics services and constructing technology for logistics services chain. The realization of the information platform provided an information operation platform for regional logistics operation and is validated in the 4PL information platform construction in Ningbo City.

Keywords: Forth Party Logistics, Web Services, Operation Process, Logistics Service, Logistics Services Chain

1. Introduction

4PL is a modern logistics operation mode, which firstly put forward by Accenture. The main aim of 4PL is to realize the logistics information sharing and make full use of the social logistics resources and realizing the optimism operation of the logistics enterprises. The operation mode and enabling technologies for 4PL had widely studied in academic and industry field presently. For instance, LI Xiu designed the logistics system framework and operation mode in the e-business environment, on the basis, provided the distribution system framework and key issues for the implementation of 4PL\cite{1}. Liu Wei put forward the operation mode of 4PL based on the analysis of the service objects, operation organization and service contents of 4PL, and put forward some suggestion to develop 4PL\cite{2}. Xiu Li provided 4PL operation mode and system framework based on the analysis of the characteristic of 4PL in the e-business environment, and realized TY-4PL, a information platform for 4PL\cite{3}. Wen Haixu studied the optimism solutions for 4PL with different algorithms from the aspect of routine optimization\cite{4}. Yer V.H had a research on the benefits, cost and risk analysis for HongKang being 4PL center with the approach of AHP and ANP model\cite{5}. Xiu X.F, Jiang yu and Tiejun Pan, ete had a research on 4PL information platform from of system models\cite{6-9}. Yiqun Li had a research on the Information Services Platform of International Trade Based on E-commerce and its key points on e-ports in China\cite{10-11}. From the literature analysis, most of the present studies are focus on the aspects of operation mode, 3PL evaluation and logistics network optimism, while the service-oriented information platform and enabling technologies for 4PL, such as the expression of logistics service, logistics service operation approach based on the information platform, need deeply studied for the modern logistics industry.

2. Requirements analysis for 4PL information platform

4PL is a SCM provider, which provides the totally integrated SCM solutions for the customers. Presently, there exists three operation model for 4PL\cite{6}.

(1) Collaboration operation model. In collaboration operation model, 4PL and 3PL develops the logistics services market together, and 4PL provides serials of services for the 3PL, such as technology service, SCM strategy service, marketing entrance ability, and project management service, etc.
(2) Solution integration provider model. 4PL provides the whole SCM operating and managing solutions for the customers. 4PL is a service hub, which can integrate the resources and abilities of different logistics providers and customers.

(3) Industry innovators model. In the industry innovators model, 4PL develops and provides SCM solutions to the customers from different industries. The integration of SCM duties is the kernel of the industry innovators model. 4PL integrates different 3PL and provides solutions for the customers.

From above analysis of 4PL operation models, it is obvious that the operation of 4PL is relayed on the information platform. The construction of 4PL information platform is the precondition of the integration and management of the 3PL and other logistics providers. 4PL information platform is an internet-based application platform, which provides the function of information release, function integration, and logistics information services. To realize the dynamic management of logistics services, 4PL information platform should satisfied the following requirements.

(1) Providing the integrated SCM solutions for the logistics requestors. 4PL information service platform should integrate the resources, information and service capabilities of different 3PL providers, and provide an integrated, low cost logistics service solution for the customers. By the way, inspecting and managing the process of logistics services execution.

(2) Providing the business requirements and information services for the logistics services providers. 4PL information platform should realize the integration the customers’ logistics service requirements and decomposition the logistics tasks with optimization solutions to lower the logistics operation cost.

(3) 4PL information services platform are required to support the integration of heterogeneous logistics information resources. 4PL information platform need gather information from different heterogeneous systems to realize the networked optimism decision and transfer the decision results to different systems.

(4) 4PL information services platform are required to be extended on demand. To effectively support the integration of the outer system resources and other logistics service enterprises, 4PL information service platform should have the ability to be extended and realize the logistics enterprises’ joining and service providing.

3. The 4PL Information Platform based on Web Services

3.1. System Framework of the 4PL Information Platform based on Web Services

To provide an integrated SCM solution for the customers and support the integration of heterogeneous logistics information resources, this paper put forward a forth party logistics information service platform based on the characteristic of SOA and Web services technologies. The system framework of 4PL information platform is shown in figure 1. The platform is composed by five components, which are logistics resource layer, basic service layer, function service layer, logistics service process execution layer and application portal.
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Figure 1. The system framework of the 4PL information platform based on web services

(1) Logistics resource layer. The logistics resource layer is the basic resource support for 4PL information service platform, which is composed by the basic database and logistics resources of logistics service providers. The logistics resources include logistics equipments, legacy systems of logistics enterprises, logistics human resources, database, documents, knowledge base, etc. The logistics resources will be encapsulated as web services and published to provided logistics services for the customers.

(2) Basic service layer. The basic service layer is the information technology infrastructure for constructing 4PL information platform. The protocol of Web services is realized in this layer, as well as some common function of the platform, such as transaction management, message engine, log management, resource schedule engine and running inspection engine, etc.

(3) Function service layer. The function service layer provides 4PL services by Web services. The function services include logistics task management service, logistics task schedule service, logistics service process inspection service, logistics service resource management service, QoS management service, logistics transaction service, 3PL choosing service, common information service, logistics distribution service and logistics cost management service, etc.

(4) Logistics process execution layer. The logistics process execution is the concrete realization of 4PL mode in the information service platform, which includes the process of logistics task decomposition, logistics service mapping, logistics services chain construction and execution, process inspection and KPI analysis, etc. with the execution of the logistics process, the logistics services of the customers are satisfied.

(5) Application portal. The application portal is the user access interface for 4PL information platform. The users can visit the platform via multi ways, such as web browser, RFID, PDA etc, to execute the task of logistics requirements input, logistics service search, logistics service process query, etc.

3.2. The operation process of 4PL information platform

The 4PL information platform operation process is the main process for 4PL operation. The operation process includes four sub processes, which are logistics services encapsulation and publishing, logistics outsourcing tasks submission and planning, logistics services chain
modeling and construction, logistics services chain execution inspection and KPI evaluation. The operation process of 4PL information platform is shown in figure 2.

![Figure2. The operation process of 4PL information platform](image)

(1) Logistics services encapsulation and publishing. The logistics services providers not only includes traditional 3PL, but IT integration companies and consulting companies in the environment of 4PL operation mode. These logistics services are distributed in different region and heterogeneous in structure and semantic expression. To effectively realize the efficient service search and optimal allocation, the service-oriented 4PL operation mode should encapsulate the logistics services provided by the 3PL, IT integration companies and consulting companies, into web services with the service-oriented computing technologies. The logistics services are described by WSDL and registered in the 4PL information platform with the mechanism of UDDI.

(2) Outsourcing logistics tasks submission and planning. This phase receives the customers’ outsourcing logistics tasks and decomposed into several sub logistics tasks and described them with standard form. The operation process of outsourcing logistics tasks submission and planning includes three phases. That is, the phase of outsourcing logistics tasks reception, the outsourcing logistics tasks decomposition and planning based on the 4PL information platform, formal description for the function and requirement of the logistics sub tasks with task description language.

(3) Logistics services chain modeling and construction. Logistics services chain is the key for the operation of service-oriented 4PL operation mode. The phase of logistics services chain modeling and construction includes three processes, which are logistics services chain concept modeling, logistics services mapping and choosing, and logistics services chain construction.

(4) Logistics services chain execution inspection and KPI evaluation. The execution, inspection and KPI evaluation of logistics services chain is the main process for service-oriented 4PL operation management, which is realized with the supporting of 4PL information platform. The functions realized in this process include logistics services chain execution status management, process collaboration of logistics execution process, logistics services KPI management, and reconstruction of logistics services chain.
4. Web services encapsulation for logistics services

The logistics services of 4PL are based on the network and information technologies with the encapsulation of logistics resources and logistics capabilities by web services, which can be registered, mapped and chosen and combined into logistics services chain to provide logistics services for the customers. The formal definition of the logistics services is as follows.

**Definition 1:** Logistics Services = (LSBInformation, LSFunction, LSQoS, LSResource, LSVisit, LSState).

The logistics services can be described by six views. LSBInformation is the basic information view, which described the general information of logistics services, such as service number, service name, service owner, etc. LSFunction is the function view of logistics services describing the function provided by the logistics services. LSQoS is the QoS management view for logistics services describing the QoS information, such as time, cost, quality, etc, of the logistics services. LSResource is the resource view of the logistics services which describes the resource composition of the logistics services, such as logistics equipments, tools, human resources and logistics knowledge, etc. LSVisit is the visit view of the logistics services which describes the visit information of the services. LSState is the status view of the logistics services which describes the work status of the logistics services.

With the formal definition of six views of the logistics services, the logistics services are specified defined and described. On the basis, to eliminate the heterogeneous among different logistics services and help 4PL platform recognize and deal with the different kinds of logistics services, this paper adopts web services technologies to encapsulation the logistics services. The process of encapsulation the logistics services with web services including following four steps.

1. Firstly, establishing the conception model for the logistics services and describing the services views, including basic information view, function view, resource view, QoS view, status view and visit view, with specified mode.
2. Secondly, describing the static information and dynamic information of the logistics resources and capabilities with XML according to the schema file of logistics resources and capabilities definition.
3. Thirdly, realizing the logistics services with professional programming platforms, such as J2EE, .Net, etc, and generating the WSDL description language with the static and dynamic XML file of logistics resources and capabilities generated in step 2.
4. Finally, deploying the realized logistics services in 4PL platform and registering the logistics services describing file in the UDDI of 4PL platform.

Based above four steps, the Web services encapsulated logistics services are realized. Take logistics order services for example, the service interface description is shown in table 1.
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Table 1. Fragments of service interface description

```xml
<?xml version="1.0"?>
<definitions name="LOrder-interface"
Target Namespace="http://www.example.com/LOrder-interface"
xmlns:tns="http://www.example.com/LOrder-interface"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:soap="http://schemas.xmlsoap.org/wsdll/soap"
xmlns="http://schemas.xmlsoap.org/wsdll">
<documentation>
WSDL service interface definition for a Logistics Order Services.
</documentation>
……
<types>
<schema target Namespace="http://www.example.com/Lorder.xsd"
Xm1ns="http://www.w3.org/1999/XMLSchema">
<element name="LOrderCreate">
<complexType>
<element name="ServicesID", type="string"/>
</complexType>
</element>
</Schema>
</Types>
……
</definitions>
```

5. The Construction Technologies for logistics services chain

The operation of logistics services chain is the kernel of 4PL operation mode based on 4PL information service platform. The logistics services chain begins from the customers’ requirements and ends with the finish of customers’ requirements fulfilled, which is a logistics services set integrated by the logistics services provided by different logistics vendors, and supported by 4PL information service platform. The logistics services chain is composed by a series of logistics services with specific business logic. The logistics services in logistics services chain include different kinds of logistics services, such as transportation services, inventory services, distribution processing services, information services, financial services, logistics process design services, etc. the formal description of the conception model of logistics services chain is as follows.

The logistics services chain for a specific logistics task can be represented by S, and $S = \{T_i\mid 0 < i < n\}$. That is to say, a logistics services chain can be seen as a complex task chain $T_s = \{T_i\mid 0 < i < N\}$ combined by the task set $T_s$, $n$ is natural number. The total task $S$ can be divided by several basic services logically, which can be represented $S = \bigcup_{i=1}^{u} \{T_i; T_{i+1}; \ldots; T_{im}\}$. Along with, $S_{step} = \{T_{i1}; T_{i2}; \ldots; T_{im}\}$, then $S = \bigcup_{i=1}^{u} \{T_{i1}; T_{i2}; \ldots; T_{im}\}$.
The construction of logistics services chain is one of the key technologies for the optimism operation of 4PL, which includes the process of task decomposition, logistics network plan generation, logistics service mapping, logistics service evaluation and choosing, logistics services chain generation, etc. The construction and realization of logistics services chain is shown in figure 3.

**Figure 3. The construction and realization of logistics services chain**

The construction process of logistics services chain based on logistics service integration includes following four steps.

Step 1, the information service platform constructs the logistics network plan based on the logistics task WBS. The basic function unit of the logistic network plan is logistics task.

Step 2, firstly, the requirement model of logistics tasks is setup by 4PL information service platform. Secondly, the information service platform searches the potential logistics services which satisfied the logistics services in function by service mapping and evaluation.

Step 3, the information service platform evaluates and chooses the logistics services for the logistics tasks, and forms the logistics services chain by scheduling the execution of logistics services based on the logistics network plan.

Step 4, the logistics services chain is combined by BPEL, which can be executed in 4PL information service platform, and operated by the driving of BPEL workflow engine.

The operation process of logistics services chain is inspected and evaluated by the forth party information service platform. When the abnormal incidence happens, the platform reconstructed the logistics services chain by re-mapping and re-evaluation of the logistics services, which guarantees the finish of logistics tasks as schedule.

6. Case Study

Ningbo city is the important port city and logistics node city in China. The local government pays highly attention to the development of modern logistics industry. To effectively promote the process of modern logistics industry in Ningbo, a 4PL information platform focuses on information services and business transaction is constructed, which is supported by the local government. The 4PL is developed by web services technologies and operated by Ningbo...
international logistics company. The 4PL information platform is composed by seven function modules, which are e-government services for transportation, e-business for transportation, transportation logistics services, credit management, portal services, operation management and data exchange management. The system interface of 4PL information platform of Ningbo is shown in figure 4.

![Image of the system interface of 4PL information platform of Ningbo](image)

**Figure 4.** the system interface of 4PL information platform of Ningbo

The 4PL information platform is based on Ningbo city, facing to the whole china, and has become the logistics hub of Zhejiang province. The construction and operation of the 4PL information platform achieves following benefits.

1. Obvious reducing the logistics cost, and improving the whole running environment of regional logistics supply chain in Ningbo city.
2. Based on the membership mode and container transportation, realizing the logistics information sharing and exchange, the logistics efficiency is improved.
3. With the application of logistics e-Business, the operation efficiency of the logistics enterprise is improved, and the logistics service function and the comprehensive competitiveness of the city is improved.
4. With the application of logistics e-Government, the information is shared in different government sectors and the government efficiency is greatly improved, which promotes the high efficiency public logistics services provided by the government.

7. Conclusions

4PL is the trends of modern logistics industry, and the result of specialized division of modern industry. According to the requirements of logistics service providing, logistics service publishing, logistics operation and heterogeneous system integration for the information service platform in the process of 4PL operation, a web services based information platform system framework and operation process for 4PL is provided. On the basis, two enable technologies for constructing the platform which include web services modeling approach for logistics and constructing technology for logistics services chain, are studied, finally, the 4PL information platform of Ningbo is provided.
8. References