The Construction of Collaborative System of Military Production Supply Chain

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Abstract. Firstly, the paper proposed the definition and characteristics of military production supply chain from the perspective of system science. Secondly, it constructed the framework of collaborative system of military production supply chain based on the analysis of collaborative system of military production supply chain, and put forward the collaborative structure model of military production supply chain based on three-dimensional, three-dimensional displayed and three-collaborative-point plane model of collaborative system of military production supply chain based on the collaboration of strategic level, information sharing layer and business layer. Finally, it put forward suggestions to optimize the collaborative system of military production supply chain, which has a strong reference value for China's military development and production units to coordinate the supply chain and optimize the production.

Introduction

With the rapid development of economic globalization and information technology, the relationship between the upstream-downstream members of the supply chain is increasingly getting more and more complicated. The application of supply chain management model has become wider and wider in industrial manufacturing enterprises and commodity circulation enterprises. So the collaboration issue between the upstream and downstream enterprises of supply chain has also become the focus of scholars and business decision-makers. In military production supply chain, how to achieve collaboration has become a new focus of research. For today's enterprises, competition is not just the competition between enterprises. It has already extended to the competition between enterprise supply chains and supply chains. Compared with the traditional competition between enterprises, the competition between supply chains pays more attention to "Competition - Cooperation" mechanism. In this process, the collaboration among supply chain enterprises is the key for enterprises to gain competitive advantage. For the range of the necessary military components and raw materials is wide, the military production supply chain is a relatively complex system. The paper will propose the definition and characteristics of military production supply chain from the perspective of system science, analyze the basic theory of the collaboration system of military production supply chain, plan to construct the framework and model of collaboration system of military production supply chain and further improve the coordination theory of military production supply chain by combining with the development characteristics of military production, aiming to guide China's military development and production units to collaborate with supply chain and optimize production practices.

The Definition and Characteristics of Military Production Supply Chain

The Definition of Military Production Supply Chain

Supply chain is a network of “supply - production – sales” relationship around the core enterprise, namely a cooperative relationship which regards the interests of core businesses, suppliers and vendors as the core [1]. Core enterprises achieve the overall control and management of the production chain by controlling the logistics, information flow and capital flow of the upstream and
downstream enterprises. In this process, the function network formed by suppliers, manufacturers, vendors, and customers is called supply chain. This supply chain is also a value-added chain, including the value-added process of all materials chains, capital chains and information chains from suppliers to users, including raw materials procurement, freight, manufacturing, order management, inventory management, maintenance services, and other links [2-4].

The definition of military collaborate supply chain regards military research and development unit as the core, which is a process beginning with raw materials procurement, then to the implementation of batch production process by controlling three flows in the process of production development, and finally to the realization of military products delivery through delivery network. Like the production of traditional manufacturing enterprises, military production supply chain refers to the process in the manufacturing process regarding military development and production unit as the core, which begins with the procurement of product raw materials, spare parts, then to the product development and assembly production, and the final delivery to the demand side of military products [5-8]. In this process, all suppliers, military development and production unit and the demand side of military products form a network like a chain structure, which has things in common with the supply chain of traditional manufacturing. What can reflect the characteristics of military production lies in that the development of the military is a complex process. However, military production supply chain has different security classifications between levels, which makes the entire chain information cannot be fully shared. And only after a very long period of pre research in earlier stage, the performance and technical indicators of military products can be guaranteed to meet the standard [9].

According to the above definition, the general form of supply chain structure constructing military production as shown in Figure 1:

![Figure 1. The basic structure of the military supply chain.](image)

**The Characteristics of Military Production Supply Chain**

1) *Market demand-oriented, significant leading role of technology.* Under current market conditions, for the technology Research Institute with solid scientific research strength, it is difficult for make-to-order only to keep a foothold in the increasingly fierce military market. Numerous Military Institutes of Technology conduct necessary development and production according to the current technical level and potential market demand, which not only ensures its products to gain
2) **Military production supply chain has the characteristics of short head and tail.** For general manufacturing supply chain, its main components include suppliers, manufacturers, distributors, retailers and customers, etc. And sometimes suppliers and distributors will have several levels. In contrast, military production supply chain does not have the link of dealers and retailers. Suppliers also usually have several levels. However, compared with many supplier networks of ordinary manufacturing enterprises, the supplier network of military production is much more concise. On the one hand, it is because that military products have security features as a special kind of military product, which has a higher requirement to military parts suppliers and should not to use too many suppliers; On the other hand, as a kind of special product with high technology content and big development difficulty, military products have a very high demand to supplier's scientific research and technical level. Such almost harsh technical requirements will certainly make less part suppliers of military products [10]. Therefore, the process of batch production supply chain with military technology research institute as the main body has the characteristics of short head and tail.

3) **The distribution of military production supply chain is in the form of reticulum.** The network of military production supply chain also presents the distribution characteristics of reticulum at the same time. As shown in Figure 2, in this military production supply chain, military technology research institute as a manufacturer is in the center of the supply chain. Surrounding parts suppliers are mainly divided into 2 categories of ordinary suppliers and custom class suppliers. And ordinary parts suppliers provide the required parts of standard military production. Their relationship with military technology research institute is also based on the relationship between planning and inventory. This relationship is generally stable and not affected by different types of military products; another type of supplier is the suppliers customizing parts. This kind of suppliers provides custom type parts for the batch production of military products. According to the different types of military development and production every time, Military Technology Research Institute selects appropriate suppliers for customized parts. Their relationship is a cooperative relationship based on tasks. Therefore, it is somewhat different and usually dynamic.

![Figure 2. Structure with CALT center of supply chain.](image)

4) **The collaboration of military production supply chain is complex.** The complexity of military production supply chain is embodied in the complexity of form and subject. The supply chain of military production is an extremely complex system, including cooperation and competition. This process is a process of dynamic and continuous game [11-13]. Military production technology research institutes, military parts suppliers and military products demand side form a dynamic
supply & demand supply chain with a fast response. On the dynamic supply chain, each member enterprise shoulders the responsibility to realize one or several functions. The mutual cooperation and restraint between these members directly relate to the exertion of the overall function of the supply chain. These members can achieve common value only by collaboration. It is this complex topological structure of network that determines the complexity in the form of military production supply chain [14].

The Collaborative System Framework of Military Production Supply Chain

In military batch production, the collaborative system of supply chain, with the manufacture of military products as the core, refers to a kind of common value chain formed by many enterprises which regards military production as strategic objective, is also a benefit association constituted by joint and consultative organization at the same time. This kind of collaborative supply chain is very favorable to the competitive environment and complex competition with manufacturers as the core, seeking an effective organizational effect, reducing overall cost and pursuing value chain advantages, forming a competitive advantage group and the competitiveness of core manufacturers. Therefore, in the actual operation process, the collaboration of military production supply chain should embody the collaboration of different levels.

Based on the basic theory of supply chain and the characteristics of military production supply chain, the research has constructed a three-level system framework for the collaboration of military production supply chain. The collaboration of military production supply chain is divided into three levels, namely strategic organizational level, information sharing level and business process level. Strategic organization and business process are the core of military production supply chain collaboration. Information sharing level is the basic premise of the military production supply chain coordination.

1) Collaboration in strategic organizational level. The characteristics of military production determine that all enterprises of military production should make the completion of military production mission as the core. The cooperation between enterprises is particularly important under a common goal. The agreements and game between enterprises are the basis to distinguish responsibilities and obligations. Clearing the demand of military customers is a prerequisite to achieve goals. Perfecting collaboration organization between enterprises is a protection to achieve goals.

2) Collaboration in information sharing level. Information sharing is a basic prerequisite to achieve collaboration. Through information sharing platform, it will integrate the information of military production between each military enterprise, realize the information sharing in the production process, supplier supporting material information, inventory information sharing, deliver information to the military, and share and exchange market information and operational information at the same time, improve the quick response and collaborative ability of the whole supply chain, and meet the production and technical requirements of military customers.

3) Collaboration in business process level. According to the actual characteristics and features of military production supply chain collaboration, customers are the military at the operational level while several other nodes of supply chain regard manufacturers as the main body. It is different from the general supply chain for it has no the link of wholesalers and retailers. So it is the relationship between suppliers and core manufacturing enterprise that plays a critical factor in the supply chain collaboration of military production, namely supplier's choice as a key element. These factors determine the effect of collaborative system of military production supply chain.
Collaborative Structure Model of Military Production Supply Chain

Three-dimensional Collaborative Structure Model
From the analysis based on the collaboration framework of military production supply chain, it draws that the collaboration of military production supply chain in three levels is a three-dimensional collaboration. In the three-dimensional structure of the composition, the lines of strategic coordination point A, business collaboration point B and information collaboration point C form a triangular area, which constitutes a three-dimensional coordination system with the minimum of cost O as the core. The plane formed by $\triangle ABC$ is a collaborative plane formed by the collaboration of three levels, which is the collaboration under their optimal conditions, namely the condition of the lowest price. The line between A and B is just the information flow line in the supply chain, the line between A and B the capital flow line; the line between C and B the logistics line, thus an effect collaborative system surface of supply chain is formed.

Three-dimensional Expansion Collaborative Structure Model
Based on above Figure, three-dimensional $\triangle ABC$ plane is a common collaborative surface formed under the lowest cost and optimal condition of three collaboration levels, namely the collaboration plane of military production supply chain. The vertical distance between the surface and the cost O is the optimal cost of supply chain collaboration of military production. In order to simplify the complex problem and extend three-dimensional planes for analysis, combine the collaboration system of military production supply chain based on frame analysis. The surface formed by strategic collaboration A, business collaboration B and cost O is the collaborative surface of strategic level. The surface formed by information collaboration B, strategic collaboration A and cost O is the collaborative surface of information sharing level. The surface formed by business collaboration C, information collaboration B and cost O is the collaborative plane of business level.

Plane Collaborative Structure Model Formed by Three Collaborative Points
From the three-dimensional collaborative system diagram of military production supply chain in Figure 5, it can be drawn that a plane of three-dimensional triangular presented from the three-dimensional structure and the plane formed by the lines of $\triangle ABC$ are collaborative system plane of military production supply chain. The advantage of expanding plane is to describe the operation process in detail. But in order to calculate the budget, production and profit of military production, accurate mathematical calculations and sophisticated software techniques are needed, which will make the calculation simpler at the same time.

In order to simplify the research process of the problem, we firstly start with the military production supply chain formed by the main members. The member enterprises of the supply chain from top to bottom are respectively demand enterprises (D), military production research institute (R), raw material suppliers of military production (S). The following is a detailed description of the parameters in the model system.

- Raw material suppliers’ cost per unit of product is $c_1$.
- The necessary cost of the production unit of production technology research institute is $c_2$. Suppose $c_1$ and $c_2$ are constant, there will be no shortage cost and dull sale.

- When providing raw materials with production research institutes, the price that the raw material suppliers of military production is abbreviated as wholesale prices $v$, $v>c_1$.
- After the final development of military, the final selling price is $p$, $p>c_2+v$.

- The quantity of parts ordered from military production research institute by the suppliers is equivalent to the quantity of military production $q_1$.
- Demand side’s number of military production purchased from military production research institute is $q_2$. Suppose $q_1=q_2=q$.

Suppose the demand side obtains a certain level of utility ($u$) according to the characteristics of the product itself when buying military products. The utility is actually embodied as a function of...
price and quantity: \( u = u(p, q) = \alpha p + \beta q \), if \( \alpha > 0, \beta > 1 \), investigate demand enterprises’ attention degree to the quantity and price of products.

In addition, according to the curvilinear relationship between supply and demand of general market, suppose that there is a hyperbola – like relationship between quantity and price. That is, when the price \( p \) increases, sales volume \( q \) will decrease. The relationship between them can be expressed as: \( q = Ap^{-n} \), where \( A \) is constant, namely the elasticity of demand price. When \( >1 \), it shows the demand price of mass-produced items of military industry is elastic.

**Suggestion on the Collaborative Optimization of Military Production Supply Chain**

The fifth plenary session of the 18th CPC Central Committee proposed the strategic task to develop armed forces, aiming to form a development pattern with total elements, multi-field and high efficiency, adhere to the integration of all elements, promote two-way flow and infiltration compatibility of the information, technology, human resources, capital, facilities, services and other elements between Chinese army and its civilians, and form the depth collaboration between the entire country, all production factors and total resources. At present, the weapons & equipment development and production in China have already established a centralized and unified leadership decision-making mechanism, coordinated working mechanism with the army and civilians participated in military & government authorities, military and private enterprises. Each department divides labor clearly. Military and civilian division of labor is managed separately. The work system of planning connection, division construction, collaborative operation and resource sharing has initially been established. Around the major strategic deployment of national weapons and equipment, suggestions on the collaborative optimization of military production supply chain are as follows:

1) **Construct the collaborative system of military production supply chain.** Firstly, strengthen the internal information network construction of military production supply chain system. The established network information exchange platform should be open. Meanwhile, popularize the application of electronic communication mode in military production supply chain system, and promote the full sharing and flow of information. Secondly, as the core enterprise in military production supply chain, determine the rights and responsibilities of each member enterprise by combining quantitative and qualitative analysis; optimize collaborative solutions; and ultimately establish an effective profit collaborative system. Thirdly, to ensure that each enterprise can strive for the whole performance in supply chain system, eliminate the pursuit of maximizing their own interests, military production supply chain enterprises should establish a certain trust mechanism.

2) **Achieve the internal and external collaboration of military production supply chain system.** On the one hand, promote the construction of internal collaboration system by establishing common cultural atmosphere in military production supply chain system; On the other hand, combine the characteristics of military production supply chain system with the characteristics of the external market environment; take full advantage of their own characteristics by analyzing the internal and external characteristics, aiming to adjust the internal operating mechanism of the system to adapt to the changing external environment. Through the establishment of specialized agencies and departments, ensure company culture and atmosphere adapt to the mission, objectives, composition, function and framework of military production supply chain system at home; as well as the efficient and convenient channel of information transmission and communication between the internal enterprises of system. Collect external environment market information; achieve the adaptation between the interior and exterior of systems, aiming to achieve external collaboration of the whole supply chain system.

3) **Regard military technology research institute as the core; give full play to the guidance advantage of technology.** The research institute of military supply chain should be granted a dominant status to give full play to their core values and lead the direction of research and development. To make the military production supply chain obtain quick adaptability to the market,
the employees within the supply chain should be granted a right position based on the different capacities, aiming to make them give full play to the value of the individual in the group, make them become an indispensable part of a small team, help and encourage each other and promote each other's progress to maximize the effectiveness of collaborative systems.

4) Comprehensively optimize and upgrade the market competitiveness of military production supply chain system. Make full use of the communication and learning platform in supply chain; complement and perfect relevant information in the process of practice; adjust and improve the collaborative system of military supply chain; make it become a perfect information exchange mechanism, profit collaborative system and trust mechanism, and gradually improve the learning ability, innovation ability and production and marketing ability of the whole supply chain system. Meanwhile, participate in the competition of international supply chain timely; make the realization of supply chain’s strategic cooperation and strategic partnership construction a strategic focus. Promote the collaboration and integration of supply chain, and enhance the overall competitiveness of China's military production supply chain system.

References


