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Interface Implementation Of Manufacturing Industry Agile Supply Chain Nodes Based On Service Agent

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Abstract

This paper addresses the relation of supply chain integration with manufacturing industries. Here, the main objective is to analyze that the Supply Chain Integration is related to manufacturing industries in what all aspects. Supply Chain Management is mainly contributed to improve the organizational competitiveness in the twenty-first century. As it is involving in all of the activities in industrial organizations, it is said that there is a big relationship between Supply Chain Management and manufacturing industries. Supply Chain Management is meant to define the quality of the products and thereby the customer satisfaction in manufacturing industry. Therefore this paper concentrates on providing guidelines and references for manufacturing engineers who all interested in Supply Chain Integration.

Key words: *Agile supply chain, Supply chain nodes, Information integration, Service agent***.**

01. Introduction

Supply chain is a structure network which made up of different types of function nodes, such as customers, distributors, manufacturers, suppliers, each type of nodes has many enterprises. Agile supply chain is used to achieve dynamic alliance and agile manufacturing in the competition, cooperation and dynamic market environment, and it is a whole dynamic supply network with better flexibility and rapid reaction capability to connect suppliers, manufacturers, distributors and end-users in demand-production supply process. The agility of supply chain needs a comprehensive management to materials supplying, product processing, distribution, sales, customer service and so on, using computer technology, information technology and management technology to build an effective, agile supply chain management system. Agile supply chain management system crossing each node has the internal organic coordination function, integrate information flow in tactical level to achieve synchronous supply chain planning and control. Dynamic changes of supply chain nodes and business rules increase the implementation complexity of supply chain system. The cooperation of more autonomy, adaptable, cooperative agency is needed to achieve the agility and re configurability of supply chain management system. Using multi-agent cooperation to achieve supply chain transaction processing, business

information processing, and it can effectively support the dynamic construction and reengineering of supply chain process. The present studies pay attention to the coordination mechanism and structural model of software agents, the interaction of different objects is not compatible and efficient; it is difficult to realize the low cost dynamic configuration in response to the formation and disintegration of the supply chain. Thesis, in this paper, service agents and web service technology has been used to design and implement the supply and demand interfaces of agile supply chain nodes. Use standardized data models and service agents to realize the dynamic collaboration of inter-enterprise and within enterprises in supply chain.

The agile supply chain is market sensitive – it is capable of reading and responding to real demand. Most organizations are forecast-driven rather than demand-driven. In other words, because they are not market sensitive in terms of actual customer requirements, they tend to make forecasts based upon historical sales data and use those forecasts to determine their inventory requirements (Christopher, 1999). The sharing of information between supply chain partners has become increasingly important as companies focus on their core competencies, choosing to outsource all other activities. In this environment, a greater reliance on suppliers and partners becomes inevitable, and new types of relationships are needed.

There is a growing recognition that individual businesses no longer compete as stand-alone entities but rather as supply chains. Individual businesses that previously competed as stand-alone entities are now aligning themselves in network relationships and competing as supply chains. Organizations that can effectively coordinate and manage relationships with their partners in a network committed to closer and more agile relationships with their final customers should quickly gain the advantage. Emphasis will be placed on leveraging the strengths of network partners to achieve a greater response to marketplace demands (Christopher, 1999).

02. The relation among agile supply chain nodes in manufacturing industry

02.1 Function analysis of supply chain nodes

The nodes of supply chain can be divided into four types. Node of Sale (NS), mainly sales raw materials in supply chain, represents the raw material supply source (source supplier). Node of Distribution (ND), plays an intermediary role through implementing the procurement, inventory, sell functions of materials in supply chain, which represents raw materials, semi-finished products or finished products distributors. Node of Process (NP), changes material properties through materials process and circulation, such as semi finished products or finished products manufacturers. Node of Buy (NB) procures and uses products in supply chain, which represents products demand source.

The cooperative foundation among supply chain nodes is contract, the downstream node transfers the business-related order data and payment data to its upstream nodes, the upstream node transfers the business-related delivery data and invoice data to its downstream nodes. The supply and demand relation exists among the four types of nodes; each type of nodes has all or some inventory, finance business. Each type of nodes contains different functions, such as sell, purchase, inventory, production, finance.

02.2. The interface description of agile supply chain in manufacturing industry

According to the nodes function analysis, the supply chain in manufacturing industry can be expressed as a combination of different types of nodes, the demand and supply relation based on contracts exists among nodes. The downstream nodes transfer order data and payment data to adjacent upstream nodes when some business occurs between two nodes, the upstream nodes transfer delivery data and invoice data to adjacent downstream nodes normally. Order is defined as ordering information transmission among nodes, payment is defined as payment information transmission among nodes while ordering products, delivery is defined as the information transmission of products supply among nodes, invoice is defined as money information transmission which related with delivering products among nodes.

The supply chain in manufacturing industry is a network structure of a number of four types of nodes, in addition to NS and NB, ND and NP have a variety of combinations in supply chain. No matter what combination among four types of nodes, the data transmission mode among the supply chain nodes is stable.

02.3. The interaction information among and within nodes

When each type of nodes in the model has an enterprise, there are three interactions among the four enterprises, and each interaction requires four kind of data transmission of Order, Payment, Delivery, and Invoice. Information interaction differences exist among functions within different type of nodes. Each information interaction among nodes requires five kinds of data transmission among functions: Notification of Short Shots, Notification of Order, Notification of Payment and two Notification of Sale. Based on the analysis of information interaction among nodes and within nodes, two kinds of information are identified: Positive Information (PI) and Notifying Information (NI).

The positive information among supply chain nodes in manufacturing industry includes Order, Payment, Delivery and Invoice, which are respectively represented with PI-order, PI-payment, PI-delivery, PI-invoice. The information senders transfer data details to receivers. Five kinds of data transmission among functions which each information interaction among nodes requires are called Notifying Information (NI), which are respectively represented with NI-short shots, NI-order, NI-payment, and NI-sale. Such information when two nodes collaborating closely in supply chain operate procurement or sale business, one node can query inventory of materials of another node. Here a kind of interactive information-Querying Information is introduced, expressed as QI-material; it only reads data of other nodes.

03. Interface design of manufacturing industry agile supply chain nodes based on service agent

Agent is an abstract entity presenting in certain environment, and it can sense the environment, receive messages from the environment, and respond to the environment. Service Agent is a software entity which receives messages of the environment and responds to the environment based on web service technology, it has the capabilities of self-organization and autonomy.

Service agents can communicate across computing platforms.

03.1. Service agent contract of agile supply chain in manufacturing industry

To achieve the operation of manufacturing industry supply chain, the integrated supply chain management system has been designed as a network which is made up of collaborative service agent modules. Each service agent completes one function of certain node, and collaborates with other service agents. The functions of four types of nodes must deal with three kinds of information interaction. These necessary functions are designed to service agents to focus on data transmission of supply chain business.

Table -1 The information transmission of four types of service agent

Service agent	Message type	Output message	Input information
Service Agent of Purchase (SAP)	PI	Order	Delivery
	NI	Notification of Order	Notification of Short Shots
	QI	Material Inquiry	Notification of Sale
Service Agent of Sell(SAS)	PI	Notification of Sale	Payment
	NI	Delivery	Delivery
	QI	Notification of Short Shots	Notification of Sale
Service Agent of Inventory (SAI)	PI	Material Inquiry	Payment, Invoice
	NI	Payment, Invoice	Notification of Order, Notification of Sale
	QI		
Service Agent of Finance (SAF)			

The middleware server can handle supply chain operations within enterprises and inter-enterprise according to the interface analysis of the supply chain nodes' functions in manufacturing industry, the transaction of adjacent upstream and downstream nodes has a theoretical standard model, namely, it need the inventory, purchase, finance functions of the downstream node and the sale, inventory, finance functions of the upstream node. Except the production function is designed to a form of the internal system, the four kinds of functions(inventory, purchase, finance, sale) are designed to four types of service agents: Service Agent of Inventory(SAI), Service Agent of Purchase(SAP), Service Agent of Finance(SAF), Service Agent of Sell(SAS). One transaction between adjacent upstream and downstream nodes includes ten data transmissions between functions within the two nodes, the data transmissions need to be designed as messages among four kinds of service agents in order to achieve the migration from interaction between functions to interaction between service agents. Table 1 defines the information transmission of four types of service agents. To achieve inter-enterprise information integration, appropriate application interface need to be provided. The agent receiving data needs to provide the interface receiving data to the agent sending data, so that the data-receiving agent can simultaneously receive data when data occurs in the sender agent.

For four types of nodes about positive information, SAS must provide order inputting service, SAI provides delivery inputting service, SAF provides payment inputting service and invoice inputting service; about notifying information, SAP must provide the order notification service, SAS need to provide sale notification service, SAI provides the

short shots notification service, SAF provides a payment notification service; about querying information, SAI provides material inquiry service. The raw material providers and end customers in the supply chain upstream and downstream ends only contain the necessary service agents to complete the whole supply chain business.

03.2. The interface model of agile supply chain nodes in manufacturing industry based on service agent

The interface model of manufacturing industry agile supply chain nodes based on service agent is shown in Figure.1. From the perspective of service agents in supply chain, SAS must provide two service of S-PI-order, S-NI-sale; SAP must provide the S-NI-order service; SAI must provide three service of S-PI delivery, S-NI-short shots, S-QI-material; SAF must provide three service of S-PI-payment, S-PI-invoice, S-NI-payment. The nine kinds of service are vital basic service achieving information integration of manufacturing industry agile supply chain.

Four types of service agents in Node of Distribution and Node of Process need fully provide the nine kinds of service. Node of Sale and Node of Buy separately contain three types of service agents. In order to facilitate data exchange, suppose the adjacent upstream and downstream nodes adopt a consistent data structure, so that service providing agents receive messages from its adjacent service using agents.

04. Interface realization of manufacturing industry agile supply chain nodes

04.1. Web based information integration framework of manufacturing industry supply chain

Web service-based interface solution of manufacturing industry agile supply chain nodes uses private UDDI mode manage web services provided by service agents of each node. Web service technology is based on three protocols: WSDL, SOAP, UDDI. The applications of different enterprises may adopt different development platforms, languages and communication protocols. Only use web service encapsulates present applications to provide essential interfaces, and register web services in private UDDI registration center, enterprises can provide SOAP-based business services for service requestors. Any service users can also find required services in the private UDDI of upstream and downstream enterprises, and then remotely call the services through Internet/Intranet.

04.2. Implementation of agile supply chain system

According to the business analysis of four nodes, the customer's purchasing, inventory system and manufacturer’s logistics management system have been developed based on J2EE platform and Java language, the distributor’ logistics management system and supplier’ sale, inventory system have been developed based on .NET platform and C # language. Corresponding with the service agent contracts of customer, manufacturer, distributor, supplier, four, nine, nine, five services are generated with Visual Studio.NET and Eclipse tools. The UDDI

registries provided by the J2EE JAXR and Window Sever 2003 are used. The nine kinds of services for four types of nodes have been developed: S-PI-order, S-PI-delivery, S-PI-payment, S-PI-invoice, S-NI-order, S-NI-sale, S-NI-short shots, S-NI-payment, S-QI-material.

05. Building the resilient supply chain

Supply chain managers strive to achieve the ideals of fully integrated efficient and effective supply chains, capable of creating and sustaining competitive advantage. To this end they must balance downward cost pressures and the need for efficiency, with effective means to manage the demands of market-driven service requirements and the known risks of routine supply chain failures. Better management and control of internal processes together with more open information flows within and between organizations' can do much to help.

However, in an age of lengthening supply chains serving globe-spanning operations, recent events around the world have provided frequent reminders that we live in an unpredictable and changing world. Natural disasters, industrial disputes, terrorism, not to mention the spectra of war in the Middle East, have all resulted in serious disruptions to supply chain activities. In these situations 'business as usual' is often not an option.

Modern commercial supply chains are in fact dynamic networks of interconnected firms and industries. No organization is an island and even the most carefully controlled processes are still only as good as the links and nodes that support them. All are dependent on efficient and reliable transportation and communication systems, an obvious point, but one that is often overlooked.

This paper reports on some of the findings and recommendations of the second stage of that program. The work is empirically based and draws on insights from a number of important industries including food retailing, oil and petrochemicals, pharmaceutical, packaging, electronics, transport services and the distribution of automotive spares. It also includes input from private and public sector organizations involved in the provision of health care and in defense. In particular it focuses on the development of a managerial agenda for the identification and management of supply chain risk, with recommendations to improve the resilience of supply chains.

05.1. Supply chain resilience

When working effectively and efficiently modern supply chains allow goods to be produced and delivered in the right quantities, to the right places, at the right time in a cost effective manner. Until recently the term 'supply chain' was not widely used beyond the confines of academia, specialist sectors of industry and the professional management community. Now, in the wake of a number of far reaching supply chain disruptions to economic activity it has crossed over into the everyday vocabulary of politicians, general managers and the wider public.

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In practice legacies of functional biases within organizations, together with varying perspectives of specialist firms mean that the term 'supply chain' continues to imply different things to different people. It is still frequently used to describe either the management of integrated manufacturing and/or logistics activities within a single firm's

manufacturing, transport, distribution or retail network. It is also regularly applied (particularly in the context of purchasing) to describe the management and performance monitoring of an organization's supplier base, through quality improvement initiatives, involvement in new product introductions, promotions and overall cost reduction.

In IT terminology 'robustness' is 'the ability of a computer system to cope with errors during execution'. A robust process may be desirable, but does not itself equate to a resilient supply chain. We are using the term 'resilience' as it relates to supply chains as networks, so have adopted a dictionary-based definition that is rooted in the science of ecosystems. We define resilience as 'the ability of a system to return to its original state or move to a new, more desirable state after being disturbed'. Implicit in this definition is the notion of flexibility, and given that the desired state may be different from the original, 'adaptability' earns a place in our thinking too.

The final term we must deal with at this stage is potentially the most problematic of all. It is 'risk'. There are many different interpretations of risk in the academic literature. Amongst the most widely cited are variance-based definitions drawn from classical decision theory, where risk is the 'variation in the distribution of possible outcomes, their likelihoods and their subjective values'; or the hazard focused interpretation, common in risk management, which is more likely to present risk in terms of: 'Risk = Probability (of a given event) x Severity (negative Business impact)'. In this work we use risk in line with common usage in the sense that it relates to supply chain vulnerability, as 'at risk: vulnerable; likely to be lost or damaged'. Given the interdependencies between organizations and their supply chains, it may be the business that is at risk from its supply chain or the supply chain that is at risk from a business. The predicament of Land Rover, a subsidiary of Ford, in January 2002 illustrates this point.

When chassis manufacturer UPF-Thompson became insolvent at the end of 2001, the impact upon its major customer was sudden and severe. UPF was the sole supplier of chassis for the Land Rover's best-selling model, the Discovery. The receivers, KPMG, threatened to halt supply unless Land Rover made an immediate up-front payment of between £35 and £40 million. KPMG justified its actions by pointing out that it was legally obliged to recover money on behalf of its creditors and the sole supplier agreement represented a valuable asset. The action followed an earlier court ruling in the UK that had determined that receivers were legally entitled to exploit a customer's vulnerability for the benefit of creditors. Land Rover faced the very real possibility of having to shut down production of the Discovery until a temporary injunction was secured granting the car-maker a short term reprieve. The injunction allowed Land Rover to arrange for another supplier to acquire the failing business, averting the lay-off of 1400 Land Rover workers and many more amongst the car maker's network of suppliers. That supply chain was actually at risk because of the failure of UPF's business, not directly due to a problem between the supplier and its automotive industry customers, but as a result of losses suffered by UPF in an unrelated but ill-starred foreign venture.

06. Location

The geographical location of facilities, warehouses, and suppliers are the base elements of a logistics network. For an electronics manufacturer,

the location of the contract manufacturer is key. Many contract manufacturers set up their organizations in low-cost manufacturing areas. However, OEMs not only look to cut manufacturing costs, but also look to streamline their supply chain. This leads to selecting contract manufacturers not only in low-cost manufacturing locations, but also in locations with strong transportation facilities. Also, contract manufacturers that are located in close proximity to the company are often selected in order to reduce transportation cost and lead time. Companies can receive significant cost benefits as well as dramatically increase their own supply chain's agility by utilizing a geographically close contract manufacturer (Kumar, 1999). Close proximity can also be important for new and/or complex products that require a high level of interaction between the OEM and the contract manufacturer.

07. Transportation, distribution, and warehousing

Transportation is one of the most important elements in the execution of the supply chain. Transportation decisions include modal selection (e.g. rail, truck, air, or water), shipment size, vehicle routing, and scheduling, all of which are directly related to the location of warehouses, customers, and plants. The strategy for distributing outsourced products is also a major concern for companies who employ contract manufacturers.

The introduction of contract manufacturing into the logistics network can alleviate the need for electronics manufacturers' warehouses, traditionally used for storing both raw material and finished product inventory. There are three main distribution and warehousing options for the OEM who chooses to outsource.

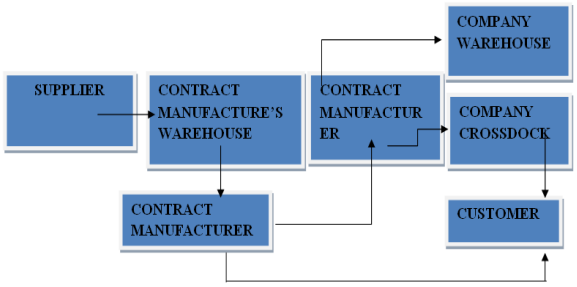

Figure 1: Transportation, Distribution, and Warehousing

First, the OEM could choose to allow the contract manufacturer to ship products directly to end customers. If the OEM uses a direct shipment strategy, no warehouses are needed, as the finished products will be stored in the contract manufacturer's warehouse. This decision can potentially increase the agility of the OEM's supply chain by reducing both on-hand inventory and lead-time. However, OEMs often receive customer orders that, if shipped directly from the responsible contract manufacturer, would not be large enough to fill an entire trailer. These less-than-full truckload (LTL) shipments sent directly from the contract manufacturer are very costly. Also, manufacturer transportation costs would increase, when compared to simply shipping from one large warehouse, because the manufacturer would have to send more small trucks to more locations. Economies of scale favor large shipment sizes, which lower the transportation cost on a per-unit basis.

A second option for OEMs is to ship finished products from the contract manufacturer to one of their own warehouses or distribution centers. Although the outsourcing of the manufacturing process alleviates the need for raw material warehouses and potentially the need for finished

goods storage, some companies prefer contract manufacturers to ship the finished products to their warehouses before they are distributed to customers. This enables the company to monitor the inventory level of finished products. Most companies that deal with low volume orders use lower-rate, full-truckload shipments to ship finished product from the contract manufacturers to intermediate distribution warehouses located near their customers. These warehouses improve supply chain agility by being able.

08. Conclusion

Based on web service and service agent, the information integration system of manufacturing industry agile supply chain including four nodes has been realized. The prototype system has implemented cross platform information sharing and data exchange, can loosely connects and dynamically integrates applications within and inter enterprises, and evidently reduces the complexity of enterprise application integration. The program takes into account the complex combination of different types of nodes and the extension requirement of interface realization. The service agents and service identification method provided have a common reference value for supply chain systems. Because of knowledge restriction, only information exchange between nodes of supply and demand is concerned. The internal operational support, data standard, supply chain decision coordination mechanism, information transfer security among enterprises, web service access control of the agile supply chain system need further study.

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