Framework of Analyzing Service-Centric Cluster Supply Chain: A Case Study of Collaborative Procurement

Xiao Xue
Lab of Service Science, Henan Polytechnic University, Jiaozuo, Henan, P.R.China
xuexiao@tsinghua.org.cn

Zhe Wei and Zhifeng Zeng
College of Information Network Security, Yunnan Police Officer Academy, Kunming, P.R.China
{weizhe1026, hhzzf}@163.com

***Abstract*—In order to help small and medium enterprises (SMEs) cluster to face the global challenges, the definition of "cluster supply chain" is put forward as a new type of management pattern, which is the combination of industrial cluster and supply chain management. However, the related research on cluster supply chain is still in its infancy, and it is difficult to put theory results into practice. Based on the background, we give a case study of collaborative procurement in a textile & garment industry cluster to demonstrate the construction and development of cluster supply chain, in which the role of service system is described in detail. In the end, this paper summarizes an analytic framework to present the completed modeling process of collaborative procurement. The framework includes four views - business modeling, specification modeling, realization modeling, system evolution.**

***Index Terms*—cluster supply chain (CSC); service system design; agent modeling technology; collaborative alliance.**

I. INTRODUCTION

Porter proposed that today's economic map of the world is dominated by clusters: geographic concentrations of linked businesses that enjoy unusual competitive success in their field. [1] When firms operate in a cluster, they can have the advantage of scale without dealing with the inflexibilities of vertical integration or formal linkages. The repeated interactions among them can boost competition, improve productivity, innovation and coordination, and build trust. In nations such as Germany, Italy, India, and the United States, this kind of internal specialization and trade – and internal competition among locations – fuels productivity growth and hones the ability of companies to compete effectively in the global arena.[2, 3, 4, 5].

Currently, globalization and the ease of transportation and communication have led many companies to move some or all of their operations to locations with low wages, taxes, and utility costs. For stable, labor-intensive activities such as manufacturing assembly and software localization, low factor costs are often decisive in driving location choices. In the context, China becomes the dominant makers of steel, coke, aluminum, cement, chemicals, leather and other goods, which drives the rapid growth of its economy in recent years. However, the competitive advantage mainly relies on cheap labor and natural resources, and there is a real possibility of losing the competitive edge to cost competitors like Viet Nam, Philippines and Malaysia. With the advent of financial crisis and the intensification of environmental damage, it is becoming more and more difficult to remain the old development pattern. From the perspective of value chain, China's industrial cluster is still in its initial stage, and there are some critical problems:

(1) **The absence of critical segments in the whole value chain**. Most of China's industrial clusters only rely on policy advantages and local resources to occupy the low end of global value chain, such as processing and manufacturing. For those export-oriented clusters, the core segments (such as R&D, distributing channels, raw material supplier, equipment providers, productive services) of the value chain are often located outside the cluster, which may make it easier to decline.

(2) **The mismatch between various segments in competitiveness.** In China's industrial clusters, the competiveness of different segments of the value chain is not balanced, e.g. the mismatch between leading enterprises and supporting enterprises in the information management. According to the principle of "bucket effect", the weakness in some key segments will lead to the difficulty in the cooperation between upstream and downstream partners, which will undermine the overall competitiveness of the cluster.

This work is supported by National Nature Science Foundation under Grant 60905041,Fundamental Science Research Foundation of Henan Province under Grant 092300410216, and Young Scientist Foundation of HPU under Grant 649100.
Xiao Xue, Henan Polytechnic University, Jiaozuo, 454000, China (phone: 86-391-3989805; E-mail:xuexiao@stinghua.org.cn)

doi:10.4304/jsw.7.4.733-740

(3) **The lack of support from public service infrastructure.** The upgrade of cluster needs the support of public service infrastructure, such as trade associations, financial service, credit rating service, logistics service, etc.. Many clusters are only geographically concentrated, which can't demonstrate the advantages of virtual organizational alliance fully (interrelated, interdependent and specialized division of labor).

The solution to the above problems demands new mindsets in managing business. The growing application of supply chain management in various industrial clusters and sectors [6] is driving the birth of the concept of "cluster supply chain (CSC)"[7], which make full use of the advantages of industrial cluster and supply chain management to help SMEs to move beyond this stage. Its core idea mainly consists of the following two parts:

(1) Supply chain analysis (SCA) suggests a systemic understanding of resource allocation and information exchange between firms engaged in sequential stages of production [8]. Through vertical cooperation (i.e. the cooperation between upstream and downstream enterprises within a single supply chain), enterprises can specialize some core business and give way to an external division of labor. Inter-enterprise cooperation can facilitate internal efficiencies in sourcing and in sharing technology and information. In a word, SMEs can strengthen their competitiveness to strive for high-value added segments by utilizing shared capabilities and resources.[9] As a consequence, the whole cluster not only occupy low-value added segments (such as component fabrication, assembly and customer service), but also some core segments of the value chain, such as R&D, marketing, and even related businesses.

(2) Cluster network analysis (CNA) is not particularly concerned with sequentially organized ties, but rather with horizontal relationships between firms [7]. Through horizontal cooperation (i.e. the cooperation between homogeneous enterprises across different supply chains located in the same cluster), cluster allows each member to benefit *as if* it had greater scale or *as if* it had joined with others formally – without requiring it to sacrifice its flexibility, e.g. obtaining lower price by means of bulk-purchase, pooling their production capacities together to strive for bigger orders and so on [10]. As a result, SMEs can achieve a breakthrough in some critical segments of the value chain (e.g. strategy development, core technology and workflow optimization) and even compete with industry giant in international market.

Research into managing cluster supply chain has blossomed, and has been accompanied by research across a range of academic disciplines, with each discipline making use of its own theoretical lens, such as Economic Science [11, 12], Management Science [13, 14], Social Science [15], and Information Science [16, 17] to analyze and explain collaborative behaviors of firms. Despite much effort from government, research institutes and SMEs, the actual construction and operation of cluster supply chain does not show successful results than it should be. This shows that substantial gaps exist between theories developed and what is actually occurring in practice. "How to apply IT technology to support the business strategy on cluster supply chain" is identified as one of the main barrier to effective CSC.

This paper focuses on how to introduce the concept of service system to bridge the gap mentioned above. The design of service system will serve as clues to integrate the research results from different disciplines, in order to support the construction and operation of cluster supply chain. The rest of this paper is organized as follows. Section 2 introduces the case study of collaborative procurement in a textile & garment cluster, in which the role of service system is described in detail. Section 3 provides an analysis framework to present the completed modeling process of collaborative procurement. The concluding remarks will be given in section 4.

II. CASE STUDY OF COLLABORATIVE PROCUREMENT

Currently, globalization and the ease of transportation and communication have led many companies to move some or all of their operations to locations with low wages, taxes, and utility costs. For stable, labor-intensive activities such as manufacturing assembly and software localization, low factor costs are often decisive in driving location choices. In the context, China becomes the dominant makers of garment, steel, aluminum, cement, chemicals, leather and other goods, which drives the rapid growth of its economy in recent years. However, the competitive advantage mainly relies on cheap labor and natural resources, and there is a real possibility of losing the competitive edge to cost competitors like Viet Nam, Philippines and Malaysia. With the advent of financial crisis and the intensification of environmental damage, it is becoming more and more difficult to remain the old development pattern.

The children garment industrial cluster in Zili Town of Zhejiang province is a typical example, which has existed since the early 1980's. Until 2009, there are more than 12,600 enterprises, 150,000 high-speed sewing machines, 250,000 employees in this area, which is with annual output of 400 million children's clothing (sets), annual sales of 15 billion RMB, more than 30% domestic market share, and 98% of the domestic market coverage. In recent years, the integration between enterprises along supply chain has begun to emerge, including material suppliers, textile processing, garment manufacturing, equipment parts providers, joint shipping stations, and some companies specializing in clothing design. However, the competitiveness of the whole cluster is still weak especially in some high-value added segments, such as the processing of high-grade fabric, clothing design and brand marketing. As shown in figure 1, Textile processing and garment manufacturing occupies the core position of the cluster, which lies at the low-end of the global value chain.

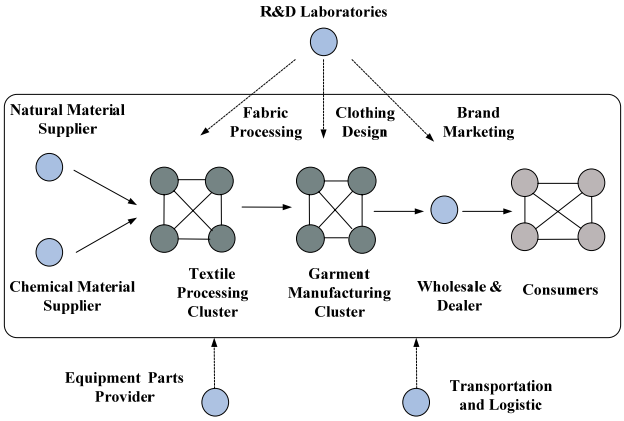

Figure 1. Value network of the textile and garment industry.

Cluster supply chain can play an important role in the migration of the cluster to high-end of the global value chain. Different firms in cluster can collaborate in the pattern of cluster supply chain (including collaborative procurement, collaborative design, collaborative manufacture and collaborative sale), and try to optimize the market for their common benefits, including cost reduction, rent creation, or rent capture. Figure 2 gives an explanation on how to cut down the cost through collaborative procurement in the cluster.

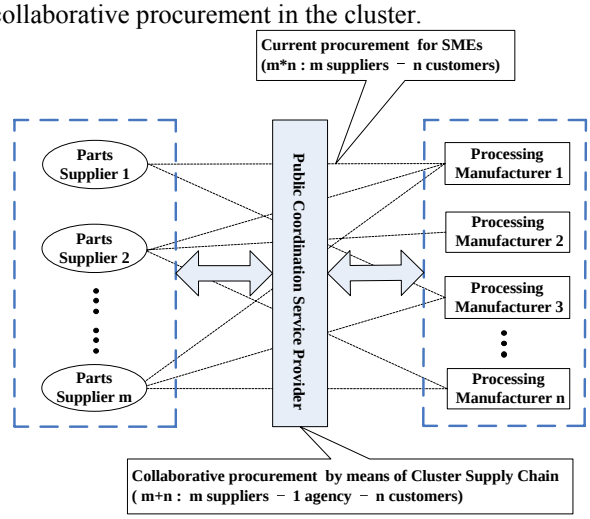

Figure 2. Collaborative Procurement in the textile and garment cluster.

Before implementing collaborative procurement, each processing manufacturer purchases its own materials and parts respectively and there are a large number of interactions between suppliers and textile processing manufacturers. Consequently, service is uneven, costs are high, and processing manufacturers are confused and frustrated. After implementing collaborative procurement, the transaction complexity can be reduced a lot. Because more information on supplier performance and availability becomes accessible, textile processing manufacturers will have greatly increased leverage to make well choices and reap enormous benefits. At the same time, the competition among suppliers will eliminate low-quality suppliers, while retaining those who are competitive. Ultimately, the competitiveness of the entire cluster will be enhanced. In order to achieve the goal, the business mode of cluster supply chain begins to emerge step by step.

(1) At the beginning, each company in cluster is responsible for its entire business, such as procurement, manufacture, sale etc. As a result, it is difficult to reduce the high interactive costs among the partners, improve the product quality, and speed up the response of supplying processes in order to maximize the whole cluster performance. Therefore, it is necessary to synthesize relevant social resources to provide a package of industrial services for manufacturing companies by way of pooling procurement, machining and establishing supply-sales network world-wildly.

(2) In order to achieve the target, some public service system needs to be constructed to support the operation and upgrading of cluster supply chain, such as coordination center, information center, design center and other public platforms. The service providers may be from private and public sectors, as well as academia and nonprofit organizations.

(3) Then, several companies in cluster jointly sponsored and founded Public Service Provider (PSP), which provides pooling procurement service in industrial raw material and accessory such as steel, tools, standard parts for manufacturing customers. Public Service Provider uses the pooling concept to synthesize customers' needs, makes the package of purchasing plan, optimizes the purchasing processes and distributing scheme, selects the best supplier over the world in order to reduce the purchasing and logistic costs for customers.

(4) Based on the principle of voluntary and mutually beneficial, more and more companies in cluster begin to outsource their own non-core business to Public Service Provider. Meanwhile, Public Service Provider offers the related services, such as warehousing & distribution, early processing. The cluster supply chain alliance can use the synergy to reduce the logistic cost for manufacturing industry and enhance the competitive capacity of the whole supply chain to satisfy the dynamic industrial demand.

(5) Through the integration and optimization of the whole cluster sources, Public Service Provider will concentrate efforts on providing the full industrial service solution for the manufacturing industry customers. The services will contain not only basic logistic services such as warehousing, packing and transportation, but also covering pooling procurement, order managing, stock management and product sales, etc. In a word, Public Service Provider helps to build up long-term strategic cooperation among all the partners in the cluster, diminish the interactive costs and optimize the performance of the supply chain.

B. Service supporting system

Service supporting system can be considered as "an approach to achieving business goals in which technology

is used to support the operation of CSC for purpose of enabling or facilitating the enterprises collaboration in and across supply chains as well as the making of decisions that underlie those activities". This definition of service supporting system not only represents an integrated view of management/economics/sociology perspectives that focus on trading (computer-based means for accomplishing buying-selling transactions), information exchange (distribution of information in the conduct of business), activity (the use of technologies to enable business activities both across and within supply chain boundaries), and effects (the reasons and outcomes of conducting CSC strategy), but also highlights the importance of information technology including acquiring, selecting, matching and externalizing and internalizing services from partners in the execution of collaboration. The goal of service supporting system is to fuse the boundary between business and IT and helps enterprises to acquire capabilities to maximize the value of the new business patterns.

Today, high expenses in service infrastructure cost are also viewed as the main barriers, followed by other reasons, such as profit sharing, location, brand, labor, uncertainty. Integrating the CSC strategy into any cluster environment can cost millions dollars and account for major application implementation delays and customer dissatisfaction. This area has been the focus of significant technology development in recent years. On demand, Web Services, Grid Computing, Autonomic Computing, Legacy Revitalization, and Integration Technologies are all being vigorously pursued by technology companies. The recent advancement of information technologies has transformed the traditional economy into a network- and knowledge-based economy where public service facilities have assumed an increasing important role in reshaping buyer-supplier relationships, improving core business processes, providing electronic intermediation, and reaching new segments and markets [18]. Based on public service facilities, SMEs may gain the advantages of CSC at a lower total cost.

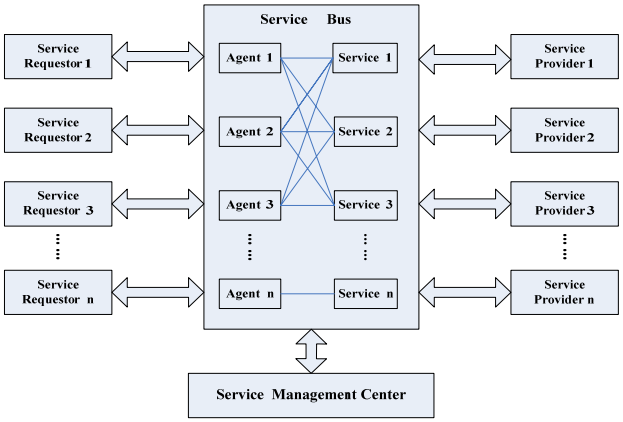

Figure 3. The SaaS-based service supporting system

In the context, SaaS (software as a service) may be an appropriate choice to construct the open, integrated, scalable and flexible service platform, which support the flow of products/services, funds and information between enterprises. In figure 3, we give a SaaS-based system architecture to support the operation of cluster supply chain, which plays an intermediary role to link service requestors directly to service providers, thereby enabling supply and demand to be quickly matched. On the left side, a lot of participating enterprises join interconnected and inter-operable business, and search for appropriate business services to form CSA. On the right side, many third-party service providers (such as coordination center, information center, design center and other public institutes) support the aligning and integration of business processes between different participants to enable collaboration along the whole supply chain. The service providers may be from private and public sectors, as well as academia and nonprofit organizations.

The public service platform plays an intermediary role and has the ability to “plug and play” at both the business process and IT infrastructure levels. It represents the critical step to enable cluster supply chain to be adaptive and sense and respond to environmental changes. In sum, the system should have the following characteristics.

(1) The system, as a whole, will cover all stages of the whole supply chain, thus offer more flexible choices to meet the special needs of each company.
(2) For a targeted supply chain stage, such system can independently provide not only operation management functions, but also strategic, analytical, and decision-support functions.
(3) Such system is interoperable and can be integrated seamlessly with each other, and with other companies’ IT systems and consumers along the supply chain through service components.
(4) The integration is dynamic, which means a company is able to choose and integrate with those partners that best suit its needs. This dynamic integration transforms the supply chain from a traditional fixed sequence into an adaptive network, which helps the company achieve both internal and external efficiencies.

However, it is worth noting that one firm may play both "service provider" and "service customer" at the same time. Because each firm belongs to one node of service chain, it may act as "service provider" to back nodes and "service consumer" to previous nodes. For example, in terms of manufacturer, it provides services to end customers, and consume services from other partners (auxiliary partners, public coordination institutes) at the same time. Therefore, during the analysis and design of service system, we aim at the whole service chain, not a separate entity. The success of cluster supply chain depends on the joint efforts of service providers and service consumers. In order to realize global optimization, each company needs to have the reciprocal knowledge to adjust strategies continuously to reach equilibrium between individual interests and common interests.

III. FRAMEWORK FOR ANALYZING CLUSTER SUPPLY CHAIN

As a virtual economic organization consisting of heterogeneous firms gathered in vast dynamic and virtual coalitions, cluster supply chain is depicted from four different aspects in the framework. In the subsection, we will give the details of each modeling phase.

A. Business Modeling

Business models need to clarify what kind of services can be provided by cluster supply chain, that is decided by sources of value emanating from it, and all kinds of factors to impact it, including coordination mechanism, IT infrastructure, business context, customer participation etc.. Based on business models, we can evaluate current situation of the whole network organization, and decide whether cluster supply chain is an appropriate choice. Business modeling typically falls into three tiers: strategy, tactical and operation. The categories are based on the planning horizon, the apparent width of the opportunity window, and the level of precision required in the supporting information. The following will give the analysis details from three levels:

Strategic tier: Strategic scheduling is concerned with industry trends and tries to find out whether some business pattern innovation is feasible, such as collaborative procurement among enterprises. The core mechanism of collaborative procurement is to reduce external complexity (the interaction between suppliers and manufacturers) through increasing internal complexity (the interaction between different manufacturers). The related issues in this tier include expected incremental improvements in the business process, risk assessment for related changes, tasks decomposition and assignment, requirement for additional tooling, manpower and planning.

Tactical tier: Tactical scheduling focuses on how to realize the business pattern innovation (e.g. collaborative procurement) at the level of management. The cooperation between public coordination institutes and the involved enterprises needs to be considered seriously, including types of cooperation, their own responsibilities, actions to be taken, coordination mechanism etc.. Furthermore, it is necessary to find out all related external factors, such as general availability of infrastructure, business policies, commitment rules and so on.

Operational tier: Operational scheduling deals with technical elements in support of the achievement of collaborative procurement. Issues considered include interactions between enterprises (logistics, capital, information, etc.), the lifecycle and dynamic changing rates for enterprises organization, types of organizational structure, etc.. Tools typically used in support of daily operation include material resource planning (MRP), decision support, recovery models and deterministic forward schedulers and so on. Usually, these techniques are used to render enterprises to response in real time to external changes.

B. Specification Modeling

Specification modeling can clarify the internal structure of enterprises and their roles in the cluster improve current defects and mine the potential for collaboration. In the cluster supply chain, the collaborative strategy and commissioned relationship between firms may change dynamically over time and external environment. The notion of agent allows us to decompose, analyze, and then reconstruct cluster supply chain conveniently, in which each role can be depicted by concepts borrowed from those agent oriented methods. Generally speaking, it should be divided into three modeling steps:

Individual model: the use of agent expression to describe the characteristics of individual enterprise in the cluster, including the extraction of appropriate agent architecture from existing agent literature and systems; the mapping between agent architecture and enterprise structure, including selection criteria and design specifications; the definition of a development process to guide the depiction of various enterprise.

Organization model: the use of agent organization to depict the network characteristics of cluster supply chain, including the definition of organizational rules in formal description language, and the run-time performance analysis and risk assessment; the definition of organizational structure, and the corresponding graphic identification; the classification of representative organization patterns, thereby useful to understand and apply.

Collaboration model: the use of agent interaction and coordination mechanism to describe the collaboration between enterprises from three layers: content layer, representation layer and transport layer, i.e. what content needs to be transferred in the interaction between enterprises; how to use agent communication language to express the content; how to deal with those accidents and conflicts in the interaction.

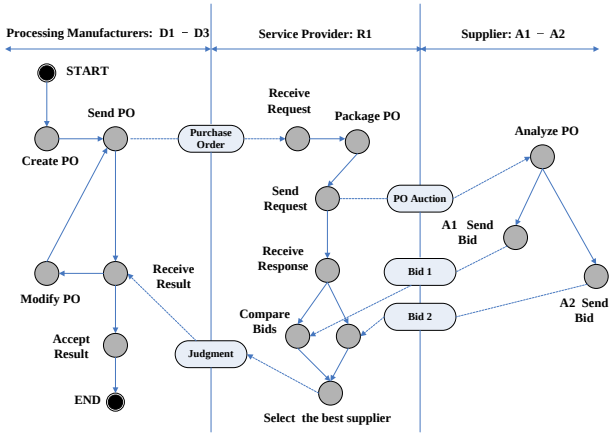

Figure 4. The collaboration model for collaborative procurement.

Figure 4 gives a collaboration model to explain collaborative procurement in the cluster, which adopts the sequence diagram in AUML as modeling means. The agents in the model are divided into three different roles: service provider (R1), processer agents (D1- D2) and supplier agents (A1 - A3). The sequence of collaboration process is shown as follows:

1) D1-D3 submit orders for materials to R1 respectively. R1 is responsible for orders package

and market survey, and then arranges specific plans to meet order demands.

2) R1 gives an auction on the order, and negotiates with suppliers A1-A2 on related issues, such as time limits and quality requirements, to form a optimized task commission.
3) In the end, the best supplier is selected to accomplish the specific order, and returns result to D1-D3. If some accidents happen in the process of task implementation, D1-D3 may negotiate with R1 on the modification of PO.
4) At the end of the mission, D1-D3 accepts the received result. After reaching the agreement, R1 will sign the contact with the selected supplier. The information flow is always accompanied by the flow of capital and logistics.

C. Realization Modeling

To leverage the advantages of cluster supply chain effectively, it is necessary to bridge the gap between front room organization collaboration processes and back room service support processes by means of service system. Therefore, the agent-oriented specification needs to be transited into service-oriented realization models. Services can be regarded at a higher level of abstraction than objects in object oriented programming. A service can be implemented by an object, a group of objects, or even a business process.

The most important result of the phase is the construction of services model, which is comprised of a set of IT services that support the desired business collaborative process. Aimed at the above collaborative procurement, figure 5 gives a description to clarify the relations between public service providers, textile processing manufacturers and material suppliers. It can be seen that some agents can play as both service provider and service consumer. In order to get the final service sets, the detailed modeling steps are shown as follows:

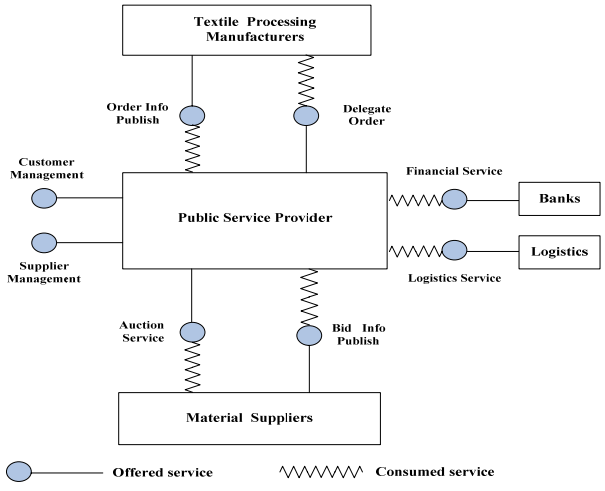

Figure 5. The service components in collaborative procurement.

1) The first step involves identifying candidate services, candidate enterprise components, and flows. This step exploits the results of business modeling and specification modeling to relate business components to the collection of candidate services. It is worth noting that the particle size of different services needs to be balanced between small and big granularity. If a service is too small, the orchestration logic can be too complex, and communication overhead can be heavy. When function A and B are often detected to be used together in various cases, grouping them into a service means this service can be shared by multiple business processes and the reusability of this service is increased. If a service is too big, that means big parameter list and multiple purposes. It can increase the complexity to implementation and reduce the reusability of services.
2) The second step specifies the internal structure of each component and the communication between them. In reality, we need to have multiple different types of services designed for fulfilling special kinds of tasks. In order to realize the communication between different services, three issues need to be paid attention to: service functions, service provider, and service non-functional aspects. Though it is still an open question, people agree that there are some common principles to follow: (i) well defined based on open standards to improve the interoperability and reusability of services; (ii) capable of loosely coupling; (iii) with the appropriate granularity and correct abstraction level; (iv) correspondent to the demands of the business processes. In the step, a series of innovative tests will be applied to narrow down the initial candidate service set.
3) The third step involves decisions on how to compose these services to achieve more complex tasks. Generally speaking, the composition process will be divided into three levels: (i) Service Orchestration: the aggregation of fundamental services to create a service flow to meet existing business objectives. (ii) Service Choreography: the collaboration between different services belonging to various owners to execute the common goals of the organization. (iii) Service Coordination: aimed at the conflicts in collaboration, services need to be coordinated to drive the organization's strategic objectives. Here, the collaborative procurement process is composed of services from three types of entities: textile processing manufacturers, public service provider, and suppliers. The internal functions from public service provider, such as “receive PO (Procurement Order)”, “package PO”, “compare bids” and “select supplier”, are firstly orchestrated to construct a service “delegate order”. Then, the whole collaborative procurement is achieved through service choreography between public service provider, textile processing manufacturers and suppliers.

Although relevant regardless of whether a service system uses information technology, the models are also potentially useful in visualizing the realities of moving

toward automated service architectures. Currently, SOA is an appropriate choice to translate service models into software implementation. SOA is a higher level abstraction than OO programming with respect to its uses in analyzing and implementing service oriented system. In SOA, services are autonomous, platform-independent entities that can be described, published, discovered and loosely coupled. SOA is used to build a common platform to integrate different data sources and connect standalone applications. Web services can be regarded as an implementation of SOA. Web services are based on a set of W3C and OASIS open specifications: SOAP for communication, WSDL for service interface description, UDDI for service publishing and index, BEPL for Web service process description.

D. System evolution

The business environment is changing at a rapid pace, fueled in part by the e-business evolution and in part by competition and globalization. In this environment, companies must be able to adapt quickly to change if they wish to compete, survive and thrive. The business partners can improve their supply chain performance by flexible business collaboration to maximize the performance of the whole cluster.

The target of cluster supply chain is not mere tools and accelerators for cluster, but to organize all enterprises as an organic entity. Based on the feedback on service delivery, we need to optimize service solution to drive business level to higher levels of accuracy, efficiency, and financial predictability. In order to be accepted by customers, system evolution has to adopt step-by-step policy and give full consideration of existing legacy systems, from electronic business (front end), to enterprise resource planning (core), to customer relationship management (back end).

As shown in figure 6, the supporting service system should always be in the cycle of evolution. In the process of improving the performance of cluster supply chain, three key problems have to be faced with: (i) how to manage the service system to make the best of its effectiveness; (ii) how to evaluate whether the service system can meet the demands of customers; (iii) how to reconstruct the whole service system with the fast-paced customer demands. The details are shown as follow:

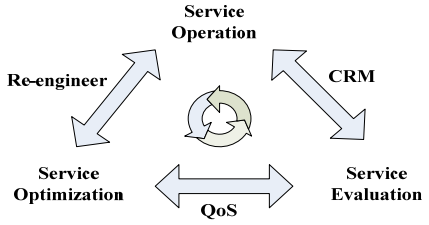

Figure 6. The cycle of system evolution.

Operation: During the process of system operation, we need to recognize events, the status of customers, partners, competitors, and the global environment. The effectiveness of a cluster supply chain depends on its ability to recognize critical business events “in time” and before competitors. This information can be gathered to recognize data and events of interest in business processes, inventory systems, and on the manufacturing floor.

Evaluation: The benefit of cluster supply chain is obvious, but it does require a collaborative effort to fully realize its worth. Through evaluating a broad variety of operation situations, it will ultimately lead to valuable and productive strategic insights. The critical evaluation issue is whether they take advantage of the collective wisdom and resources of the cluster to improve operational efficiency.

Optimization: Optimization will be a vital component of the enterprise if defects are to be managed, challenges to be met and a competitive edge to be retained. The companies need to optimize not only their internal supply chain, but also collaboratively optimize the performance of the cluster supply chain. This collaborative optimization involves the selective sharing of critical events and information, the distribution of decision rights, the redistribution of work, and the better allocation and use of all the resources available in the cluster. In the end, the gap between enterprise demands and service systems can be decreased through reengineering and enter into the state of smooth operation again.

IV. CONCLUSIONS

Cluster supply chain is a new economic theory for SMEs to improve competitiveness and face global challenges through all kinds of collaborative strategies. Through vertical cooperation (i.e. the cooperation between upstream and downstream enterprises within a single supply chain), SMEs can strengthen their competitiveness to strive for high-value added segments by utilizing shared capabilities and resources. Through horizontal cooperation (i.e. the cooperation between homogeneous enterprises across different supply chains located in the same cluster), SMEs can achieve a breakthrough in some critical segments of the value chain (e.g. strategy development, core technology and workflow optimization) and even compete with industry giant in international market.

Based on the above background, we utilize a case study of collaborative procurement in a textile & garment industry cluster for demonstrating the construction and development of cluster supply chain, in which the role of service system is described in detail. Furthermore, the paper proposes a modeling framework to depict cluster supply chain from four views (business models, specification models, realization models and system evolution), which makes full use of service concept to bridge the gap between academic theoretical studies and practical realization regarding the application of cluster supply chain, and another one between research methods in management science and information science. In the next step, we will design a set of Key Performance Indicators (KPIs) for performance evaluation, which will play an important role in verifying whether models can be in line with practice. Based on the feedback, we can

improve current models and give better guides for the modification and upgrading of cluster supply chain.

ACKNOWLEDGMENT

This work is supported by National Nature Science Foundation under Grant 60905041, the Research Fund for Fundamental Science of Henan Province under Grant 092300410216, and the Young Scientist Fund of HPU under Grant 649100.

REFERENCES

[1] Porter, M.E. “Clusters and the new economics of competition”, Harvard Business Review, Vol. 76, No. 6, pp. 77-90. (1998)
[2] Brenner, T. “Innovation and Cooperation during the Emergence of Local Industrial Clusters: An Empirical Study in Germany”, European Planning Studies, 13(6), pp921-938. (2005)
[3] Antoldi F. Between local tradition and global competition: introduction to phenomenon of Italian industrial districts. In: Antoldi F (ed) Small Enterprises and Industrial Districts. Il Mulino, Bologna. (2006)
[4] Biswas,S. Roy,S and Seshagiri,S. “Collaboration in Indian SME Clusters: A Case Study”. In: Steinfield, C. et al., Proceddings of the 3rd International Conference on Communities and Technologies, pp.28-30. Springer-Verlag. (2007).
[5] Tom DeWitt, Larry C. Giunipero and Horace L. Melton. “Clusters and supply chain management: the Amish experience”. International Journal of Physical Distribution & Logistics Management, Vol. 36 No. 4, pp. 289-308. (2006).
[6] Damien Power. “Supply chain management integration and implementation: a literature review”. Supply Chain Management: An International Journal. Vol 10, No.4, pp.252-263. (2005).
[7] Jizi, Li. Study on Cluster Supply Chain and its management. PHD thesis. Huazhong Agricultural University, Wuhan, China. (2006).
[8] Lazzarini, S.G., Chaddad, F.R., Cook, M.L. "Integrating supply chain and network analyses: the study of netchains", Chain and Network Science, Vol. 1 No.1, pp.7-22. (2001).
[9] Kim, S.W. "The effect of supply chain integration on the alignment between corporate competitive capability and supply chain operational capability", International Journal of Operations & Production Management, Vol. 26 No.10, pp.1084-107. (2006)
[10] Dayasindhu, N. “Embeddedness, knowledge transfer, industry clusters and global competitiveness: a case study of the Indian software industry”, Technovation, Vol 22, pp 551-60. (2002)
[11] Mikkola, J.H., Skjott-Larsen, T. "Supply chain integration: implications for mass customization, modularization and postponement strategies", Production Planning & Control, Vol. 15 No.4, pp.352-61. (2004)
[12] Patti, Anthony L. “Economic clusters and the supply chain: a case study”. Supply Chain Management: An International Journal. Vol 11 No.3, pp266–270. (2006).
[13] Fox, M.S., Chionglo, J.F., and Barbuceanu, M. The Integrated Supply Chain Management System. Internal Report, Dept. of Industrial Engineering, University of Toronto. (1993)
[14] Villa A, Antonelli D, Cassarino I. “Issues in the management of collaborative demand and supply networks”. In: Strengthening competitiveness through production networks, pp.47-57. Belgium: European Communities. (2005).
[15] Zhou Min, Deng Feiqi and Wu Sai. “Coordination game model of co-opetition relationship on cluster supply chains”. JOURNAL OF SYSTEMS ENGINEERING AND ELECTRONICS , vol 19, No 3, pp 499-506. (2008).
[16] Siau, K., Tian, Y. "Supply chains integration: architecture and enabling technologies", Journal of Computer Information Systems, Vol. 44 No.3, pp.67-72. (2004)
[17] Hendricks, K.B., Singhal, V.R., Stratman, J.K. "The impact of enterprise systems on corporate performance: a study of ERP, SCM and CRM system implementation", Journal of Operations Management, Vol. 25 pp.65-82. (2007)
[18] McIvor, R., Humphreys, P. and Huang, G. “Electronic commerce: re-engineering the buyer-supplier interface”, Business Process Management Journal, Vol. 6 No.2, pp. 122-138. (2000)

Xiao Xue received the B.Tech. degree from the North China Electric Power University, Beijing, China, in 2001, and the Ph.D. degrees in 2007, from Institute of Automation, the Chinese Academy of Science. He is a post doctor at Tsinghua university, Beijing, China, focused on service science & engineering and agent oriented modeling technology. Prior to that, he was an Assistant Professor with the CS Department, Henan Polytechnic University. His research focuses on the development of agent-based modeling tools to support the design and management of complex enterprise IT systems exploiting recent advances in service science and knowledge engineering. He has published over 20 refereed research articles in academic conferences and journals in the areas of agent oriented methodology, cluster supply chain, information integration and emergency management.