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Collaborative Services: A Four-Level Model for Supply Chain Management with Big Data Technology

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Abstract. The accelerating development of information technology boosts the progress of Big Data, Cloud Computing and Internet of Things. Companies that involved in supply chains store vast amounts of structured and unstructured data which are inherently difficult to maintain, expand and collaborate. This hampers the cost control and risk management of supply chain. Taking equipment manufacturing industry as the study background and cooperating with integrating with supply chain collaborative requirements, this project designs a four-level expandable cloud platform for achieving collaborative services of supply chain and constructs the Collaborative Services Model through perspectives like sales, purchase and manufacturing etc.. This model realizes the valuable exchange that from data to information and then to knowledge, which reduces the cost and improves the competition of the company effectively.

Introduction

Recently, the accelerating development of information technology boosts the progress of Big Data, Cloud Computing and Internet of Things. People all over the world are experiencing data explosion. The widely use of Internet provides a mature environment for large sale and distributed data management, which stores and transforms these automatic generation data with relative low cost. In this situation, the potential value of Big Data is receiving increasingly attention from diverse fields. Techniques like data mining and data analysis are introduced to decision making.

The application of Big Data is gradually being a new economic growth point of China and this technology is widely used in supply chain. For example, camera, smart phone and personal computer are widely used by supply chain members. These intelligence devices store a great amount of structured and unstructured data which contains transactions data, time data, customer service data and location data etc. However, unstandardized progress, data and technologies bring significant difficulties to supply chain management in terms of achieving expandability, maintenance and collaboration. This hampers the cost control and risk management of supply chain. Continuously optimizing of supply chain management is one of the virtual strategies for companies to achieve the sustainable development.

In order to achieve the visuality, collaboration and optimization, this project takes equipment manufacturing industry as the study background and cooperates with integrating with supply chain collaborative requirements, this project designs a four-level expandable cloud platform for achieving collaborative services of supply chain and constructs the Collaborative Services Model through perspectives like sales, purchase and manufacturing etc.. This model realizes the valuable exchange that from data to information and then to knowledge, which reduces the cost and improves the competition of the company effectively.

Related Work

The Application of Big Data in Supply Chain Management Field. Volume, variety, velocity, veracity and value are five characteristics of big data. Appropriate storage and analysis of these data have

been a productive approach for companies to optimize current operations and enhance their competition [1]. During the last decades, big data was widely applied and researched by scholars and currently been applied to various industries. With referencing to industry chain, Fang[2]analyzed the supply chain finance of e-business platforms which operated B2C tactics. This paper proposes novel services of supply chain finance for different financing objects in big data environment. Wu[3] proposed a three-level supply chain cooperation strategy model which contains retailer-pay contract, union-pay contract and cooperation contract. Lv[4] came up with a multiple evaluation model for renewable resources policy. Chen[5]analyzed the value and characteristics of information aggregation business pattern in supply chain operations, so as to demonstrate its value creation mechanism in big data area.

Previous work shows that acts as one of the last technologies, big data plays an important role in fields like in e-business, e-finance and supply chain. However, rare scholars propose models for catching, dealing and presenting supply chain data which is volume, structured and unstructured.

Current Collaborative Services Research of Supply Chain. A number of scholars work on collaborative services of supply chain. Long[6] studied the effect of suppliers, customers, cross-departments and collaboration ability to the innovation of enterprise. Additionally, the regulating effect of dynamic environment was analyzed. Gong[7]constructed a collaborative supply chain model under symmetric and asymmetric information situation. Based on game theory and comparative static analysis, Hou[8] researched the collaborative issues of a supply chain which is composed by a retailer and a supplier with promotion action. Wu[9] studied the phylogeny issues of the collaborative operation of a low carbon supply chain, and constructed the evolution model to deal with this issue with referencing rate principle of dynamic systems. Under the limited information sharing condition, Du[10] introduced concession negotiation strategy to construct the supply chain produce-sale collaborative planning conflict negotiation model and prove the availability of Cultural Genetic Algorithm and Conflict Negotiation Algorithm by example simulation.

Previous work constructed supply chain collaborative and evolving models with theories like dynamic systems, game theory and genetic algorithm. Simulations for theory and application had been done theoretically and methodologically. However, current research shows that rare job has focused on solving supply collaboration, manufacturing collaboration and collaborative services of supply chain systematically.

The expandable four-level supply chain collaborative services model

Collaborative Services of Manufacturing Supply Chain. The collaborative services process contains various enterprises, such as core enterprise (refers to equipment manufacturing enterprises), suppliers, distributers, retailers, the third-party logistics. Collaborative operation is a complex interchange process between internal and external systems of companies. In this big data era, mature Internet environment and ubiquitous intelligence devices, such as sensor, camera, smart phone and personal computer, enable members of a supply chain to share information effectively. The supply chain collaborative services include sales, purchase, design and manufacturing. The collaborative management of these operations introduces big data technology to analyze and deal with the data related to raw materials, semi-products, products and final products' data collection and transmission. This situation requires the construction of a specific manufacturing oriented expandable big data model.

Cloud based Collaborative Services Model. This project based on scenario analysis to acquire the requirements of supply chain collaborative services, based on big data technology, design an expandable cloud based four-level supply chain collaborative services model. Specifically, data obtaining level, data dealing level, data exhibiting level and collaborative services level.

① Data obtaining level: This is the data resources of supply chain. It is for data perception and acquisition by using sensor, RFID, moving devices, cameras, GPS and Internet, Internet of Things, Internet of Cars. This level comprehensively integrates perceptions and acquires diverse information of manufacturing industry, and stores information into database like SQL, NoSQL, MPP and HANA。

② Data dealing level： This level analyzes and deals with data transparently. Additionally,

reconstructing, cleaning and integrating structured and unstructured data. With referencing to the big data theoretical background, adopting Hadoop to construct big data platform based on 'low-level configuration' devices, so as to analyze and deal with heterogeneity and non-heterogeneity.

③ Data exhibiting level：In order to meet the specific requirement of big data, a cloud based big data storage system should be constructed. The volume characteristics of big data can be achieved by stablishing the public information cloud, basic service cloud, value-added service cloud and storage supply chain requirements predict services, product innovation services, call services of resources. Additionally, providing an exhibit platform for structured, semi-structured and unstructured big data.

Collaborative services level：Web services are provided by this level, such as Web services calling, Web services discovering and matching, Web services grouping. Establishing a model based on Web services grouping and supply chain application. This realizes the intelligent search of Web services, so as to support calling and grouping of Web services, and exchanging information to contents for providing service. See Fig.1.

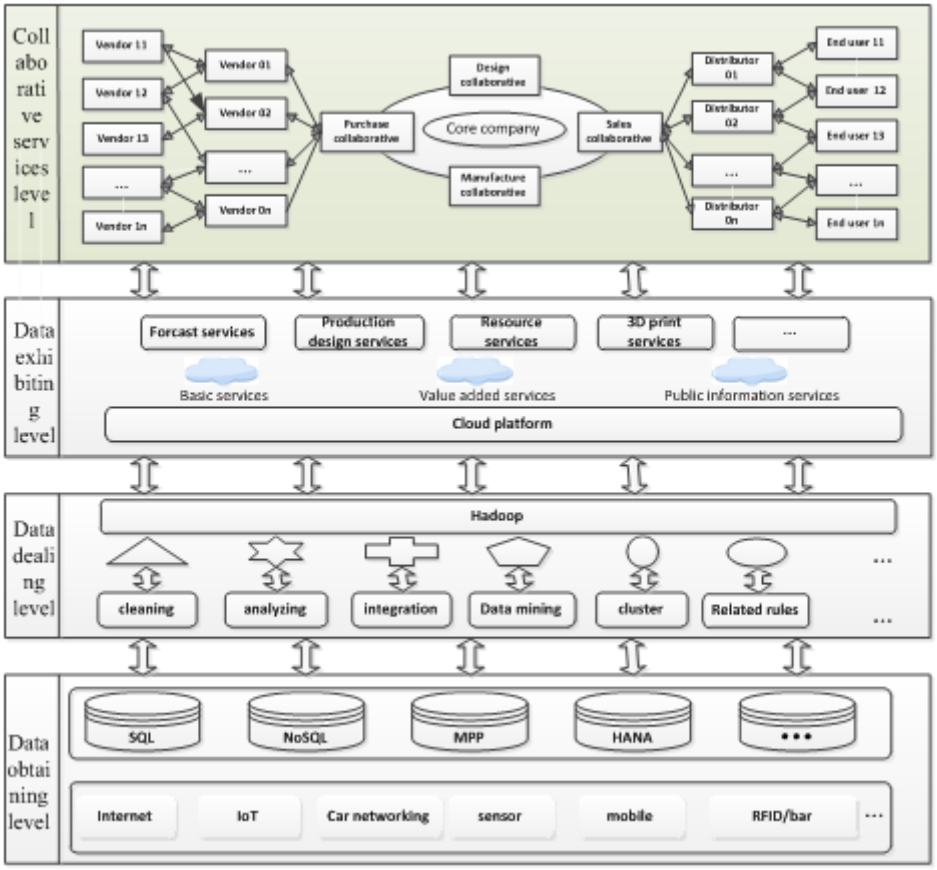

Figure 1. Four-Level Collaborative Services Model

Analysis of Core Supply Chain Collaborative Services

Sales Collaborative Services. The sales management of a company mainly contains price, order, delivery and customer information. Operation objects include materials, customer record, price, order, delivery and related receipts, data and graph. Sales procedures include price, order, delivery, package, receipt and payment. Each operation is composed by fine-grained services, and every fine-gained service takes data access logic component to conduct data search, update and store. Sales Collaborative Services is shown in table.1

Table 1 Sales Collaborative Services

Sales Procedures	Collaborative Services Activities	Collaborative Services Functions	Collaboration Type
Core customer database	Adding customer information	Establishing new customer record based on the provided information	External
	Maintaining and updating customer information	Editing customer information	Internal
Sales price	Establishing price sheet	Negotiating and pricing based on customer requirements	External
	Generating orders based on pricing sheet	Creating orders based on price sheet	Internal
Orders	Order establishment	Creating sales order based on customer orders	External
	Order changing	Order editing based on customer requirements	External
Delivery	Establishing delivery order	Creating delivery order based on customer requirement and inventory	External
	Picking	Picking list generation	Internal
	Packaging and delivering	Packing and delivering based on customer requirements	Internal
Payment	Receipt	Generating receipt lists regularly and giving receipts to customer	External
	Receipt delivery	Record the payment	Internal
Sales analysis	Sales data analysis	Business analysis based on the sales data	Internal

Procurement Collaborative Services. The purchase management of a company should cooperate closely with the up-stream supplies. Supply chain management system can response customer in timely manner and reduce inventory cost by collaborating the internal organizations of a company and external purchase procures. Procurement Collaborative Services should complete the whole functions of a purchase procedure. For instance, suppliers interchange and management collaborative services, trade matching collaborative services, procurement contract collaborative services, inventory and supply chain management collaborative services, material data and information searching collaborative services. Procurement Collaborative Services is shown in Table 2

Manufacture Collaborative Services. The manufacturing department of a supply chain should closely cooperate with its down-stream company, so as to achieve manufacture planning and produce controlling effectively. In order to realize the synchronization of a manufacturing in a supply chain, a transparency working mechanism should be established between companies. The supply chain manufactures are changing from hierarchical control organization mode to flat network organization. In order to realize the Internet based collaboration management, the whole manufacturing process should include product collaboration services, manufacturing planning services, outsourcing processing services, order dealing services. Manufacture Collaborative Services is shown in Table.3.

Table 2 Procurement Collaborative Services

Procurement **Collaborative Services**	**Collaborative Services Activities**	**Collaborative Services Functions**	**Collaboration Type**
Suppliers management	Adding and evaluating new suppliers	Establishing new supplier record based on the provided information	External
	Maintaining existed suppliers	Editing existed supplies information	Internal
Procurement Planning procedures	Making purchase planning	Generating procurement planning based on manufacturing department	Internal
	Placing Procurement order	Delivering procurement planning to supplier	External
Pricing negotiation	Price enquire	Enquiring price from supplier	External
	Suppliers provide price information	Suppliers provide price information	External
	Price dealing	Choosing and informing the appropriate supplier	External
Procurement orders dealing procedures	Creating procurement order	Creating procurement order based on the provided price	Internal
	Giving the orders to supplier	Placing order	External
Products Receiving procedures	Receiving the delivery information	Receiving the delivery information	External
	Checking and putting in the inventory	Checking and putting in the inventory	Internal
	Returning management	Returning the 'bad quality' goods	External
Payment	Checking receipt	Checking receipt	External
	Sending the receipt to accounting department	Sending the receipt to accounting department and making payment	Internal
Procurement analysis procedures	Procurement data analysis	Business analysis based on the procurement data	Internal

Conclusion

This project takes equipment manufacturing industry as the study background and cooperates with integrating with supply chain collaborative requirement scenarios, designing a four-level expandable cloud platform for achieving collaborative services of supply chain. Additionally, this project analyzes the core procedures sales, purchase and manufacturing of a company. The proposed four-level collaborative services model realizes the value exchange of a company. It enables a company to overcome the region and organization limitations and achieve a more productive communication between cross-companies and cross-regions. This model significantly decrease operation cost and improve the competitiveness of companies. The future work will mainly focus on the achievement of the intelligent technologies of supply chain collaborative services, evaluation criteria for the proposed collaborative services model, data processing of collaborative services. A more productive supply chain collaborative services procedure will be established.

Table 3 Manufacture Collaborative Services

Manufacture Collaborative Services	Collaborative Services Activities	Collaborative Services Functions	Collaboration Type
product collaboration services	Requirement management	Customer new requirements recognizing and extracting	External
	Product data management	Product design and creating and updating the information of new products	Internal
manufacturing planning services	Operations of MPS and MRP	Generating MPS and MRP	Internal
	Deriving procurement planning	Deriving procurement planning for components	External
	Deriving manufacturing planning	Generating manufacturing planning for components with enough resources and capabilities	Internal
	Deriving outsourcing planning	Outsourcing the components that cannot be produced and making planning for them	External
manufacturing coordinating services	Usability checking	Usability checking for materials within the manufacturing planning	External
	Unavailability checking	Checking the unavailability of the manufacturing process	Internal
	Planning rearrangement	Rearranging the amount, time, configuration and materials of the planning.	Internal
outsourcing processing services	Signing the outsourcing contract	Signing the outsourcing contract with appropriate company	External
	Tracking	Tracking the whole process	External
	In/out inventory	Quality guarantee	External
	payment	Pay the outsourcing company	External
order dealing services	Manufacturing orders	Arranging manufacturing and generating order	Internal
	Order implementation	Product manufacture	Internal
	Inventory	Inventory for transportation	Internal
Manufacture data analysis	Manufacture data analysis	Cost analysis based on manufacture data	Internal

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