International Journal of Electronics Communication and Computer Engineering
Volume 3, Issue 3, ISSN 2249 –071X

Matching Model Analysis of Supply Chain Structures and Production Mode Under Mass Customization

Yanhong Qin, Yuanfang Geng

***Abstract* — As an effective way to reduce costs and improve customization level, postponement strategy has been adopted by many domestic and foreign enterprises. In order to make correct choice of the supply chain structures according to product characteristic and market demand, different from simply study of supply chain structures before, matching model of supply chain structures(rigid, postponed, modularized and flexible) and production mode (MTS, ATO, MTO and ETO) are analyzed based on the cost control and customization. We applied the matching model to some various actual cases to help the enterprise to choose the right supply chain structure under different production mode.**

***Key Words* — Cost; Postponement; Supply chain structure; Production mode**

I. INTRODUCTION

With the development of social economy and diversification of customer needs, enterprises increase product portfolios based on market demand forecast in order to meet customer needs, but the uncertainty of demand forecasts is often not good for production optimization development [1]. Alderson (1950) introduced the concept of "postponement", and he defined "postponement" as a marketing strategy which postponed changes of forms and characteristics as far as possible, and customer driven activities in supply chain are delayed until received orders, which makes products and service meet customer needs better. Hewlett-Packard sent computers which were not installed power supply system to various places and then installed a suitable power supply system according to local demand [2]. Benetton delayed dyeing activity until the end market, and it first sewed white fabric, and then dyed different colors according to needs of customers. Postponement strategy not only can reduce product inventory but also reduce the risk of demand uncertainty [3].

Cost control and customization are the two important factors in supply chain management. Cost is related to the difficulty degree of the products' design, manufacture and assembly in the whole supply chain, and customization is related to the satisfaction degree of customer diverse demand [4]. By analyzing correspondence relationship between supply chain structure and production mode based on the cost control and customization not only has great theoretical significance to the research of postponement strategy, but also has great management significance to the development of enterprises [5]. Enterprises adopt supply chain which combine push and pull supply chain, and the goal is to provide low-cost personalized products to the customer quickly, so that the enterprise can select the appropriate supply chain structures according to the characteristics of products to reduce costs and optimize the customer demand [6, 7].

II. PRODUCTION MODE BASED ON THE COST CONTROL AND CUSTOMIZATION

The key to carry out postponement strategy is CODP (CODP, Customer order decoupling point) [8]. Before CODP, enterprise mainly adopt push supply chain which mainly forecast market demand and implement large-scale production, and the goal is to improve supply chain efficiency and reduce the cost of the supply chain [9]. After CODP, enterprise can mainly adopt pull supply chain which depend on customer orders and implement small-scale processing, and the goal is to improve the response speed of the supply chain as well as the ability to provide customers with customized products and service [10].

In general, supply chain activities include supply, design, manufacture, assembly and retail. The position of CODP is changeable [11]. The more upstream of CODP in the supply chain, the more obvious pull supply chain, and the higher the degree of customer participation. The more downstream of CODP in the supply chain, the more obvious push supply chain, the lower the degree of customer participation [12]. The different position of CODP lead to different modes of production, this is a new understanding of these four production modes based on cost and customization. As shown in Figure 1, the vertical axis represents the cost, and the horizontal axis represents customization level. When other conditions are same, scale advantage plays a very important role in reducing the production cost, but it also reduces customization level. At this point, the cost and customization level are in a low level, enterprises will adjust the position of CODP according to product characteristic and market demand characteristic, every points will result in corresponding changes about the costs and customization level. As shown in Figure 1, from MTS (Make to stock) to ETO (Engineer to order), The costs and customization level increase or improve one by one.

A. MTS

Make To Stock, CODP is positioned in retail activity. Enterprises forecast products fully depend on market demand and arrange production according to their own inventory. In the supply chain, there is not the participation of customers from the supply to the retail, customers select their favorites in the final product, the entire supply chain can quickly and timely response to customer demands, and the costs is low, but the available choice of customers is very limited. Under this production mode, customization level is very low, and if existing deviation in the market forecast, it can easily lead to

overstock or out of stock, which lead to the loss of funds further.

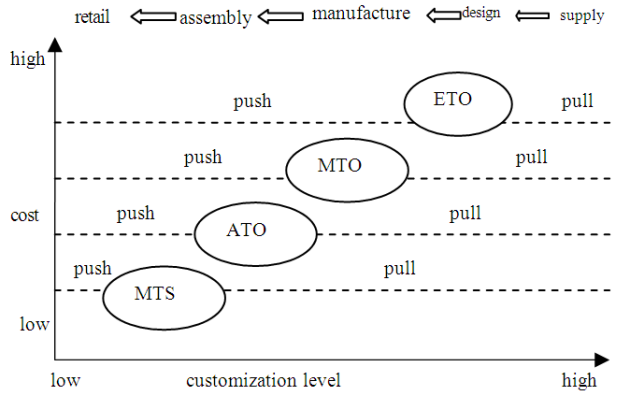

Fig.1. Four production mode based on different positioning of CODP

B. ATO

Assemble to order, CODP is positioned in assembly, enterprises produce large-scale standardized components and assemble existing standardized components and modules to meet customer order requirements after receiving customer orders, customers participate in assembly aspects. Under this production mode, production cycle is reduced and the response time to customers is prolonged, costs and customization level are both improved relatively. Enterprises can avoid overstock or out of stock, and they can also meet customers demand quickly. Most products are about electronic equipment, automobiles, etc.

C. MTO

Make to order, CODP is positioned in manufacture activity, enterprises arrange production plans with purchased components and modules to meet the needs of customers, customers participate in manufacture aspects. Under this production mode, advantages of scale economy is gradually weaken, the response time to customers are longer, cost and customization level are relatively higher. Enterprises will arrange production only receiving customer orders, not to make any inventory. Most products are about aircraft, ships, etc.

D. ETO

Engineer to order, CODP is positioned in design activity, enterprise entirely design product according to customer order, and then proceed to the procurement, production and other activities, and customers participate in design aspects from the beginning, enterprises meet the demand of customer service at the greatest degree. Under this production mode, production costs and customization level are highest. Such enterprises generally have a high degree of product design management capabilities, and most products are about complex structure, such as special test equipment, generator sets, etc.

III. SUPPLY CHAIN STRUCTURE BASED ON THE COST AND CUSTOMIZATION

According to the modularization of inbound logistics and the postponement of outbound logistics, Ricardo (2000) and Sheng (2004) have divided supply chain into four classes: rigid, postponed, modularized and flexible. Rigid supply chain is a traditional vertical integrated supply chain, and the goal is to obtain scale economy through producing and storing a large number of products. Modularized supply chain gets standard finished products through the assembly of its component, and the procurement of the components can be obtained through the outsourcing and other forms which can provide the products to the customers at a reasonable price. Postponed supply chain obtained scale economy by mass production to meet specific customer need according to the customer order. Flexible supply chain integrate modularized supply chain and postponed supply chain, manufacturers outsource different components and finally design, product and assemble components according to special customer needs.

As two important factors of supply chain management, different costs and customization level reflect different supply chain structures, although dividing the supply chain into rigid supply chain, postponed supply chain, modularized supply chain modular and flexible supply chain from the two dimensions, the meaning is different. As shown in Figure 2, the vertical axis represents the cost, and the horizontal axis represents the customization level. These two dimensions divided the region into four parts, the parts I represents rigid supply chain with low cost and customization level parts II represents postponed supply chain with a high customization level but the cost is low, parts III represents modularized supply chain with high cost but low customization level and parts IV represents flexible supply chain with high costs and customization level.

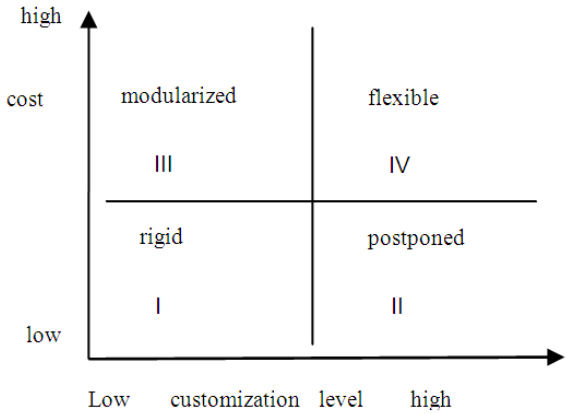

Fig.2. Supply chain structures based on the cost control and customization

A. Rigid supply chain

Complexity and products cost are low, enterprises produce and store large amounts of products entirely according to market demand forecast, and customers select

their most satisfied final products, so customization is low, enterprises reduce costs mainly through economies of scale.

B. *Postponed supply chain*

Complexity and cost of products are relatively lower, but a high customization level is required, enterprises' major goal is to meet customer needs while reducing customer response time and costs. in the entire supply chain, before CODP, , it allows enterprises to take advantage of economies of scale to achieve cost advantages due to products with low complexity, and after CODP, enterprises produce according to the diverse needs of customers, so that it not only reduce the uncertainty costs, but also reduce market uncertainty risks.

C. *Modularized supply chain*

Complexity and cost of products are relatively higher, enterprises' major goal is to reduce costs on the basis of improving customized products and service capabilities. In general, the enterprises purchase components through outsourcing and other forms to get standardized finished products, but these formats of the finished product are limited. Therefore, customization level is relatively low.

D. *Flexible supply chain*

Complexity and cost of products are highest, products are required to meet the needs of customers from design aspect, enterprises' major goal is to reduce costs while improving customer response speed, best meet the customized needs of the customer, which requires to combine costs with customization level effectively.

IV. MATCHING MODEL OF SUPPLY CHAIN STRUCTURE AND PRODUCTION MODE

Enterprises should select the appropriate supply chain structure and production mode based on cost control and customization to meet various customer needs with low cost and high efficiency. Enterprises should be aware that if it is to reduce costs through scale economy, the level of customization is inevitably low, but in order to get high level of customization, costs will increase. If products are about daily necessities, there is no need to require a high level of customization, but to reduce costs by mass production, and thus the rigid supply chain is the most appropriate. If the products are about technical, customer demand is complex and diverse, in order to meet customer demand, costs will increase, and then the enterprise will select the specific supply chain structure based on the specific characteristics of the products.

Supply chain structure and production mode are respectively elaborated above, this section the correspondence connection between the two is analyzed based on cost control and customization. As shown in Figure 3, the horizontal and vertical axis still represent customization level and costs, four matches are obtained, that is rigid MTS, modularized ATO, postponed MTO and flexible ETO.

A. *Rigid MTS*

The combination of MTS and rigid supply chain as shown in Figure 1 and Figure 2, when MTS is adopted, customization level and costs are very low, so it is suitable for rigid supply chain. The products under rigid MTS are about a large class of low complex standardized products, costs and delivery time are key factors in delivery process, which requires enterprises to produce and store large amounts of standardized products, such as the largest food and beverage manufacturer Wahaha, the species has been involved in the drinking water, carbonated drinks, tea drinks, milk drinks and other beverages industries to meet the diverse needs of customer. Swiss coffee beans have instant coffee, espresso grind coffee which is provided for customers to choose.

B. *Modularized ATO*

The combination of ATO and modularized supply chain, When ATO is adopted, customization level is relatively low and the cost is relatively high, So it is suitable for modularized supply chain. The color and size of Tisettanta furniture can be adjusted according to customer demand, but each part of the furniture has different cycles, the cost is high. Under modularized ATO, enterprises combine different standardized modules into a limited variety of products to meet customer demand, although choice of customers is limited, but it allows enterprises to produce mass standard parts and components to get the advantage of economies of scale, and it also allows enterprises to get components by outsourcing to provide a reasonable price to the customer, such as computer industry, enterprises use the advantages of manufacturing resources around the world to produce parts and to assemble in places close to the sale of land, For example, Dell put their main focus on co-operation with suppliers in order to share information with suppliers, purchase and organize production after receiving customer orders. GOME in China has its own warehouse, in addition to store products, in order to meet diverse customer need, so it also requires packaging and processing in the warehouse to improve the value of the products.

C. *Postponed MTO*

The combination of MTO and postponed supply chain, When MTO is adopted, customization level is relatively high, the cost is relatively low, it is suitable for postponed supply chain. Enterprises store a lot of raw materials and parts in order to obtain scale advantages, and the rest of the activities will be delayed until the customer orders. Amaretto is the cream liqueur produced in Italy, it can take different customer strategies according to different market demand. In the face of international market, the enterprise delay packaging and labeling, but in the local market, timely delivery does not allow the enterprise postpone any link. Procter & Gamble has adopted "Network order management" online system to complete the order request of the end retail link, whenever and wherever retail customers can be directly connected to the P & G. In the application of the network platform, according to the order analysis, enterprise identified the factors that attract consumers and allow people to answer a set of questions to reflect their needs. For example, a shampoo enterprise

can produce unique shampoo according to the different customers. Another example is Levi, which can produce customized jeans based on different sizes of consumers, by providing the following options: colors, pants, knee width in the web site, the customers can truly make their own jeans, the sales access to customer's size to produce jeans in the factory.

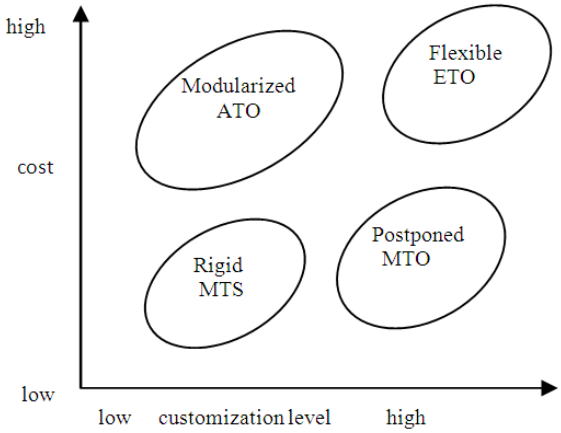

Fig.3. Matching model of supply chain structure and production mode

D. Flexible ETO

The combination of ETO and flexible supply chain, when ETO is adopted, customization level and costs are very high, so it is suitable for flexible supply chain.

The components have standard interfaces, so enterprise would assemble timely according to customer needs, and they have their own suppliers and distributors, and take flexible supply chain structures based on the expectations of the customer strategy. Toyota's production accounts for a substantial advantage in the automotive market driven by customer orders, and Trainer aircraft manufacturer Macchi aircraft can produce a variety of aircraft for special training according to the special needs. Another example is furniture manufacturing enterprises, as furniture products is heavy and large, the processing time is quite long and expensive, there is a certain response time to customers, So the purchase of raw materials and production plans should be made prior to product promotion to determine a reasonable time to reach the finished assembly line. B & B Italia furniture manufacturing company would make market research and communicate with customers before production for the purchase of raw materials, then make production plans based on customer orders, For example, the company delays production of sofa foam framework to the receipt of customer orders.

V. CONCLUSION

Cost control and customization are two important factors in supply chain management, this paper discussed how to choose correct supply chain structures according to the cost control and customized level. Then, with case study of domestic and foreign enterprise, supply chain structures and production mode are rediscussed and matched on the basis of these two factors, which can bring enterprise certain significance on choices of the supply chain under internal and external environmental factors. There are four match types in analysis of matching model, rigid MTS is the combination of MTS and rigid supply chain, and customization level and costs are very low. Modularized ATO is the combination of ATO and modularized supply chain, and customization level is relatively low and the cost is relatively high. Postponed MTO is the combination of MTO and postponed supply chain, customization level is relatively high and the cost is relatively low. Flexible ETO is the combination of ETO and flexible supply chain, and customization level and costs are very high.

REFERENCES

[1] Y. S. Li, F. F. Ye. Yang Jianguo, "Modelling and Optimization of Supply Chain Based on Modularization and Postponement", *China Mechanical Engineering*, vol. 15, no. 11, pp. 968-972, 2004.

[2] P. Zipkin, "The Limits of Mass Customization", *MIT Sloan Management* , vol. 42, no. 3, pp. 81-87, 2005.

[3] E. Ricardo, K. Bardia. "Evaluation of Supply Chain Structures through Modularization and Postponement", *European Journal of Operational Research*, vol.124, no. 3, pp. 495-510, 2001.

[4] B. Alessandro, Marta Z, "Evaluation of product customization strategies through modularization and postponement", *International Journal of Production Economics*, vol. 120, no. 3, pp. 205-220, 2009.

[5] W. Alderson, "Marketing efficiency and the principle of postponement",*Cost and Profit Outlook* , March, 1950.

[6] R. B. Chase, "The customer contract approach to services: Theoretical bases and practical extensions", *Operations Research*, vol. 29, no. 4, pp. 698~706, 1998.

[7] M. R.Susan, "Case Studies of Postponement in the Supply Chain", *Operations Research*, vol.13, no. 4, pp. 68~76, 2004.

[8] B. Dan, "Mass Customization—Build Enterprises' Core Competitiveness in the 21st Century", Chinese Science press, May, 2004.

[9] J. Liu, "The Research of Separation Positioning and its Form Choices under Postponed Manufacturing", *Jiangsu Commercial Forum*, no. 1, pp.69-70, 2004.

[10] S. H. Ma , J. Liu, "The significant means of supply chain management — postponement", *East China Economic Management*, vol. 16, no. 2, pp.80-81, 2002.

[11] P. G. Wang, R. Q. Chen, "Postponed Manufacturing—The Dell Customization Core Strategy", *Science and Technology Management Research*, vol. 24, no. 5, pp. 35-37, 2004.

[12] Y. X. Wang, "Chain Enterprise Research of Postponement Strategy in Massive Procurement Orders", Logistics Management, vol. 29, no. 12, pp. 137-140, 2006

[13] S. W. Sun, "The discussion about push-pull supply chain based on delay tactics", *Storage Transportation & Preservation of Commodities*, vol. 32, no. 9, pp.103-105, 2010.

AUTHOR'S PROFILE

Yanhong Qin

Sichuan Province, China. Birthdate: Nov, 1981. Work as associate professor in Management School of Chongqing Jiaotong University, and research interests on mass customization and supply chain management.

Yuanfang Geng

Henan Province, China. Graduate student in Management School of Chongqing Jiaotong University, and research interests on mass customization and postponement strategy.