Analysis of Uncertainty and Advanced Solutions in Enterprise Supply Chain Management Based on Game Theory

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Abstract. The so-called supply chain refers to the network chain structure formed around the core enterprises, namely suppliers, manufacturers, distributors, final customers, logistics service providers and even supplier suppliers and distributors. An effective supply chain system allows companies to plan and utilize resources from a global perspective. Through the construction of management strategies, management processes, partnerships and information systems, real-time monitoring and regulation of the operation of various business activities within the enterprise. Fundamentally speaking, whether the supply chain node enterprises establish cooperative partnership is a game problem between node enterprises. We need a lot of practical support, more efforts and research work. Only by establishing long-term strategic partnership among supply chain node enterprises can a win-win situation be created and higher profits be brought to enterprises. That is to say, to achieve collective rationality on the basis of individual rationality and to achieve optimal cooperation.

1. Introduction
With the rapid development of high technology, the traditional enterprise management mode can no longer meet the market demand. Modern market competition has gradually changed from competition between enterprises to competition between supply chains [1]. Advanced enterprises regard the value chain that creates customer value as an organic whole and make the supply chain more competitive by increasing the value of the value chain and reducing the overall cost [2]. And supply chain management refers to people's use of scientific management methods such as system management technology, operations research, management science, decision support system, information technology to regulate and control the information flow, logistics, capital flow and value flow in the supply chain on the basis of understanding and mastering the internal laws and interrelationships of all links in the supply chain [3]. By establishing strategic partnerships among members of the supply chain, information sharing can be achieved across the supply chain, reducing the inventory of raw materials, components, and finished products, in order to achieve the best combination and maximize efficiency. Achieve the goal of providing maximum value to customers at minimal cost [4].

Traditional supply chain management theory holds that manufacturers and sellers, as two major components of the supply chain, are more beneficial to their cooperation. However, based on the relevant theories of cooperative and non-cooperative game theory, a new understanding of the two-level supply chain analytical model of manufacturers and sellers is proposed [5]. Under certain circumstances, it is more advantageous to adopt competition between the two sides. The relationship between supply chain member enterprises is both cooperative and competitive. Enterprises should not only ensure their own interests are not violated, but also realize the maximization of supply chain benefits. Making corporate decisions very complicated [6]. How to effectively combine the supply chain members
themselves with the entire supply chain performance and scientifically analyze the specific decision-making actions of enterprises is particularly important [7]. At present, China's research on supply chain management has just started, and has not yet formed a complete scientific system. It is necessary to establish a game model within the framework of game theory to analyze how companies achieve “win-win” in a cooperative state and how to maintain such long-term cooperative relationships [8].

2. Supply Chain Theory and Game Theory Foundation

2.1 Supply chain theory
In the late 1980s, the traditional "vertical integration" management model showed some shortcomings in the operation of enterprises. At the same time, the information system is backward and the coordination of the system is poor. The effective market response and evaluation criteria of customer service cannot be established. Suppliers and distributors compete for price in the short-term interest, thus losing the trust of suppliers and missing opportunities for cooperation. These shortcomings make the transaction costs within traditional enterprises much higher than the adjustment costs of their external prices, and they do not achieve the competitiveness they deserve. In this case, the idea of "horizontal integration" comes into being, that is, to use the external resources of the enterprise to quickly respond to the market demand, and only need to care about the product direction and market. This idea forms a "chain" that runs through all enterprises from suppliers to manufacturers to distributors. Due to the relationship between demand and supply shown by neighboring node enterprises, when all neighboring enterprises are connected according to this, a "supply chain" is formed. At the same time, the supply chain is getting more and more attention.

2.2 Theoretical Basis of Game Theory
The principle of game theory is a mathematical modeling and analysis method based on objective-oriented conflicts and interactions in cooperation, i.e. an analysis method of mathematical modeling. Game theory research occurs when several participants have goal-oriented interactions, including conflicts, cooperation, or both. Game can be divided into cooperative game and non-cooperative game. The difference between cooperative game and non-cooperative game mainly lies in whether the parties can reach a binding agreement when people's behaviors interact. If there is, it is a cooperative game, and vice versa is a non-cooperative game. The cooperative game emphasizes group rationality, emphasizing efficiency, fairness, and fairness. Non-cooperative games emphasize individual rationality and individual optimal decision-making. The result may be efficient or inefficient. The mutually beneficial cooperation obtained under the rational state can only be achieved under the equilibrium situation. If any party deviates from the equilibrium and does not bring additional benefits, the parties will abide by the rules.

3. Uncertainties in the supply chain and the necessity of corporate cooperation

3.1 Supply chain enterprise cooperation
The so-called supply chain refers to the network chain structure formed around the core enterprises, namely suppliers, manufacturers, distributors, final customers, logistics service providers and even supplier suppliers and distributors. Supply chain management is to design, plan and control the logistics, capital flow and information flow in the supply chain from the perspective of system. To minimize the internal friction and waste of each member of the supply chain, and improve the competitiveness or welfare level of all members through overall optimization. Supplier relationship management is used to improve relationships with suppliers upstream of the supply chain. It is a management idea and software technology solution dedicated to establishing and maintaining long-term and close cooperation with suppliers. The goal is to establish a long-term and close business relationship with suppliers and to jointly develop the market by integrating the resources and competitive advantages of both parties.
Expand the market demand and share, reduce the high cost in the early stage of the product, and realize a win-win enterprise management mode.

3.2 Importance of Cooperation among Supply Chain Enterprises
Traditionally, most enterprises think that they and other enterprises exist independently of each other and compete with them for survival. There is often more confrontation than cooperation between enterprises and upstream and downstream. Many enterprises still seek to reduce costs or increase profits on the basis of damaging the interests of other members of the supply chain. Because it is difficult for individuals to have all the advantageous resources, they must resort to other individuals. The purpose of cooperation is to reduce costs, reduce risks, increase group benefits and maximize individual utility. Demand in today's consumer market is changing rapidly, not only manufacturers, but also suppliers, distributors, and retailers must respond quickly and quickly to these changes. It is possible to gain a foothold in the market and gain a competitive advantage. The competitiveness of the supply chain comes from the close cooperation of the enterprises in the supply chain. This kind of cooperation connects the individual isolated information islands of each enterprise, so that the entire supply chain operates like a single enterprise without losing the core advantages of each enterprise.

3.3 The impact of uncertainty on supply chain management
The first kind of uncertainty is transmitted from the customer's demand along the information flow direction of the supply chain to the suppliers at all levels. It directly affects the inventory and inventory time of suppliers at all levels in the supply chain, thus greatly increasing inventory costs. The second kind of uncertainty starts from the initial material supplier to the level of supply along the supply chain, which directly affects the production assembly process and delivery time of the product, thus affecting customer satisfaction. In contrast, the gradual amplification of demand information deviation only increases the inventory of upstream suppliers, while the delay in material supply will lead to the failure of on-time delivery. Serious and even lead to product backlog losses caused by customer returns, so the consequences caused by the second impact are more serious. The network chain structure of supply chain management determines the existence of uncertainty, which brings difficulties to enterprise supply chain management. Measures should be taken as far as possible to reduce the possible adverse effects of uncertainties.

4. Measures to Improve and Develop Supply Chain Management

4.1 Building an Effective Supply Chain System
An effective supply chain system enables enterprises to plan and utilize resources from a global perspective through the construction of management strategies, management processes, partnership and information systems. Real-time supervision and regulation of the operation of various business activities within the enterprise, and the establishment of management strategies to meet the needs of the supply chain. In some enterprises with vertical management mode, all important business activities run in different departments according to different schedules and conflicting objectives. Engineers design products, market personnel develop product strategies and promotions, sales personnel and customers trade, retailers negotiate with suppliers, logistics departments arrange shipments of goods, and so on. But the problem is that no one is responsible for the operation of the entire supply chain. Companies must establish an organizational structure that satisfies the supply chain business processes and make them as flat as possible to facilitate management. In addition, the decision makers in each department need to be brought together to establish an inter-departmental supply chain team to jointly develop strategies and find the best solution.

Supply chain is a dynamic system, which emphasizes the coordination and cooperation between enterprises. Therefore, before an enterprise constructs a supply chain system, it needs to change its values towards its partners. Set up the awareness of "sharing risks and benefits" and treat the value chain and interaction of partners with a win-win attitude. The cooperative relationship between enterprises in
the supply chain should be driven and maintained by interests. On the basis of fully considering their own interests, each enterprise is formed through negotiation, solidified in the form of contract and embodied in the contract. This solidified partnership not only improves supply chain performance, provides a stable supply to buyers, but also provides stable demand for suppliers. Stable partnerships can also reduce transaction costs and strengthen collaboration.

![Figure 1 Supply Chain Management Evaluation System](image)

4.2 **Pay Attention to Knowledge Management Strategy and Apply Knowledge Management Strategy**
Based on the principle of confidentiality, coordination, openness and sharing of knowledge management in the supply chain, a communication mechanism for supply chain is established through the information system. In the era of knowledge economy, knowledge will become the most important strategic resource for enterprises. How to manage and utilize the knowledge resources of enterprises has become a new topic of enterprise management. Knowledge management will become a new management content and development direction of the supply chain. Enterprises should establish an internal knowledge base to improve the knowledge network and information network between enterprises and enterprises. Reduce information interaction costs, optimize business processes, and automate information processing. Using Information Flow to Promote Closer Cooperation between Core Enterprises and Associated Enterprises. Effectively connect suppliers, manufacturers, distributors and customers to promote mutual trust between enterprises. This will enable enterprises to join the supply chain cooperation with higher enthusiasm and make all links of business operation more coordinated. Promote the improvement of capital flow, inventory, cost and service to improve the overall competitiveness of the supply chain.

4.3 **Designing a Comprehensive and Reasonable Supply Chain Cooperation Agreement**
The supply chain cooperation agreement is a text agreement that routinizes, standardizes and standardizes the daily management of the supply chain. It enables the supply chain system to effectively control, operate well and give full play to its efficiency, specifically including the following aspects. Cooperation and coordination mechanism, incentive mechanism, information sharing mechanism, risk sharing mechanism, benefit distribution mechanism, punishment mechanism and elimination mechanism of enterprises at all nodes of the supply chain. They provide the basis and method for solving problems or conflicts between partners in the daily operation of the supply chain. In supply chain management, various measures have been taken to eliminate various hidden dangers and prevent supply chain uncertainty. However, the supply chain is a multi-link, multi-channel complex system, and it is often difficult to avoid such an accident. Therefore, the node enterprises should be fully prepared for the occurrence of such incidents, and predict the degree of loss of various risks in advance, and effectively control them within the acceptable range of the enterprise itself.
5. Game Analysis of Establishing Partnership

5.1 The way of game in the supply chain enterprise transaction

Fundamentally, whether or not to establish a partnership between supply chain nodes is a game problem between node companies. According to the game theory, the profit of a certain node enterprise depends not only on its own behavior, but also on the behavior of another node company with which to trade. In the enterprise transactions between supply chains, the game mode can be divided into cooperative games and non-cooperative games. The cooperative game means that the two parties negotiate to reach an agreement and then act in unison. On the contrary, the non-cooperative game means that the two sides of the game cannot reach an agreement or reach an agreement and betray the agreement, and cannot act in unison. Due to the nature of self-interest, the conflict of interest between the two parties is inevitable, and the possibility of non-cooperation is even greater. Any party to the game does not know what strategy the other party will choose when he has to make his own strategic choices, but each party will anticipate the strategy that the other party will choose. Nash equilibrium is a pair of expectations about each party's choice. This equilibrium is based on the individual's pursuit of self-interest.

5.2 Specific Game Analysis of Supply Chain Cooperation Relationship

In fact, it is very wise to cooperate for the common interests of both parties. The prisoner's dilemma provides us with a counterexample of such a non-cooperative game. When individuals pursue their own interests, the results are very unfavorable to each other. Suppose there are two game participants, one is the supplier in the upstream of the supply chain and the other is the manufacturer in the downstream of the supply chain. Suppliers have two strategies, that is, cooperation and non-cooperation. However, manufacturers also have two strategies of cooperation and non-cooperation, and both suppliers and manufacturers can adopt strategies independently. When both the supplier and the manufacturer adopt the cooperation strategy, assuming the income is 4 units. When the supplier cooperates and the manufacturer does not cooperate, the utility is -2 units and 6 units respectively. The utility matrix is used to represent the game combination of both parties, as shown in fig. 2.

![Game matrix](image)

Figure 2 Game matrix

As can be seen from the figure, no matter what kind of strategy the manufacturer chooses, the profit of the supplier choosing non-cooperation strategy is higher than that of choosing cooperation strategy. At the same time, no matter what kind of strategy the supplier chooses, the manufacturer's benefit of choosing non-cooperative strategy is higher than that of choosing cooperative strategy. Therefore, the supplier and the manufacturer only have the strategy combination (2,2) in a game transaction, and both parties choose not to cooperate. However, this balance does not reach the optimal combination strategy (4,4) that we most want to achieve. In the real economic society, the rationality of the players in the game is bounded rationality, coupled with the existence of incomplete information, which makes cooperation in limited games possible. That is to say, if this kind of game transaction is repeated between the supplier and the manufacturer, the situation is very different. In many repeated games, each participant has the opportunity to establish the credibility of cooperation, and at the same time encourage each other to establish the credibility of cooperation, so that the optimal combination strategy becomes a point of equilibrium.
6. Summary
In today's global economic integration environment, the construction of an excellent supply chain system has become an important means to achieve value and competition in most industries. It is an important weapon for enterprises to gain market advantage and increase profitability. However, in reality, there are still differences in the degree of informatization of enterprises in the supply chain, management methods, and inconsistencies in efficiency. Therefore, it is particularly important to build an effective supply chain system, improve the construction of enterprise information systems, strengthen knowledge management strategies, and attach importance to supply chain integration strategies. Secondly, although game theory is ideal as a tool to study supply chain management, the lack of application also makes it difficult for us to obtain specific data for reference. Therefore, we need a lot of practical support, more efforts and research work. Only by establishing long-term strategic partnership among supply chain node enterprises can a win-win situation be created and higher profits be brought to enterprises. That is to say, to achieve collective rationality on the basis of individual rationality and to achieve optimal cooperation.

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