Research on Collaborative Procurement in the Cluster Supply Chain Environment

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Abstract: The cluster supply chain can effectively solve the coordination among the small and medium enterprises. This paper firstly gives the concept and features of the cluster supply chain. Then, this paper expounds four models of the collaborative procurement in the cluster supply chain environment, including the model of non-horizontal coordination and non-vertical coordination, the model of non-horizontal coordination but vertical coordination, the model of horizontal coordination but non-vertical coordination and the model of horizontal coordination and vertical coordination. From the calculation result, we can draw the conclusion that the model of horizontal coordination and vertical coordination in the cluster supply chain environment can obtain the biggest amount profit. At last, this paper points out that the informatization construction is an important safeguard of collaborative procurement in the cluster supply chain environment.
Keywords: cluster supply chain, collaborative procurement, coordination procuremnent

1. INTRODUCTION

Since the reform and opening up, China's economic has growed rapridly. However, the small and medium-sized enterprises in China are still in the extensive development stage. Small and medium-sized enterprises directly facing international competition, in order to improve the efficiency of the industry, enhance the competitiveness of enterprises, rely on the network construction of small and medium-sized enterprises, and gradually promote the development of enterprise clusters, is to improve the competitiveness of small and medium-sized enterprises, the formation of a major development strategy of industrial clusters. There is a close relationship between the development of industrial cluster and the supply chain. The cluster supply chain is a new organizational form based on the coupling of industrial cluster and supply chain. The coupling relationship between industrial cluster and supply chain objectively exists in the industrial clusters at home and abroad, and plays an important role in upgrading and improving the core competitiveness of the industrial clusters. After a period of development, the cluster supply chain basically exists in four operation modes, namely, the related type, the embedded type, the competing type and the collaborative cluster supply chain. With the continuous development of the cluster supply chain, enterprises in the cluster supply chain are inevitably more deeply reflect the relationship between competition and cooperation. Cluster supply chain between enterprises competing relationship are basically homogeneous, and between enterprises has the heterogeneity and highly complementary knowledge, each enterprise in the supply chain to improve their competitive advantage, so knowledge management has become a trend of the development of supply chain. In a cluster supply chain, each enterprise through knowledge sharing behavior, realize the integration of knowledge between enterprises, speed up the innovation of enterprises, and improve the production efficiency of enterprises. The higher degree of cooperation between enterprises in the cluster supply chain, the stronger the integrity and stability of the supply chain.

2. DIFFERENT PROCUREMENT MODELS IN THE CLUSTER SUPPLY CHAIN ENVIRONMENT

The enterprises can adopt variety of procurement models to organize the procurement, including the model of non-horizontal coordination and non-vertical coordination, the model of non-horizontal coordination but vertical coordination, the model of horizontal coordination but non-vertical coordination and the model of horizontal coordination and vertical coordination. When the cooperative object is other enterprises in the same level of the supply chain, the collaborative purchasing is included in the models of horizontal coordination; when the cooperative object is downstream or upstream enterprise in supply chain, the model is called the vertical coordination; when the model contains both the horizontal coordination and the vertical coordination, it is called the model of horizontal coordination and vertical coordination. Figure 1, Figure 2, Figure 3 and Figure 4 respectively show the above four procurement models.

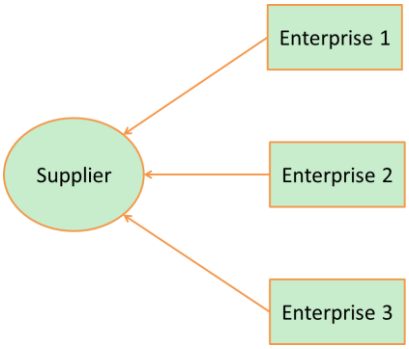

Figure 1 sketch map of model of non-horizontal coordination and non-vertical coordination

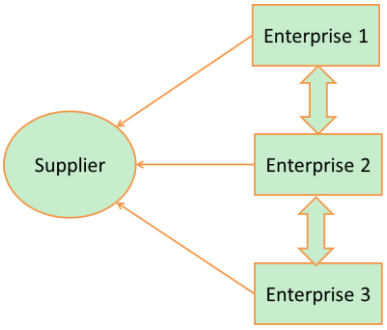

Figure 2 sketch map of model of non-horizontal coordination but vertical coordination

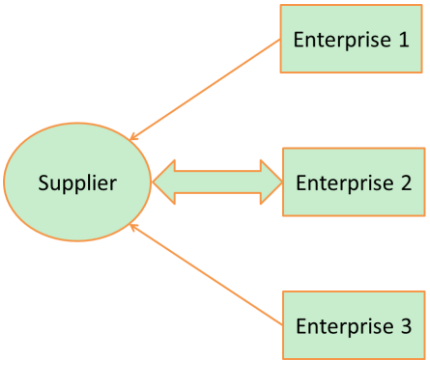

Figure 3 sketch map of model of horizontal coordination but non-vertical coordination

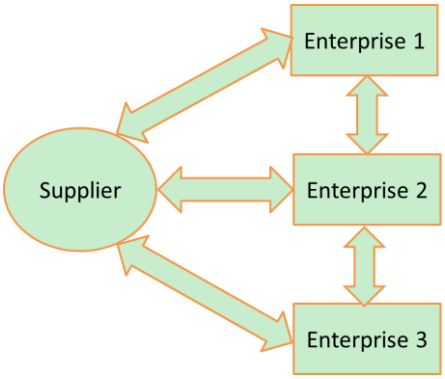

Figure 4 sketch map model of horizontal coordination and vertical coordination

The meanings for the symbols used in the model are shown in Table 1.

Table 1 meaning for the symbols used in the model

P_m product price provided by the supplier	H_r unit inventory cost of enterprise
P_r product price provided by enterprise $P_r>P_m$	Di Demand of enterprise i
O_m production preparation cost of supplier	Q_{mi} order amount of enterprise i
H_m unit storage cost of supplier	Q_r order amount of procurement alliance
C production cost of supplier（$P_m>C$）	C_i total cost of enterprise i
C_m total cost of supplier	B_i total profit of enterprise i
B_m total profit of supplier	B_r total profit of procurement alliance
O_i order cost of enterprise i	B_{mi} enterprise i profit cooperating with supplier
O_r order cost of procurement alliance	B_{mr} total profit of the procurement alliance
B_{mir} total profit of the system when supplier cooperates with enterprise i	

3. PROFIT CALCULAITON OF DIFFERENT COLLABORATIVE PROCUREMENT MODELS

3.1 Model of Non-horizontal Coordination and Non-vertical Coordination

The profit of enterprise i:

$$B_i = (P_r - P_m)D_i - \frac{D_i}{Q_i}O_i - \frac{Q_i}{2}H_r$$

When the Bi reaches the max Bi, the optimal order quantity:

$$Q_i^* = \sqrt{\frac{2D_iO_i}{H_r}}$$

The total profit of enterprise i:

$$\max B_i = B_i(Q_i^*) = (P_r - P_m)D_i - \frac{D_i}{Q_i^*}O_i - \frac{Q_i^*}{2}H_r$$

$$=(P_r - P_m)D_i - \frac{D_iO_i}{\sqrt{\frac{2D_iO_i}{H_r}}} - \frac{\sqrt{\frac{2D_iO_i}{H_r}}}{2}H_r$$

$$= (P_r - P_m)D_i - \sqrt{2D_iO_iH_r}$$

The total profit of the supplier when the enterprise i reaches the maximum profit:

$$B_{mi}(Q_i^*) = (P_m - C)D_i - \frac{D_i}{Q_i}O_m - \frac{Q_i^*}{2}H_m$$

$$=(P_m - C)D_i - \left(\frac{D_iO_m}{\sqrt{\frac{2D_iO_m}{H_r}}} + \frac{\sqrt{\frac{2D_iO_m}{H_r}}}{2}H_m\right)$$

$$= (P_m - C)D_i - \sqrt{\frac{D_iO_iH_r}{2}}\left(\frac{O_m}{O_i} + \frac{H_m}{H_r}\right)$$

Therefore, the total profit of one supplier and n enterprises of the model of non-horizontal

coordination and non-vertical coordination is:

$$B_{mr}(Q_i^*)=\sum_{i=1}^{n}B_i(Q_i^*)+\sum_{i=1}^{n}B_{mi}(Q_i^*)$$

$$=\sum_{i=1}^{n}\left[(P_r-P_m)D_i-\sqrt{2D_iO_iH_r}+(P_m-C)D_i-\sqrt{\frac{D_iO_iH_r}{2}}(\frac{O_m}{O_i}+\frac{H_m}{H_r})\right]$$

$$=\sum_{i=1}^{n}(P_r-C)D_i-\sum_{i=1}^{n}\sqrt{2D_iO_iH_r}(1+\frac{O_m}{2O_i}+\frac{H_m}{2H_r})$$

3.2 Model of Non-horizontal Coordination but Vertical Coordination

When the supplier cooperates with enterprise i, the profit of supplier is:

$$B_{mi}=(P_m-C)D_i-\frac{D_i}{Q_i}O_m-\frac{Q_i}{2}H_m$$

The profit of the enterprise i:

$$Q_r^*=\sqrt{\frac{2nD_i(O_r+O_m)}{H_r+H_m}}$$

$$B_i=(P_r-P_m)D_i-\frac{D_i}{Q_i}O_i-\frac{Q_i}{2}H_r$$

The total profit of the supplier and the enterprise i:

$$B_{mir}=(P_m-C)D_i-\frac{D_i}{Q_i}O_m-\frac{Q_i}{2}H_m+(P_r-P_m)D_i-\frac{D_i}{Q_i}O_i-\frac{Q_i}{2}H_r$$

$$=(P_r-C)D_i-\frac{D_i}{Q_i}(O_m+O_i)-\frac{Q_i}{2}(H_r+H_m)$$

We calculate the max B_{mir}, and achieve the optimal order quantity:

$$Q_i^*=\sqrt{\frac{2D_i(O_i+O_m)}{H_r+H_m}}$$

$$\max B_{mir}=B_{mir}(Q_i^*)=(P_r-C)D_i-\sqrt{2D_i(O_i+O_m)(H_r+H_m)}$$

When a supplier cooperates with n enterprises, the profit of the supply and demand system is:

$$B_{mr}(Q_i^*)=\sum_{i=1}^{n}B_{mir}(Q_i^*)=n(P_r-C)D_i-n\sqrt{2D_i(O_i+O_m)(H_r+H_m)}$$

3.3 Model of Horizontal Coordination but Non-vertical Coordination

The profit of the procurement alliance constructed by n enterprises is:

$$B_r=\sum_{i=1}^{n}(P_r-P_m)D_i-\sum_{i=1}^{n}\frac{D_i}{Q_r}O_r-\frac{Q_r}{2}H_r=n(P_r-P_m)D_i-\frac{nD_i}{Q_r}O_r-\frac{Q_r}{2}H_r$$

We calculate the maxB_r, achieving the optimal order quantity of the procurement alliance:

$$Q_r^*=\sqrt{\frac{2nD_iO_r}{H_r}}.$$

Therefore, the optimal total profit of the procurement alliance:

$$\max B_r=B_r(Q_r^*)=n(P_r-P_m)D_i-\sqrt{2nD_iO_rH_r}$$

In the above condition, the total profit of the supplier:

$$B_m(Q_r^*)=n(P_m-C)D_i-\frac{nD_i}{Q_r^*}O_m-\frac{Q_r^*}{2}H_m=n(P_m-C)D_i-\sqrt{\frac{nD_iO_rH_r}{2}}(\frac{O_m}{O_r}+\frac{H_m}{H_r})$$

According to the above two formulation, the maximum profit of the supply and demand system is:

$$B_{mr}(Q_r^*)=B_m(Q_r^*)+B_r(Q_r^*)=n(P_r-C)D_i-\sqrt{2nD_iO_rH_r}(1+\frac{O_m}{2O_r}+\frac{H_m}{2H_r})$$

3.4 Model of Horizontal Coordination and Vertical Coordination

The total profit of the supplier and the procurement alliance is:

$$B_{mr}=\sum_{i=1}^{n}(P_r-P_m)D_i-\sum_{i=1}^{n}\frac{D_i}{Q_r}Q_r-\frac{O_r}{2}H_r+\sum_{i=1}^{n}(P_m-C)D_i-\sum_{i=1}^{n}\frac{D_i}{Q_r}O_m-\frac{Q_r}{2}H_m$$

$$=n(P_r-C)D_i-\frac{nD_i}{Q_r}(O_r+O_m)-\frac{Q_r}{2}(H_r+H_m)$$

We calculate the $\max B_{mr}$, obtaining the optimal order quantity:

$$Q_r^*=\sqrt{\frac{2nD_i(O_r+O_m)}{H_r+H_m}}$$

When the order quantity equals the above formulation, the B_{mr} achieves the biggest quantity.

$$B_{mr}(Q_r^*)=n(P_r-C)D_i-\frac{nD_i}{Q_r^*}(O_r+O_m)-\frac{Q_r^*}{2}(H_r+H_m)$$

$$=n(P_r-C)D_i-\frac{nD_i(O_r+O_m)}{\sqrt{\frac{2nD_i(O_r+O_m)}{H_r+H_m}}}-\frac{H_r+H_m}{2}\sqrt{\frac{2nD_i(O_r+O_m)}{H_r+H_m}}$$

$$=n(P_r-C)D_i-\sqrt{2nD_i(O_r+O_m)(H_r+H_m)}$$

4. SAFEGUARD OF COLLABORATIVE PROCUREMENT IN THE CLUSTER SUPPLY CHAIN ENVIRONMENT

Effective collaborative sourcing must rely on strong technical means. Enhance the level of information procurement of materials, construction of information sharing platform is the only way for enterprises to carry out collaborative procurement. IT technology and advanced management methods are integrated can make the procurement problems eased. Collaborative procurement information platform should first realize the sharing and transmission of purchasing data, and realize the basic functions of timely input, dynamic update and real-time sharing of procurement information. Procurement information, including demand information, supply information, inventory information, procurement information and price information Each of the above information must be clear and complete, not only contains the quantity and quality of materials, including the type, number, order date, expected date of arrival and so on. Horizontal, Collaborative Procurement Manager, buyer, the project team members and members of the Department can view real-time information updates, to grasp the latest data, to change the situation in the past fragmented information. Vertically, it is used to realize the information sharing between the company and its strategic cooperative suppliers. Through information sharing, strategic cooperative suppliers to understand the type, quantity, delivery date and special requirements of the materials can help suppliers to supply better. Integrate all kinds of

standard management into the information system. More importantly, the number of delivery and procurement information platform of precipitation delivery quality, procurement cost, on-time delivery, service satisfaction, inventory turnover, cash flow and other indicators of collaborative, the data base for supplier selection and elimination.

5. CONCLUSION

The core of the cluster supply chain is the collaborative strategy to enhance competitiveness of the related enterprises. The collaborative Procurement is an important coordination way among the enterprises. This paper gives the different collaborative procurement models in the cluster supply chain environment and calculates the profit in different models. The results show that the maximum profit can be obtained in the horizontal and vertical coordination. The model should be wideldy adopted in the cluster supply chain environment.

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