Executive DBA, Université Paris-Dauphine

巴黎九大高级工商管理博士学位项目

Program for the Degree of Executive Doctorate in Business Administration

Research on the Relationship between Supply Chain Control Tower and Enterprise Performance in Machinery Manufacturing Industry

(Thesis submitted for the degree of Executive Doctorate in Business Administration)

Cohort: 2015

Candidate: Zhu Huadong

Supervisor: Prof. Fan Yushun

10th November, 2017

Declaration of Confidentiality and Authorization

There is a need to protect the confidentiality of information provided by the interviewees and their organizations. For this reason, the data and other material included in the thesis have been presented in such a way as to protect the interests of the participants. This thesis has been accepted as confidential, and will be handled according to the Université Paris-Dauphine' confidentiality policy.

Furthermore, the writer fully understands the relevant policy of Université Paris-Dauphine, regarding to the reservation and usage of the dissertation, namely that the University has the right to retain copies of the thesis, allow the thesis to be accessed and borrowed; The university may publish all or part of the contents of the thesis, and can save the thesis by photocopying, microprinting or other means.

Signature: Signature of Supervisor: Date:

Abstract

The competition between modern enterprises is indeed the competition between their supply chains. If an enterprise wants to win in the competition, it needs a more integrated and flexible supply chain that can cope with the increasingly complicated and fluctuating environment. Like a commander of the control tower at the airport, he must, with the support of a radar screen, clearly know the path of each and every airplane in the air and give unified instructions. In recent years, some enterprises have tried to change the supply chain plan management model and put supply chain control tower into the practice of supply chain management. However, as a new supply chain management model, how can we build the supply chain control tower? Can supply chain control tower really improve corporate performance? All these problems are subject to further research. Therefore, the study of the theoretical framework and operational mechanism of supply chain control tower and its value for the improvement of corporate performance is of great theoretical value and realistic significance for the enterprises to use supply chain control tower to improve their performances.

This paper analyzes, based on the summarization of the research status and developments of supply chain collaboration and the relationship between supply chain collaboration and corporate performance at home and abroad, the make-up and functions of supply chain control tower, puts forward research hypotheses after exploratory researches on the building of the conceptual model for supply chain control tower and corporate performance for the manufacturing industry, and finally, analyzes and verifies the impact of supply chain control tower on corporate performance in the manufacturing industry by the comprehensive use of confirmatory factor analysis, structural equation modeling, hierarchical regression and other methods after collecting relevant corporate data through questionnaires. Research results show that:

(1) Supply chain control tower is an interdepartmental organization. It is an information center backed by system integration that can provide visual services for the supply chain. It can be applied to the transportation and warehousing activities on the supply chain and monitoring and metering. Supply chain control tower plays the role of central pivot of supply chain collaboration and simulates, visualizes, analyzes and predicts information and possible results for all stakeholders who can use such information to solve problems, to avoid risks and improve operating efficiency.

(2) Supply chain performance assessment is the evaluation on the performance of the whole supply chain and corporate on the supply chain nodes, and the implementation and collaboration relationship among corporate on the supply chain nodes. It is the assessment indicator based on the working process. BSC-SCOR supply chain performance assessment model combines the framework from BSC and the detailed process from SCOR, offering a standard description of the management process of the supply chain, achieving a

comprehensive and balanced evaluation on the performance of the supply chain.

(3) In the exploratory cases, the two companies are very good at obtaining, sharing and integrating external and internal information resources based on their advanced information technology and unified information technology standard, to realize supply chain timing, cost and financial advantages and improve the overall competitiveness of their supply chain. On the basis of the exploratory case study and combining the researches of other people, this paper puts forward a conceptual model for the impact of supply chain control tower on corporate performance that takes corporate performance as dependent variable (explained variable), supply chain control tower as independent variable, plan and process control as mediating variable and environmental uncertainty as moderating variable.

(4) Experimental results show that the information integration capacity of the machinery manufacturing industry's supply chain control tower can effectively save time and lower cost, thus further improving market growth rate and profitability of the enterprise. Supply chain control tower information collaboration mechanism can effectively save time, lower cost and reduce uncertainties, thus further improving the market growth rate, profitability and product innovation efficiency of the enterprise. The degree of information sharing of supply chain control tower can effectively lower cost and reduce uncertainties, thus further improving the market growth rate, profitability and product innovation efficiency of the enterprise. In general, information collaboration capacity of the machinery manufacturing industry's supply chain control tower can effectively lower cost and reduce uncertainties, thus further improving corporate performance, while external environmental uncertainties have a significant negative impact on the relation between plan and process control and corporate performance.

Key words: Machinery manufacturing industry; supply chain control tower; supply chain collaboration; corporate performance

Acknowledgement

This thesis would not be completed successfully without distinguished Professor Fan Yushun's guidance. Teacher Fan is humble and kind, with great and profound knowledge, rigorous and pragmatic education style and sagacious and open thinking. Teacher Fan's training and education for me during my doctoral degree will benefit me all my life.

I sincerely thank all the teachers in Tsinghua University and Université Paris-Dauphine. Without your patient guidance, this thesis would not be finished smoothly.

I sincerely thank my classmates' selfless care and help in the process of thesis completion and work and study.

I would like to express thank to the enterprises and managers that this thesis visits. Their management process and experience provide sufficient data support for the thesis topic, increase the credibility and feasibility of the thesis.

I would also like to thank my colleagues, friends for offering help during my writing and my family for their support to my study.

At the same time, I would like to thank the guiding experts, professors and teachers for taking your valuable time out of busy schedule to participate in the review and reply, sincerely thank you for your valuable advice on this thesis.

Last but not least, I wish everyone around me good health, smooth work and successful career.

Table of Content

Content of Figures and Tables

Content of Figures

Contents of Tables

Chapter I Introduction

1.1 Research Background and the Raise of Questions

1.1.1 Research background

Enterprise management model went through three stages: independent operation management, vertical integration management and horizontal integration management, namely, supply chain management. The first half of the 20th century was the era of independent operation management. Michael Porter's Five Forces Model described the competitive pattern in this period of time. Enterprises and their suppliers, competitors and customers' relations were demonstrated as a kind of opposition and competition. In order to win the initiative in the competition, they created the vertical integration management model, namely, core enterprises stressed the control over product life cycle process (including raw material supply, product design, manufacturing, distribution, and sales). In this model, all enterprises were displayed as "being large and all-inclusive" or "being small and all-inclusive". Many manufacturing enterprises had all production equipment and personnel for from blank casting, parts processing, assembling, packaging, transportation, and sales. In a relatively stable environment and under the precondition of taking product as the center, the vertical integration management model was very effective. But from the 1980s and with the constant advancement of science and technology, the global information network and global market were taking shape and technological change sped up, which brought severe challenges and competitions to enterprises, including: more complicated products, shorter delivery cycle, more flexibility requirements; more requirements for customized or semi-customized manufacturing of products in small batches and multiple varieties, meaning it being hard to satisfy the needs of individualized orders, inventory, and accurate sales and prediction.

Under such background, the vertical integration management model apparently could not give full play to enterprise's financial and human resources effectively, which invisibly increased operational risks. Besides, vertical integration management model could not adopt correct measures to adapt to market changes. Therefore, in order to increase advantages in operation and competition and market shares, enterprises could not merely depend on limited internal resources but increase utilization ratio of different kinds of internal resources and comprehensive strength. Besides, enterprises should attach importance to connection between internal departments and external enterprises, achieving win-win cooperation in the supply chain. Core competitiveness was enterprises' capability to stay competitive, and it was cultivated by gaining and allocating resources. This meant one enterprise had certain advantages or leading technologies in the process of product design, production, after-sales service, sales and could provide customized products for customers. This included two aspects: one was the capacity of the enterprise to obtain resources or technologies and integrate or transform them into its own technologies or products; the second was the capacity of the enterprise to organize and coordinate production factors to carry out activities ranging from raw material purchasing, supply, transportation, storage, production, distribution, market

development, to sales and after-sales services, etc., to optimize all links for highly effective operation. Supply chain referred to the supply-demand network consisting of raw material suppliers, manufacturers, warehousing and distribution centers, wholesalers, retail sellers and end users in the whole process of production and circulation of products. Put it simply, supply chain included all activities from unprocessed materials to end users, including the supply and purchase of raw materials, product design, production plan, material processing, ordering process, property management, transportation, warehousing and customer service. These activities on the supply chain might happen in one department in the organization and might happen in between enterprises. Supply chain management took all members of a supply chain as an organic whole to plan, coordinate and control the material, information and capital flows between member enterprises of the supply chain, so that the whole process, from purchase of raw materials, manufacturing of products, transportation, distribution to retail sales, could be effective managed and at the same time, business partners could jointly share responsibilities, risks and benefits, realizing the maximum profit with the minimum cost. Supply chain management is a kind of horizontal integration management model that stresses that enterprises should put their energy on their core businesses and should let their cooperative business partners do their non-core businesses by adopting the "outsourcing" strategy so that a global cooperative partnership can be established for advantage complementation between suppliers and distributors.

Currently, China has already become a manufacturing power. Manufacturing plays a critical role in China's economic development. Thus, the supply chain of manufacturing has become a core issue in economists researches. Besides, an increasingly modernized development of concepts and contents of the supply chain management is going on. For example, Integrated Supply Chain Management (ISCM) has gradually replaced Distributed Supply Chain Management (DSCM). Collaborated Supply Chain Management (CSCM) has become a current research focus under the new situation. Transformation in concepts and forms of the supply chain management is helpful for enterprises to lower production risks, shorten product life cycle, guarantee product diversification and finally gain a firm foothold in the increasingly competitive market.

1.1.2 The raise of questions

Supply chain collaboration requires that all links on the supply chain be aligned and collaborated as to improve the overall competitiveness of the supply chain. Material flow holds the key to logistics collaboration. The main reason is that information and capital flows can be realized through electronic network and other modern technologies that are not subject to the constraint of time and space. It is not hard to realize synchronization between supply chain enterprises. However, material flow has to overcome time and space barriers in order to transport goods from one place to another. Especially, in the machinery manufacturing industry, for example, engineering machinery manufacturing, a product often is assembled from thousands of parts supplied by hundreds of suppliers, and because difference materials or parts are supplied by suppliers from different regions or even different parts of the world, it is very hard to realize synchronization, which means, it is very hard to transport parts from

difference suppliers in due time and in accurate quantity to the manufacturer to get assembled. Because of that, the upstream supply material flow of the machinery manufacturing industry, compared with the downstream distribution material flow, is even more complicated. At the upstream of machinery manufacturer, parts in great varieties and huge quantities are transported from suppliers in different places to the manufacturer to assemble, which is a kind of many-to-one relations. More than that, the management on supply material flow is harder than that of finished product distribution logistics due to that the material types in upstream many-to-one supply material flow are more than those in downstream one-to-many distribution logistics. More importantly, finished product distributors or retailers are relatively independent, almost requiring no synchronization between each other in terms of logistics. But parts suppliers are closely interlinked to each other. If one supplier delays, the whole production would be influenced or even suspended. Therefore, the logistics management of machinery manufacturer supply chain not only puts high stress on the relation between supplier and manufacturer and the relation between manufacturer and customer, but also on the matching and synchronization between parts suppliers. If the latter are not coordinated, the upstream of the supply chain cannot be collaborated, and the performance of the whole supply chain will decline.

This shows that the competition between modern enterprises is indeed the competition between supply chains. Enterprises, if wanting to win, need to enhance their agility and efficiency on the supply chain. This is significantly important in the Internet era. In the Internet era, manufacturers will face even more complex supply chain environment. Enterprises need to obtain a capacity of holding the whole picture of supply chain. Traditional supply chain management system is hard to adapt to such environment, so a supply chain that can handle an even more complicated and fluctuating environment is needed. Like a commander of the control tower at the airport, he must, with the support of a radar screen, clearly know the path of each and every airplane in the air and give unified instructions. Driven by realistic demand, supply chain control tower is born at this moment. Supply chain control tower plays the role of gathering information of all links of the supply chain, sharing in real time such information and integration management. It is a “data center” backed by the system to ensure the synchronization and integration of the whole supply chain, thus enhancing cost effectiveness of the supply chain versus customer service level. In recent years, some enterprises have tried to change the supply chain plan management model and put supply chain control tower into the practice of supply chain management. However, as a new supply chain management model, how can we build the supply chain control tower? Can supply chain control tower really improve corporate performance? All these problems are subject to further research.

1.2 Purpose and Meaning of Research

1.2.1 Purpose of research

With the globalization of economy and the individualization and diversification of customer needs, fierce market competition is no longer limited to one enterprise and another.

Enterprises, whilst building their core competitiveness, are making use of their external resources in order to lower cost and make rapid response to customer needs. Breaking their own limitations, enterprises are beginning to cooperate with other enterprises in their supply chains in different processes. Meanwhile, the uncertainties of supply chain activities and the complexity of decision-making process, including the different needs of customers and different resource demands, increasingly unpredictable changes and expected target obtain ability between supply chain enterprises, have increased the demand of enterprises for supply chain synchronization. Especially, after the competition has extended from between enterprises to between supply chains, enterprises that can manage, coordinate, organize the relations between their partners in the supply chain can form a better and closer partnership. Therefore, collaborating and utilizing supply chain partnership has already been regarded as the key factor for an enterprise to obtain competitive advantages and successfully manage supply chain.

The purpose of research in this paper: take the realistic problem as the background and try to expound the theory of the new supply chain management model, namely the supply chain control tower. Theoretically explore the framework and operating mechanism of this type of supply chain management model, and analyze the impact of supply chain control tower of manufacturing industry on corporate performance through case study and questionnaire survey, to provide theoretical guidance for the improvement of supply chain management level and performance for manufacturers.

1.2.2 Meaning of research

Supply chain management stresses the concept of system, considering the competitive edge of product from an overall perspective, stressing the establishment of a strategic partnership through which an association between strong enterprises is established so that every enterprise can make full use of their own strengths in order to reach a win-win result on the value-added chain. Hence, the study of supply chain management is getting more attention. Supply chain consists of different economic real entities with different optimization objectives and private information. These optimization objectives often are conflicting with the overall optimization objectives of the system. In order to optimize supply chain decision-making, each member of the supply chain should not only optimize its own objectives but also consider the impact of their own objectives on other members and on the whole supply chain as a whole, and should coordinate with other members to reach the optimization of objectives for the whole supply chain. At the same time, the market environment is constantly changing and unpredictable. In order the meet market demand, all real entities and functional units in the supply chain must strengthen cooperation and information exchange. So, how to build an effective supply chain control tower has become an important content of supply chain management research. An effective supply chain control tower is conducive to: more rapid time-to-market of new product, inventory reduction, turnover time reduction, high-efficient human resources, improvement of customer service and corporate competitiveness. Therefore, the study of the theoretical framework and operational mechanism of supply chain control tower and its value for the improvement of corporate performance is of great theoretical value and realistic

significance for the enterprises to use supply chain control tower to improve their performances.

1.3 Research Content

This paper analyzes, based on the summarization of the research status and developments of supply chain collaboration and the relationship between supply chain collaboration and corporate performance at home and abroad, the make-up and functions of supply chain control tower, puts forward research hypotheses after exploratory researches on the building of the conceptual model for supply chain control tower and corporate performance for the manufacturing industry, and finally, analyzes and verifies the impact of supply chain control tower on corporate performance in the manufacturing industry by the comprehensive use of confirmatory factor analysis, structural equation modeling, hierarchical regression and other methods after collecting relevant corporate data through questionnaires.

The paper falls into six chapters, the main structure and content of which are as follows:

Chapter 1 - Introduction: First of all, it introduces the research background, research questions, research purpose and meaning; then it introduces the main research contents, methods and technical route; at last, it illustrates several innovation points of this research paper.

Chapter 2 - Literature Review: A summarization and general review are made on relevant research literature, mainly including: general review on research of supply chain collaboration, supply chain information collaboration research, and the impact of supply chain collaboration on corporate performance, etc.

Chapter 3 - Theoretical Analysis on Supply Chain Control Tower: First, the analysis of the background of supply chain control tower; second, the framework of supply chain control tower and the analysis of core factors of supply chain control tower, i.e. information collaboration.

Chapter 4 - Analysis on the Assessment of Supply Chain Performance: First, the introduction of the concept of supply chain performance; second, the idea and principle of assessment of supply chain performance; finally, the way to assess supply chain performance.

Chapter 5 - Conceptual Model and Research Hypothesis of Manufacturing Supply Chain Control Tower and Corporate Performance: First, XCMG and JH are taken as examples for exploratory case study; then, explore the relation between the manufacturing supply chain control tower and corporate performance; finally, put forward the conceptual model of manufacturing supply chain control tower and corporate performance.

Chapter 6 - Empirical Research on Manufacturing Supply Chain Control Tower and Corporate Performance: Taking machinery manufacturing industry as an example, carry out questionnaire surveys on 212 machinery manufacturers to obtain sample data, and use structural equation modeling, hierarchical regression and other methods to analyze and verify it, to discuss the relation between manufacturing supply chain control tower and corporate from two aspects, namely, direct and indirect impacts.

Chapter 7 - Research Conclusions and Outlook: First, draw research conclusions for this paper; then business management; at last, point out the inadequacies or shortcomings of this research and show the outlook of the research.

1.4 Technical Route and Research Method

Based on the above research content and framework, the technical route of this research is as follows:

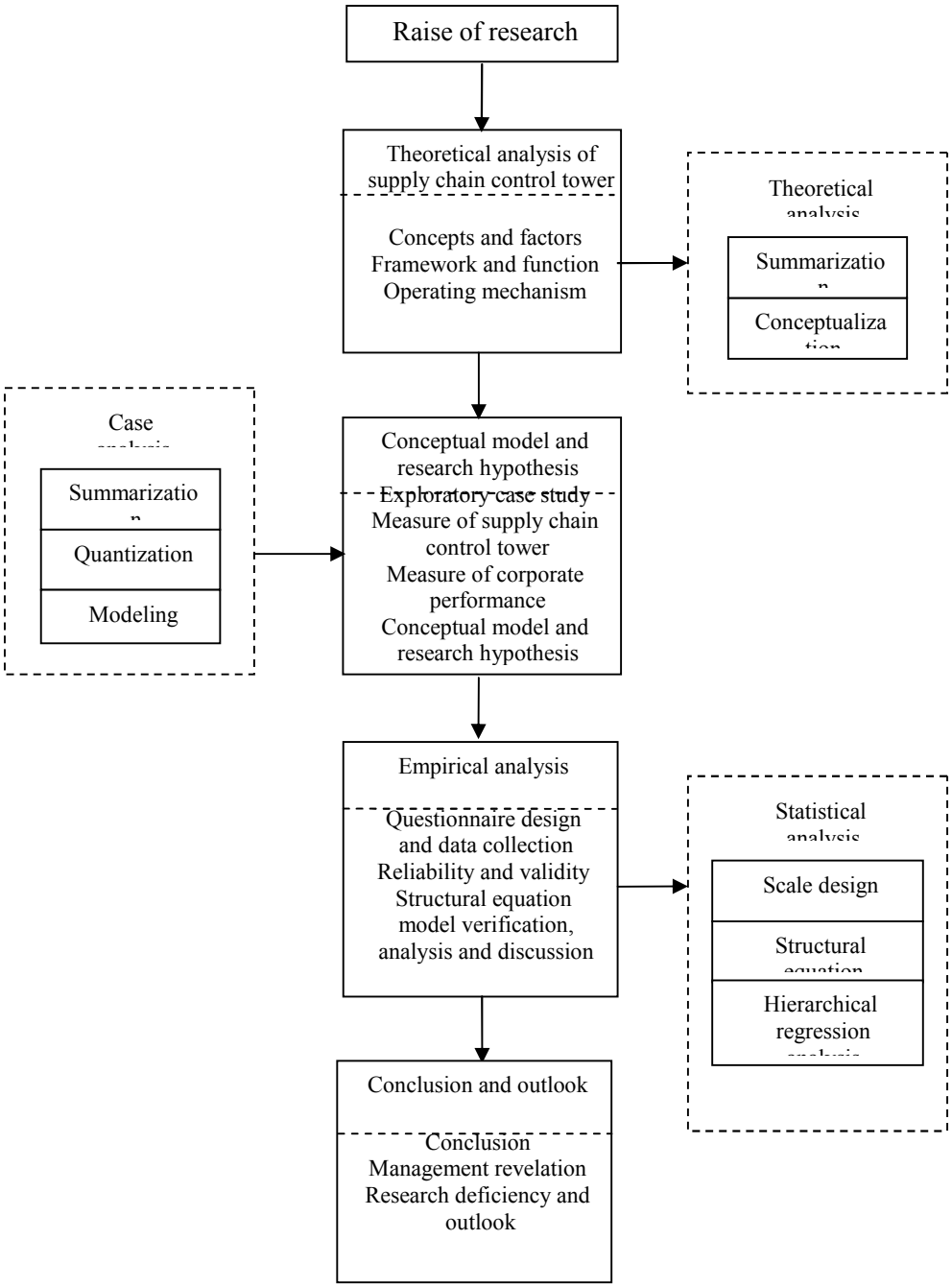

Figure1.1 Technical Route of the Paper

Research methods to be adopted in this paper:

(1) Literature research: This research mainly uses electronic databanks to search for research

literature pertinent to supply chain collaboration, supply chain information collaboration, relation between supply chain and corporate performance, etc. Based on the existing literature, a summarization will be drawn for the inadequacies of existing researches.

(2) Questionnaire survey: The questionnaire is designed for manufacturing supply chain control tower based on typical corporate supply chain control tower exploratory researches and other conclusions from other researchers.

(3) Case study: Adopt the case study method to analyze the practices of typical manufacturing supply chain control tower, to form the preliminary understanding about the impact of manufacturing supply chain control tower on corporate performance, and put forward the conceptual model of the impact of manufacturing supply chain control tower on corporate performance, combining relevant literature.

(4) Statistical analysis: In the research process, many frequently used statistical analysis methods used in management research are adopted. For example, in order to verify the direct impact of manufacturing supply chain control tower on corporate performance, in this paper, the structural equation modeling method is used. Another example is that in this paper, hierarchical regression model is used to verify the indirect impact of manufacturing supply chain control tower on corporate performance.

1.5 The Proposed Innovation Points in This Paper

The proposed innovation points in this paper are as follows:

(1) Take realistic problems as the background to try to make theoretical and empirical analysis on the "innovation of supply chain management in the era of Industry 4.0", namely, manufacturing supply chain control tower and its impact on corporate performance, and to put forward the definition of supply chain control tower, its component factors and the relations between these factors. Research perspective and contents are relatively new.

(2) Based on the exploratory study of supply chain control tower application in machinery manufacturing industry, a conceptual model is built for the relation between manufacturing supply chain control tower and corporate performance and research hypotheses are put forward.

(3) Relevant corporate data are collected through scales and questionnaire surveys and confirmatory factor analysis, structural equation modeling, hierarchical regression model and other methods are used for empirical analysis of the impact of manufacturing supply chain control tower and corporate performance.

Chapter II Literature Review

Supply chain control tower is a new concept. There are only a few of papers that can be referred to currently. They are mainly research about the concept, characteristics and structure of supply chain control tower (Sun Xiaoyuan, 2015; Gao Ruiping, et al. 2016). Supply chain control tower in essence is a supply chain collaboration control model adopting "overall information view and comprehensive collaboration and control". So the main focuses of this literature review of this paper are supply chain collaboration and its relation with corporate performance.

2.1 Research on Supply Chain Collaboration

Supply chain collaboration refers to the coordination and mutual efforts of each node enterprise on the supply chain to improve the overall competitiveness of the supply chain. All node enterprises form a network union type through corporate agreement or joint organization or other methods. In this collaboration network, suppliers, manufacturers, distributors and customers can dynamically share information, work closely together, developing towards the common goal. Supply chain collaboration requires node enterprise to share information and knowledge innovation results based on technologies and the Internet, and to establish "win-win" awareness and make efforts to achieve the same goal. It also requires partners to cooperate on the basis of trust, commitment and elastic agreement. At the same time, collaborative node enterprises are required to reintegrate supply chain, change previously pieced information system, electronic data interchange (EDI), etc. Supply chain collaboration shall be based on the free exchange of information, sharing of knowledge innovation results, mutual trust, collaborative decision-making, seamlessly connected production process and common strategic objectives.

According to the nature and time-place relationship of collaboration, supply chain collaboration can be divided into internal and external supply chain collaboration. Internal supply chain collaboration refers to the collaboration among different departments within an enterprise, such as the collaboration among the Procurement Department, Production Department, Warehouse, Sales Department or other business departments involved in the internal process of product manufacturing and circulation of the enterprise, and the collaboration among the enterprise's overall strategy, tactics and operation levels, etc. The goal is to integrate various resources within an enterprise and realize information sharing, achieving strategic goals. Besides, an enterprise should eliminate its disadvantages in internal collaboration to push forward with long-term sustainable development. External supply chain collaboration refers to the collaboration among multiple enterprises in supply chain. According to the level of collaboration, it can be divided into operation and business process collaboration, management and business standard collaboration, strategic collaboration. Among which, the collaboration requirements of business process and business standard are often synchronous. Supply chain enterprise collaboration consistently achieves the common strategy, which is the highest level of collaboration. According to the content, it can be

divided into demand collaboration, financial fund collaboration, order collaboration, material flow collaboration, manufacturing collaboration, demand planning collaboration, etc. Order collaboration is the basis of other collaborations. Internal supply chain collaboration is the precondition for the collaboration between enterprise and the external. The most important part of that is the collaboration between external suppliers and customers, which is a key problem for supply chain collaboration management.

Currently, domestic and international scholars have had deep understandings and researches of supply chain collaboration, which includes its concept, role, influencing factors, evaluation, and the relationship between supply chain collaboration and corporate performance and other aspects.

Rothwell (1992) held a unique view, pointing out that collaborative cooperation of supply chain management requires the high integration of internal elements and this was newly defined as "the fifth generation of innovation".

Horvath (2001) believed the essential requirement and key of supply chain management is collaboration.

Vereecke & Muylle (2006), through the field research on assembly manufacturing enterprises, empirically analyzed and verified that supply chain collaboration can effectively improve the overall performance level of supply chain.

In the concept of supply chain collaborative operation, "integration" and "coordination" are its essential thoughts. "Strategic collaboration" and "relationship coordination" are important ways to guarantee maximized benefits of supply chain collaboration. A large number of scholars at home and abroad more or less researched internal mechanism, essential problems and other key elements of supply chain collaboration (Petrson & Cecere, 2001; Akkermans, 2004; Soylu et al., 2006; Sabri & Beamon, 2000; Song Huaming and Ma Shihua, 2005; Wang Fushou and Ma Shihua, 2006). On the ways of achieving supply chain collaboration and enterprise's prospective earnings brought by supply chain collaboration and other problems, many scholars have done a great deal of work: Anderson & Lee (1999), on the basis of discussing the general conditions and possible challenges of supply chain collaboration, analyzed the value of supply chain collaborative operation. Lei & Beamon (2006), based on the research on supply chain node enterprise's resource structure, decision-making mode, control mode, risk sharing and benefit sharing and other aspects, put forward operable selection methods and steps of collaboration mechanism. In order to research how internal supply chain operates collaboratively, Manthou et al. (2004) adopted classified researches to research the key capacities to achieve supply chain collaboration and assessed and analyzed collaboration performance later. Domestic scholars, Xu Haoming and Kang Shuli et al. (2003), Xia Weijun and Wu Zhiming (2005), Liu Jian and Ma Shihua et al. (2004), Chen Jianhua and Ma Shihua (2005), Ma Shihua and Yang Wensheng et al. (2005), Song Huaming and Ma Shihua (2007), also did a lot of work in the pattern and method of supply chain collaboration.

As shown in the existing related researches, supplier's involvement in collaboration can improve the performance of various activities in supply chain. For example, Petersen et al.

(2005) pointed out that, at the stage of new product development, the participation of supplier in the product design and trial-manufacture of manufacturer can shorten product's development cycle and improve the performance indexes of all aspects in the process of new product development. He also proposed that rapid and effective product development can make manufacturers take market demand as the guide, thereby reducing the loss caused by the uncertainty of market demand. Through researches and analysis, Fu et al. (2004) pointed out that by supplier's complete sharing of production and inventory information and close cooperation with manufacturer, the inventory level can be obviously reduced and thus maximized interests can be achieved. Erevelles & Stevenson (2006) believed that the existing research pays more attention to the segmentation of demand side. If the segmentation of supply side can be paid attention to at the same time, then based on the former, the collaboration relationship between the upstream and downstream on the supply chain can be further strengthened, and the competitive advantage of supply chain can be improved.

Stank et al. (2001) argued that node enterprises should make common goals to strive for so that they could achieve win-win relation between enterprises' interests and overall interests.

Manthou (2005) put up a unique viewpoint that supply chain collaboration was that different enterprises strived to achieve coordinated cooperation in terms of resources sharing, decision sharing and common progress to create unique competitive advantages of supply chain.

Zhang Cuihua et al. (2005) drew following conclusions by analysis: supply chain collaboration management is based on information collaboration technology and information sharing and it is of paramount importance. To achieve a maximized supply chain value, enterprises should make orderly and that can bring mutual benefits, trust each other, effectively avoid different kinds of risks and realize the maximized interests.

Donald et al. (2014) believed that the big influence of supply chain comes from information and resources sharing and coordinated cooperation among enterprises.

Xie Lei et al. (2012) found that the material flow collaboration of supply chain significantly improves the agility and performance of supply chain.

Lu Bin (2012), based on the theory of collaboration, defined that the collaboration degree of supply chain system means the overall collaboration realization degree of relational capital, supply chain situation, and knowledge learning subsystem in the process of system evolution.

Barratt (2004), when researching supply chain collaboration, found that mutual-trust, win-win cooperation, information sharing, openness, communication, understanding and other collaborative cultural factors are important supporting factors of supply chain collaboration. Cross-functional collaboration, process consistency, collaborative decision-making and the effective measurement of supply chain performance are the key factors to the successful implementation of supply chain collaboration. Resource and commitment, cross-enterprise collaboration, the participation in collaboration enterprise strategy, successful cases of collaborative operation and the effective use of science network are the strategic factors for the long-term collaboration of supply chain.

Manthou (2004) integrated resources, capital and material flows from the point of the whole supply chain, and pointed out that resources collaboration is the basis of the overall collaboration of supply chain. The science and technology and value of resources sharing are crucial component elements of resources collaboration of supply chain.

Sridharan and Simatupang (2005), through literature research and survey and interview, generally divided supply chain collaboration into three levels: resources sharing, decision synchronization and incentive alignment. They firstly put forward the assessment methods of supply chain collaboration, adopting the index of collaboration degree to measure the degree of resources sharing, decision synchronization and incentive alignment of supply chain collaboration. The index of collaboration degree reflects the degree of supply chain collaboration. Related statistics also proved the significant positive correlation between supply chain collaboration degree and supply chain performance.

Matopoulos (2005) built the frame model of supply chain collaborative operation, including two aspects: the design and operation of supply chain activities and the establishment and maintenance of supply chain relationship.

Arshinder (2007) believed that supply chain collaboration can be regarded as the continuous variable of the degree of resources sharing and decision synchronization among participants of supply chain collaboration. The degree of supply chain collaboration changes with the degree of resources sharing and decision synchronization among collaborative partners.

Soroor et al. (2009) found that supply chain collaboration must be achieved by cooperative partners' effective implementation of four collaboration mechanisms: cooperative contract, resources sharing, communication technology and cooperative planning.

Supply chain collaboration is an effective way to improve its performance. By the sufficient information and resource sharing among interdependent back bone enterprises, supply chain collaboration can realize the common goal and the maximization of customer interests of the whole supply chain. The success of Walmart's supply chain collaborative operation has prompted more multinational enterprises, such as P&G, HP, etc., to begin the implementation of supply chain collaborative operation. Supply chain collaborative operation is becoming more common, but the research on supply chain collaborative performance and the assessment of collaboration degree remain a puzzle.

Bahinipati et al. (2009) researched the assessment method of fuzzy measure for the horizontal collaboration degree of supply chain. They assessed the horizontal collaboration degree of supply chain from four dimensions: industry characteristics, competitive advantages, internal index and external index and applied this assessment method to the assessment of the horizontal collaboration degree of supply chain in semiconductor industry.

Ramanathan et al. (2011), by studying on previous cases, researched the collaboration objective, expected achievement and corresponding standard at the initial and top stages of supply chain collaboration, providing key information for the assessment of supply chain collaborative performance.

Klassen and Vachon (2008) researched the impact of supply chain collaboration on manufacturer's performance. They found that by the cross-enterprise collaboration with the up-and-downstream enterprises of supplier, including the establishment of the common goal, joint planning and collaborative activity launching, etc., the management performance of manufacturer can be improved. Information collaboration operation with supplier can improve the operation performance of supply chain, and information collaboration operation with customer can promote supply chain's market performance based on products.

Muylle and Vereecke (2006), by empirical research, proved that to promote supply chain's performance on capital, flexibility, procurement, date of delivery, market launch time and other aspects, manufacturers must collaborate effectively with suppliers and customers, which will greatly enhance supply chain performance.

Elofson et al. (2007) carried out analog simulation research by C3 software of integrated customer collaboration, verifying that the resources collaboration between supply chain manufacturer and customer can effectively improve supply chain performance.

Zhang and Cao (2011) believed that supply chain collaboration includes three levels: resources collaboration, goal compatibility and decision synchronization. They proved that, under highly uncertain environment, by resources collaboration, the core manufacturing enterprise realizes the substantial sharing of information, capability resource and knowledge with its customers and suppliers, which can significantly improve corporate performance.

Zacharia et al. (2011) argued that supply chain knowledge, resources absorbing and utilization capability and joint collaboration capability of supply chain have significant impact on continuous supply chain collaborative performance, and can significantly improve the collaboration operation level and relationship performance among different industries.

2.2 Research on Supply Chain Information Collaboration

Information collaboration is the important precondition for realizing the high visibility and agility of supply chain operating process. Information flow collaboration is the important precondition for material and capital flow collaboration of supply chain. Information is the core factor of supply chain collaboration. Supply chain information collaboration is of great significance and value. Domestic and international researches on information collaboration mainly include concept, mechanism and influence factor of supply chain information collaboration.

Stank et al. (1999) believed that sufficient and effective communication, information sharing, in-depth collaborative relationship and measurement of information collaboration performance are important characteristics of cross-enterprise information collaboration.

Zhang Qing and Liu Zhixue (2008) advocated that supply chain information collaboration is mainly the integration of information system of supply chain node companies by Internet technology. It promotes the timely, efficient and accurate sharing and exchange of procurement, production operation, customer demand and other information. It impels supply chain to faster and effectively respond to customer demand, enhancing enterprise's customer

value.

Zhang Xiangxian et al. (2010) pointed out that information collaboration applies the idea of collaboration to each step of information integration and produces collaboration force.

Wiengarten (2010) believed that information collaboration of supply chain has great influence and function. Thus, information is viewed as an integral part of supply chain collaboration.

Liu et al. (2012) advocated that information flow plays an important role in supply chain collaboration. Through correct channels and transmission mechanism, information flow realizes the timely, efficient and accurate transmission of information in node enterprises, and can create benefits for node enterprises, so as to enhance the comprehensive strength of supply chain.

Li Lingju (2006) found in the research that the information collaboration refers to the procurement information collaboration between the core enterprise and supplier and the core enterprise and retailer and the internal information collaboration of the core enterprise.

Wang Xiayang (2005) believed that, as a major part of supply chain collaboration, information collaboration not only needs the information technology of node enterprises as its support, but also the coordination by the establishment of reasonable contract mechanism.

Liu Xinyu et al. (2005) found that, in every stage of building information collaboration platform, upstream enterprises must have sufficient capacities, according to the business characteristics of both parties, establish unique supply operation system of supply chain material to advocate the strategic information collaboration of downstream enterprises.

Li Yipeng and Ma Shihua (2011) established a new supply chain information collaboration mechanism Supply-Hub, of which the main objective is to realize the reduced collaboration value of the total inventory cost of manufacturer. Supply-Hub information sharing realizes the synchronous supply of multiple upstream suppliers to the core manufacturer, and reduces the unmatched demand, supply information and possibility of information uncertainty and distortion of supply chain.

Boddy et al. (2000) found through researches that the basic obstacle of information collaboration among supply chain enterprises comes from the difference of cultural backgrounds, resource abundance and capabilities among collaboration bodies. If closer cooperation has been achieved, then in every stage of collaboration, the enhancement of the cultural level and skill and research and communication on company management among collaboration enterprises contributes greatly to the formation of supply chain information collaboration.

Larsen (2003), by theoretical and empirical research, finally found that mutual-trust is a very crucial influencing factor in every stage of information collaboration.

Holweg et al. (2005), in the analysis on the influencing factor of strategy selection of supply chain information collaboration, found that characteristics of supply chain products and the classification of supply chain customer and supplier are three categories for the core

enterprise of supply chain to select information sharing.

Cetindamar et al. (2005) found in the analysis that the trust, common goal and collaboration support mechanism among cooperative enterprises are the positive factors for supply chain information collaboration. However, the lack of trust, goal incompatibility and the irrational distribution of interests are the obstacles to supply chain information collaboration. With the development of the society, enterprises find that collaboration and innovation are the direct channels for supply chain to obtain competitiveness. Therefore, collaboration process requires enterprise senior's high attention and innovation thoughts to gradually realize supply chain collaboration.

Chae, BS, et al. (2005) introduced partnership as a new concept when analyzing IT technology's impact on supply chain collaboration, which was a new perspective on innovative exploration. The research found that IT technology promotes the collaboration performance among node enterprises to a certain extent. A good collaboration performance can effectively enhance application of IT technology in supply chain collaboration.

Fawcett (2011), in the statistics analysis, argued that information sharing technology can promote information collaboration performance to a certain extent, help enterprises to obtain supply chain competitiveness and effectively improve supply chain performance.

Hong et al. (2014) first categorized different kinds of data in supply chain collaboration with target and deeply studied privacy protection technology, and then reviewed previous research materials and modern supply chain technology, properly expanding research channels in academia. The thesis depicts the development trend and potential challenges as a whole in supply chain collaboration and shows these to the whole world.

Li et al. (2008), after conducting in-depth research on the information sharing model among single core manufacturer and multiple retailers, found that information security is the key factor for effective implementation of information sharing. Potential security problems will play into the hands of retailers. Retailers will obtain the confidential information of other retailers from manufacturers and advantages in price competition, causing the entirety of supply chain at a low level in the long run. Under the condition of information security, the free information sharing can be guaranteed, and the profits of supply chain will be at a higher level.

Henry C (2009), based on dynamics and stakeholder theory, researched supply chain collaboration deeply and found that the stakeholders of supply chain are highly interdependent and have high degree of collaborative willingness, which can promote node enterprises to adopt cooperation strategy, and actively cooperate with the core enterprise to collaborate if this finding can be properly utilized. When the interdependence level among stakeholders is low, collaborative willingness is also at a low degree. As a result, if the core enterprise enforces collaboration at this time, it will cause competition and lower collaboration performance among enterprises.

To sum up the above literature research, it can be found that the influencing factors of supply

chain information collaboration discussed by foreign scholars mainly include credibility, IT technology, company ideas, information security, cooperative willingness, the rationality of interest distribution, cooperative goal compatibility, etc. There are both long-term and short-term influencing factors. These factors exert influences on supply chain information collaboration, promoting or hindering its development comprehensively.

2.3 Research on Supply Chain Performance

Supply chain performance directly reflects management level of enterprise supply chain. It is the overall assessment of supply chain operation and results. All aspects of supply chain operation are involved. This is the assessment of supply chain operation and management final results as well as assessment of operation results of design in various levels, angles, parts and stages.

Whole supply chain management is the process of continuously updating existing supply chain. First is the current supply chain operation, and then the performance assessment of operating supply chain. Thus, defects can be found and improvement can be made on this basis. After implementing improvement solution, next repeating stage will be initiated.

Increasing number of researchers begin to focus on how to evaluate supply chain performance. However, there is no unified assessment index for judging supply chain performance.

Kaplan and Norton (1992) proposed Balanced Score Card model, which evaluates supply chain performance from four key aspects including finance, customer, internal operation process, grow and study. This model not only showcases overall business performance of supply chain but also the actual operation status to researchers. It shows the relations between core enterprises and customers. This model emphasizes the balance between financial indexes and non-financial indexes. It also measures short and long-term indexes to conduct real-time monitor on specific performance of supply chain.

Lummus et al. (1998) proposed seven steps of supply chain plan. 4 indexes were raised for measuring whether these seven steps are successful or not. They believed that these four indexes are key assessment indexes for performance of supply chain as they cover supply, process management, delivery and demand management.

Lambert et al. (2000) claimed that previous standards no longer met current development needs so new type of supply chain performance assessment system must be established timely. Service quality is the key element to measure whether supply chain performance is reasonable or not. Ten important supply chain assessment indexes were listed: surface performance, stability, response speed, effect, service quality, reliability, relevance, confidentiality, communication and customer intimacy.

Ma Shihua et al. (2000) published a specific standard for evaluating supply chain performance in China in early days, which covered production quality, customer service, cost and asset management. In terms of customer service, there are seven indexes including saturation rate. In terms of production quality, there are seven indexes with per delivery system included. For asset management, there are seven indexes with inventory turnover included. Cost also

contains seven indexes with total cost/unit cost included. At the same time, they pointed out that other overall standards shall be referred to in addition to above indexes. For example, conduct quantification by using supply chain production efficiency.

Liu Xiaoping et al. (2002) proposed that performance indexes of supply chain management mainly include performance assessment and index for order implementation, partners on supply chain, production level, delivery, customer satisfaction, finance and logistic related cost. Thus, supply chain performance assessment framework is formed.

Beamon (2000) adopted the method of the combination of qualitative and quantitative indexes. Qualitative indexes are mainly composed of the integration degree of information and material flow, customer satisfaction, supplier background, product flexibility, etc. Quantitative indexes include financial information, business process, etc.

Gunasekaran (2001) made a general judgment on supply chain performance according to strategical, tactical and operational levels, of which, procurement plan, order quantity, financial background and partnership are all measurement standards.

Ross et al. (2002) established assessment method based on Benchmarking, which key is the confirmation of benchmarking enterprises.

Ye Chunming et al. (2005) used the combined method of Balanced Scorecard to build the system of assessment index of supply chain performance on the basis of BP Neural Networks.

Chen Jianhua and Ma Shihua (2006), when assessing the specific supply chain performance, selected the indexes from the internal, external and comprehensive levels as reference data, including product quality, customer service attitude, financial and cost status and other indexes.

Liang Yuezhong (2006) advised to evaluate the status of enterprise from SCOR model, best practice and performance assessment combining with analysis of enterprise processes.

Chen Jiumei et al. (2007) simplified assessment standards and eliminated the impact of subjective factors on the basis of robustness, time, cost, and other indexes.

Li Kai et al. (2009) proposed supply chain performance assessment mechanism based on separating process. Performance assessment shall be conducted from quality, cost, time, asset utilization and collaboration these five aspects.

Shi Wenli et al. (2010) used unascertained set theory to analyze and assess supply chain performance.

Heim et al. (2010) suggested dividing supply chain performance assessment indexes into qualitative ones and quantitative ones. Qualitative ones are customer satisfaction, flexibility, logistic integration and information flow. There are two types of quantitative indexes, one is for cost and the other is for customer response. At the same time, performance assessment standards for early established model were summarized as well, which cover cost, response speed, customer satisfaction, flexibility and time for activity.

2.4 Research on the Impact of Supply Chain Information Collaboration on Performance

In the new economic era with highly developed information and network technology, competition is no longer the competition of individual enterprise, but the competition of supply chain networks composed of multiple enterprises. The efficient operation of supply chain requires the sufficient sharing of true and accurate information among each node in supply chain system. Information is unique and valuable resource owned by enterprise. Efficient sharing and integration of information bring collaborative earnings to supply chain and enterprises. Information collaboration is an important part of supply chain collaboration, is a crucial precondition for the collaboration of material and capital flows in supply chain. Information collaboration can effectively improve the cooperation level among supply chain node enterprises, enhance the cooperative credibility among supply chain node enterprises, improve the overall efficiency of supply chain collaborative operation, and help the whole supply chain to achieve collaboration. Supply chain collaborative earnings are mainly reflected in the significant improvement of cost, flexibility, quality, time and other indexes.

The development potential brought by supply chain information collaboration has attracted more attention of scholars and enterprise management personnel in different fields. The existing statistics have shown that information collaboration can effectively reduce the cost of supply chain, improve partnership, improve operational efficiency of material flow, accelerate the speed of delivery, improve the fulfillment rate to increase customer satisfaction, enhance channel coordination to a certain extent, so as to strengthen overall competitive advantages for supply chain.

Many foreign scholars have carried out researches on the impact of supply chain information collaboration on performance. These researches showed that supply chain information collaboration can effectively improve the operation, product and R&D innovation performances of supply chain, win competitive advantages in time, cost, operation and other aspects for supply chain.

Weng (1995), by empirical research, proved that the collaboration mechanism of each node enterprise on supply chain could greatly promote enterprise's individual decision-making capability.

Sanders (2007) believed that the collaboration among supply chain node enterprises can also improve the supply chain performance by giving full play to each body's internal business collaboration.

Vachon (2008) researched the impact of supply chain collaboration on manufacturer performance. He found that by the cross-enterprise collaboration between different enterprises and suppliers, including the establishment of the common goal, joint planning and collaborative activity launching, etc., the management performance of manufacturer can be greatly improved. And the information collaboration operation with suppliers can improve the operation performance of supply chain, and the information collaboration operation with customers can promote supply chain's market performance based on products.

Vereecke (2006), by empirical research, proved that, to promote supply chain's performance on cost, flexibility, date of delivery, procurement, market launch time and other aspects,

manufacturers must collaborate effectively with suppliers and customers, especially collaboration of information, which will greatly enhance supply chain performance. More enterprises realize that improving the level of information collaboration between suppliers and customers can fully enhance supply chain performance, and win the world-class competitiveness for the enterprise.

Hyland (2008) believed that the good collaboration between enterprises and partners not only can promote supply chain's operational efficiency but also can facilitate enterprise's breakthrough and incremental innovation. More supply chain member enterprises realize the importance of designing collaborative product and forecasting customer demands. Collaborative operation based on information sharing can realize the high quality, low cost, punctual delivery and effective operation.

Supply chain collaboration with customer systems and useful sharing of customer information and demand can improve supply chain performance and reduce supply chain inventory. Elofson (2007) carried out analog simulation research by C3 software of integrated customer collaboration, verifying that the information collaboration between supply chain manufacturer and customer can effectively improve supply chain performance.

Cao Mei (2011) believed that supply chain collaboration mainly includes information collaboration, goal compatibility and decision synchronization. They proved that, under highly uncertain environment, by information collaboration, the core manufacturing enterprise realizes the sufficient sharing of resource and knowledge with its customers and suppliers, which can significantly improve corporate performance and realize collaborative communication, resource sharing, incentive alignment, efficient work, joint knowledge creating, business collaboration, quality and innovation and other supply chain competitive advantages and make supply chain extremely competitive.

Donald et al. (2011) proved that by collaboration between each node and the main body, performance of supply chain can be increased.

Zachafia (2009) found that the interdependence degree of information and process among up-and-downstream enterprises on the supply chain, supply chain's insight into collaborative opportunities, and information collaboration degree are closely related to supply chain's operation, relationship and business performances. The research also found that supply chain information collaboration plays a significant role in improving asset utilization ratio, performance and profit. In the research on the capabilities of supply chain collaboration process, Zacharia (2011) found that supply chain knowledge, information absorbing and utilization capability and process collaboration capability of supply chain are related with supply chain collaborative performance, and can improve the collaboration operation level and relationship performance among enterprises.

Frohich and Westbrook (2001), in addition to proposing "integration arc" concept in previous parts targeting at supply chain integration, researched on relationship between supply chain integration and performance of multinational corporations. By conducting empirical research on sample enterprises, it was found that enterprises with comparatively more suppliers and

customers, and core enterprises that cooperate with customers and suppliers usually have better performance.

Christina Gimenez and Eva Ventrua (2003) researched on supply chain integration of Spanish retail enterprises. Supply chain integration were divided into internal integration and external integration. The research showed that these two integrations are relevant to each other. When internal integration was not so popular in most of the enterprises in market, enterprises that could integrate well internally had stronger competitiveness than the rest enterprises. Such enterprises also outperformed other enterprises in terms of performance. However, as internal integration becomes popular, it turns into a prerequisite and no longer plays a significant role in enhancing competitiveness.

Zhu Yihua (2004) researched on benefits brought by logistic integration to enterprises performance via studying on influence of logistic. He formed model and conducted empirical research to analyze and discuss the relationship between supply chain integration, logistic capacity and enterprise competitiveness. By analyzing results, it was found that internal integration greatly boosts logistic. In addition, enterprise performance, and performance of collaborative suppliers on supply chain also improved. Internal integration is the basis for external integration. They are connected and developing together.

Meixell and Gargeya (2005) comprehensively researched on involved elements in supply chain from a holistic perspective. It was found that the influence on performance brought by integration of relations of up-and-downstream enterprises on supply chain, how to effectively improve integrated supply chain performance, etc. remained unsolved yet.

Pan Wenan (2006) held a unique view. He conducted in-depth research on partner cooperative relationship on supply chain to find out how supply chain integration affects cooperation performance. Empirical research was conducted via questionnaires. The results showed that internal and external integration have larger in-direct influence but smaller direct impact on cooperation performance. Every enterprise needs to focus on achieving high performance and enhancing competitiveness. External integration is one of the key solutions.

By analyzing research results of Cousin and Mengue (2006), we can find that supply chain integration is positively related to performance.

Chopra and Meindl (2008) held a different view. They thought that elements which influence supply chain performance will affect each other and commonly pose effect on supply chain performance. A good supply chain shall recognize such interaction quickly and make a trade-off with the prerequisite of ensuring revenue. Supply chain driving force shall only be used with limited condition. It can reduce cost and improve efficiency.

Flynn (2010) used structural and contingency perspectives to research how supply chain integration influences performance and analyze the relationship between supply chain performance and customer integration and supplier integration, and supply chain performance and internal integration. By studying research results, it is found that customer integration and internal integration can better enhance performance. On the contrary, supplier integration has

not much influence on improving performance.

Xu Dehui et al. (2012) had a different opinion. With analysis, they concluded that internal integration greatly boosts operation performance and finance performance. Customer integration directly promotes enterprise performance and to an extent propels the development of finance performance. Supplier integration cannot be used for enterprise performance directly.

2.5 Brief Review

In conclusion, the existing research has made extensive analysis on supply chain collaboration and supply chain information collaboration and obtained abundant research results, laying a good foundation for the further relevant research. However, the existing research still has the following shortcomings:

The current research on supply chain collaboration, from the angle of collaboration level, can be divided into operation technology collaboration and strategic collaboration. Operation technology collaboration means the information sharing and operation collaboration of the upstream and downstream on the supply chain realized by certain technological means. Its main content includes operation plan, product design, demand forecast, material flow collaborations. Strategic collaboration is the highest level of supply chain collaboration. From the current research status, whether the research on collaboration level or on collaboration content, is the research on vertical collaboration among the upstream and downstream on the supply chain, with only few focus on supply chain control tower.

On the other hand, the existing research mainly adopts Contract Theory, Game Theory and other methods to research the information sharing process and its influencing factors in the procurement, production, inventory, sales and other specific operation activities of two-stage or three-stage supply chain, but less involves the research on the assessment of the overall information collaboration performance of supply chain, and the framework, operational mechanism, and the impact of supply chain information collaboration on corporate performance.

Chapter III Theoretical Analysis of Supply Chain Control Tower

This chapter first describes the background of supply chain control tower, and then puts forward the function and framework of supply chain control tower, and analyzes the core element of supply chain control tower, information collaboration.

3.1 The Concept of the Raise of Supply Chain Control Tower

3.1.1 The background of the raise of supply chain control tower

The following phenomenon is common to the current supply chain management model: Node enterprises or various departments within the enterprise seemingly connect into a unified supply chain, essentially are closed to each other. This means the information managed by themselves are business secrets and they make business decision followed based on them. It seems like they are cooperating with each other while in fact such collaborative relation doesn't exist. Its disadvantages are obvious:

(1) Market response is slow. Node enterprises on the supply chain often receive biased and overdue information, and the information exchanging is not smooth as well. They are unable to transmit customers' demand information to supply chain enterprises quickly and respond quickly to the market changes. The supply and demand cannot reach the balance, finally leading to customer dissatisfaction and sales loss.

(2) Decision synchronization cannot be realized. Node enterprises on the chain lack trust and collaboration and are suspicious of each other, failing to achieve information and resource sharing among node enterprises in supply chain. They cannot collect accurate data so that the effectiveness of decision making is unknown. In order to improve supply chain collaboration methods, strengthen supply chain management, and improve competitiveness to enhance their profitability, supply chain enterprises need to create a management mechanism, make up the disadvantages of the traditional supply chain management, and this, coupled with each link's close collaborations and timely information sharing, can help to achieve the common goal of supply chain enterprises.

In conclusion, the detailed significance and profound influence of collaborative supply chain management are as follows:

(1) Improving supply chain' market response capabilities and better satisfying customers' personalized demand. Supply chain collaboration is not only good for the improvement of the depth and agility of information sharing among supply chain enterprises but can also help enterprises to grasp overall market information, adjust manufacturing timely according to information changes and shorten product life cycle. Besides, it can also realize customized service and increase order fulfilling at a maximum level, so as to optimize customer service level and win more customers.

(2) Evaluating customer demand in a scientific way and lowering risks of supply chain management. On the basis of collaborative supply chain, enterprises can take full advantage

of product information, sales data and customer order to achieve collaboration and unification among enterprises, lower risk level, improve the effectiveness of demand evaluation at a maximum level, reduce product inventory and try best to avoid bullwhip effect.

(3) Drawing up emergency plans. The emergencies often occur in the supply chain management process, such as transportation problems, order cancellation, etc. At this time, supply chain collaboration mechanism can deal with emergencies timely, and, with the help of advanced information processing technology, inform relevant nodes of the supply chain of information in real time to take targeted solutions.

(4) Increasing the value of supply chain resource integration and giving full play to comprehensive strength of supply chain. Supply chain collaboration, on the basis of customer and supply chain relation management, can integrate up-and-downstream enterprises appropriately to achieve supply chain collaboration in the whole industrial system, giving full play to each enterprise's resources and technology advantages to form a unique supply chain system that includes resources, management and technologies. This can really lower enterprise's procurement and raw material costs, achieve the maximum appreciation of the whole supply chain networks and give full play to overall competitiveness of supply chain.

3.1.2 The concept and characteristics of supply chain control tower

Supply chain control tower is an important means to supply chain collaboration. Supply chain collaboration is a network union type connected through corporate agreement or joint organization or other methods by two or more than two enterprises in order to achieve certain strategic purpose. The external reason of supply chain collaboration is apparent, to cope with the status of intensified competition and environmental dynamism. Its internal reasons include seeking intermediate organization effect, pursuing advantages of value chain, building competitive advantage group and maintaining the competitiveness of the core culture. In terms of key content of supply chain management, supply chain collaboration aims to achieve the optimized integration of resources. Supply chain collaboration includes three aspects: The collaboration on organization level transforms into "cooperation-integration", each other's more specific division of labor and duty in supply chain from "cooperation-game". The collaboration on business process level, breaking enterprise boundary on supply chain level and focusing on the core of satisfying end-customer demand, conducts integrative recombination of process. The collaboration on information level, by the Internet technology, realizes the integration of information system among supply chain partners and the real-time sharing and exchange of operation and market data, so as to achieve better and faster collaborative response to end-customer demand. Only when above three aspects meet the requirements of supply chain collaboration, can the whole supply chain achieve faster response speed and more forward-looking predictability to reduce uncertainty in operation and satisfy customer's needs to a maximum extent needs.

One of the greatest challenges that the Internet era has brought to manufacturing industry is the urgent demand for the optimization of supply chain: more complicated products, shorter delivery cycle, more flexibility requirements; more requirements for customized or

semi-customized manufacturing of products in small batches and multiple varieties, meaning it being hard to satisfy the needs of individualized orders, inventory, and accurate sales and prediction. Supply chain control tower is thus produced to meet the demand of increasing resource utilization. Supply chain control tower manages material flow by using a unified control center, greatly saving manufacturing and distribution cost and having greater flexibility and control capabilities. **Supply chain control tower is a cross-departmental organization and the "information center" supported by system integration. It can provide supply chain's visual services, and is used to monitor, measure and manage the delivery and warehousing activities on the supply chain.**

Supply chain control tower combines organization (person), information system and process. In the whole process of supply chain, it provides excellent services for supply chain partners and has the management control of three levels: The first is strategic level, the control on network design of supply chain. The second is tactical level, the design for procurement, operation and distribution based on market demand. The third is operational level, covering various real-time functions including delivery management, inventory tracking and exception management. In addition to the basic functions, the control tower has some other important functions, including planning and path, audit and report, forecast, incident management and decision making.

Supply chain control tower has following three characteristics: (1) flexibility, which means instantaneously integrate in accordance with business demand of various departments and increase resource utilization ratio. (2) transparency, which means every link is in accurate record with clear and detailed indexes. (3) visibility, which means informatization and digitization of manufacturing process.

3.2 The Function and Framework of Supply Chain Control Tower

3.2.1 The function of supply chain control tower

Enterprise's order management mainly involves following departments: Commodity Production, Inventory Material Flow, Electronic Commerce, Payment Processing, Financial Accounting, Business Intelligence and Customer Service. The emergence of supply chain control tower makes each link of order management more standardized, thereby enhancing enterprise's operating profits.

(1) Improving the controllability of production and commodity allocation

During commodity production, supply chain control tower, as the regulator of integration process (get market demand - product distribution - redeliver market demand), shows current operation status, which has become an important basis for enterprises to formulate market strategy and specify operating links and manufacturing standards.

(2) Improving inventory management efficiency

In terms of inventory, with the help of control tower replenishment model, control tower clearly formulates replenishment and production standards, and collaborates the upstream and downstream. Under the precondition of guaranteeing supply, it improves inventory

management efficiency and capability.

(3) Providing real-time material flow information

For material flow and electronic commerce, control tower can manage every link from shipment to delivery, provide logistics information more timely and archive necessary document records such as different proofs, signature, time, etc.

(4) Optimizing payment step

In financial management, control tower can specify every step of planning, optimize payment experience and follow up payment progress in real time so that payment step can be optimized and accounting date and internal capital flow will be accelerated.

(5) Improving the transparency of key performance indexes for order management

As a well-structured and completed system, control tower standardizes every step of the supply chain, which has become an important standard for enterprise's performance.

(6) Preventing uncertainty of order management

The high-tech control tower can enhance the predictability of emergencies, realize real-time notification and interaction with customers on timetable of order management process and regulate overall delivery to guarantee time of arrival.

(7) Reducing consumption

Strike a balance among above-mentioned manpower, materials and finances can help to reduce consumption and lower costs.

3.2.2 The framework of supply chain control tower

The framework of supply chain control tower is shown in Figure 3.1.

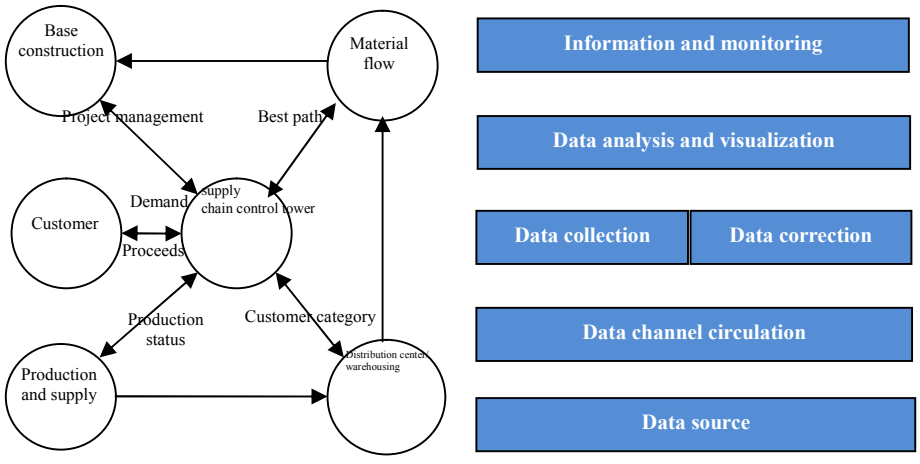

Figure 3.1 The Framework of Supply Chain Control Tower

Supply chain control tower acts as the central role of supply chain collaboration, and simulates, visualizes, analyzes and predicts information and possible outcomes for all stakeholders. All stakeholders use information to solve problems, avoid risks, and thus

improve operational efficiency. With supply chain control tower, the stimulation of causal relationship and what-if analysis can help planning personnel to understand how production, material flow, delivery or supply chain operation affects enterprise. These supply chain analysis functions help planning personnel make accurate plans and take precautionary measures to avoid or minimize the factors that may result in supply chain nightmare.

3.3 The Information Collaboration in Supply Chain Control Tower

With the rapid development of computer, communication and network technologies, enterprises can construct the Intranet and Extranet on the basis of the Internet to form a relatively complete supply chain management information system and provide support for realizing the coordinate operation of supply chain management. Modern information technology can provide unified and collaborative supply chain control tower for supply chain management system, and realize the sufficient information collaboration among all enterprises in supply chain system.

3.3.1 The information type in supply chain control tower

(1) Sales data: Sales data are generally collected from POS. After that, supply chain members can use different methods to analyze sales trend and identify customer preference, so as to better determine R&D direction of new products, inventory level and goods shelf arrangement.

(2) Sales forecast: Sales forecast conducted by supply chain members according to the data can better reduce bullwhip effect and effectively lower inventory level. For example, by sharing information with suppliers, retailers can effectively know current market situation and draw out suitable market development plans.

(3) Production/delivery schedule: Enterprise's production schedule is closely related to up-and-downstream enterprises and has certain influence on demands of upstream enterprises and supply of downstream enterprises. Downstream retailers need to know upstream suppliers' production schedule so as to make their own ones. On the other hand, downstream enterprises also have certain influence on upstream ones: demand for suppliers affects the production schedule of suppliers.

(4) Inventory level: Generally, supply chain members will share all inventory data. Every member will share their inventory information, which can effectively control the total inventory level of supply chain.

(5) Order status for tracking: partners are allowed to inquire order implementation status, which is convenient for taking measures as soon as possible for deferred orders, and can ensure high service level of whole supply chain.

(6) Delivery status: Advanced modern GPS system can dynamically monitor delivery material flow.

3.3.2 Information collaboration level in supply chain control tower

The main function of supply chain control tower is to realize supply chain information

collaboration. It mainly includes the following parts.

(1) The information collaboration of supply networks

The information collaboration of internal supply chain is to make it easier for suppliers and enterprises to draw up internal production schedule and make correct decisions on procurement and production. The network information collaborations of supply chain include several aspects, mainly between suppliers and suppliers, suppliers and manufacturers, material flow service suppliers, material flow service suppliers and parts suppliers. In supply process, as the core enterprise, manufacturer will develop production schedule according to raw material and parts demand. Sometimes, some special parts need the collaborative R&D and coordination between manufacturers and suppliers to ensure normal production. Manufacturers and suppliers will constantly exchange their information. Material flow service suppliers, as a medium, will make arrangement according to information of both parties, which can avoid too much parts inventory, ensure normal production and smooth supply chain operation, and improve production efficiency of the whole supply chain.

The information collaboration is very important to a supply chain, which has several advantages. It can shorten production cycle, reduce suppliers' inventory and enable enterprises to quickly respond to customer demands. Whether information collaboration of the whole supply chain is smooth or not directly determines whether this supply chain can take the lead in the market. For manufacturers, after knowing production capabilities and schedules of its suppliers, they can adjust their own ones accordingly to keep inventory at an appropriate level and remain a normal production. After knowing manufacturers' production schedules, suppliers can adjust their own ones accordingly to earn more profits. Take automobile manufacturing industry as an example, engine suppliers play a key role in the whole automobile supply chain. It is especially important for whole automobile suppliers to know suppliers' production schedules. The production schedule sharing between two supplies is the information collaboration. In addition to engine suppliers, whole automobile suppliers also have steering wheel, wheel and other parts suppliers. Besides whole automobile suppliers, engine suppliers should also conduct information collaboration with other parts manufacturers to make sure they can also participate in R&D process of new products. This will not only lower their own inventory, draw up correct production schedule, but also avoid stock out risk.

1) The information collaboration between suppliers and suppliers

In general, parts manufacturers have close relation with parts suppliers. To achieve complete information collaboration of the whole supply chain, it requires complete sharing of respective product design and inventory information among suppliers and downstream manufacturers should refer to that. The main information shared by suppliers are as follows: suppliers should first share their production schedules for reference to coordinate production; and then discuss production schedule according to order information provided by manufacturers to give manufacturers a certain delivery batch. When manufacturers need parts of new products, every supplier should share product design information. Though suppliers make different products, through constant exchange and improvement, the most suitable

products will be designed and the whole product performance will be increased.

2) The information collaboration between suppliers and manufacturers

The raw material and parts suppliers are the basic suppliers for enterprise production. Under the same supply chain, information collaboration should be conducted between parts suppliers and manufacturers. Suppliers share inventory level, production lead time, order response time, production standard and other information with manufacturers, and manufacturers share production schedule schema, product design demand for parts and parts demand. Two types of enterprises change the existing schedule according to data they get to achieve information collaboration, which leads to higher-quality parts produced by manufacturers and a smoother production schedule. Suppliers can cooperate with manufacturers to conduct R&D of new products together, which cannot only improve their product quality but also abilities in scientific researches. The satisfaction assessment can be conducted and both parties can improve themselves accordingly and constantly to realize a better cooperation.

3) The information collaboration between material flow service suppliers and manufacturers and parts suppliers

Information collaboration should also be realized between suppliers and material flow service suppliers. Suppliers share production lead time, response time and other information with material flow service suppliers. Material flow service suppliers timely feed manufacturers' inventory information back to suppliers afterwards.

According to the material demand information shared by manufacturers, material flow service suppliers will realize the JIT and punctual delivery according to related information provided in order to ensure time of delivery matches manufacturers' production schedules.

The core manufacturer is extremely strict with the inventory control of its own parts, even better to have zero inventory. Material flow service suppliers should quickly deal with these orders and are able to achieve punctual delivery according to the specified time of delivery. As a result, when delivering for core manufacturers, material flow service suppliers should realize JIT, which is very high-demanding for them because they should manage every step strictly.

(2) The information collaboration of inner-enterprise

The larger the enterprise's scale is, the more complicated information it needs to deal with, so the various departments within the enterprises should have high collaboration capabilities to improve business operation. Following are the reasons why they need information collaboration: firstly, internal resources can be better allocated to different departments, so that sales, production and R&D department can respectively collect information that is needed for decision-making, timely providing the most accurate information and improve resources utilization ration; Secondly, internal information collaboration can improve working efficiency of every department, which means repeated work will not exist. Besides, it is conducive for cross-regional operation. Improvement of working efficiency can also effectively control operational costs.

The exchange and mutual-learning among enterprise's internal members can enrich their knowledge, improve their abilities and thus create better performance for the enterprise. For example, exchange of enterprise's R&D Department, Marketing Department and Sales Department can help the enterprise to know information about production and R&D; information sharing between enterprise's Production Department and R&D Department can help the enterprise to know the products that customers really need. Information exchange can help different departments to get more comprehensive information and to respond to customer needs, achieving a better performance for the enterprise.

The enterprise can establish internal data base to make every department have access to other departments' information. Inputting various of information collected by different departments in the data base and setting permissions for this system to guarantee that only internal employees have access to the information. Before entering information, it should be verified first to ensure integrity, authenticity and completeness. Besides, ambiguous and obscure information cannot be entered.

(3) The information collaboration of distribution networks

Information collaboration of distribution networks is needed to better identify customer needs and increase their satisfaction degree.

In the downstream distribution networks of the core enterprise, information collaboration aims to promote the visibility and planning of information. In order to achieve the collaboration of distribution networks, enterprises should make sure that their information is accurate. Enterprises can share their own information and timely adjust their production information according to customer needs to provide better service and increase customer satisfaction degree. Material flow service suppliers, as the medium, mainly provide services for downstream enterprises. Node enterprises generally collect sales statistics, inventory level and other information and predict the market accordingly, helping to draw up production schedule and new product development strategy.

Many famous international companies have prospered due to distribution information networks. P&G, a well-known enterprise, annually collects and sorts data. It obtains inventory data from the distribution centers, and obtains sales data from retail stores, which helps it better identify customer needs, timely respond to customer needs, develop product that is more in line with customer needs and better control inventory level. Manufacturers' close information sharing and exchange with retailers helps them not only to better predict the future market but also the related cost. For retailers, they can better control inventory level and improve enterprises' performance.

1) The information collaboration between manufacturers and retailers

In order to reduce the bullwhip effect of supply chain, good information collaboration between manufacturers and retailers is needed. The bullwhip effect of supply chain is mainly due to manufacturers' inaccurate forecast of demand information of end-customers caused by wrong gathered information. Customers are dissatisfied about products so that manufacturers

have to store products in warehouse. As warehouse cannot be used well, liquidity is reduced. Therefore, whole supply chain working efficiency reduces and customer satisfaction decreases, which drag the operation speed of supply chain. Finally, supply chain efficiency is reduced. Based on documents, it's obvious that if manufacturers and retailers can communicate and share information, supply chain risks will be reduced and both sides' benefits can be improved. Retailers provide manufacturers with gathered information. Based on this, manufacturers make market prediction and produce products that meet customers' needs. This will not only improve customer satisfaction and market share but also better control inventory. Retailers mainly offer information about customers' needs, POS gained by retail department and inventory of retailers, etc. However, manufacturers shall not leak such information to other enterprises. Manufacturers can provide retailers with information on discount, quality, etc. to achieve information sharing.

2) The information collaboration between retailers and retailers

There is also space for information collaboration between retailers and retailers. They can share information about inventory, product brand design and image design, which not only prevent malicious competition but also jointly improve brand image. For example, there are two retailers located closed to each other. When one retailer is out of stock, the commodity can be sold to customer by the other retailer nearby to achieve quick response to customer demand. Retailers collaboratively provide customers with home delivery service and other better services, which not only improve its service capability but also make contribution to brand image enhancement.

3) The information collaboration among material flow service suppliers, manufacturers and retailers

Material flow service suppliers provide material services for supply chain distribution networks. According to customers' order demand information and product inventory information, they provide convenient third-party material flow services. Material flow service suppliers should improve information sharing and communication with retailers and suppliers. The more reliable information is, the faster and more accurate the delivery is and the higher satisfaction customer will have. Good information collaboration among them three has great benefits. First, material flow service suppliers can deliver faster as they have more accurate and reliable information to help them better understand customers. Second, with great information collaboration, material flow service suppliers can gain information with the fastest speed to make response. This is especially important when manufacturers have urgent orders. Material flow service suppliers can also meet customers' needs, provide better service to improve customer satisfaction. In IT industry, HP, IBM and other enterprises ask suppliers to share information with retailers to rationally control inventory on both sides so that enterprises can response to customer's needs. This paper mainly researches on information collaboration. Based on information collaboration, this paper proposes the common information technology platform, information collaboration supporting mechanism and the supply chain information collaboration model of the process and development capabilities of

information collaboration, including the information collaboration of many bodies, such as information collaboration of members in supply chain pivoting on core manufacturers, information collaboration of internal distribution network, internal supply network and internal enterprises, time and money spent on information collaboration, etc. Thus, information collaboration plays a bigger role.

3.3.3 The information collaboration approaches in supply chain control tower

The information collaboration in supply chain control tower mainly has the following approaches:

(1) Point-of-sales (POS) data: POS means a system that automatically analyzes the data from commodity sales and make bilateral communication between data and department via internet channel so that system design of operational efficiency can be enhanced. Manufacturers can use POS information to make sales forecast. They can also compare POS information and order data to develop proper production schedule and retailers' inventory replenishment schedule.

(2) Electronic data interchange (EDI): EDI is to, according to the market rules, format business documents, and by computer network technology, conduct data sharing and automation among the computer network systems of trade partners. The main elements that make up EDI system are: EDI software and hardware, communication network and data standardization. The use of EDI helps to communicate data, reduce management cost and improve the efficiency of business activities within a short time.

(3) Vendor managed inventory (VMI): VMI system is to, on the basis of EDI/Internet, ID code and bar code, achieve supplier's control of retailer inventory. The supplier is able to monitor and check the inventory status during transportation so as to quickly respond to changes in customers' needs to ensure the production plan is appropriate. For example, P&G manages its inventory in Wal-Mart by VMI system to realize the sales information sharing between suppliers and retailers. P&G can utilize the real-time feedback information to process products to be sold and follow market trend.

(4) Continuous replenishment program (CRP): The traditional procedure of placing orders by retailers is changed into the communication between suppliers and retailers, and the replenishment program is determined according to the first line product demand information and inventory level. The information exchange is carried out through EDI, and CRP system can be operated directly by either the supplier or the third-party service provider. The purposes of implementing CRP effectively are to reduce inventory pressure, improve service quality and save manpower for retailers.

(5) Quick Response (QR): Retailers and suppliers work together, predicting data trend by sharing POS information, using EDI to speed up information flow and minimizing replenishment time and cost by acting together to make quick response to market demand. The specific strategies are Floor Ready Mechanism and Automatic Material Handling, etc.

(6) Efficient consumer response (ECR): The use of scanning technology and POS system

makes the commodity flows freely circulate among each enterprise on the supply chain to quickly meet customer demand and introduce new products quickly. Basic strategies include Efficient Store Assortment, Efficient Replenishment and Efficient New Product Introduction.

(7) Collaborative planning, forecasting &replenishment (CPFR): CPFR uses a series of system models to provide the collaborative plans that covers the entire supply chain structure. By sharing information, it improves the partnership between retailers and suppliers, and adjusts product sales trend and supply chain operation.

From the angle of the utilization of information technology, the degree of information collaboration can be divided into: information transfer, resources sharing, application integration and other modules:

(1) Information transfer

Using POS and EDI to speed up information transfer and reduce cost. This belongs to information integration of information transfer. This level of integration is relatively low, because the upstream enterprises on the supply chain are passive as they rely on information sent by the downstream enterprises, while the rest of information of the downstream enterprises is opaque to the upstream.

(2) Resources sharing

During information sharing, both sides want to have more consumption data, which requires them to actively access data. Groupware, shared database and high-speed special connection, etc. are the technologies that meet this demand. Shared data can increase the understanding among each business unit and the overall objectivity of forecast and fitting rate, and also reduce the interference caused by repeating information transfer.

(3) Application integration

With only shared data is not enough for predicting market trend. If the data processing principles and methods are inconsistent, it may also bring difficulties for adjustment. For example, if both manufacturers and sellers obtain market historical data at the same time, when the forecast methods are not uniform, the forecast results may be completely different, and if both sides rely on their respective data to carry out business, there will be conflicts. Application integration helps to improve logical relationship between two parties so that their progress can be uniformed in market prediction.

3.3.4 Information collaboration framework in supply chain control tower

The supply chain control tower based on the Internet/Intranet uses appropriate information technology as its support, realizing the seamless connection between the enterprise information platform and the supply chain information transfer system, the efficient sharing of data and unified collaboration. Supply chain control tower must have sufficient information integration capability to ensure the smooth circulation of supply chain information flow.

The information resources in supply chain control tower can be accessed by the core manufacturing enterprise, material flow service suppliers and their upstream and downstream

enterprises to ensure the timely sharing and communication of various information, guarantee the efficient operation of supply chain, improve the efficiency of supply chain operation and realize the information collaboration of time, cost and finance. The building of supply chain control tower can realize scheduled information collection and transportation, improve the efficiency of information transfer and overall profitability, realize the precise and highly collaborated supply chain.

Supply chain information collaboration is a complex system, so the building of an integrated information technology platform-supply chain control tower based on supply chain information system resources is an important prerequisite for supply chain information coordination. Information security, incentive and organization supporting mechanisms are important pillars of supply chain control tower. Information collaboration process capability is an important guarantee for supply chain control tower. The time, cost and financial advantages of information collaboration are the benefits of supply chain control tower. Information collaboration development capability is the driving force for the sustained and in-depth development of supply chain control tower.

Based on supply chain supply networks and distribution networks, etc., manufacturing industry's maximized information collaboration framework of supply chain control tower is built as shown in Figure 3.2. The imaginary line in the figure represents information flow, and the one-way arrow represents the one-way information transmission, and the two-way arrow represents the two-way information sharing and transmission. Supply chain node enterprises adopt a series of information technologies (ERP, SAP, etc.) to read and use stored data in platform, make collaborative decision, improve accuracy of supply chain demand forecast, reduce supply chain inventory, shorten supply chain's production and procurement lead time, improve the overall operational efficiency of supply chain so that relationship among three parties are closer and trust is enhanced.

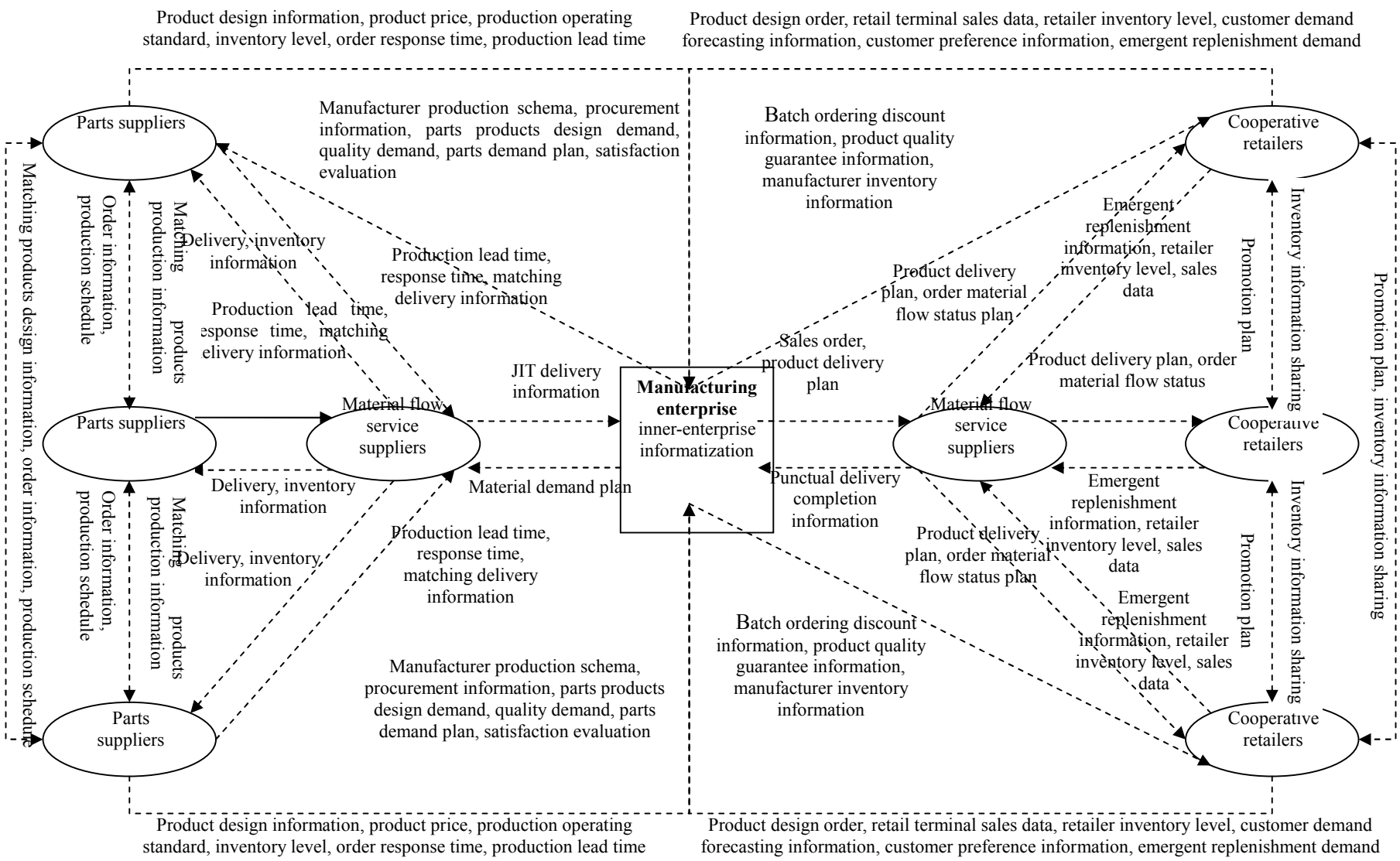

Figure 3.2 Manufacturing Industry's Information Collaboration Framework of Supply Chain Control Tower

3.4 Chapter Conclusion

This chapter first describes the background of the raise of supply chain control tower, then puts forward the function and framework of supply chain control tower and analyzes its key elements. The results show that:

(1) Supply chain control tower is a cross-departmental organization and the “information center” supported by system integration. It can provide supply chain’s visual services, and is used to monitor, measure and manage the delivery and warehousing activities on the supply chain. Supply chain control tower is an important way of supply chain collaboration.

(2) Supply chain control tower acts as the central role of supply chain collaboration, and simulates, visualizes, analyzes and predicts information and possible outcomes for all stakeholders. All stakeholders use the information to solve problems, avoid risks, and thus improve operational efficiency.

Chapter IV Analysis on the Assessment of Supply Chain Performance

This chapter firstly introduces the concept of supply chain performance, secondly proposes the idea and principle of assessment of supply chain performance, finally discusses the assessment method of supply chain performance.

4.1 The Concept of Supply Chain Performance

What is performance? Performance is the individual (group's) describable work behaviors and measurable workload within specific time in an organization, and is that, combined with individual (group's) quality and capabilities in previous work, the organization guides it to improve and estimates the total of work effect acquired by the individual (group) within specific time in the future. Simply put, performance refers to the achievements acquired by on-going or ended certain activities. Therefore, performance not only can be regarded as the presentation of a process but also can be viewed as the results generated by a process.

Supply chain performance is the overall performance of supply chain, including both the performance of each node enterprise and the collaborative performance among enterprises. It refers to the total value brought by product or service provision or work through business cooperation and the use of material resources such as infrastructure, human resources and technologies by enterprises on supply chain.

Supply chain performance means the overall operational efficiency of supply chain. Management of supply chain performance is the assessment of business process of supply chain. With reasonable monitoring and management, supply chain can be managed.

4.2 The Idea and Principle of Assessment of Supply Chain Performance

4.2.1 The idea of assessment of supply chain performance

The assessment of supply chain performance is a complicated mission. Thus, a scientific, normative and instructive system of assessment of supply chain performance is needed.

The proper assessment of supply chain performance shall abide by the following steps:

(1) The key and also the purpose must be made clear, that is why there should be an assessment of supply chain performance;

(2) The assessment of supply chain performance shall develop both qualitatively and quantitatively;

(3) Process monitoring and assessment shall be combined, with dynamic monitoring on process;

(4) Distinguishing bodies, different bodies are related to different supply chain performance, shall have different index systems.

4.2.2 The principle of assessment of supply chain performance

Schneier et al. (2005) pointed out that grasping the nature of work is the key to establish a successful performance assessment model. The purpose of performance assessment is not to quantify all aspects to be objective, but to avoid subjective assume, doubt and measurement when assessing. As a result, based on the inherent characteristics of supply chain, the ease of use of implementation process, combined the features of assessment model, the establishment of index model of performance assessment of supply chain shall abide by the following principles:

(1) The principle of goal-oriented. The purpose of performance assessment of supply chain is to analyze if supply chain achieves the goal of supply chain management, to provide guidance for the improvement of supply chain. Assessment index must reflect the goal of supply chain management.

(2) The principle of sufficiency. The establishment of index model shall fully reflect all the aspects of supply chain. They shall not only reflect the operation status of single node enterprise, but also the operational effectiveness of the whole supply chain, so as to make each aspect of support chain effectively reflected in operation process.

(3) The principle of simplicity and validity. The index model that is established shall be simple and feasible based on actual condition. System that is too simple cannot achieve in-depth performance assessment. However, overcomplicated system may have requirements that are so high that it is hard to implement.

(4) The principle of operability. The selected indexes shall have reliable data sources and suitable acquisition difficulties.

(5) The principle of comparability. The index shall be measured with scalable ways like numbers as far as possible. Priority shall be given to quantitative indexes. For qualitative indexes, their implications shall be made clear. Based on certain standards, they are assigned to make them suitably reflect the nature of index. Qualitative indexes must be quantified to facilitate the assessment among different supply chains.

(6) The principle of guidance. To find out influencing factors of performance and reflect them via index to achieve better management.

4.3 The Assessment Method of Supply Chain Performance

The assessment of supply chain performance is the assessment of the overall operation performance of the whole supply chain, supply chain core businesses and the process implementation and partnership among node enterprises on supply chain, is the performance assessment index based on business process. In the life cycle of supply chain, the assessment of supply chain performance plays an important role. It is the major task of the operating period of supply chain. Through the assessment of supply chain performance, managers can clearly and objectively understand the implementation of supply chain process and supply chain strategy. It is a significant guarantee to push the constant improvement of supply chain and ensure the effective operation of supply chain. Referring to relevant materials literature that can be consulted currently, the assessment of supply chain performance mostly uses these

two methods: Supply-Chain Operations Reference-model (SCOR) and Balanced Score Card (BSC).

4.3.1 Supply-Chain Operations Reference-model

Supply-Chain Operations Reference-model (SCOR for short) was developed and sponsored by Supply Chain Council (SCC for short), is suitable for the performance assessment model in different industrial fields. SCOR is the first standard reference model for supply chain process, and the diagnostic tool of supply chain that covers all industries. SCOR can help enterprises on problems concerning accurate supply chain exchange, objectively assess its performance, determine the goal of performance improvement and influences the future development of supply chain management procedure. It integrates business process reengineering, benchmarking management and best business analysis into a multifunctional and incorporate model structure, provides universally applicable and common standards for cross-industrial supply chain application.

When describing supply chain according to the standard process, SCOR divides supply chain into definition level, allocation level, process element level and other levels. Each process of each level has well-defined performance assessment index and best business performance. SCOR includes the following three levels. The first level of SCOR describes five basic processes: Plan, Source, Make, Deliver and Return. It defines the scope and content of reference model of supply chain operation. According to the analysis of the first level of SCOR, enterprises can make basic strategic decisions. Its second level is allocation level, consists of 30 core process categories that may constitute supply chain. Enterprises can select the defined standard process unit at this level to build their supply chains. Each product or product model can have its supply chain. The third level of SCOR is process decomposition level. It gives the detail of process element in each process category in the second level, and provides enterprises with information necessary for successfully planning and setting the improvement of goals of supply chain. There might be the fourth level or more levels below the third level, and these levels are all implementation levels. The performance assessment indexes of SCOR have five characteristics: the delivery reliability, reaction capacity, flexibility, total cost and asset management of supply chain. Every aspect shows a typical type of supply chain, and each level has corresponding assessment indexes. By the calculation of the first-level indexes, enterprises can measure their own organizational operations whether to reach the given market competitive goals.

SCOR integrates business process reengineering, benchmarking comparison and process assessment and other concepts into a cross-functional framework. It is not only a process reference model designed for the effective communication among supply chain partners but also a standard language helping managers focus on management problems. SCOR has extensive coverage, including all interactional users from order entry to payment receipt, all logistic and trade information from suppliers to users and order corresponding trade market led by customers' needs. SCOR helps to achieve scientific and efficient operation of supply chain, improve overall performance and strengthen core competitiveness of enterprises.

Using SCOR to conduct the assessment of supply chain performance manly has the following advantages: First, emphasizing that the assessment of supply chain performance must be the assessment based on business process. Second, connecting specific process with performance goal after fully understanding business process, which easing the selection of index. Third, making helpful attempts for unified assessment and information integration. Last but not least, this is not an empty talking but a specific assessment based on actual condition.

4.3.2 Balanced Score Card

Kaplan and Norton, who established the system of supply chain assessment, published a series of articles related to Balanced Score Card combining the financial assessment in the past performance assessment with the driving force of the future value. The core idea of Balanced Score Card (BSC for short) reflects the balance among various indexes, namely, the balances between short-term and long-term goals, financial and non-financial indexes, internal and external performances. Management attention shifts from the realization of short-term goals to the consideration to the realization of strategic goals in long term. Not only the conclusion should be thought about but also the reasons for the conclusion. Kaplan and Norton design BSC from four aspects, respectively, the aspect of customer, internal process, study and development and finance, which represents interest of shareholders, customers and employees, facilitating enterprises in making plans for achieving the long-term goal.

BSC shall be implemented based on various information. Its mission is to help enterprises meet their goals by conducting overall assessment on corporate value. Its divides the factors that influence the operation capabilities of enterprise into several aspects and specifically designs corresponding assessment indexes, so as to systematically and comprehensively reflects the overall performance of enterprise and guides enterprises in achieving the long-term goal.

Using BSC in the assessment of supply chain performance mainly has the following advantages: (1) Providing multidimensional and three-dimensional assessment perspective. (2) Pointing out supply chain performance's causal relationship among finance, customer, business process and innovation and development. (3) Reflecting the chronicity and continuity of assessment of supply chain performance. (4) Giving the basic assessment framework from a macro perspective, conducting macro performance assessment from a strategic level.

4.3.3 BSC-SCOR assessment model of supply chain performance

Under the current supply chain environment, the operation of enterprise has dynamic adjustability, randomness and other characteristics. The pure finance-or-process oriented assessment system cannot meet the requirements of the overall performance assessment. Integrating various assessment models into a comprehensive assessment model is the new trend of assessment of supply chain performance.

Supply chain manages information, logistic and property flows. Such chain contains procurement of parts, product process, product distribution and purchase. It enables raw material supplier, manufacturer of the product, seller of end-product and consumers to interact and contact each other. According to the leading role of manufacturing enterprises and circulation enterprises in supply chain, supply chain can be divided into the supply chain dominated by manufacturing enterprises and that dominated by circulation enterprises.

Although BSC macroscopically provides a framework for the overall performance assessment of enterprise from four relatively independent dimensions: finance, customer, internal process and innovation and development, it does not provide the method to decompose the macro indexes. It is difficult to measure performance as supply chain is quite complicated. At the same time, the indexes involved in BSC do not take into account of factors of competitors, which cannot comprehensively reflect the strong competitiveness of supply chain. Given this, this thesis introduces SCOR to make up the shortage of BSC on process segmentation.

BSC-SCOR assessment model of supply chain performance combines the system framework provided by BSC with the process segmentation provided by SCOR. It provides specific index for the assessment of supply chain process management, regulates the connection between each link of the supply chain. Suitable method shall be adopted based on actual condition. BSC-SCOR assessment model of supply chain performance realizes the comprehensive and balanced assessment of supply chain performance, and conveniently achieves the mapping from long-term goals benefiting supply chain value to specific business processes, activities or tasks, having good guiding effect to the establishment of rational index system of assessment of supply chain performance.

The major missions of supply chain management are to shorten time and reduce unnecessary cost so that enterprises can gain more profits. However, index system of assessment reflects final performance of supply chain. Thus, the assessment of supply chain performance shall not only focus on the current operation status, but also look at long-term development capabilities. As a result, in the process of selecting performance assessment indexes, the profitability, sustainable developing capability, stable growing capability, profit growth potential (innovation of products and services) and other factors of supply chain shall be comprehensively considered.

4.4 Chapter Conclusion

This chapter firstly introduces the concept of supply chain performance, secondly proposes the idea and principle of assessment of supply chain performance, finally discusses the assessment method of supply chain performance. The research shows that:

(1) The assessment of supply chain performance is the assessment of the overall operation performance of the whole supply chain, supply chain node enterprises and the process implementation and partnership among node enterprises on supply chain, is the performance assessment index based on business process.

(2) BSC-SCOR assessment model of supply chain performance combines the system

framework provided by BSC with the process segmentation provided by SCOR. It provides the standard description of supply chain management process and realizes the comprehensive and balanced assessment of supply chain performance.

Chapter V Conceptual Model and Research Hypothesis of the Relation between Manufacturing Supply Chain Control Tower

In this chapter: First, XCMG and JH are taken as examples for exploratory case study; then, explore the relation between the manufacturing supply chain control tower and corporate performance; finally, put forward the conceptual model of manufacturing supply chain control tower and corporate performance.

5.1 Exploratory Case Study

Case study is the most commonly used method for verification on a theoretical basis. Where a question is put forward by “how” or “why” and where a surveyor cannot take the event process under control and the focus has a real background, case study becomes a very effective research method. In this paper, the “how” question is studied. Therefore, the case study method can more directly and effectively explain the theme of this paper. Here multiple exploratory cases are adopted in combination of literature analysis to build the theory. And further researches are carried out in a vertical manner into a certain case. There are several advantages. This method is on one hand conducive to ensuring the rationality of the theory and on the other hand ensuring the depth of the case study because it goes deeper into the background of the case. In the process of the research, this paper sticks to the general principles, steps and methods of case study. Through full discussions on the process of the cases, this paper explores the relation between supply chain collaboration and supply chain performance of machinery manufacturing enterprises, and puts forward and verifies relevant research propositions. Taking it as the cutting point, we figure out the countermeasures for the improvement of supply chain performance of enterprises.

For manufacturer supply chain, how to effectively integrate existing resources and technology capacities to promote the effective collaboration is the major difficulty for node enterprises. In the supply chain management environment, node enterprises maintain trust and unified development to realize resources sharing by coordinating things effectively to maximizing supply chain performance improvement. Vachon (2006) analyzed and claimed that both sides of trade can achieve unified decision-making based on common development goal. At the same time, maximizing the performance of manufacturers by tracking business items. In addition, information collaboration can improve supply chain performance to a certain extent. To explore the impact of supply chain control tower on corporate performance in machinery manufacturing industry, in this paper two typical machinery manufacturing enterprises are chosen for exploratory case study so that through the case study and the comparison study of multiple cases we can explore the relation between supply chain control tower (or supply chain information collaboration) on corporate performance in machinery manufacturing industry and its function mechanism, providing realistic basis for the building of the conceptual model and the hypothesis of the relation between manufacturing supply chain control tower and enterprise chain performance. Case selection should meet the following two basic requirements:

(1) Follow the principle of research focus. Case enterprises should be those machinery manufacturing enterprises with a preliminary supply chain control tower or with significant supply chain information collaboration characteristics.

(2) Follow the "typical" requirement. Case enterprises should be those enterprises that are pioneers in their sub-industry.

According to the above rules, we choose Xuzhou Construction Machinery Group (XCMG) and Company S as our typical cases to analyze the impact of supply chain collaboration on corporate performance.

5.1.1 Xuzhou Construction Machinery Group

(1) Company introduction

XCMG was founded in the late 1980s. Since its establishment, it has been the pioneer of construction machinery industry in China. Viewing from data, it is in the fifth place in the world's construction machinery industry and named 44th in top 500 companies in China. It is the leading machinery companies in China and the biggest in scale with most complete product varieties and series, and most competitive and influential large-scale enterprise group in China's construction machinery industry.

XCMG stresses technological innovation. It established a research and development mechanical system centering on the national level. XCMG Technical Center has been ranking the first in the industry since founded. Backed by XCMG Research Institutes around the country, XCMG have staged a batch of products that lead China and even the world, including: 2,000-ton level of all-terrain crane, 12-ton level of large-duty loader that is the largest in China, the fourth generation of smart road surface construction equipment, etc., which have a subversive influence in the global construction machinery industry, breaking the global monopoly of foreign companies. Currently, XCMG owns over 2,000 patents with effective authorization, of which over 100 are authorized patents for invention. "All-terrain crane key technology development and industrialization" was awarded the second prize for national science and technology advancement in 2011. XCMG has established a global marketing network providing all-around marketing services for users through over 280 overseas agents. So far, XCMG's machinery and basic parts enjoy the NO.1 market share in China. Its export quantity of machinery is also in a leading position in China.

(2) Supply chain collaboration status

With rapid social development, there are more emerging enterprises and increasingly fierce industrial competitions. Mid-downstream machinery industry gets squeezed in terms of profit. Their profit growth rate is lower than sales growth rate. As competitors are actively coping with cost pressure, integrating internal resource and expanding their businesses to form scale effect, trying to become stronger and capture the international market, XCMG also feels the pressure. Facing the changes in the global economic environment, if it wants to keep the leading position in the industry, it should improve supply chain performance and supply chain response speed. In order to do so, XCMG decides to learn from advanced supply chain

management ideas, develop procurement process orderly by utilizing information tools, reduce expenditure, improve procurement model and further enhance customer satisfaction.

First, in terms of procurement model, XCMG adopts different procurement models for different material types. For example, for bulk materials or materials that are universally used with a large quantity of procurement, the Group shall set up a material supply company for integrated procurement and supplier management. At the same time, procurement personnel are selected from subsidiary companies. By doing this, the leverage effect of integrated procurement is guaranteed and the efficiency of procurement is enhanced. For scattered materials, subsidiary companies and supply company coordinate with each other in the management of suppliers in the entry process to ensure from the source of the quality of materials from the suppliers, but specific procurement procedures are managed by the subsidiary companies.

To better realize the diversity and agility of XCMG procurement model, improve the collaboration of upstream and downstream of XCMG, enhance speed and quality, reduce communication cost, supply chain information system is urgently needed. XCMG is constructing procurement supply chain platform for controlling procurement processes comprehensively and internally, strengthening information exchange and job division, broadening external supply channels and communicating as well as cooperating with suppliers. Meanwhile, adopting such a platform can help standardize procurement management, implement a highly effective strategic procurement management philosophy as guidance, as to reach the goal of improving collaborative procurement efficiency, standardizing procurement procedures, increasing income and reducing expenditure, integrating all procurement procedures, reducing purchase expenditure, broadening supply channels, guaranteeing raw material supply, satisfying personalized demand and establishing scientific supply chain brand features with XCMG characteristics.

XCMG procurement supply chain platform has multiple function modules, such as information communication management, supplier sourcing verification, profit management, product price management, procurement collaboration management (such as supplier delivery management, account checking management, etc.), SAPERP, product quality communication and cooperation management, etc., which basically covers the whole process from strategic procurement to daily procurement execution.

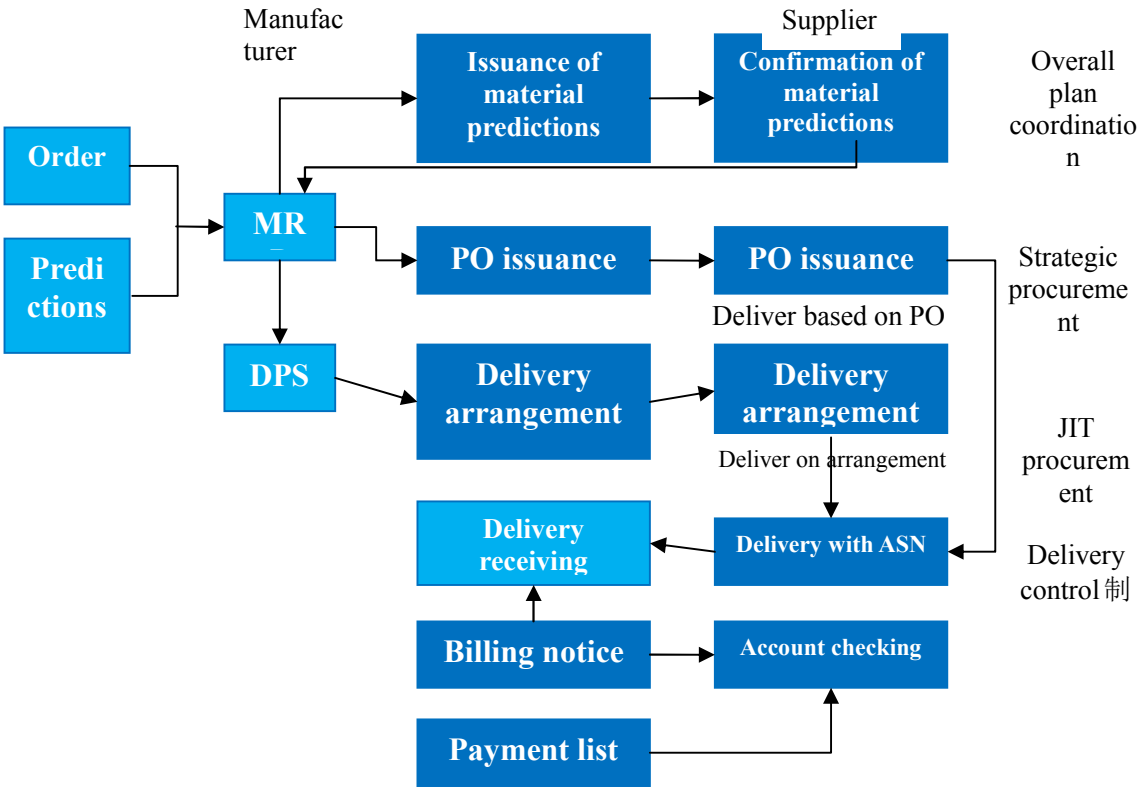

Figure 5.1 XCMG Collaborative Procurement Whole Process

Supplier sourcing: Suppliers may become potential suppliers after registering on the gateway website. After meeting requirements, the system will send a preliminary assessment form to the supplier who may fill in the form online. Then the supplier verification procedure is initiated.

Supplier preliminary assessment: Potential suppliers will finish the preliminary assessment online. The system will carry out the preliminary assessment automatically on the investigation template. After the preliminary assessment, the system will give an assessment report providing the comprehensive analysis of supplier weakness and strengths. Once the supplier passes the preliminary assessment, it will automatically enter into the qualified supplier list or qualified vendor list (QVL).

Supplier material verification: As for the suppliers in the QVL, the system can send them a sampling notice and suppliers may confirm it online. After the sample is verified to be qualified, the supplier can be considered as standard backup supplier, be asked to directly supply materials, with a certain proportionate.

RFQ management: Using the RFQ function in system, the procurement personnel may initiate price negotiation based on detailed cost list provided by supplier.

Electronic catalog management: The system can automatically build a complete set of qualified suppliers electronic catalog to make supplier management more supportive and effective. Thus, rapid strategy can be made in time of supplier structure adjustment and accident to reduce risks to the maximum extent.

Supplier performance management: The comprehensive assessment on supplier performance is conducted through a supplier performance assessment system. The assessment is objective. It can also be done by combining manual assessment on the data, to form a comprehensive assessment analysis. In addition, the multidimensional performance analysis results can be used to set a clear goal for the supplier to make improvements in their performance, thus promoting the elimination of underperforming supplier.

Collaborative procurement: Achieve organic integration of enterprise data, utilize internet transfer to reduce procurement cost and optimize raw material procurement. Improve cooperation quality via work indexes, transfer and receive board, pre-alert, etc. Enhance timely data feedback so that manufacturing and supply can be perfectly combined.

Closed-loop PO collaboration: Through the supplier input module, the supplier can manage their orders. When confirming order, submitted order can contain promised date of delivery. As for orders that have serious problems, suppliers may send order modification request to procurement department for approval.

Acceptance and quality inspection tracking: The supplier may check the delivery and AOG acceptance status and may also check out the quality inspection status and NG reasons at any time.

XCMG integrated the whole process of procurement and gradually pushed forward logistics integration. Through the design of integrated procurement core information platform and the design of global parts procurement logistics information system, it built a one-stop and visualized service system for XCMG supply chain.

(3) Impact of supply chain collaboration

Based on the establishment of an integrated supply chain mechanism covering procurement models of centralized and different types of product research and development groups and raw material suppliers, XCMG has basically realized an objective and obvious supply chain that can provide multiple procurement modes based on actual manufacturing conditions and improve flexibility in dealing with events. XCMG tries to build an internal procurement information sharing platform, a supplier's resources sharing and synchronization platform, a dedicated logistics platform and a global procurement platform, which aims at creating a quality-oriented, cooperation-linked, performance-targeted, logistics-looped XCMG supply chain management system in which all parties expand the market together, share the risks and profits together, and enjoy win-win situation together. It greatly reduces the raw material procurement cost of XCMG and meanwhile putting VMI, JIT and other operating modes into effective implementation, thus enhancing the turnover rate of inventory, cutting inventory cost, reducing production stoppages caused by insufficient raw materials, improving work efficiency of procurement personnel, lowering different expenditures, and greatly increasing economic efficiency.

The further sharing of supply chain inventory information will not only cut the cost of XCMG but also help suppliers reduce their inventory cost and logistics cost, thus increasing XCMG's

competitive advantages in the whole supply chain network.

5.1.2 JH

(1) Company introduction

Anhui Jianghuai Automobile Co., Ltd. was founded on September 30, 1999. It was a publicly listed company in China. It's one of the few auto companies that sell in their own brand in the market. Refine MPVs has the highest market sales share in China. The Group specializes in R&D, manufacturing and sales of cars and auto parts. Main products are transmission, light trucks, etc. Its annual output is 120,000 cars. Refine MPV project began in 2001 and was put into mass production in 2002. It is one of the excellent enterprises that manufacturing commercial vehicles in China with advanced production technology. This company has robots with high precision that can achieve automated production lines in a comparatively large scale, reaching designed single-shift annual output at 400,000 cars.

(2) Supply chain collaboration status

The competition of auto industry in China is increasingly fierce. Enterprises need to keep improving their technology if they want to secure their stand in the auto industry. JH started informatization in 1994, which is quite early. It successively implemented CAD, MRPII, ERP and other informatization projects and finally realized the significant improvement in overall informatization.

The developing business has posed pressure on procurement department. How to quickly transfer information related to supplier such as procurement, production, finance, etc., and timely manage information in supply chain to improve response speed was the urgent issue for company in 2001. Company gained great benefit by initiating ERP. However, as time went by, company gradually found above issues. It found that the weakest part in informatization was the communication and cooperation between upstream and downstream enterprises. Existing ERP system failed to meet the need of rapid development and above issues. Therefore, they turn their eyes to supply chain management. This uses e-purchase to realize the close integration of the supplier and the enterprise. Synchronization is realized. Supply system is optimized. A highly efficient supply chain system is built, which is faster and more comprehensive comparing with ERP system. It includes four sub-systems: communication platform, collaboration procurement, electronic inquiry and quotation, and supplier performance assessment (See Figure 5.2).

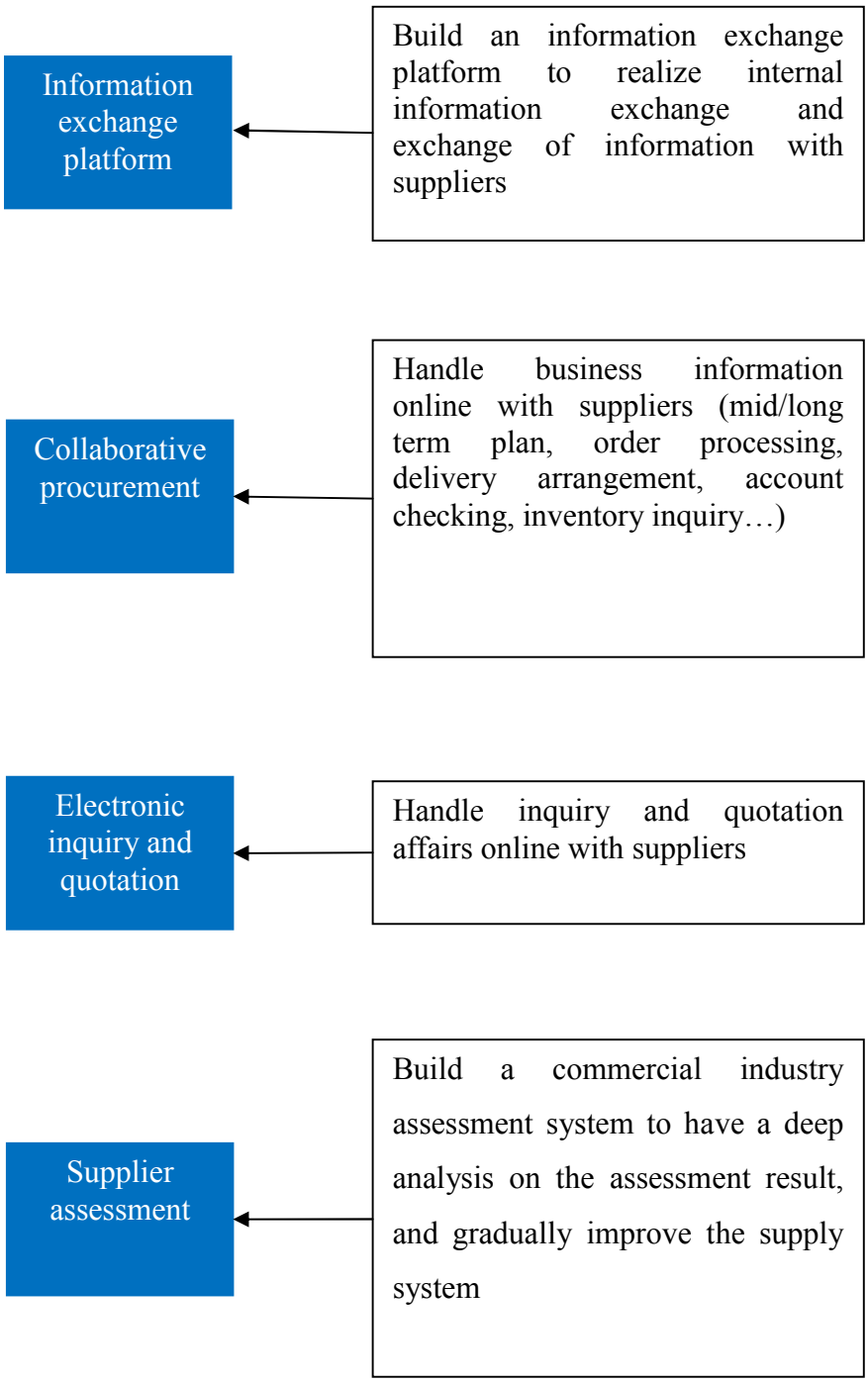

Figure 5.2 JH Supply Chain Collaboration System

The first level is communication platform, which is relatively simple among the four. The purpose of it is to let suppliers cultivate a habit of using the system to exchange information. On this platform, enterprise can transfer document, feedback on problems to relevant department, publish latest information about production, quality, etc. Thus, equal communication with suppliers can be achieved. In addition, it greatly reduces the use of telephone and facsimile.

The second level is collaborative procurement, which aims to finish business communications closely related to suppliers. Such communications are PO confirmation, delivery management, inventory inquiry, account checking and other business related matters with the suppliers. In the original procedural model, procurement has much information to exchange with suppliers, and most information including PO, billing notice, daily plan, inventory information, etc., are handled through e-mail, fax or phone calls that cannot pass information in time. Such means cost time and labor and with omissions or deficiencies that cannot timely get feedback from the suppliers, which may cause production stoppages or a lack of materials. By adopting the collaborative procurement system, data can be synchronized from ERP without using fax or phone calls so that suppliers can gain related data timely and give feedback. Such system also effectively solves the communication problem on order, inventory, delivery and account checking. By using this system, enterprise releases POs online for suppliers to check and confirm. If there are problems, they can be negotiated in time. At the same time, VMI model is supported. Suppliers may check out the inventory information and can supplement the goods according to the quantity of the order or inventory. The suppliers will create a goods delivery sheet online before the delivery, and publish a delivery notice when making the delivery. By doing that, the enterprise can monitor supplier via the system and find missed order timely. Meanwhile, the Procurement and the Warehousing can also know in first time the delivery status, which helps to manage inventory and replenishment. The delivery record also helps manage inventory and account checking, which reduce the burden of Procurement and shortened the payment processing cycle. The system saves communication cost and improves work efficiency.

The third level is inquiry and quotation and supplier assessment system, which is the extension and supplement of the second level. The inquiry and quotation system allows the procurement personnel to understand the price of the product online and publish inquiry information to suppliers who may reply it with their quotation data. The procurement personnel carefully consider the reply and decide to accept or decline the quotation of the supplier based on actual needs. The supplier who is declined may re-quote. Online inquiry and quotation is time-and-labor-saving and improves procurement efficiency. It provides a basis for price negotiation. Supplier performance assessment system means to establish a complete supplier assessment system that allows the analysis of suppliers from multi-dimensions including quality, delivery, service, etc. so that in-depth analysis can be done over the suppliers. By that, we know who’s fine and who’s not so that the whole supply system will be optimized. The suppliers may, after the publishing of assessment results, check their scores, analyze the reasons and make rectifications.

(3) Impact of supply chain collaboration

JH has built a supply chain management system for sub-systems to cooperate and quick information transfer. Currently, all suppliers use the communication platform to pass their information and resources of all kinds. The construction of supply chain collaboration system has reduced the workload of procurement personnel, labor, and the use of communication tools like phone calls and fax has lowered relevant cost and resources. The reform of existing

working procedures helps us timely discover and solve problems, improve information transfer efficiency and further consolidate the foundation for optimizing supply chain management system. Finally, collaboration between suppliers is realized; work efficiency of the whole supply chain is improved; changes in the market are coped with; win-win situation is achieved.

5.1.3 Revelations of exploratory cases

Through the above analysis we find that the two companies in the exploratory cases are very good at rapidly obtaining, timely sharing and effectively integrating internal and external resources on the supply chain based the advanced information technology and unified information technology standard to realize their supply chain time, cost and financial strengths and improve their overall supply chain competitiveness. Information collaboration stresses the collaborative value of information that is shared, namely the revenue of information collaboration. Supply chain node enterprises' accurate, timely and efficient information communication and sharing process is the necessary but insufficient condition of information collaboration. Information collaboration not only includes information sharing but also stresses the collaborative value and revenue of information sharing. The value of supply chain information collaboration refers to that through sharing information, lowering transaction cost, shortening delivery time and lowering inventory volume a time-based advantage, a cost-based economic advantage and a revenue-based financial advantage will be obtained.

Information integration refers to transparently sharing key information in supply chain using existing technology, which mainly involves information process technology and sharing methods. Comparing with normal information integration, information collaboration stresses the value and revenue of information sharing. In addition to above two aspects, information collaboration includes sharing revenue. One of the key driving elements for supply chain enterprises is partnership. Information collaboration is a process covering obtaining, sharing, communicating and integrating information. Supply chain information collaboration runs through the whole of the supply chain. Throughout production and operation, production and sales of product require information sharing with other enterprises. During information process and transfer, enterprises shall set unified process mode and transfer standard. Only by doing so, can information security be guaranteed, collaborative value of information be improved. Thus, different enterprises can work closely to allocate resources and improve revenue.

Through analysis, we get a preliminary understanding of the relation between supply chain control tower and corporate performance:

Hypothesis 1: Supply chain control tower has a positive impact on corporate performance.

5.2 Relation between Supply Chain Control Tower and Corporate Performance

5.2.1 Impact of supply chain control tower on corporate performance

(1) Impact of information integration level on enterprise production and operation

The information integration of supply chain control tower has a critical impact on product order plan, production and operation plan, product inventory control, sales plan and product distribution, etc. Effective information integration is the necessary condition for supply chain to realize synchronized operation. Through the integration of demand, product cost, lead time, production capacity and other information by up-and-downstream enterprises and the optimized design of collaborative strategy, demand prediction collaboration, product design collaboration, plan collaboration, procurement collaboration and inventory collaboration can be realized.

As the Internet has an increasing influence today, using the Internet rationally during production and operation can improve enterprise revenue, promote mutual understanding between enterprise and partners. In addition, effective communication can be achieved on production, delivery, etc., using internet so that whole supply chain of the enterprise can work properly. In terms of actual production, user demand drives supply chain to work. As for supply chain, information integration is key to the accuracy of transferred information. If there are errors in the process, wrong information will keep growing through supply chain and resulted in breaking in supply chain as products fail to meet actual needs. Enterprises have to conduct effective information communication with upstream and downstream so that each party can play their role in production and operation. Only by doing so, can market be expanded and enterprises work with the highest efficiency. The whole supply chain will not be smooth without improved information sharing among enterprises. This is critical for enterprises to obtain competence, adapt to market development needs, increase revenue and secure the stand in market.

There are different independent information systems in the enterprises, which are divided into different systems based on demand types. Internal data integration shall be achieved with these systems. However, the enterprise is only a very small member of supply chain. In order to provide high quality service, enterprises need to improve system integration with other procedure in the supply chain in actual production and operation.

Internal information integration of the enterprise. ERP system helps to achieve high integration of internal information and business process of the enterprise. In addition, it links finance other function modules of the enterprise to share information. By that, it shortens production cycle and reduces production cost. But ERP cannot realize the integration of ALL information in the enterprise. It needs to combine with other systems to meet growing information sharing demand in the enterprise. One typical example is the integration of ERP and CAD/CAM/CAPP, and integration of ERP and OA. This also shows the good compatibility of ERP, which adapts to basic business needs of enterprises.

With economic development, information integration is no longer limited within enterprises. With the deepening of cooperation, internal information will integrate with other partners' information, which is the integration of supply chain. Members in this supply chain will share integrated information and make plan for enterprise development. Thus, highly integration of each part of the production can be realized. Such integration was first display in the

application of EDI, which has high cost and low flexibility. With the rapid development of the Internet, electronic business system appears. It is more demonstrated as a kind of B2C model information sharing and mainly applied in retail channels. Its main advantages are linking the backend support system with the front-end customer service system and adapting to interactions at different level. With the development of internet technology, new technology like SCM, CRM and EAI emerged. In order to adapt to the new technology trend, a new business mode also emerged, which is "Collaborative Commerce". The benefit brought by information integration of supply chain becomes more significant.

According to the above analysis, this paper puts forward the following hypothesis:

Hypothesis 2: The information integration capacity of supply chain control tower has a positive impact on corporate performance.

(2) Impact of information collaboration mechanism on corporate performance

The degree of cooperation trust means enterprises' trust for other enterprises on the same supply chain. Collaboration can only be achieved by improving cooperation and communication between enterprises and trust among them. For each node enterprises, their collaboration will pose influence on collaboration between other enterprises. Collaboration requires extremely high trust as the basis. On this basis, different enterprises cooperate, communicate, share information, discuss development strategy, adapt to market development and design new operation mode.

An important indicator for measuring whether supply chain collaboration enterprises gain equal revenue is the level of information collaboration and revenue sharing. Information system generates more economic benefits for enterprises. However, such benefits shall be distributed based on level of participation in collaboration. Rational distribution is key to long-term development of enterprises. Trust among enterprises will not increase and market competence of supply chain will not improve without distributing benefits rationally. Therefore, the degree of information collaboration revenue sharing is an important representation of information collaborative development capacity.

According to the above analysis, this paper puts forward the following hypothesis:

Hypothesis 3: The information collaboration mechanism of supply chain control tower has a positive impact on corporate performance.

(3) Impact of information sharing level on corporate performance

A key indicator for measuring whether the shared information is transferred timely and information is correct or not is information sharing level. Such indicator comprehensively considers most of the influential factors in information transfer, such as timeliness, completeness and accuracy of information. With multiple researches conducted by professionals, it is found that if shared information is accurate and in time, flexibility of supply chain can be enhanced. High-level information sharing helps to consolidate trust among partners and further propel supply chain to develop. According to the above analysis, this paper puts forward the following hypothesis:

Hypothesis 4: Information sharing level of supply chain control tower has a positive impact on corporate performance.

5.2.2 Impact of supply chain control tower on enterprise plan and control

Many scholars proved that in actual operation, appropriate information sharing between partners in supply chain can improve supply chain quality in certain degree. The famous scholar Li (2006) researched and found that during operation, enterprises can improve the profitability of the whole supply chain if they can acquire information from upstream timely and increase response speed. Flexibility of supply chain will further enhanced if enterprises gain enough clear information in operation. In addition, famous scholar Yu (2010) conducted investigation and found that without information sharing, enterprises will fail to produce products that meet actual demand in operation, which increase the possibility of bullwhip effect. Enterprises need to clearly understand information such as production needs to fully utilize productivity to manufacture products that satisfied customers' demand. In view of product research and development, collaborative research and development can greatly improve successful rate of research and development, reduce cost and shorten cycle. In addition, service quality can be improved and enterprises can develop.

Enterprises can improve profitability by continuously increase input on development of technology and construct effective information sharing mechanism. During production, enterprises must enhance cooperation and communication with other enterprises and use gained information to improve service, adapt to market needs, shorten product development cycle, increase supply speed and build good reputation.

Suppliers and manufacturers need to participate in new product research and development for adapting market development. In this process, the two parties can achieve information sharing, jointly solve potential problems, and share revenue based on corresponding laws. In terms of actual design, research and development, sharing of material selection, process manufacturing, etc. must be conducted confidentially. In research and development, the trust and communication between two parties will improve successful rate of product research and development. Better products will be designed within a shorter time. Technology also contributes to increase in productivity. In addition, suppliers in supply chain will have higher satisfaction thanks to information sharing and communication and cooperation among different enterprises will be enhanced as well.

Hypothesizes 1-4 focus on the direct impact of supply chain control tower on corporate performance. But, information communicated and shared in the enterprise or between enterprises is hard to plan or control, if it is to have a real impact on corporate performance. Hence, the impact of information sharing of supply chain control tower on corporate performance cannot be direct. It must be realized indirectly by virtue of enterprise plan and control as a media conductor. Effective plan and control mainly mean timesaving, cost-reduction and uncertainty-decreasing. According to the above analysis, this paper puts forward the following hypothesis:

Hypothesis 5: Information integration capability of supply chain control tower has a positive

impact on cost saving.

Hypothesis 6: Information collaboration mechanism of supply chain control tower has a positive impact on cost saving.

Hypothesis 7: Information sharing level of supply chain control tower has a positive impact on cost saving.

Hypothesis 8: Information integration capacity of supply chain control tower has a positive impact on cost reduction.

Hypothesis 9: Information collaboration mechanism of supply chain control tower has a positive impact on cost reduction.

Hypothesis 10: Information sharing level of supply chain control tower has a positive impact on cost reduction.

Hypothesis 11: Information integration capacity of supply chain control tower has a positive impact on uncertainty reduction.

Hypothesis 12: Information collaboration mechanism of supply chain control tower has a positive impact on uncertainty reduction.

Hypothesis 13: Information sharing level of supply chain control tower has a positive impact on uncertainty reduction.

5.2.3 Impact of environmental uncertainties

Wathne (2001), Wathne and Heide (2004) researched and believed that specific transaction mechanism is adopted in supply chain for dealing with environmental uncertainties. With economic development, factors are complicated and emergency conditions bring in uncontrollable factors for enterprises development. In operation, say, launching new product, enterprises need to make reasonable prediction over competitors and try to minimize possible influence. In order to do so, an in time and effective communication mechanism is needed so that trust can be enhanced based on improved communication, and good partnership can be formed. In addition, enterprises should improve technology research and development, enhance capacity to acquire and analyze information. Thus, timely adjustment and improvement on production can be made, and revenue will be maximized. Correct prediction on possible results brought by decision can be made so as preventive measures for negative results.

From the perspective of transaction cost theory, a long-term cooperation can be maintained due to the same information acquiring technology owned by two parties. On this basis, they conduct necessary information sharing to reduce possibility of information asymmetry and random trade so that interests can be maximized. Based on above analysis, in operation and production, enterprises should have strong information acquiring capacity and construct effective communication with partners. Only by doing so, can cooperation be conducted smoothly. Some scholars tried to verify this conclusion from a mathematical perspective. The most famous investigation was conducted by Wei (2012). After investigating some

manufacturing enterprises from Taiwan, Wei believed that the degree of environmental uncertainty might affect the cooperation and level of trust between the parties to a large extent. According to the above analysis, this paper puts forward the following hypothesis:

Hypothesis 14: Environmental uncertainties have a negative regulating impact on the relations between plan and control and corporate performance.

5.3 Conceptual Model

Analyzing from the overall structure of the model, corporate performance is taken as dependent variable (explained variable), supply chain control tower as independent variable, plan and process control as mediating variable and environmental uncertainty as moderating variable. Of which, supply chain control tower can be measured from several aspects: information integration capacity, information collaboration mechanism, information sharing level, etc. Plan and process control can be measured from several aspects: timesaving, cost reduction, uncertainties, etc. Corporate performance can be measured from three aspects: market growth, profitability and innovation capacity. Environmental uncertainty can be measured by four aspects: increase of competition, needs, competitors and technical uncertainties, as shown in Figure 5.3.

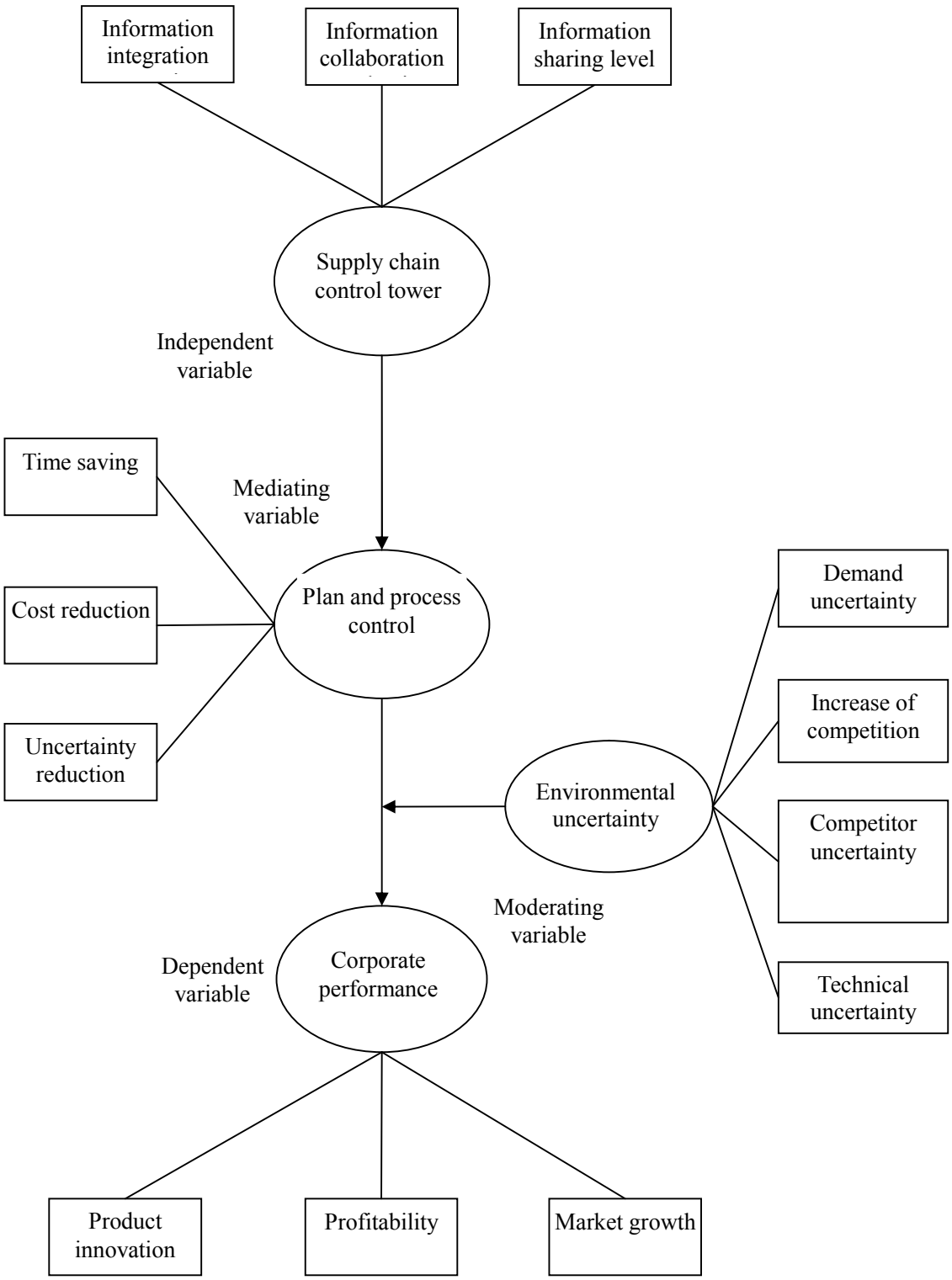

Figure 5.3 Conceptual Model for the Relation between Manufacturing Supply Chain Control Tower and Corporate Performance

5.4 Conclusion

This chapter gets preliminary hypothesizes on the functional mechanism of supply chain

control tower on corporate performance through exploratory case study, and carries out in-depth analysis on it in the combination of existing literature. The findings show:

(1) In the exploratory cases, the two companies are very good at obtaining, sharing and integrating external and internal information resources based on their advanced information technology and unified information technology standard, to realize supply chain timing, cost and financial advantages and improve the overall competitiveness of their supply chain.

(2) On the basis of the exploratory case study and combining the researches of other people, this paper puts forward a conceptual model for the impact of supply chain control tower on corporate performance that takes corporate performance as dependent variable (explained variable), supply chain control tower as independent variable, plan and process control as mediating variable and environmental uncertainty as moderating variable.

Chapter VI Empirical Study of the Relation between Manufacturing Supply Chain Control Tower and Corporate Performance

On the basis of case study and the theoretical research, this paper uses questionnaires to investigate, hoping to further and effectively study the impact mechanism of manufacturing supply chain control tower on corporate performance. Supply chain control tower, plan and process control, environmental uncertainty and corporate performance related data cannot be obtained from public information, so this paper decides to adopt questionnaires for quantitative empirical study.

6.1 Questionnaire Design and Data Collection

6.1.1 Questionnaire design

Whether questionnaire design is reasonable or not will directly influence the results. In terms of questionnaire, the design and objective will affect results in a large extent. When designing questionnaire, reasonable arrangement shall be made on questionnaire layout and options by combining actual question requirements. This questionnaire adopts Likert 5 points scale to score. This paper further illustrates the design concept and whether this questionnaire is reasonable or not in following content.

1) Step 1: Carry out preliminary literature research

In the analysis of topic related to this paper, relevant knowledge about supply chain management, supply chain control, plan and process control and corporate performance was gathered, categorized and read from existing literature from both home and abroad, including domestic and foreign magazines, to preliminarily form a research idea about the impact of manufacturing supply chain control tower on corporate performance.

2) Step 2: Ask experts for their advice and suggestions on the literature research

The author has, by participating in various activities at home and abroad including many seminars, carried out in-depth communications and research on supply chain management with professors and scholars from home and abroad. Based on the above work, the author preliminarily determined the research idea of this paper and formed the research outline for the next step of exploratory case study.

3) Step 3: Exploratory case study and enterprise field interview

Based on the above preliminary idea, the author chose several typical machinery manufacturing enterprises in Xuzhou, Jiangsu province, to carry out field surveys and interviews. Interviewees include top management of those companies, especially their supply chain management persons-in-charge. In the interview, the author firstly explained supply chain collaboration, supply chain control tower and other theoretical concepts, and then got to understand the general situation of these companies and their supply chain collaborations, and

finally asked the interviewees to fill in the questionnaires.

Based on the analysis of the interview content, the results of the exploratory case study were sorted out and a theoretical model for the impact mechanism of manufacturing supply chain control tower on corporate performance was built. At the same time, combining with relevant literature, confirm research variables, refer to existing scales in authoritative empirical researches to make proper adjustments to the research purpose of this paper to form the preliminary draft of the questionnaire.

4) Step 4:

Revise the questions on the questionnaire after discussing them with experts of the academic circle and managers of enterprises. With a seminar held, the author discussed the questions on the questionnaire with relevant experts and on the logic relations between research variables, made adjustments to the wordings and categories of questions, made additions and deletions to some items. In addition, the author also invited some leaders of machinery manufacturing enterprises in Xuzhou to give their precious advice and suggestions, based on which the second draft of questionnaire was formed.

5) Step 5: Improve the questions on the questionnaire and finalize content of the questionnaire

The author conducted a small-scale pretest of the questionnaire to verify the reasonability of the indexes and question statements in it. The questionnaires were handed out to the executives and supply chain persons-in-charge of these enterprises for pretesting so that corresponding question statements could be improved and perfected, based on which the final questionnaire came into being (See the Appendix).

6.1.2 Measures of variables

(1) Supply chain control tower

Measures of supply chain control tower include information integration capacity, information collaboration mechanism and information sharing level.

1) Measures of information integration capacity

In the operating process of supply chain information flow, a unified information technology standard and common technology platform is adopted. The realization of effective integration of information is an important precondition for information collaboration.

The establishment of supply chain information collaboration platform requires that supply chain node enterprises must have corresponding information technologies and information systems as their support, such as barcode technology, RFID, EDI, ERP, etc., and at the same time, must use information technologies to realize seamless connection between supply chain node enterprises. Supply chain node enterprises usually are different main bodies of businesses, so the establishment of information technology standard and the realization of seamless connection of information between node enterprises are of great importance to supply chain information collaboration. Information technology standard is the norm and theoretical support for supply chain information collaboration management.

Information collaboration technology refers to the generic term of information systems and information technologies used by supply chain node enterprises to realize information collaboration. Currently many large enterprises begin their own information constructions and require that node enterprises on their supply chains adopt an integrated information system to realize information collaboration management. Information collaboration technologies adopted by supply chain node enterprises include enterprises resource plan(ERP), CRM, SCM, PLM, MES, PDM, barcode technology, FRID, EDI and other technologies. ERP system technology seamlessly integrates the information flow of the enterprise, including financial information, human resources information, supply chain and customer information, and is widely used in enterprise supply chain. In the future, the new generation of apps and platforms based on cloud computing based information technology capacity and software as service (SaaS) will gradually become more attractive information technology options that make the enterprise information system even more efficient. Cloud platform service providers will provide the collaboration between supply chain node enterprises with connection, moderation and support services so that enterprises using such services can improve speed of information collaboration and sharing to gain revenue.

Information technology is the platform to realize supply chain information collaboration. The application of information technology must take standardization as the precondition. Standardized information technology platform can realize the safe, effective and unified information access and interaction and realize information sharing between supply chain node enterprises. Information technology standard is an important coordination system between supply chain node enterprises. Standardization pushes forward the development of supply chain information collaboration. Supply chain information collaboration standardization involves integration of technical data, company information, trade data, etc. Information sharing process standardization involves integration of information exchange, search, publication, etc. In order to realize information sharing among all node enterprises on supply chain, it is critical to standardize the procedure. Core enterprises make the rules for standardization of information sharing procedures, establish basic information sharing operating processes, clarify information access right and develop the job responsibilities manual for technical personnel to guide the enterprises in informatization operation of their own and with others.

According to the above analysis, this research measures the supply chain information integration capacity from three aspects, namely, the quality of IT personnel, business process standardization and information system construction. As for the quality of IT personnel, this research adopts three subjects to measure it, namely, the allocation of IT personnel, the ability of IT personnel and the training of IT personnel. As for business process standardization, this research adopts two subjects to measure it, namely, the standardization of the coding of technical data, enterprise information and transaction data, etc., and the standardization of procedures for information exchange, retrieval and release. As for information system construction, this research adopts three subjects to measure it, namely, the construction of ERP and other information management system, the consistency of the information

management systems between the enterprise and the key node enterprises on the supply chain, and the operational efficiency of information management system.

2) Information collaboration mechanism

In the process to realize supply chain information collaboration, ensuring information security and data privacy is of vital importance for node enterprises to further cooperate with each other. The information framework between supply chain node enterprises is very complex and different node enterprises have different goals, so the process of supply chain information collaboration may meet information misoperations, confidential information leakages, illegal use of shared information for individual interest and other security issues. To effectively reduce risks in supply chain information collaboration, the supply chain must be built with an information collaboration security mechanism so that supply chain information collaboration reliability can be enhanced by measures such as information security system verification, collaborative enterprises confidentiality agreement, IT personnel information security training, etc. When information is shared between supply chain node enterprises, the information boundary will expand from the enterprise to the whole supply chain. Shared information comes from node enterprises at different levels of the supply chain. Information collaboration needs corresponding protective measures and information security mechanisms based on the security level of the information. Corresponding monitoring mechanisms should be built for information at different security levels to prevent information leakage and unauthorized sharing and use of information. For example, the new product development information communicated between the manufacturer and its strategic cooperative supplier is of high level of security and needs to be strictly kept confidential by both parties; the product shipment information including the shipment advice between the manufacturer and its downstream wholesaler is of low level of security and requires only a general confidentiality control.

According to the above analysis, this research measures supply chain information collaboration from three aspects, namely, security and confidentiality mechanism, incentive mechanism and organizational support mechanism. As for security and confidentiality mechanism, this paper adopts three subjects to measure it, namely, obtainment of information security system verification, signing of confidentiality agreement with supply chain members, and building of information management mechanism at different levels of security. As for incentive mechanism, this research adopts two subjects to measure it, namely, signing of information coordination and revenue sharing agreement with supply chain members and incorporation of information coordination into personnel assessment of the enterprise. As for organizational support mechanism, this research adopts three subjects to measure it, namely, the degree of top management support for supply chain information collaboration, the degree of employees' involvement in information collaboration and the establishment of an information coordination work mechanism with supply chain members.

3) Information sharing level

Supply chain information sharing is regarded as the basis for supply chain management and plays a significant role in enterprise operation. When communicating about information, such

process should be transparent and shared so that win-win situation can be achieved. By managing partnership on the basis of information sharing, friendship between enterprises and information management system can be enhanced, product supply procedure can be improved, overall efficiency can be boosted and deals can be made. In order to improve supply chain efficiency, some scholars proposed “bullwhip effect” so that such issue can be solved from the source using supply chain information sharing. Supply chain information sharing level can be measured by two standards, including the level of information sharing between enterprises on the supply chain and the quality of information sharing.

Information that can be shared on the supply chain falls into many classes, and the standard for classification is also very complicated. For instance, Chen and Chen believed that shared information like arrangement information, arrangement change information, engineering quality and its change information, design cost information, service information, etc. is needed for operating JIT. Lee and Whang proposed information sharing requirements in personal computer industry, which include sales prediction, inventory level, order status, product delivery and sales data, that should be achieved with the cooperation between suppliers and manufacturers. Li, JQ et al. put forth the idea of transactional, operation and strategical information sharing.

Based on the research results of other people, this research shall manage the connection of supply chain to make decision. Variables like order handling information shared with supply chain members, materials or inventory stock requirements shared with supply chain members, production information shared with cooperative partners and overall order prediction information shared with supply chain members are used to measure the supply chain information sharing level.

Supply chain requires information sharing to be of high quality, understandable, accurate, etc. Information delivering process showcases efficiency of enterprises while high quality information reflects specific requirements that enterprises have on information. Cognition is generated from enterprises after information sharing, which also reflects the accuracy, timeliness, effectiveness and reliability of information communicated between supply chain members. Following relevant operation will pose some influences on supply chain members after information is received.

In the research for this paper, we adopted the measurement design by Li and Lin (2006) for the measuring of quality of information sharing. This is mainly based on the follower several reasons: First, the research is conducted on quality of information sharing based on supply chain, which shares the same research background. Second, ideas of this research includes all theoretical basis of information sharing and also emphasizes specific features of supply chain. Lastly, the research result is very persuasive. Therefore, this paper directly adopts their measurement on this variable, mainly including: timely share information with supply chain members, accurately exchange information with supply chain members, and totally share information with supply chain members.

(2) Measure of corporate performance

The measure of corporate performance has no a complete set of standards and is subject to a different standard if the focus is different. Factors affecting corporate performance fall into many. In many evidence-based literature, if the research objects are different, the factors affecting corporate performance are different. For this paper, the author referred to typical literature and previous experiences to propose some factors affecting corporate performance and their measuring standards.

Qing Cao (2005) believed that factors affecting corporate performance included virtual enterprise, information technology and its joint effect, and that corporate performance included market growth, financial performance, product/service innovation, corporate reputation, etc. Brian Fyne et al. (2005) analyzed main factors affecting corporate performance and confirmed corporate performance included customer satisfaction and product quality performance based on supply chain cooperation. Michael Tracey (1999), when analyzing advanced manufacturing, participated strategy making and competitive performance, he measured corporate performance from six aspects: customer risk avoidance ability, cognitive ability on new products, satisfaction on purchased products, threat to market shares and competitors, and influence on market sales.

Suresh Kotha et al. (2000) had a different perspective, which measured corporate performance from market shares, sales body, competitive strengths and weaknesses, cost benefits and sales these five aspects.

Eve D. Rosenzweig et al. (2003), when studying the impact of integration intensity and competitive capacity of supply chain on corporate performance, measured corporate performance from four aspects, including return on assets, sales growth, customer satisfaction and new product rate of return.

Hale Kaynak (2003) believed that corporate performance included financial performance, market performance, quality performance and inventory management performance. Douglas et al. (2001), when studying the impact of total quality management on corporate performance, believed that corporate performance included income growth, profit growth, market share change, assets income, long-term profitability, industry position and other indexes.

We adopt the multidimensional indexes advocated by some scholars in the literature to measure it. The advantages are: one is that we can avoid the disadvantage that a one-dimensional index cannot comprehensively measure corporate performance; the other is that we can avoid the defect that a one-dimensional index has a limited scope of application; another is that we can get a more objective and true finding if we measure the corporate performance from multi-dimensions. So in this paper, corporate performance includes three variables: market growth, profitability and product innovation.

As for market growth performance, this research adopts two question items to measure it, namely, sales growth rate and market share growth rate. As for profitability performance, this research adopts three question items to measure it, namely, sales profit ratio, return on investment and profitability against competitors. As for product innovation performance, this research adopts three question items to measure it, namely, new product sale revenue

percentage, process flow innovation and product quality.

(3) Measure of plan and process control

Effective plan and process control can shorten the development cycle, production lead time, purchase lead time and order response time of new product, which allows the enterprise to respond to market need, reduce new product research and development time, and improve supply chain. In order to launch new products soon, sharing strategy on information between enterprises can be made ahead of time to gain more time for research and development. The advanced period for production and procurement is also the basis for connecting supply chains between enterprises. Before launching project, prediction must be made to reduce time and control cost so that process can be improved, competitive edge can be gained, customers can be attracted and technology is applied throughout the enterprises.

Grover et al. (2002), Zhang Xin, Ma Shihua (2007), and Raghunathan (2001) believed that a good plan and process control is helpful to lower procurement cost, inventory cost and transportation cost. Enterprises under the supply chain management environment will face complex and ever-changing market environment. Information is of multiple sources, multiple forms and multiple uncertainties, which increases the complexity and difficulty of production plan making in the supply chain environment. The uncertainties of information mostly come from consumer market and customers, the reason of which mainly is that we cannot timely get accurate information and there is a gap between the need prediction of the enterprise toward the customer and the real market need. In addition, there are other influencing factors like uncertainty in customer selection, mismatch between customer purchase desire and purchase needs, etc. Various factors influence each other, making market hard to be predicted. Thus, we are unable to timely deal with information in customer feedback to make in time adjustment in market. Market development process is fixed. Therefore, uncertainty in market information directly influences development plan. System will breakdown without timely adjustment. Market actual demand is the basis for satisfying customers' needs. Production plans will be interrupted if there is a mismatch in predicted needs. Thus, customer satisfaction and stability will be affected. Uncertainty in market factors affects implementation and application of production plans. Enterprises operation is complicated and production process is complex, internal problems like insufficient monitor, missed orders, impediment in sales occur easily, which will influence overall plan, normal implementation of production plan and cause delay in delivery, etc. Relevant leaders shall make temporary decision to deal with problems. However, such strategy cannot solve problems thoroughly. Enterprises will be faced with various issues during operation, and market demands also fluctuate. There, it is critical to make future development plan that is comprehensive and all uncertain factors are taken into consideration. Actual market needs must be thought of when building production model otherwise the plan cannot be implemented with high quality and efficiency. An effective plan and process control can help to reduce such risks.

According to the above analysis, this research measures the effectiveness of plan and process control from three aspects, namely, time saving, cost reduction and uncertainty reduction. As

for time saving, this research adopts four subjects to measure it, namely, shortening production lead time, shortening purchase lead time, shortening order response time and shortening new product development cycle. As for cost reduction, this research adopts three subjects to measure it, namely, saving procurement cost, lowering inventory cost, and lowering transportation and distribution cost. As for uncertainty reduction, this research adopts three subjects to measure it, namely, lowering the uncertainties of needs, lowering the uncertainties of production, and lowering the uncertainties of supply.

(4) Regulating effect of uncertain environment

Uncertain environment can be measured by the degree environmental stability and data related to environmental change process (Dess and Beard, 1984). Uncertain factors are different customer preferences, fluctuation of product needs, technical change or material supply fluctuation, etc. As for supply chain management, the effect of environmental uncertainties must be prioritized. There are relevant researches showing that environmental uncertainty has a regulating effect on the effectiveness of control mode (Poppo and Zenger, 2002; Cavusgil et al., 2004). Control modes of supply chain collaboration might be influenced by different environmental uncertainties in various conditions.

Levels of environmental uncertainties can be high or low. When it is lower, as interfering factors are less, especially for external enterprises, most problems in supply chain collaboration can be clearly predicted so that preparation can be made in advance. Therefore, result control can be adopted, and complete contract articles can be used to clearly define the output goal (such as output, profit, customer response time, etc.) and to agree upon the handling methods for conflicts, to effectively ensure the realization of supply chain collaboration. However, when environmental uncertainty is higher, prediction is restricted by limited rationality, the enterprise cannot predict all the conflicts in future (Williamson, 1985). Even though we can predict some possible conflicts and put solutions into the contract, we cannot make guarantee for future development (Luo, 2002). In fact, above illustration also reflects a weakness, that is the more complete the contract in result control is, the more impossible it will be to flexibly use and adapt to various conditions. With the increase of environmental uncertainty, many problems that are not predicted may increasingly appear.

Environmental uncertainty scales are relatively mature. According to research needs, I referred to the scales of Miller and Friesen (1983) and Wong et al. (2011) and on that basis, made some modifications according to actual cases, including four subjects: change in customer needs is hard to predict, competition becomes fiercer, behavior of competitors is hard to predict, and production/service technology changes frequently.

6.1.3 Data collection

To improve the quality of the questionnaire, this research has some control over the objects of questionnaire, handout area and channel. As for the objects of questionnaire, this questionnaire paper mainly targets at mid-top management of enterprises and persons-in-charge of supply chain management, ensuring that the persons that fill in the question paper are familiar with supply chain management, as to ensure the reliability of the

data. As for handout area, this paper mainly chooses machinery manufacturing enterprises in Jiangsu province and sampling enterprises are mainly construction machinery manufacturing enterprises in Xuzhou. As for handout channel, to improve the reliability and representativeness of data, the questionnaires are mainly handed out and collected back by the author himself and by his friends at Xuzhou Commission of Economy and Information Technology and other governmental departments.

A total of 400 questionnaire papers were handed out. After the effectiveness checking, 212 effective papers were collected back. The effective recovery was 53%. Sample attribute statistics see Table 6.1.

Table 6.1 Sample Attribute Statistics

Per Sales Income	**Number of Enterprises**	**Percentage**	**Enterprise Property**	**Number of Enterprises**	**Percentage**
Sales income above 20 million yuan	169	79.7%	SOE	24	11.3%
Sales income less than 20 million yuan	43	20.3%	Private and foreign-funded	188	88.7%
Total	212	100%	Total	212	100%

From Table 6.1 we can see that classified by annual sales income, above-scale enterprises (sales income above 20 million yuan) take up the majority (79.7%) of the sample enterprises and below-scale enterprises (sales income below 20 million yuan) take up the minority (20%) of the sample enterprises. Seeing from enterprise property, private and foreign-funded enterprises take up the majority (88.7%) of sample enterprises and SOEs only take up 11.3% of sample enterprises.

Table 6.2 is the Pearson related coefficient matrix of the variables produced by SPSS. It can be found that significance level of other variables is about 1% except that information sharing level and profitability are over 5%. It shows that variables are related with each other and some even share relative higher relevance. For instance, the correlation coefficient for information integration capacity and information collaboration mechanism is 0.523, and the correlation coefficient for information integration capacity and lowering cost is 0.478. The relevance among variables further proves that it is necessary to analyze relationship among variables.

Table 6.2 Pearson Related Coefficient Matrix

	Information integration capacity	**Information collaboration mechanism**	**Information sharing level**	**Time-saving**	**Lower cost**	**Reduce uncertainty**	**Product innovation**	**Profitability**	**Market growth**

Information integration capacity	1	0.513**	0.417**	0.422**	0.478**	0.295**	0.306**	0.258**	0.357**
Information collaboration mechanism	0.513**	1	0.425**	0.419**	0.446**	0.388**	0.354**	0.312**	0.421**
Information sharing level	0.417**	0.425**	1	0.562**	0.450**	0.433**	0.305**	0.172*	0.395**
Time-saving	0.422**	0.419**	0.562**	1	0.471**	0.442**	0.344**	0.222**	0.350**
Lower cost	0.478**	0.446**	0.450**	0.471**	1	0.350**	0.377**	0.348**	0.363**
Reduce uncertainty	0.295**	0.388**	0.433**	0.442**	0.350**	1	0.397**	0.314**	0.329**
Product innovation	0.306**	0.354**	0.305**	0.344**	0.377**	0.397**	1	0.377**	0.525**
Profitability	0.258**	0.312**	0.172*	0.222**	0.348**	0.314**	0.377**	1	0.385**
Market growth	0.357**	0.421**	0.395**	0.350**	0.363**	0.329**	0.525**	0.385**	1

** refers to the high relevance on the level of 1% (both sides): * refers to the high relevance on the level of 5% (both sides).

6.2 Reliability and Validity Test

6.2.1Reliability test

Before the mathematical statistical analysis of raw data, a reliability test should be done on sample data, the purpose of which is to measure the consistency and stability of variable measurements. A high reliability of sample data shows that the variable measurement of a latent variable is of high consistency and stability. This research adopts Cronbach's Alpha value and Corrected Item Total Correlation or CITC to do the reliability test. It is required that test results should have high Cronbach's Alpha value and CITC coefficient to ensure a high internal consistency of variables and reliability. It is generally regulated that if Cronbach's Alpha value is larger than 0.70 and CITC coefficient is larger than 0.35, the reliability of sample data can pass the test (Li Huaizu, 2004).

(1) Independent variable

The independent variable in this paper is supply chain control tower. The measures of supply chain control tower include information integration capacity, information collaboration mechanism and information sharing level. In this paper we will do reliability test on these three measuring dimensions.

1) Information integration capacity

Reliability test results of supply chain control tower information integration capacity see Table 6.3. In the first column of the Table are the three items of the measures of supply chain control tower information integration capacity. In Table 6.3, the Cronbach's α coefficients of

IT personnel quality, business process standardization and information system construction are larger than 0.7 and CITC coefficients are quite high, so it has passed the reliability test. Therefore, in this paper the measures of supply chain control tower information integration capacity are of high internal consistency and reliability.

Table 6.3 Reliability Test Results of Supply Chain Control Tower Information Integration Capacity

	Item	Mean Value	Standard Deviation	CITC	Cronbach's α Coefficient
IT personnel quality	IT personnel allocation	3.20	2.265	0.662	0.796
	IT personnel ability	3.35	2.163	0.654	
	IT personnel training	3.95	2.298	0.703	
Business process standardization	Standardization of coding of technical data, enterprise information, transaction data	4.12	2.674	0.826	0.767
	Standardization of information exchange, retrieval and release	4.03	2.366	0.759	
Information system construction	Construction of ERP and other information management systems	3.71	2.981	0.623	0.851
	Consistency between information management systems of the enterprise and the key node enterprises on supply chain	3.25	3.028	0.595	
	Operating efficiency of information management system	3.25	3.028	0.595	

2) Information collaboration system

Reliability rest results of supply chain control tower information collaboration mechanism see Table 6.4. In the first column are three items of supply chain control tower information collaboration mechanism. In Table 6.3, the Cronbach's α coefficients of security and confidentiality mechanism, incentive mechanism and organizational support mechanism are larger than 0.7 and CITC coefficients are quite high, so it has passed the reliability test. Therefore, in this paper the measures of supply chain control tower information collaboration mechanism are of high internal consistency and reliability.

Table 6.4 Reliability Rest Results of Supply Chain Control Tower Information Collaboration Mechanism

	Item	Mean Value	Standard Deviation	CITC	Cronbach's α Coefficient
Security and confidentiality	Obtainment of information security system verification	3.67	2.668	0.735	0.787
	Signing of confidentiality agreement with supply chain	3.02	2.587	0.701	

mechanism	members				
	Building of information management mechanism at different levels of security	3.66	2.254	0.685	
Incentive mechanism	Signing of information coordination and revenue sharing agreement with supply chain members	4.58	2.996	0.647	0.796
	Incorporation of information coordination into personnel assessment of the enterprise	3.92	2.258	0.633	
Organizational support mechanism	Degree of top management support for supply chain information collaboration	3.37	2.645	0.754	0.824
	Degree of employees involvement in information collaboration	4.06	3.360	0.781	
	Establishment of an information coordination work mechanism with supply chain members	3.95	2.696	0.693	

3) Information sharing level

Reliability rest results of supply chain control tower information sharing level see Table 6.5. In the first column are two items of supply chain control tower information sharing level. In Table 6.4, the Cronbach's α coefficients of degree and quality of information sharing are larger than 0.7 and CITC coefficients are quite high, so it has passed the reliability test. Therefore, in this paper the measures of supply chain control tower information sharing level are of high internal consistency and reliability.

Table 6.5 Reliability Rest Results of Supply Chain Control Tower Information Sharing Level

	Item	**Mean Value**	**Standard Deviation**	**CITC**	**Cronbach's α Coefficient**
Degree of information sharing	Order handling information shared with supply chain members	3.58	2.741	0.728	0.766
	Materials or inventory stock information shared with supply chain members	2.83	2.429	0.616	
	Production arrangement information shared with cooperative partners	3.52	2.526	0.745	
	Order prediction information shared with supply chain members	3.61	2.259	0.427	
Quality of information sharing	Timely share information with supply chain members	3.55	2.705	0.681	0.749
	Accurately exchange information with supply chain members,	3.28	2.527	0.672	
	Totally share information with supply chain members	3.94	3.251	0.796	

(2) Dependent variable

The dependent variable in this research is corporate performance. The reliability test results see Table 6.6. In the second column are items of measures for corporate performance. In Table 6.6, the mean values of Cronbach’ s α coefficients of the three items, namely, market growth, profitability and product innovation, are larger than 0.6, so it has passed the reliability test. Therefore, in this paper the measures of corporate performance are of high internal consistency and reliability.

Table 6.6 Reliability Test Results of Corporate Performance

	Item	Mean Value	Standard Deviation	CITC	Cronbach’s α coefficient
Market growth	Sales growth rate	3.75	2.694	0.630	0.682
	Market share growth rate	4.05	2.856	0.714	
Profitability	Sales profit ratio	3.58	2.198	0.603	0.729
	Return on investment	4.66	2.654	0.763	
	Profitability against competitors	3.87	2.125	0.687	
Product innovation	New product sale revenue percentage	3.45	2.687	0.703	0.786
	Process flow innovation	4.24	3.627	0.732	
	Product quality improvement	3.35	2.984	0.624	

(3) Mediating variable

Mediating variable in this research is plan and process control. Reliability test results of plan and process control see Table 6.7. In the second column of the table are items for measure of plan and process control. In Table 6.7, the mean values of Cronbach’s α coefficients of the three items, namely time saving, cost reduction and uncertainty reduction, are larger than 0.6, so it has passed the reliability test. Therefore, in this paper the variable measures of plan and process control are of high internal consistency and reliability.

Table 6.7 Reliability Test Results of Plan and Process Control

	Item	Mean Value	Standard Deviation	CITC	Cronbach’s α coefficient
Time saving	Shortening production lead time	3.75	2.694	0.630	0.626
	Shortening purchase lead time	4.05	2.856	0.714	
	Shortening order response time	3.58	2.198	0.603	
	Shortening new product development cycle	4.66	2.654	0.763	
Cost reduction	Saving procurement cost	3.87	2.125	0.687	0.657
	Lowering inventory cost	3.45	2.687	0.703	

	Lowering transportation and distribution cost	4.24	3.627	0.732	
Uncertainty reduction	Lowering the uncertainties of needs	3.35	2.984	0.624	0.604
	Lowering the uncertainties of production	3.75	2.694	0.630	
	Lowering the uncertainties of supply	4.05	2.856	0.714	

(3) Moderating variable

Moderating variable in this research is environmental uncertainty. Reliability test results of moderating variable see Table 6.8. In the second column of the table are items of environmental uncertainty. In Table 6.8, the Cronbach's α coefficient of environmental uncertainty is 0.746, so it has passed the reliability test. Therefore, in this paper the measures of environmental uncertainty are of high internal consistency and reliability.

Table 6.8 Reliability Test Results of Environmental Uncertainty

	Item	**Mean Value**	**Standard Deviation**	**CITC**	**Cronbach's α coefficient**
Environmental uncertainty	Change in customer needs is hard to predict	2.821	3.387	0.602	0.746
	Competition becomes more fierce	2.457	3.108	0.589	
	Behavior of competitors is hard to predict	3.468	2.246	0.698	
	Production/service technology changes frequently	3.452	2.857	0.761	

6.2.2 Validity test

Validity is the degree of effectiveness of the measure. It falls into three types, including content validity, criterion validity and construct validity. Among the three, construct validity is a test procedure that is powerful. It can objectively observe whether the data structure of measuring result is in line with the questionnaire design. Confirmatory factor analysis (CFA) method is adopted to assess the construct validity of the scales, namely, adopting the χ^2/df value to judge the overall fitting degree of the model. In addition, this paper also chooses CFI and RMSEA these two indexes as backup plan for conduct auxiliary assessment on fit index of the model. CFI is short for comparative fit index. When adopting different methods to fit the model, CFI test is relatively stable and even shows a relatively good result when fitting a small sample model, so CFI is a quite ideal relative fit index. CFI getting closer to 1 means a better fit to the model. Generally, when CFI≥0.90, the model is acceptable. RMSEA refers to root means square error approximation, which is a relatively good absolute fit index. RMSEA getting closer to 0 means a better fit to the model. Generally, when RMSEA≤0.05, the model is a good fit.

(1) Independent variable

1) Information integration capacity

Confirmatory factor analysis was conducted over IT personnel quality, business process standardization and information system construction of supply chain control tower information integration capacity. After computing by software, we got the measurement model and fitting result as shown in Figure 6.1. The validity test results of information integration capacity show that the value of χ^2/df is 3.8, which is below 5, CFI is 0.814, and RMSEA is 0.035. All path coefficients are significantly above 5%. Confirmatory factor analysis shows that the three variables of supply chain control tower information integration capacity, namely, IT personnel quality, business process standardization and information system construction, are basically fitting with the measurement model. In addition, confirmatory factor analysis has further confirmed the reasonability of dividing supply chain control tower information integration capacity into three dimensions: IT personnel quality, business process standardization and information system construction.

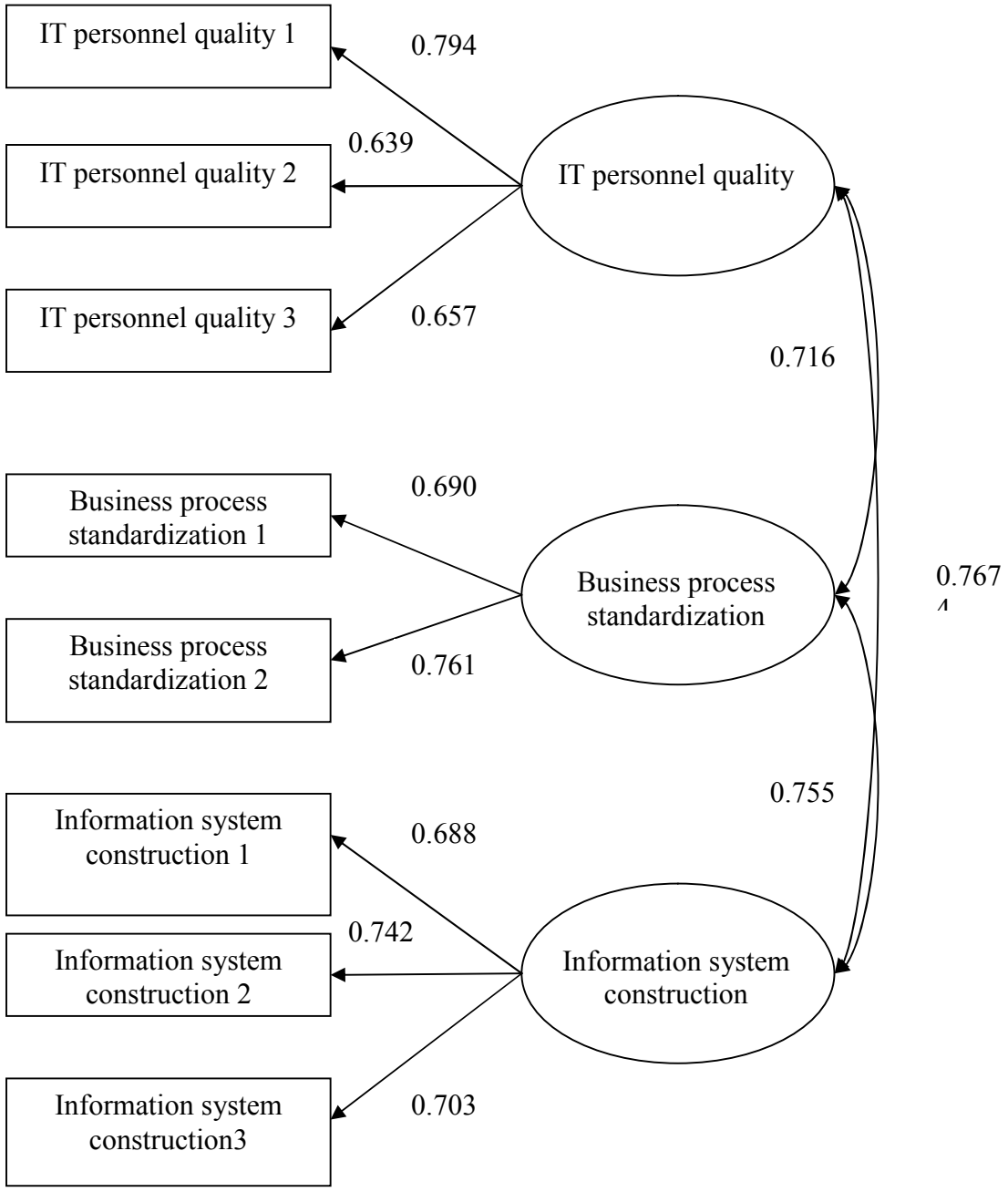

Figure 6.1 Measurement Model of Information Integration Capacity

2) Information collaboration mechanism

Confirmatory factor analysis was conducted over three variables, namely security and confidentiality mechanism, incentive mechanism and organizational support mechanism, of supply chain control tower information integration capacity. After computing by software, we got the measurement model and fitting result as shown in Figure 6.2. The validity test results of information integration capacity show that the value of χ^2/df is 4.1, which is below 5, CFI is 0.863, and RMSEA is 0.042. All path coefficients are significantly above 5%. Confirmatory factor analysis shows that the three variables of supply chain control tower information collaboration mechanism, namely, security and confidentiality mechanism, incentive

mechanism and organizational support mechanism, are basically fitting with the measurement model. In addition, confirmatory factor analysis has further confirmed the reasonability of dividing supply chain control tower information integration capacity into three dimensions: security and confidentiality mechanism, incentive mechanism and organizational support mechanism.

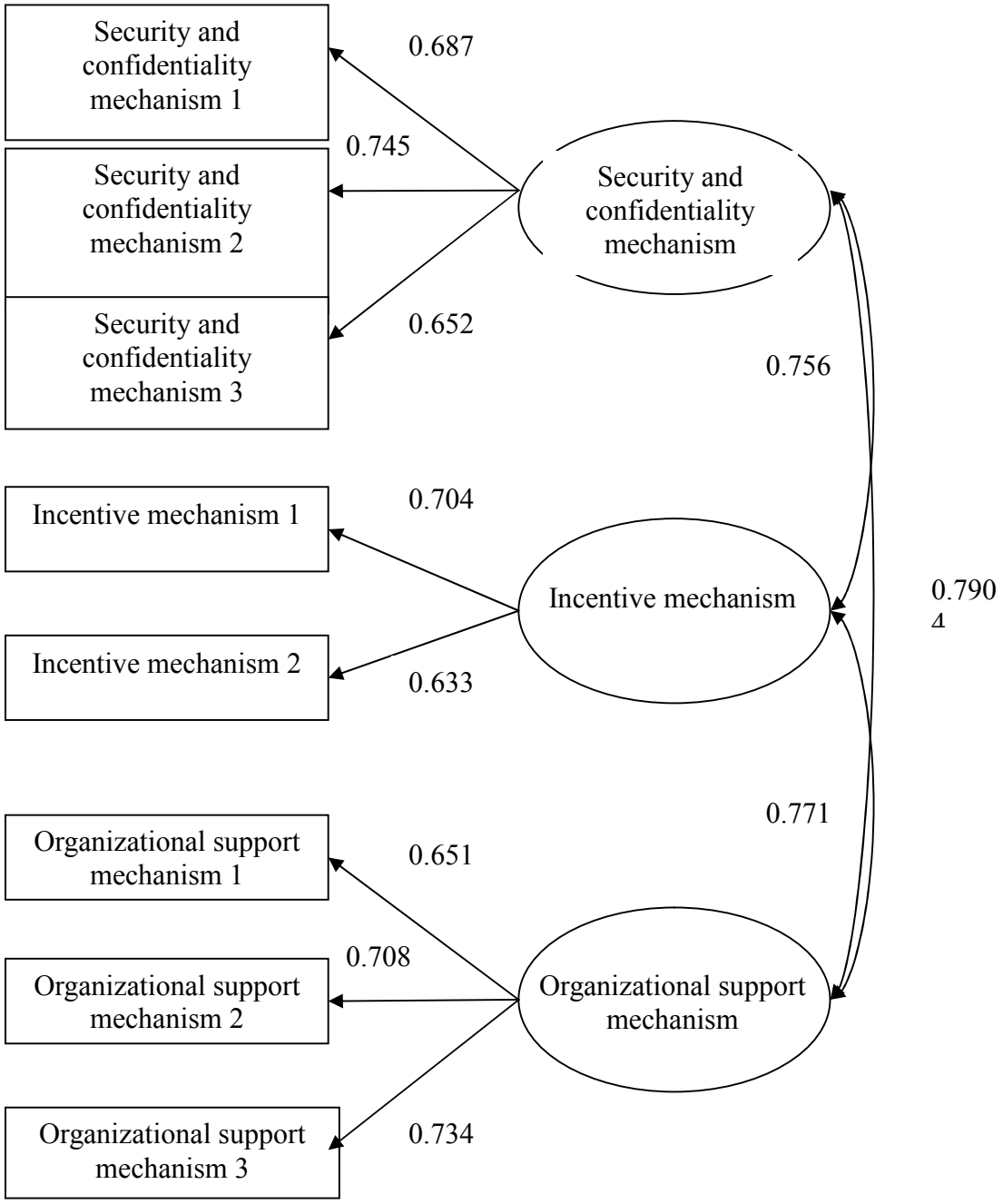

Figure 6.2 Measurement Model of Information Collaboration Mechanism

3) Information sharing level

Confirmatory factor analysis was conducted over two variables, namely degree of information sharing and quality of information sharing, of supply chain control tower information

integration capacity. After computing by software, we got the measurement model and fitting result as shown in Figure 6.3. The validity test results of information integration capacity show that the value of χ^2/df is 3.3, which is below 5, CFI is 0.956, and RMSEA is 0.037. All path coefficients are significantly above 5%. Confirmatory factor analysis shows that the three variables of supply chain control tower information collaboration mechanism, namely, security and confidentiality mechanism, incentive mechanism and organizational support mechanism, are basically fitting with the measurement model. In addition, confirmatory factor analysis has further confirmed the reasonability of dividing supply chain control tower information integration capacity into three dimensions: security and confidentiality mechanism, incentive mechanism and organizational support mechanism.

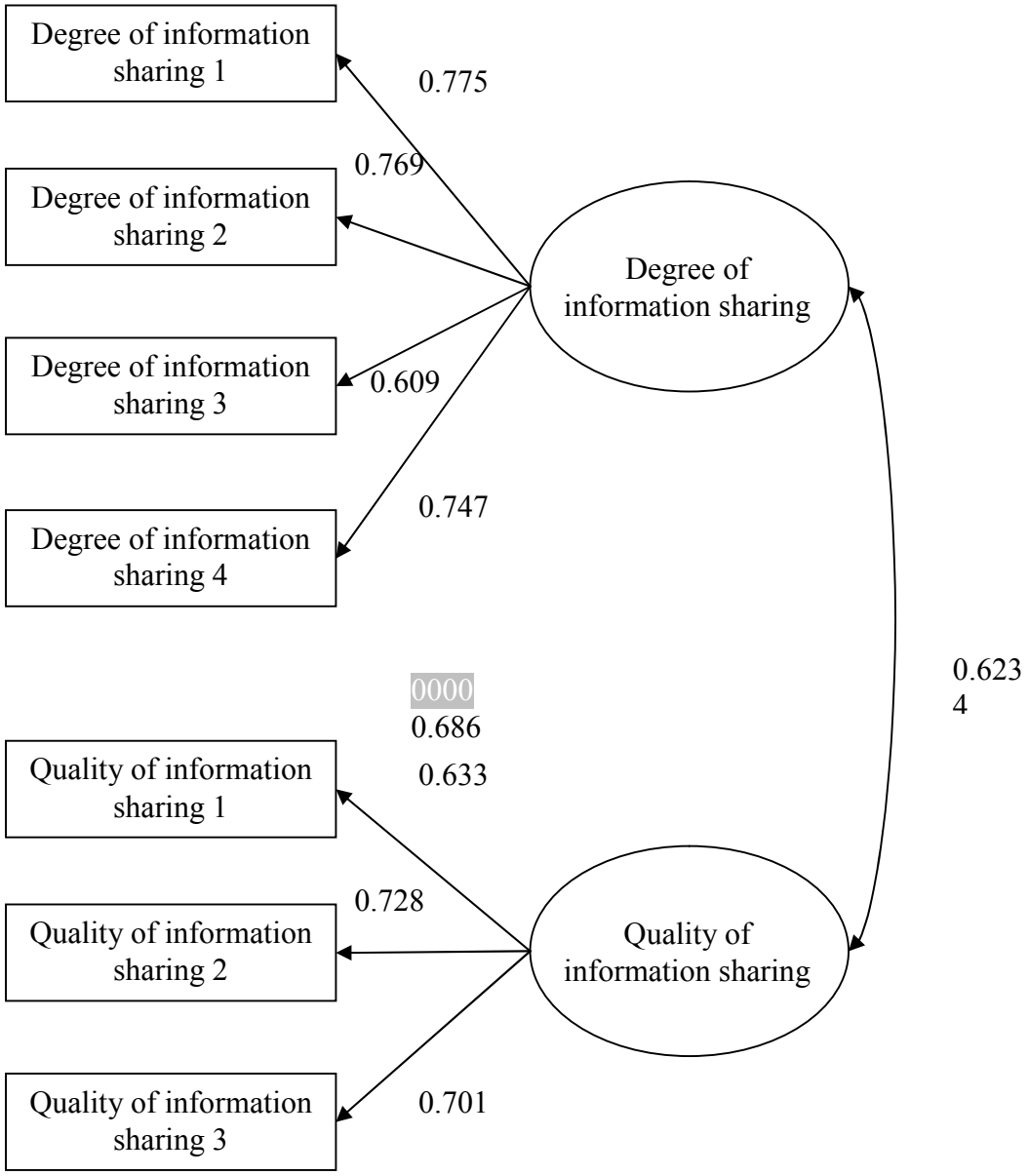

Figure 6.3 Measuring Model of Information Sharing Level

4) Supply chain control tower

Confirmatory factor analysis was conducted over three variables, namely information integration capacity, information collaboration mechanism and information sharing level, of supply chain control tower information integration capacity. After computing by software, we got the measurement model and estimated fitting result as shown in Figure 6.4. The validity test results of network centrality show that the value of χ^2/df is 2.1, which is below 3, CFI is 0.966 which is larger than 0.9, and RMSEA is 0.085 which is below 0.1. All path coefficients are significantly above 5%. Confirmatory factor analysis shows that the three variables of supply chain control tower, namely, information integration capacity, information collaboration mechanism and information sharing level, are basically fitting with the measurement model. So the division and measure of the three variables of supply chain control tower are effective in this paper.

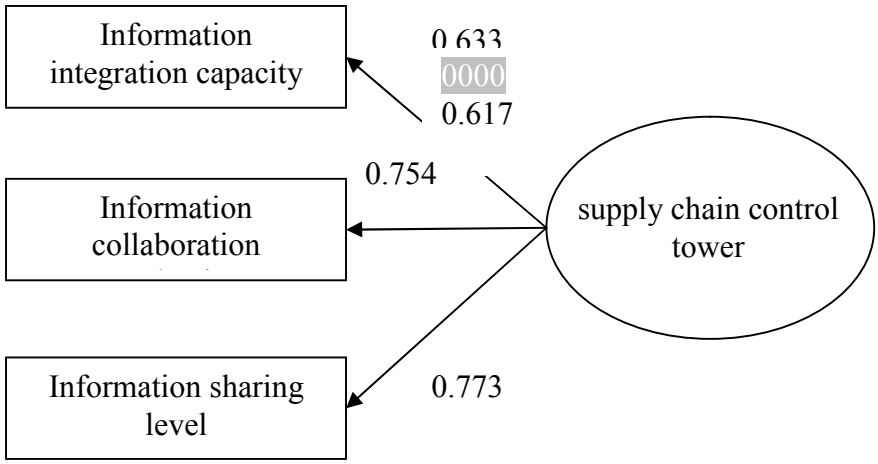

Figure 6.4 Measurement Model Of Supply Chain Control Tower

(2) Dependent variable

Confirmatory factor analysis was conducted over market growth, profitability and product innovation of corporate performance. After computing by software, we got the measurement model and fitting result as shown in Figure 6.5. The validity test results of corporate performance show that the value of χ^2/df is 2.3, which is below 3, CFI is 0.914, and RMSEA is 0.029, which is below 0.1. All path coefficients are significantly above 5%. Confirmatory factor analysis shows that the three variables of corporate performance, namely, market growth, profitability and product innovation, are fitting with the measurement model in a quite good way. So the division and measure of the three variables, namely market growth, profitability and product innovation, in this paper is effective.

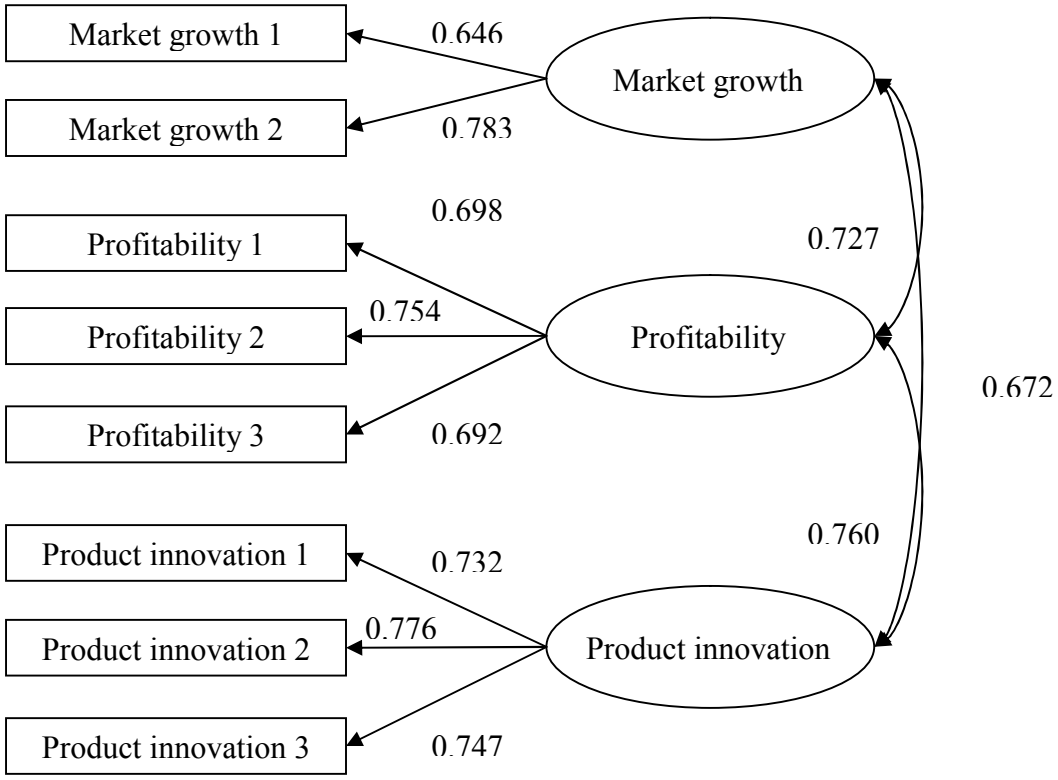

Figure 6.5 Measurement Model of Corporate Performance

(3) Mediating variable

Confirmatory factor analysis was conducted over time saving, cost reduction and uncertainty reduction in plan and process control, the mediating variables. After computing by software, we got the measurement model and fitting result as shown in Figure 6.6. The validity test results of corporate performance show that the value of χ^2/df is 2.7, which is below 3, CFI is 0.932, and RMSEA is 0.037, which is below 0.1. All path coefficients are significantly above 5%. Confirmatory factor analysis shows that the three variables of corporate performance, namely, market growth, profitability and product innovation, are fitting with the measurement model in a quite good way. So the division and measure of the two variables, namely plan and process control, in this paper is effective.

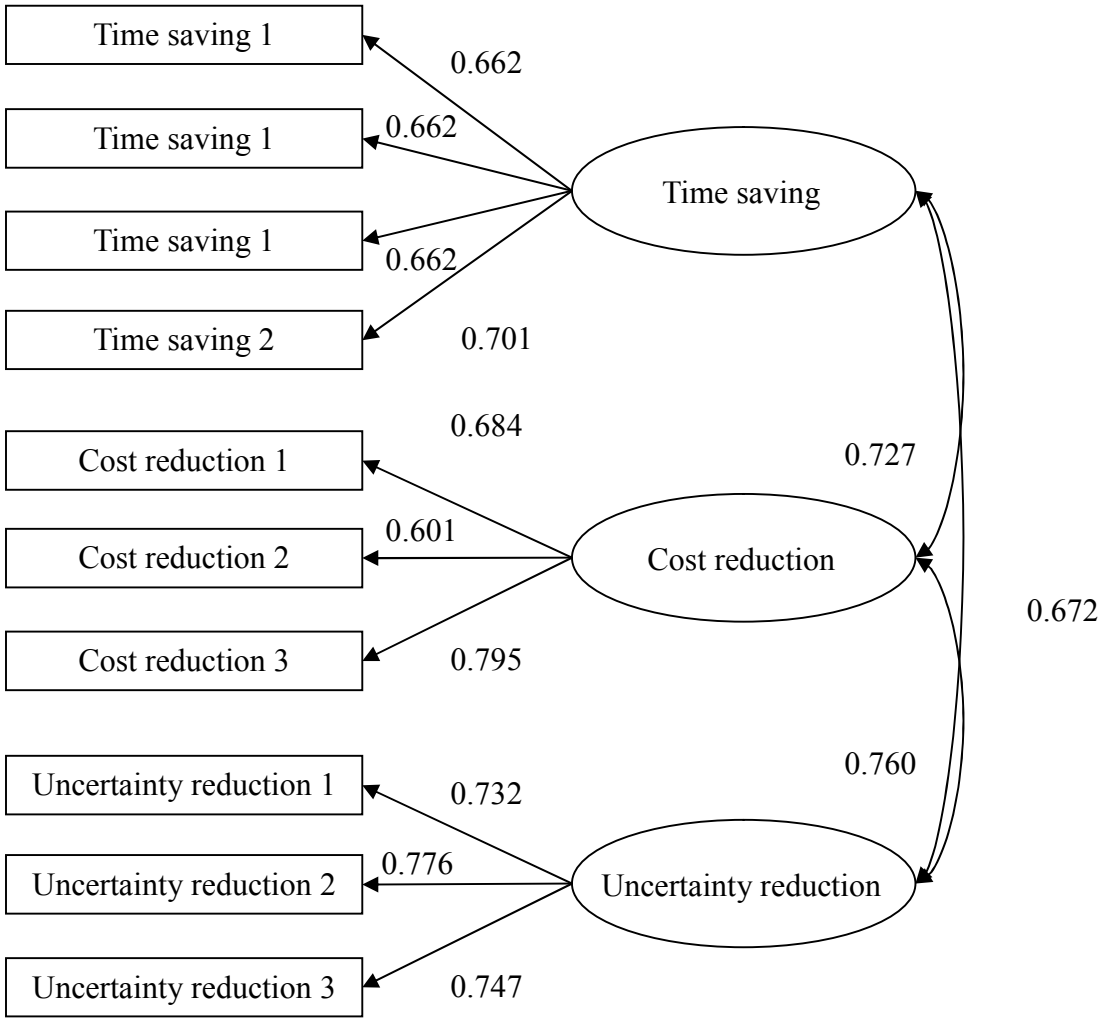

Figure 6.6 Measurement Model of Plan and Process Control

(4) Moderating variable

Confirmatory factor analysis was conducted over environmental uncertainty, the moderating variable. After computing by software, we got the measurement model and fitting result as shown in Figure 6.7. The validity test results of corporate performance show that the value of χ^2/df is 4.8, which is below 5, CFI is 0.904, and RMSEA is 0.073. All path coefficients are significantly above 5%. Confirmatory factor analysis shows that the variables of supply chain control tower, namely, environmental uncertainties, are basically fitting with the measurement model.

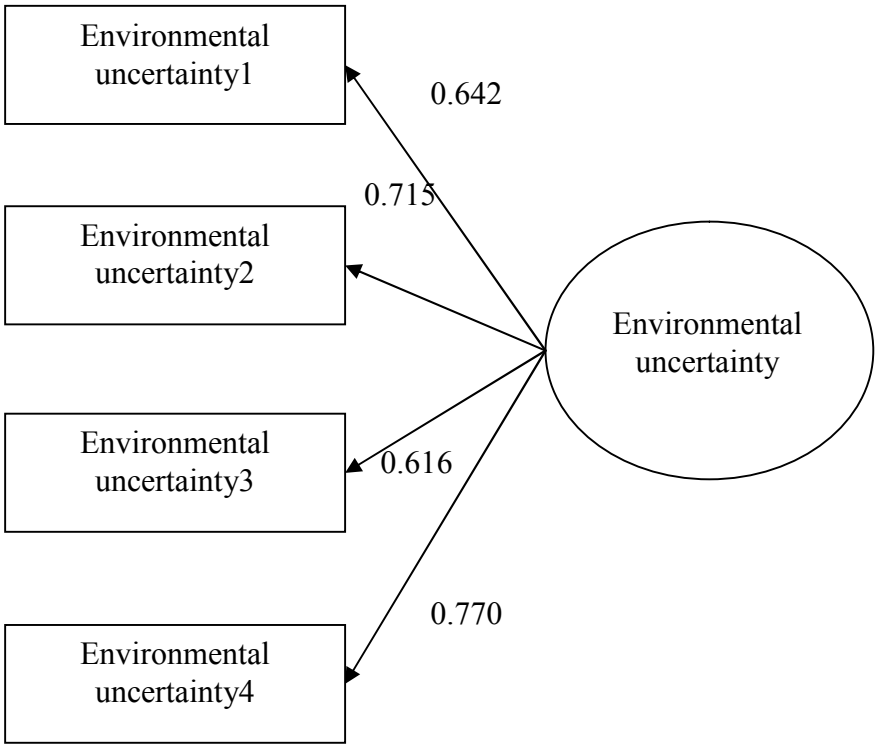

Figure 6.7 Measurement Model of Environmental Uncertainty

6.3 Structural Equation Model Test

6.3.1 Test of impact of supply chain control tower on corporate performance

(1) Impact of supply chain control tower information integration capacity on corporate performance

Based on the conceptual model of the relation between supply chain control tower and corporate performance of machinery manufacturing industry as shown in Figure 5.3, this paper builds a preliminary structural equation model (See Figure 6.8) of impact mechanism of supply chain control tower information integration capacity on corporate performance[①].

[①]Data in the figure is path coefficient. For simplification, only significant ones are marked. Same below.

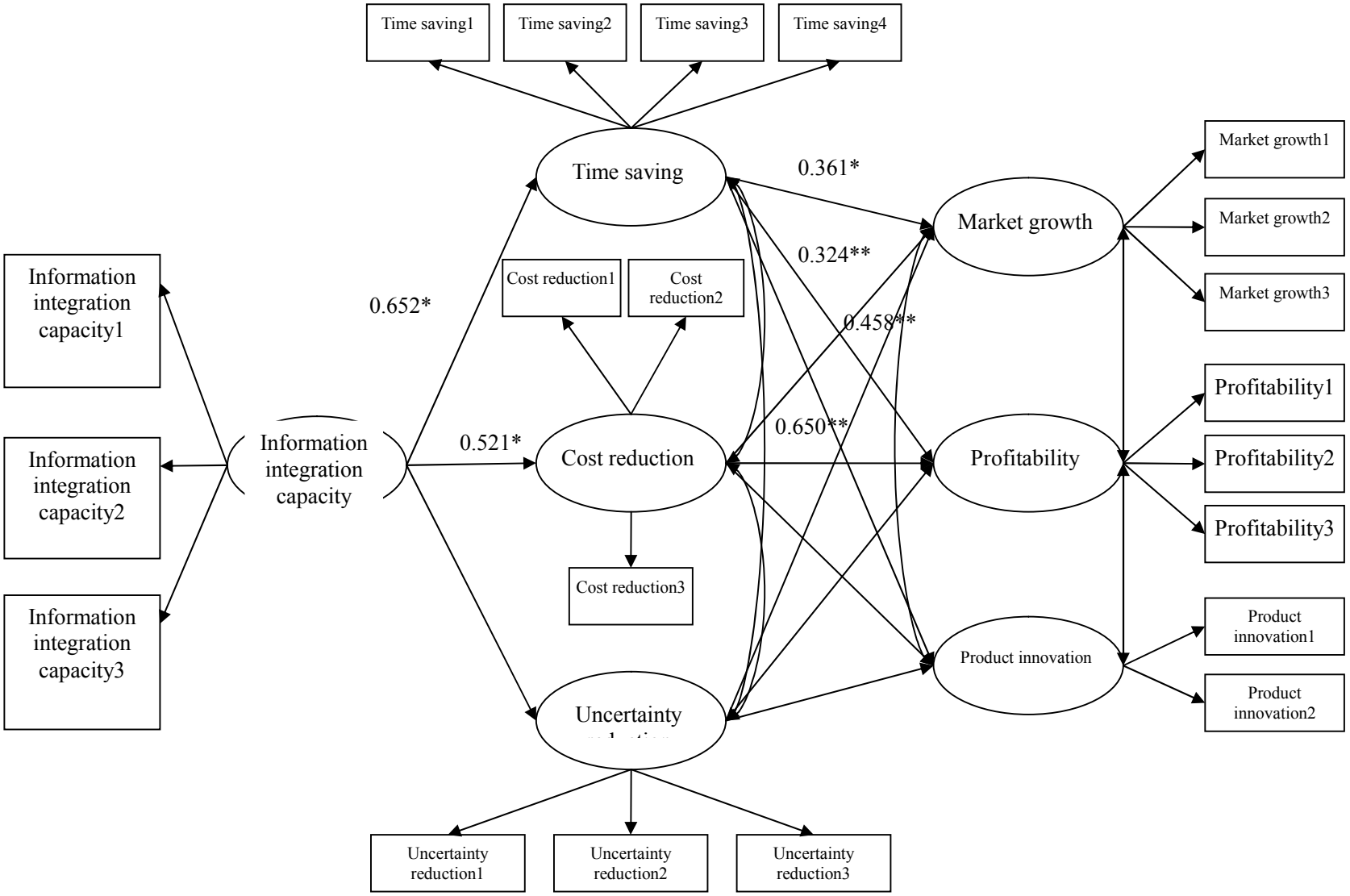

Figure 6.8 Structural Equation Model of Impact Mechanism of Supply Chain Control Tower Information Integration Capacity on Corporate

Lisrel 8.7 is used for the computing and analysis of the preliminary structural equation model, in order to decompose the preliminary computing results and make amendments to the model. A frequently-used model amendment method is to get rid of the path of the max amendment index, no longer require to get rid of the path coefficient, and then observe the fitting condition of the new model of fit index assessment. The final fit model and fit result see Table 6.9.

Table 6.9 Impact Fit Result of Manufacturing Supply Chain Control Tower information Integration Capacity On Corporate Performance (N=212)

Path	Path coefficient	T Value
Information integration capacity→Time saving	0.652*	3.45
Information integration capacity→Cost reduction	0.521*	5.28
Time saving→Market growth	0.361*	2.53
Time saving→Profitability	0.324**	1.36
Cost reduction→Market growth	0.458*	3.57
Cost reduction→Profitability	0.650*	2.85
χ^2/df	1.788	
RMSEA	0.036	
CFI	0.947	

Notes: * and ** represent being significantly below 1% and 5%.

As shown in Table 6.9, based on the finally confirmed impact mechanism model of innovation network structure embeddability on technological learning, the six paths between variables are significant. Parameters of all paths are listed in the Table. The results show that manufacturing supply chain control tower information integration capacity can effectively save time and reduce cost and further improve the market growth and profitability of the enterprise.

(2) Impact of supply chain control tower information collaboration mechanism on corporate performance

Based on the conceptual model of relation between manufacturing supply chain control tower and corporate performance as shown in Figure 5.3, this paper builds a preliminary structural equation model (See Figure 6.9) of the impact mechanism of manufacturing supply chain control tower information collaboration mechanism on corporate performance.

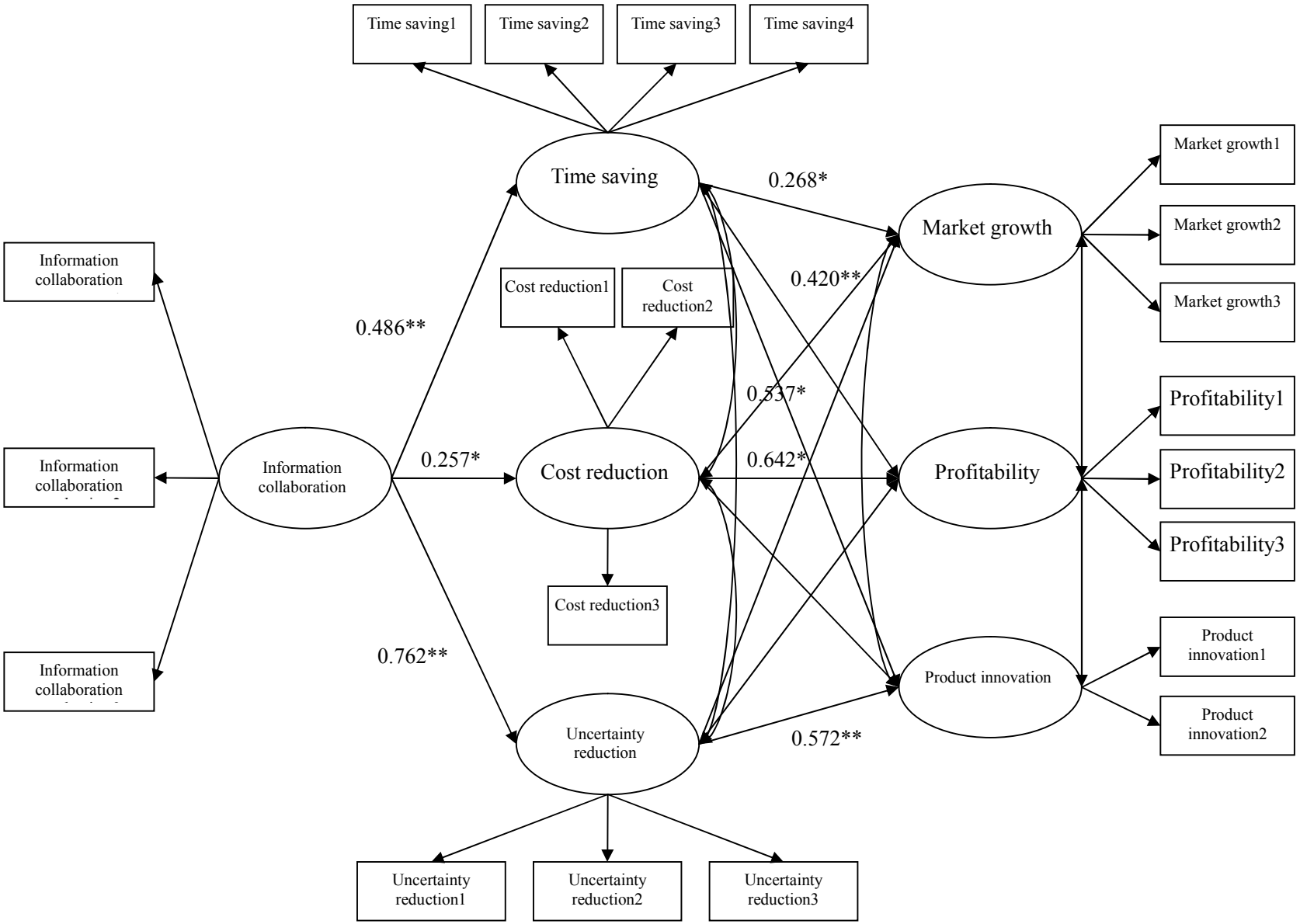
Time saving1
Time saving2
Time saving3
Time saving4
Time saving
0.268*
Market growth
Market growth1
Market growth2
Market growth3
Information collaboration
Information collaboration
Information collaboration
Information collaboration
Cost reduction1
Cost reduction2
0.420**
0.486**
0.337*
Profitability1
Profitability2
Profitability3
0.257*
Cost reduction
0.642*
Profitability
Cost reduction3
0.762**
Product innovation
Product innovation1
Product innovation2
Uncertainty reduction
0.572**
Uncertainty reduction1
Uncertainty reduction2
Uncertainty reduction3

Figure 6.9 Structural Equation Model of Impact Mechanism of Manufacturing Supply Chain Control Tower Information Collaboration Mechanism on Corporate Performance

Lisrel 8.7 is used for the computing and analysis of the preliminary structural equation model, in order to decompose the preliminary computing results and make amendments to the model. A frequently-used model amendment method is to get rid of the path of the max amendment index, no longer require to get rid of the path coefficient, and then observe the fitting condition of the new model of fit index assessment. The final fit model and fit result see Table 6.10.

Table 6.10 Fit Result of Impact of Manufacturing Supply Chain Control Tower Information Collaboration Mechanism on Corporate Performance (N=212)

Path	Path coefficient	T Value
Information collaboration mechanism→Time saving	0.486**	2.04
Information collaboration mechanism→Cost reduction	0.257*	2.61
Information collaboration mechanism→Uncertainty reduction	0.762**	1.99
Time saving→Market growth	0.268*	2.47
Time saving→Profitability	0.420**	2.54
Cost reduction→Market growth	0.537*	2.81
Cost reduction→Profitability	0.642*	3.16
Uncertainty reduction→Product innovation	0.572**	2.28
χ^2/df	1.795	
RMSEA	0.038	
CFI	0.917	

Notes: * and ** represent being significantly below 1% and 5%.

As shown in Table 6.10, based on the finally confirmed impact mechanism model of innovation network structure embeddability on technological learning, the eight paths between variables are significant. Parameters of all paths are listed in the Table. The results show that manufacturing supply chain control tower information collaboration mechanism can effectively save time and reduce cost and uncertainties and further improve the market growth, profitability and product innovation of the enterprise.

(3) Impact of supply chain control tower information sharing level on corporate performance

Based on Figure 5.3 Conceptual Model of Relation between Manufacturing Supply Chain

Control Tower and Corporate Performance, this paper builds a preliminary equation model (See Figure 6.10) of impact mechanism of manufacturing supply chain control tower information sharing level on corporate model.

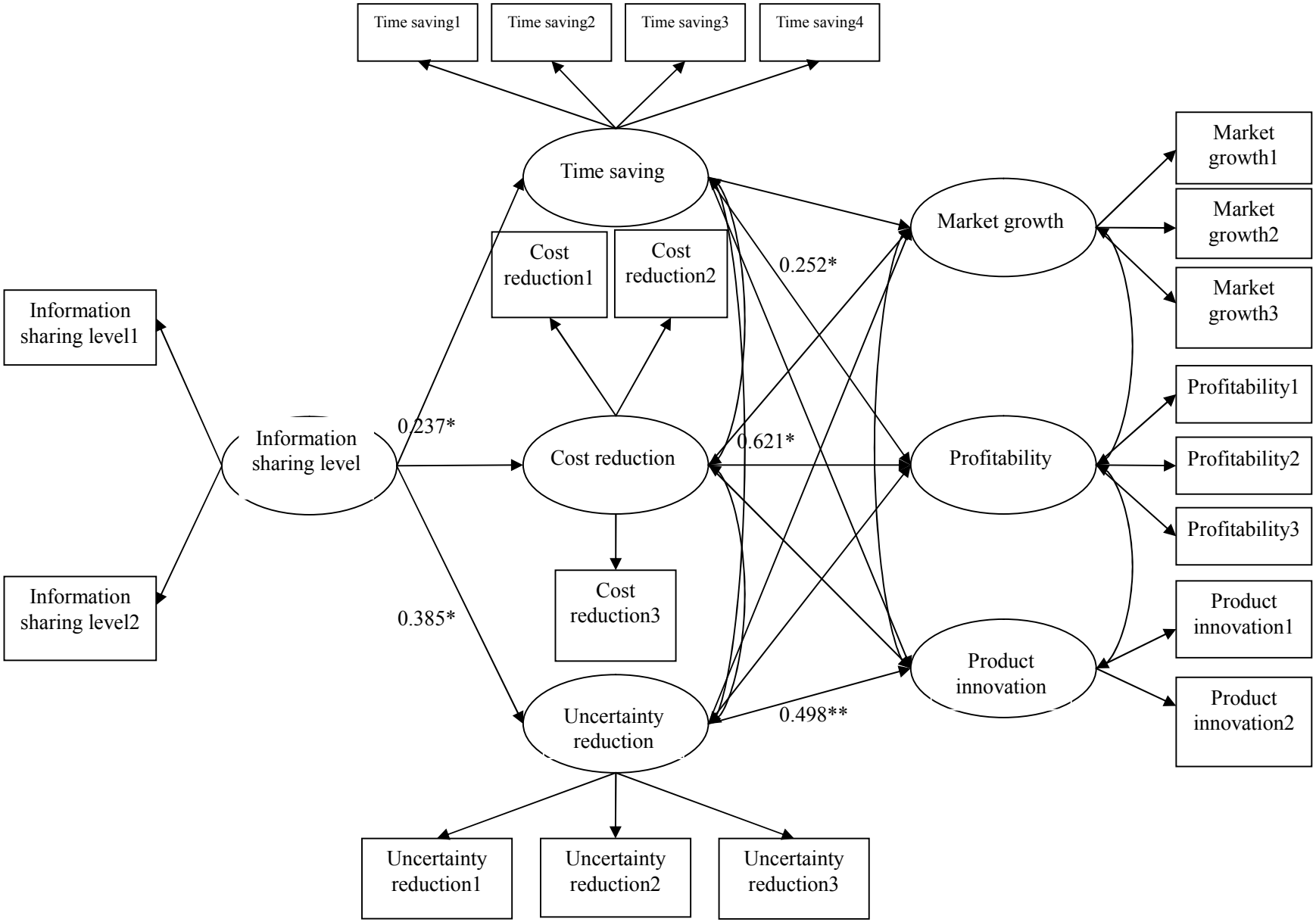
Time saving1
Time saving2
Time saving3
Time saving4
Time saving
Cost reduction1
Cost reduction2
Information sharing level1
Information sharing level2
Information sharing level
0.237*
Cost reduction
Cost reduction3
0.385*
Uncertainty reduction
0.252*
0.621*
0.498**
Market growth
Profitability
Product innovation
Market growth1
Market growth2
Market growth3
Profitability1
Profitability2
Profitability3
Product innovation1
Product innovation2
Uncertainty reduction1
Uncertainty reduction2
Uncertainty reduction3

Figure 6.10 Structural Equation Model of Impact Mechanism of Manufacturing Supply Chain Control Tower Information Sharing Level on Corporate Performance

Lisrel 8.7 is used for the computing and analysis of the preliminary structural equation model, in order to decompose the preliminary computing results and make amendments to the model. A frequently-used model amendment method is to get rid of the path of the max amendment index, no longer require to get rid of the path coefficient, and then observe the fitting condition of the new model of fit index assessment. The final fit model and fit result see Table 6.11.

Table 6.11 Fit Result of Impact of Manufacturing Supply Chain Control Tower Information Sharing Level on Corporate Performance (N=212)

Path	Path coefficient	T Value
Information sharing level→Cost reduction	0.237*	2.78
Information sharing level→Uncertainty reduction	0.385*	2.96
Cost reduction→Market growth	0.252*	3.67
Cost reduction→Profitability	0.621*	2.74
Uncertainty reduction→Product innovation	0.498**	2.13
χ^2/df	1.760	
RMSEA	0.025	
CFI	0.964	

Notes: * and ** represent being significantly below 1% and 5%.

As shown in Table 6.11, based on the finally confirmed impact mechanism model of innovation network structure embeddability on technological learning, the five paths between variables are significant. Parameters of all paths are listed in the Table. The results show that manufacturing supply chain control tower information sharing level can effectively reduce cost and uncertainties and further improve the market growth, profitability and product innovation of the enterprise.

(4) Impacts of supply chain control tower information collaboration capacity on corporate performance

Impacts of supply chain control tower on corporate performance have been studied from aspects of information collaboration capacity, information collaboration mechanism and information sharing level. Based on Figure 5.3 conceptual model, the structural equation model of impact mechanism of manufacturing supply chain control tower information collaboration capacity on corporate performance can be established (see Figure 6.11).

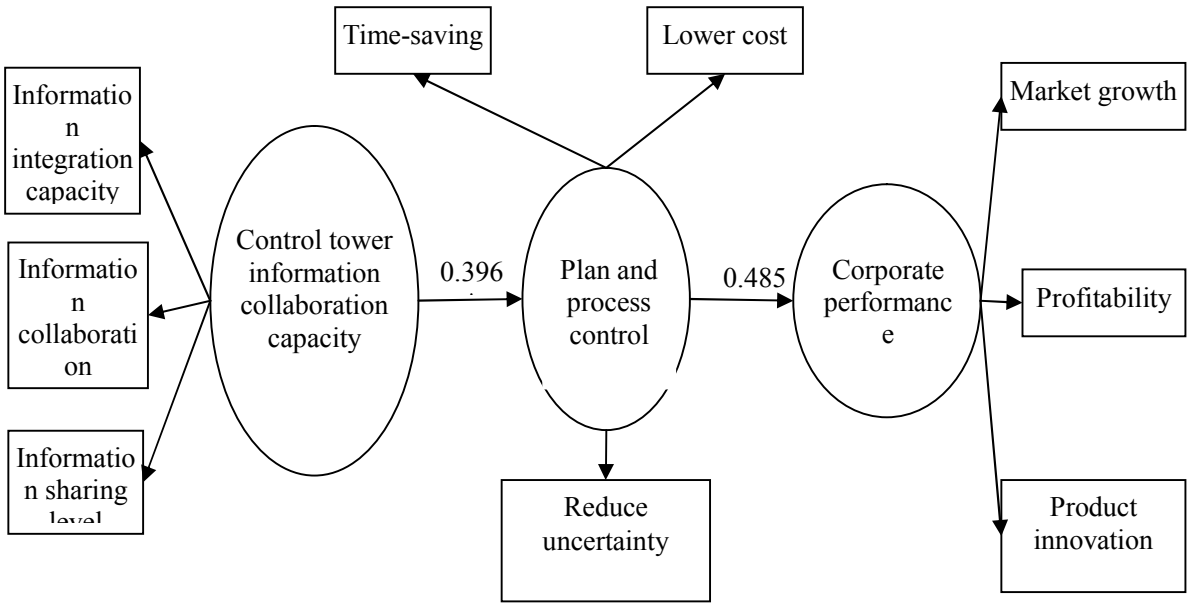

Figure 6.11 Structural Equation Model of Impact Mechanism of Manufacturing Supply Chain Control Tower Information Collaboration Capacity on Corporate Performance

Lisrel 8.7 is used for the computing and analysis of the preliminary structural equation model, in order to decompose the preliminary computing results and make amendments to the model. A frequently-used model amendment method is to get rid of the path of the max amendment index, no longer require to get rid of the path coefficient, and then observe the fitting condition of the new model of fit index assessment. The final fit model and fit result see Table 6.12.

Table 6.12 Fit Result of Impact of Manufacturing Supply Chain Control Tower Information Collaboration Capacity on Corporate Performance (N=212)

Path	Path coefficient	T Value
Information collaboration capacity →Plan and process control	0.396*	3.89
Plan and process control→Corporate performance	0.485*	4.37
χ^2/df	1.805	
RMSEA	0.032	
CFI	0.973	

Notes: * and ** represent being significantly below 1% and 5%.

As shown in Table 6.12, based on the finally confirmed impact mechanism model of machinery manufacturing industry's supply chain control tower on corporate performance, the two paths of information collaboration capacity→ plan and process control and plan and process control → corporate performance are significant. Parameters of all paths are listed in the Table. The results show that manufacturing supply chain control tower information collaboration capacity can effectively reduce cost and uncertainties and further improve corporate performance.

6.3.2 Moderating effect test

In this research, independent variable and moderating variable, after centralized treatment, generate interactive items. Hierarchical regression is adopted to analyze the moderating effect of supply chain environmental uncertainty.

The test results of moderating effect of supply chain environmental uncertainty are shown in Table 6.12. In the table, the dependent variable of models is corporate performance. The regression coefficient listed in the table is non-standardized coefficient. Model 1 introduces plan and process control variables for the regression of dependent variable. Model 2 adds the moderating variable, namely environmental uncertainty, on the basis of Model 1. Model 3 adds the interactive item (environmental uncertainty × plan and process control) that represents the moderating effect of environmental uncertainty. Table 6.13 gives the F values and significance of the models.

Table 6.13 Test Result of Moderating Effect of Environmental Uncertainty

	Model 1	Model 2	Model 3
Constant	2.246	2.237	2.224
Independent variable			
Plan and process control	0.638*	0.654**	0.670**
Moderating variable			
Environmental uncertainty		-0.255**	-0.271*
Interactive item (Environmental uncertainty × plan and process control)			-0.219*
Model statistics			
Moderated R^2	0.498	0.523	0.577
R^2 Change	0.031	0.063	0.071
F Value	58.36**	49.21**	47.65**
F Change	15.36**	13.25**	13.84**

Notes: * and ** represent being significantly below 1% and 5%.

From the table we can see that the three models' significance probabilities are all less than 0.5% in terms of F value. This shows that the overall regression effect of the models is significant.

From the angle of fit, $R^2$of Model 3is 0.577, higher than those of other models. So Model 3 has the best explanatory power, followed by Model 2.

Comparing Model 2 and Model 1, after adding the moderating variable, namely environmental uncertainty, we see that the R^2 value of Model 2 is higher than that of Model 1, which means the former better explains the improvement of corporate performance. From the regression result of Model 2 we see that the regression coefficient of environmental uncertainty is -0.255, which is significantly above 5%. This is consistent with the estimated result of structural equation. After the interactive items of plan and process control and environment uncertainty are added in, the R^2 value of Model 3 has increased significantly compared to Model 2. That means Model 3 better explains the improvement of technical capacity. From the estimated result of Model 3 we see that the regression coefficient of interactive item of plan and process control and environmental uncertainty is -0.219 and is significant above 1%. That means environmental uncertainty reduces the positive impact of plan and process control on corporate performance. In other words, with the same plan and control capacity, the higher the degree of uncertainty of external environment is, the poorer the corporate performance will be. That is consistent with research results of Hsiao-Lan Wei (2012).

6.4 Analysis and Discussion

6.4.1 Discussion on impact of information integration capacity on corporate performance

When discussing the relation between manufacturing supply chain control tower information integration capacity and corporate performance, this research finds out that information integration capacity has a significantly positive impact on enterprise plan and control. This shows that if the manufacturing enterprises can improve their capacities in information technology infrastructure construction, information technology management skill and business/information technology, they can realize improvement, achieve efficient and precise plan and process control to further improve corporate performance.

Supply chain based enterprise management model gradually changes independent and scattered enterprise groups into cluster-type enterprises, which enterprises compete and cooperate with each other. Under such circumstances, enterprises in the cluster have an important thing to do, which is to establish a trust mechanism for development. Enterprises can develop trust relation using Internet. With the rapid advancement of information technology, enterprises can use Internet technology and information management related system software to help them establish a good trust relation with supply chain members. The facilitation function of information integration capacity for the establishment of a trust mechanism with supply chain members mainly displays in three aspects: (1) At the supply chain partner selection stage, the advanced search engine technology and gateway website can help the enterprise rapidly find the cooperative objects in line with their own value system and corporate culture. To achieve cooperation, information about both parties shall be managed to evaluate if such partner is qualified. Such information can be obtained in relevant

trading market with the precondition of existence of internet. It helps enterprises to find suitable partners with less cost quickly and effectively. (2) After finding the member, at the early cooperation stage with supply chain members, both parties need to increase the mutual trust through the establishment of a contract and risk prevention mechanism. In this period, integration in three aspects will improve the trust between two sides. These three integrations are information technology, contract management and collaboration plan, which help to reduce risks on both sides, quickly confirm party that breach the contract, allow reasonable application of funds and real-time monitor of implementation progress. Above actions can be done by using information management related system software to unify alarm system, actual implementation progress, settlement management, operation analysis table, contract review and approval as well as contract modification. (3) At the long-term cooperation stage with supply chain members, trust relations shall be enhanced. The better the trust relation is, the higher revenue cooperative enterprises will gain and the higher the overall competitiveness of supply chain will be. Supply chain members will cherish the cooperative relation in order to avoid losses caused by a new supply chain. At this moment, the investment of core enterprises on the supply chain in information technology is of a much higher asset-dedicated property. As required by the core enterprises on the supply chain, both up-and-downstream enterprises employ the SAP and MES systems. The establishment of such standardized information systems will affect the change in business process restructuring and organizational structure. So up-and-downstream enterprises on the supply chain dare not exit the supply chain or change their information system easily. Therefore, the investment of core enterprises on the supply chain not only improves their own information technology capacity, but also promotes the up-and-downstream enterprises to improve their informatization level and realize system interconnectivity. Whilst improving the operating efficiency of the enterprises, standardized information technology also links all enterprises in the cluster together so that the core enterprises on the supply chain can interact with up-and-downstream enterprises on a same platform and realize the collaboration of procurement plan, production plan, inventory management and sales plan, further stabilize the trust relation between supply chain members.

Information technology capacity directly influences customer integration. Customer integration can be improved via customer trust and information technology capacity. This is why customer integration is influenced by information technology capacity. So we see that trust is very important for the enterprise to do supply chain integration.

When facing with the fiercer market competition, manufacturing enterprises must have a new understanding toward supply chain integration, and a sense of urgency and apply information technology to supply chain business process restructuring. In the restructuring process, information construction’s main objective is to provide support for the whole supply chain business and data exchanges, and supportive platform for supply chain network so that the material, information and capital flows in the supply chain can effectively operate. At this time when information amount of enterprise is increasing greatly, the enterprise has to rely on network to establish a databank-based information system to ensure the quality and efficiency of the information. The effective utilization of information technology can improve the

dynamics of supply chain and help the enterprise make timely and effective response to business-related fluctuations. Information system turns the original linear structure of information flow into a net structure to reduce the length of supply chain, avoid information delay and help links on the whole supply chain realize information sharing. However, the application of information technology only changes the means of transmission of information, not the content. Information system is featured by automatic capacity and mass data processing, but it is only a tool that helps employees do their businesses. The framework of information system depends upon the operating model of the enterprise. The quality of the content of information shared by the enterprise with its suppliers or customers cannot be only ensured by information system but improvement in trust between each other. It is necessary to prioritize the fostering of goodwill and integrity. From the long run, the establishment of a long-term stable strategic alliance relation with suppliers and customers can increase the level of trust and reduce the risk of information sharing so that the enterprise can share important decision information with their customers and suppliers. It is very hard to research on enterprise management because its supply chain integration and optimization is very complicated. The whole operation needs all links to collaborate closely. Each link is influenced by another. So the failure in one link may influence the efficiency of the whole system. Therefore, it is not enough for the enterprise to rely on only the IT system to do supply chain integration. It also needs to make full preparations for improvement of IT personnel quality and information management capacity, establishment of a trust relation with up-and-downstream enterprises on the supply chain.

6.4.2 Discussion on impact of information collaboration mechanism on corporate performance

When discussing the relation between manufacturing supply chain control tower information collaboration mechanism and corporate performance, this research finds that information collaboration mechanism has a positive impact on plan and process control. Normally, during the process of implementation of strategies and planning for development, mutual trust is irreplaceable. Whether enterprise and its partner can maintain such cooperation in following work depends on if they can keep a mutual trust relation. Goodwill trust means dominant side in cooperation choose the weaker side out of trust. Such trust can reduce possible negative influences of opportunistic behavior, avoid wrong doings like unnecessary tracking investigation, suspect, etc.so that mutual confidence between core enterprises and their suppliers is increased, stable cooperative relation is built, resources are further integrated and shared. The trust of up-and-downstream enterprises on the supply chain toward core enterprises is a capacity trust. Up-and-downstream enterprises believe that core enterprises have the capacity to cope with fierce market competition and thus help to achieve collaborative development and improvement. However, due to uncontrollable factors in reality, it is limited in actual implementation and construction of trust mechanism is hindered. In addition, such trust relation is very vulnerable. Cooperative relation will become rigid or even break down once trust relation is distorted or used for other purposes, which further influence all enterprises in cooperative relation. Thus, trust mechanism between cooperative partners

must be built using strong and powerful methods. For example, both parties can negotiate and decide relevant policies and system of awards and penalties; to construct fast and efficient communication channels for both sides to discover and solve problems; to choose highly reliable enterprises with certain competitive edge when seeking for partners. To finalize partner after comparing enterprise culture, core objectives, policy system, etc. Enterprises with high fitting shall be prioritized.

6.4.3 Discussion on moderation of environmental uncertainty

This paper studies the moderating effect of environmental uncertainty on the relation between plan and process control and corporate performance. The findings show that environmental uncertainty has a significant impact on the relation between plan and process control and corporate performance.

High environmental uncertainty forces enterprises to integrate suppliers and customers. This means in a dynamic and complicated market environment, enterprises need to implement strategies to realize higher integration of suppliers and customers to adapt to external environmental changes. Environmental uncertainty is one of the driving forces for external integration of supply chain. The increase in environmental uncertainty make more complicated supply chain partnership and information pose influence on enterprises supply chain management. They have to work with suppliers to help suppliers improve product quality, develop new products, shorten cycle, deliver on time so that opportunistic behaviors can be avoided and supply chain performance can be improved. In addition, complex and changing competition environment requires enterprises to keep close contact with customers to manage their preferences and demand changes so that enterprises can offer highly diversified high quality product and needed service to customers with low cost, high speed while satisfying market demand.

Therefore, the core enterprise on the supply chain shall fully activate up-and-downstream enterprises in supply chain to form correct strategic alliance so that collaborative development and improvement can be realized and overall supply chain performance and competitiveness can be enhanced. Such good cooperation is easy to find in reality. Take relevant manufacturing as an example. If it manages powerful and advance information technology and has certain partners, it should require partners to use information system that can perfectly connect with its own. Because it is very costly to end cooperative relation and seek for new partner, cooperative partner will not change information system or exit cooperation for fluctuated condition or over stable while keep sharing resources with core enterprises and maintaining close cooperation to actively solve supply and demand issue during cooperation so that trust can be continuously improved.

6.5 Chapter Conclusion

This chapter, based on the conceptual model and research hypothesizes of the relation between manufacturing supply chain control tower and corporate performance that are put forth in Chapter 4, takes machinery manufacturing industry as an example to carry out questionnaire surveys on 212 machinery manufacturers to obtain sample data, and use

structural equation modeling, hierarchical regression and other methods to analyze and verify it, to discuss the relation between manufacturing supply chain control tower and corporate from two aspects, namely, direct and indirect impacts. Research results show:

(1) Manufacturing supply chain control tower information integration capacity can effective save time and reduce cost and further improve the market growth and profitability of the enterprise. Manufacturing supply chain control tower information collaboration mechanism can effectively save time, reduce cost and uncertainties, and further improve the market growth, profitability and product innovation of the enterprise. Manufacturing supply chain control tower information sharing level can effectively reduce cost and uncertainties and further improve the market growth, profitability and product innovation of the enterprise.

(2) Environmental uncertainty has a significant negative impact on the relation between plan and process control and corporate performance.

Chapter VII Research Conclusion and Outlook

7.1 Research Conclusion

This paper analyzes, based on the summarization of the research status and developments of supply chain collaboration and the relationship between supply chain collaboration and corporate performance at home and abroad, the make-up and functions of supply chain control tower, puts forward research hypotheses after exploratory researches on the building of the conceptual model for supply chain control tower and corporate performance for the manufacturing industry, and finally, analyzes and verifies the impact of supply chain control tower on corporate performance in the manufacturing industry by the comprehensive use of confirmatory factor analysis, structural equation modeling, hierarchical regression and other methods after collecting relevant corporate data through questionnaires. Research results show that:

(1) Supply chain control tower is an interdepartmental organization. It is an information center backed by system integration that can provide visual services for the supply chain. It can be applied to the transportation and warehousing activities on the supply chain and monitoring and metering. Supply chain control tower plays the role of central pivot of supply chain collaboration and simulates, visualizes, analyzes and predicts information and possible results for all stakeholders who can use such information to solve problems, avoid risks and improve operating efficiency.

(2) Supply chain performance assessment is the evaluation on the performance of the whole supply chain and corporates on the supply chain nodes, and the implementation and collaboration relationship among corporates on the supply chain nodes. It is the assessment indicator based on the working process. BSC-SCOR supply chain performance assessment model combines the framework from BSC and the detailed process from SCOR, offering a standard description of the management process of the supply chain, achieving a comprehensive and balanced evaluation on the performance of the supply chain.

(3) In the exploratory cases the two companies are very good at obtaining, sharing and integrating external and internal information resources based on their advanced information technology and unified information technology standard, to realize supply chain timing, cost and financial advantages and improve the overall competitiveness of their supply chain. On the basis of the exploratory case study and combining the researches of other people, this paper puts forward a conceptual model for the impact of supply chain control tower on corporate performance that takes corporate performance as dependent variable (explained variable), supply chain control tower as independent variable, plan and process control as mediating variable and environmental uncertainty as moderating variable.

(4) Experimental results show that the information integration capacity of the machinery manufacturing industry's supply chain control tower can effectively save time and lower cost, thus further improving market growth rate and profitability of the enterprise. Supply chain control tower information collaboration mechanism can effectively save time, lower cost and

reduce uncertainties, thus further improving the market growth rate, profitability and product innovation efficiency of the enterprise. The degree of information sharing of supply chain control tower can effectively lower cost and reduce uncertainties, thus further improving the market growth rate, profitability and product innovation efficiency of the enterprise. In general, information collaboration capacity of the machinery manufacturing industry's supply chain control tower can effectively lower cost and reduce uncertainties, thus further improving corporate performance, while external environmental uncertainties have a significant negative impact on the relation between plan and process control and corporate performance.

7.2 Management Revelation

The research result shows that manufacturing supply chain control tower information integration capacity can improve corporate performance in machinery manufacturing industry. However, such supply chain information collaboration relies on member's trust and cooperation in supply chain. It requires members of supply chain to maintain stable trust with other members, enhance cooperation and communication, and strengthen information technology so that corporate performance can be boosted.

(1) Improve stable trust relation among supply chain members

Trust is an integral part of supply chain collaboration, which, to an extent, is decisive to the maintaining and development of cooperation. Trust here means that the two cooperated parties are willing to believe each other and have the capacity to perform the contract, regulations and promises. Both parties do not betray each other for a better private interest and they are even willing to bear the possible losses for the interest of both parties and bear group risks proactively. In order to improve trust among supply chain members, here are methods that can be used: ① Choosing appropriate collaborative partner. When choosing partner, common interest shall be put as premise to ensure that both sides will mutually improve, develop and form a good trust relation so that friction and divergence can be reduced and good effect is achieved. In addition, collaborative partners should bear responsibilities and duties. Official contractual relationship shall be established to lay solid foundation for official collaborative operation. In this way, once there are problems, responsible party will be found, corresponding compensation can be made, opportunistic behaviors can be avoided and business reputation related issue can be reduced. ② Enhance collaborative process management. Trust construction is a long process. Both parties shall observe past cooperation conditions. In addition, actual company development shall be evaluated as well. Thus, both collaborative parties shall understand each other in details to make overall assessment on possible future revenue. The trust level can be improved by increasing business cooperation, visualized actions and long term cooperation, etc.

There is no doubt that collaborative cooperation among corporates will be influenced by trust level. However, overly higher trust might pose negative influence on collaborative cooperation. Excessive trust could generate high risks. Thus, trust should be adjusted to be compatible with cooperative relationship, collaboration and stages in lifecycle.

(2) Improve supply chain members' cooperative level appropriately

In supply chain management research, cooperation is one kind of corporate relationship. There are competitive relationship and coopetitive relationship, etc. Acting alone by members of supply chain normally gain less revenue comparing with that gained in collaborative cooperation. Thus, supply chain members are willing to take joint actions. Here are methods for improving supply chain members' cooperative level. ① Management cooperation. Actual cooperative relationship is established before confirming cooperative sense. The key to establish such relationship is the transformation between trading cooperation and relationship cooperation. Further coordinative management can only be conducted when relationship cooperation is formed. In addition, coordinative management contains many contents such as revenue sharing, risk sharing and information sharing, unified contractual incentive, etc. ② Prevent opportunistic behaviors. Opportunistic behaviors normally exist among individual employees in company when he or she has actions for gaining greater economic interests that are hampering overall development. Opportunistic behaviors occur when there is information asymmetry or when information about one party that obtain the other party obviously deviates from fact, former party will offer opportunistic behaviors to individual employees for greater benefit. In addition, opportunistic behaviors might also happen when one party is very powerful and the other party has over reliance. In order to prevent opportunistic behaviors, contract content shall be improved, implementation process shall be strictly monitored, contract content shall be rigidly implemented and partners shall be chosen cautiously. Award and penalty are needed for better prevention of opportunistic behaviors. ③ Deal with conflict. There might be emergency issues in cooperation of supply chain partners, such as interest conflict, different understandings, various goals, which will directly influence cooperative relationship or even cause cooperation to breakdown. Conflicts can be divided into destructive ones and constructive ones. Constructive ones have comparatively smaller influence on cooperation. They can unveil possible problems in cooperation to create opportunities for problem solving, which is good for deepening cooperative relation. Destructive ones might call off cooperation because they directly affect direct interests of both parties and cooperative basis. When solving conflicts, multiple aspects shall be taken into consideration instead of neglecting signals purely for maintaining cooperation. Three main strategies are to circumvent, to buffer and to face up to conflicts. Problems shall be categorized based on severity when solving them. To circumvent conflicts that have small influence or can be solved immediately. To deal with parts of conflicts that are not very substantial but still have some influences. Serious conflicts that will influence cooperation should be handled thoroughly and relevant people should be held responsible. In addition, if necessary, conciliate through arbitral authority or even bring into court, or enhance communication, and improve trust can be considered.

(3) Improve information technology capacity

Trust and cooperative relation among supply chain members are critical to implementation of supply chain integration solution. Such trust and cooperation should be underpinned by

information technology capacity. Especially under current social background, digging the mine of data is of significance. Enterprises must maximize data value by applying latest information technology in fastest speed. They not only need to invest more in improving their own information technology infrastructure, but also improve their perception power and analyzing capacity of data and attract information technology talents. Only by doing so, can they maintain good cooperative relations with partners and secure the stand in market. Only with a huge market demand in information technology resource can they attract more supplier and enterprises to cooperate.

7.3 Research Limitations and Outlook

This research has drawn some very meaningful conclusions and some innovative explorations. But still, there are some deficiencies. So further research is needed.

(1) The building of conceptual model

Supply chain performance of the enterprise is influenced by many factors. This paper, though based on exploratory case studies and literature reviews, has put forth the conceptual models of corporate performance. But whether it has covered all the influencing factors is still a question that needs to contemplate. Building the micro basis for supply chain performance and identifying important influencing factors through mathematical model analysis may be an important direction for the supplementation of this paper.

(2) The evidence part

For the convenience of questionnaire paper collection and sorting, this paper mainly carried out the survey on machinery manufacturing enterprises and did not do it on suppliers and distributors, which might have a certain impact on the research results. In addition, the quantity of sample is relatively small and those who filled out the questionnaire might have a different understanding about supply chain control tower, so the results may be a little different. In future researches, sample size may be expanded and number of respondent may be increased to make the research have more guidance value.

References

Arshinder, A. Kanda, S. G. Deshmukh. *Coordination in supply chains: an evaluation using fuzzy logic*[J]. *Production Planning & Control*, 2007, 18(5): 420-435.

Arshinder, Kanda A, Deshmukh S G. *Supply chain coordination: Perspectives, empirical studies and research directions*[J]. *International Journal of Production Economics*, 2008, 115(2): 316-335.

Bahinipati B K, Kanda A, Deshmukh S G. *Horizontal collaboration in semiconductor manufacturing industry supply chain: An evaluation of collaboration intensity index*[J]. Computers & Industrial Engineering, 2009, 57(3): 880-895.

Barratt M, Barratt R. *Exploring internal and external supply chain linkages: Evidence from the field*[J]. Journal of Operations Management, 2011, 29(5): 514-528.

Barratt M. *Understanding the Meaning of Collaboration in the Supply Chain*[J]. Supply Chain Management, 2004, 9(1): 30-42.

Barrett S, Konsynski B. *Inter-Organization Information Sharing Systems*[M]. Society for Information Management and The Management Information Systems Research Center, 1982.

Barro F, Co H C. *Stakeholder theory and dynamics in supply chain collaboration*[J]. International Journal of Operations & Production Management, 2009, 29(6): 591-611.

Boddy D, Macbeth D, Wagner B. *Implementing Collaboration Between Organizations: An Empirical Study of Supply Chain Partnering* [J]. Journal of Management Studies, 2000, 37(7): 1003-1018.

Bowersox, D. J., D. J. Closs & M. B. Cooper. *Supply chain logistics management*. 2011

Cao M, Zhang Q. *Supply chain collaboration: Impact on collaborative advantage and firm performance*[J]. *Journal of Operations Management*, 2011, 29(3): 163-180.

Cao Yonghui. *Research on functional mechanism of supply chain quality management on enterprise quality performance in dynamic perspective* [D]. Zhejiang University, 2016.

Cetindamar D, Çatay B, Basmaci O S. *Competition through collaboration: insights from an initiative in the Turkish textile supply chain* [J]. Supply Chain Management, 2005, 10(4): 238-240.

Chae B, Yen H J R, Sheu C. *Information technology and supply chain collaboration: moderating effects of existing relationships between partners*[J]. IEEE Transactions on Engineering Management, 2005, 52(4): 440-448.

Chen Bingbing. *CSM supply chain management tactics, techniques and practices* [M]. *Beijing: Electronic Industry Press*, 2004.

Chen Jianhua & Ma Shihua. *Realization mechanism and technical solutions of supply chain*

integration management [J]. *Industrial Engineering and Management*, 2006, 11(1): 23-31.

Chen Jiumei & Kang Shiying. *Effect evaluation of rough set theory based supply chain collaboration* [J]. *Statistics and Decision*, 2007, (22): 170-172.

Chen Qinlan. *Research on strategic factors of business collaboration in supply chain* [J]. *Journal of Shanxi University of Finance and Economics*, 2007, 29(3): 83-88.

Chen Zhixiang. *Research on performance assessment index system of agile supply chain* [J]. CIMS, 2004, l (10): 99-105.

Cheng Guoping. *Research on collaboration problems in supply chain management* [D]. Master's Thesis, Tianjin University, 2004.

Cheng Yunxiang. *Empirical study on supply chain collaboration based contractual alliance and new supply chain innovation types* [D]. Chongqing University, 2014.

Cheung K L, Lee H L. *The Inventory Benefit of Shipment Coordination and Stock Rebalancing in a Supply Chain*[M]. INFORMS, 2002.

Chopra S. *Supply Chain Management Strategy Planning* [J]. Iie Transactions, 2002, 34(2): 221-222.

Cousins P D, Menguc B. *The implications of socialization and integration in supply chain management* [J]. Journal of Operations Management, 2006, 24(5): 604-620.

Deng Longan & Xu Jiuping. *Research on enterprise network innovation and performance management in supply chain integration* [J]. *Science of Science and Management of S. & T.*, 2008, 29(2): 86-90.

Fawcett S E, Wallin C, Allred C, et al. *Information technology as an enabler of supply chain collaboration: a dynamic-capabilities perspective* [J]. Journal of Supply Chain Management, 2011, 47(1): 38-59.

Flynn B B, Huo B, Zhao X. *The impact of supply chain integration on performance: A contingency and configuration approach*[J]. Journal of Operations Management, 2010, 28(1): 58-71.

Frohlich M T, Westbrook R. *Arcs of integration: an international study of supply chain strategies*[J]. Journal of Operations Management, 2001, 19(2):185-200.

Gao Ruiping, Ji Shouwen, Tian Ruiqi. *Research on the construction of a control tower based dairy product supply chain visual, controllable and trackable system* [J]. *Logistics SCI Tech*, 2016, 39(8): 25-30.

Giménez C, Ventura E. *Supply Chain Management as a Competitive Advantage in the Spanish Grocery Sector*[J]. International Journal of Logistics Management, 2003, 14(1): 77-88.

Greg Elofson, William N. Robinson. *Collective customer collaboration impacts on supply-chain performance*[J]. International Journal of Production Research, 2007, 45(11): 2567-2594.

Greg Elofson, William N. Robinson. *Collective customer collaboration impacts on supply-chain performance*[J]. International Journal of Production Research, 2007, 45(11): 2567-2594.

Grover V, Teng J T C, Fiedler K D. *Investigating the Role of Information Technology in Building Buyer-Supplier Relationships*[J]. Journal of the Association for Information Systems, 2002, 3.

Heim G. R. & Peng D. X. *The impact of information technology uses on plant structure, practices, and performance: An exploratory study* [J]. Social Science Electronic Publishing, 2010, 28(2): 144-162.

Holweg M, Disney S, Holmström J, et al. *Supply Chain Collaboration: Making Sense of the Strategy Continuum*[J]. European Management Journal, 2005, 23(2): 170-181.

Hong Y, Vaidya J, Wang S. *A Survey of Privacy-Aware Supply Chain Collaboration: From Theory to Applications*[J]. Journal of Information Systems, 2014, 28(1): 243-268.

Huang Kun. *Research on operating strategy of supply-hub based supply logistics collaboration*. [Academic Dissertation of Huazhong University of Science and Technology], 2011

Huo Jiazhen & Ma Xiubo. *Structuring of supply chain performance assessment system and improvement of grey correlation method* [J]. *Industrial Engineering and Management*, 2004, (6): 15.20.

Hyland P W, Ferrer M, Soosay C A. *Supply chain collaboration: capabilities for continuous innovation*[J]. *Supply Chain Management*, 2008, 13(2): 160-169.

Ji Zuozhe. *Brief discussion on supply chain cost management* [J]. *Journal of Jilin Province Economic Management Cadre College*, 2001, 15(4): 44-46.

Kaplan, R. and D. Norton. *The balance scored card- measures that drive performance* [J]. Harvard Business Review, 1992, 70(1-2):71-79.

Kong Pengju & Zhou Shuiyin. *Research on relation between control mode, environmental uncertainty and supply chain collaboration* [J]. *Industrial Engineering and Management*, 2014, 19(4):22-28.

Lambert D. M. & Cooper M. C. *Issues in Supply Chain Management* [J]. Industrial Marketing Management, 2000, 29(1):65-83.

Li Changming. *Research on relation between supply chain collaboration mode and innovation type* [D]. Chongqing University, 2014.

Li G, Lin Y, Wang S, et al. *Enhancing agility by timely sharing of supply information*[J]. *Supply Chain Management*, 2006, 11(5):425-435.

Li Hui. *Research on supply chain information collaboration performance assessment* [D]. Master's Thesis, Dalian University of Technology, 2013.

Li Lingju. *Analysis of information collaboration effect in supply chain management*

information system [J]. *Information Science*, 2006, 24(1): 100-103.

Li L, Zhang H. *Confidentiality and Information Sharing in Supply Chain Coordination*[J]. *Management Science*, 2008, 54(8): 1467-1481.

Li S, Lin B. *Accessing information sharing and information quality in supply chain management*[J]. *Decision Support Systems*, 2006, 42(3): 1641-1656.

Li Xinran & Sun Xiaojing. *Impact model of SCM-based corporate performance* [J]. *Science Research Management*, 2009, (3): 117-123.

Li Yipeng & Ma Shihua. *Research on supply-hub based information collaboration in uncertain supply chain*. *Journal of Intelligence*, 2011, 30(3): 151-155.

Li Yong, Zhang Yi, Yang Xiutai, Dan Bin & Zhu Tao. *Game model for cooperative R&D between manufacturer and supplier in supply chain* [J]. *Journal of Systems Engineering*, 2005, 20(1): 12-18.

Liang Yuezhong. *Supply chain performance evaluation based on SCOR* [J]. Group Economy, 2006(3): 184-185.

Liao Chenglin, Qiu Mingquan & Longyong. *Empirical research on the relation among enterprise cooperative relations, agile supply chain and corporate performance* [J]. *System Engineering - Theory & Practice*, 2008(6): 115-128

Liao Chenglin, Qiu Mingquan & Longyong. *Empirical research on the relation among enterprise cooperative relations, agile supply chain and corporate performance* [J]. *System Engineering - Theory & Practice*, 2008(6): 115-128

Liu Li. *Effects of supply chain integration on the competitiveness and performance of manufacturing companies* [D]. Southeast University, 2008.

Liu Li. *Empirical research on supply chain performance, competitive advantage and corporate performance* [J]. *China Soft Science*, 2010, (S1): 307-312.

Liu T, Lu Y, Yong Z, et al. *Research on information sharing values of supply chain management* [J]. Kybernetes, 2012, 41(9).

Liu Xinyu, Xie Weidong & Zhang Zhiyong. *Research on and application of Baosteel's customer-oriented individualized information collaboration service* [J]. *Industrial Engineering and Management*, 2005, 10(4): 107-111.

Lu Shan. *Evaluation research on relational capital and knowledge learning supply chain collaboration* [J]. *Science of Science and Management of S. & T.*, 2012, 33(8): 152-158.

Lu Shan. *On supply chain collaboration effect* [J]. *Science-Technology and Management*, 2008, 10(6): 36-38.

Lummus R R, Bokurka R J & Alber K L. *Strategic Supply Chain Planning* [J]. Production & Inventory Management Journal, 1998, 39(3): 49-58.

Ma Shihua, Lin Yong & Chen Zhixiang. *Supply chain management* [M]. Mechanical

Engineering Publishing Company, 2000.

Ma Shihua & Gui Huaming. *Supply-driven supply chain collaboration technology and management - principles and applications* [M]. Wuhan: Huazhong University of Science & Technology Press, 2009.

Ma Shihua & Linyong. *Supply chain management (Version 2)* [M]. *Beijing: China Machine Press*, 2005.

Manthou V, Matopoulos A, Vlachopoulou M. *Internet-based applications in the agri-food supply chain: a survey on the Greek canning sector* [J]. *Journal of Food Engineering*, 2005, 70(3): 447-454.

Manthou V, Vlachopoulou M, Folinas D. *Virtual e-Chain (VeC) model for supply chain collaboration*[J]. *International Journal of Production Economics*, 2004, 87(3): 241-250.

Matopoulos A, Vlachopoulou M, Manthou V, et al. *A conceptual framework for supply chain collaboration: empirical evidence from the agri-food industry*[C]// *International Workshop on Supply Chain Management & Information Systems*. 2005.

Meixell M J, Gargeya V B. *Global supply chain design: A literature review and critique*[J]. Transportation Research Part E Logistics & Transportation Review, 2005, 41(6): 531-550.

Pan Wenan. *An Empirical Study of the Effects of Trust and Relationship Commitment of Supply Chain Partners on Cooperative Performance* [J]. Science Technology Progress and Policy, 2006, 23(5): 105-108.

Pan Wenan & Zhang Hong. *Impact of trust and promise in supply chain partnership on cooperation performance* [J]. *Journal of Psychological Science*, 2006, 29(6): 1502-1506.

Qi Xugao. R*esearch on influencing factors and operating management mechanism of supply chain collaboration product innovation* [D]. Doctoral dissertation, Tianjin University, 2013.

Qian Li. *Research on decision-making for supply chain collaboration knowledge innovation* [D]. Jiangsu University, 2014.

Qiu Mingquan. *Empirical research on the relation among enterprise cooperative relations, supply chain effect and corporate performance* [J]. *Master's Thesis of Chongqing University*, 2007

Qiu Ying. *Research on internal mechanism of supply chain management, competitive advantage and performance in auto industry* [J]. [J]. Master's thesis of Wuhan University of Technology, 2012

Raghunathan S. *Information Sharing in a Supply Chain: A Note on its Value when Demand Is Nonstationary* [M]. INFORMS, 2001.

Ramanathan U, Gunasekaran A, Subramanian N. *Supply chain collaboration performance metrics: a conceptual framework*[J]. Benchmarking, 2011, 18(6): 856-872(17).

Robert M. Monczka, et al. *Success Factors in Strategic Supplier Alliances: The Buying Company Perspective* *[J]. *Decision Sciences*, 1998, 29(3): 553-577.

Ross A & Droge C. *An integrated benchmarking approach to distribution center performance using DEA modeling* [J]. Journal of Operations Management, 2002, 20(1): 19-32.

Sahin F, Jr E P R. *Information sharing and coordination in make-to-order supply chains*[J]. *Journal of Operations Management*, 2005, 23(6): 579-598.

Sanjay Gosain, Arvind Malhotra, Omar A. El Sawy. *Coordinating for Flexibility in e-Business Supply Chains*[J]. *Journal of Management Information Systems*, 2004, 21(3): 7-45.

Simatupang T M, Sridharan R. *The collaboration index: a measure for supply chain collaboration*[J]. *International Journal of Physical Distribution & Logistics Management*, 2005, 35(1): 44-62.

Skjoett‐Larsen T, Thernøe C, Andresen C. Supply chain collaboration: Theoretical perspectives and empirical evidence [J]. *International Journal of Physical Distribution & Logistics Management*, 2003, 33(6): 531-549.

Soroor J, Tarokh M J, Shemshadi A. *Theoretical and practical study of supply chain coordination*[J]. *Journal of Business & Industrial Marketing*, 2009, 24(2): 131-142.

Stank T, Crum M, Arango M. *Benefits of interfirm coordination in food industry supply chains*[J]. *Journal of Business Logistics*, 1999.

Stanley E. Fawcett Ph.D., Gregory M. Magnan Ph.D. ‡, Matthew W. McCarter B.S. §. A *THREE-STAGE IMPLEMENTATION MODEL FOR SUPPLY CHAIN COLLABORATION*[J]. Journal of Business Logistics, 2008, 29(1): 93-112.

Sun Xiaoyuan. *Research on visual, controllable and trackable service model of dairy product supply chain* [D]. Beijing Jiaotong University, 2015.

Swafford P M, Ghosh S, Murthy N. *Achieving supply chain agility through IT integration and flexibility*[J]. *International Journal of Production Economics*, 2008, 116(2): 288-297.

Tao Wenyuan, Kou Jisong & Li Minqiang. *Effect of information sharing on supply chain* [J]. Journal of Systems Engineering, 2002, 17(6): 486-490

Theodore P. Stank, Scott B. Keller, Patricia J. Daugherty. *Supply chain collaboration and logistical service performance* [J]. *Journal of Business Logistics*, 2001, 22(1): 29-48.

Vachon S, Klassen R D. *Environmental management and manufacturing performance: The role of collaboration in the supply chain*[J]. *International Journal of Production Economics*, 2008, 111(2): 299-315.

Vereecke A, Muylle S. *Performance improvement through supply chain collaboration in Europe*[J]. *International Journal of Operations & Production Management*, 2006, 26(11): 1176-1198.

Wang Hainan. *Research on grid-based circulation retail enterprises' supply chain*

collaboration [D]. Shangdong University, 2014.

Wang Xiayang. *Dynamic coordination between contractual incentives, information sharing and supply chain* [J]. *Management World*, 2005(4): 106-115.

Wang Yanna. *Supply chain collaboration mechanism of complex product manufacturer and measure of its performance* [D]. Master's thesis, Wuhan University of Technology, 2010.

Wiengarten F, Humphreys P, Cao G, et al. *Collaborative supply chain practices and performance: exploring the key role of information quality* [J]. *Supply Chain Management*, 2010, 15(6): 463-473.

Xie Lei, Ma Shihua, Gui Huaming, et al. *Research on the relation between supply logistics collaboration and supply chain agility and performance* [J]. *Science Research Management*, 2012, 33(11): 96-104.

Xu Dehui, Li Gang, Sun Linyan et al. *The relationship among environmental uncertainty, supply chain integration, and firm performance* [J]. Science Research Management, 2012, 33(12): 40-49.

Ye Fei & Li Yina. *Relation among supply chain partnership, information sharing and corporate performance* [J]. *Industrial Engineering and Management*, 2006, 11(6): 89-95.

Ye Fei & Xu Xuejun. *Impact of trust and relational promise on information sharing and operating performance in supply chain partnership* [J]. *Systems Engineering - Theory & Practice*, 2009, 29(8): 36-49.

Yin Ming. *Research on key factors affecting dynamic supply chain collaboration trust* [J]. Doctorate Dissertation of Northwestern Polytechnical University, 2006

Yu M M, Ting S C, Chen M C. *Evaluating the cross-efficiency of information sharing in supply chains*[M]. Pergamon Press, Inc. 2010.

Yuan Xumei & Zhang Xu. *Research on the impact of technical capacity on degree of supply chain information sharing* [J]. 2016(2): 3-8.

Zacharia Z G, Nix N W, *Lusch R F. An Analysis of Supply Chain Collaborations And Their Effect On Performance Outcomes*[J]. *Journal of Business Logistics*, 2009, 30(2): 101-123.

Zacharia Z G, Nix N W, Lusch R F. *Capabilities that enhance outcomes of an episodic supply chain collaboration*[J]. *Journal of Operations Management*, 2011, 29(6): 591-603.

Zeng Wenjie. *Research on influencing factors of partnership based supply chain collaboration* [D]. Doctoral Dissertation, HUST, 2010.

Zeng Wenjie & Ma Shihua. E*mpirical study on impact of manufacturing supply chain partnership on collaboration and operating performance* [J]. *Chinese Journal of Management*, 2010(8): 1221-1227.

Zhang Cuihua, Ren Jinyu, Yu Haibin. *Research progress of supply chain collaboration management* [J]. *System Engineering*, 2005, 23(4): 1-6.

Zhang Cuihua & Yu Hahbin. *Research Progress of supply chain collaboration management* [J]. *System Engineering*, 2005a, 23(4): 1-6.

Zhang Cuihua, Zhou Hong & Zhao Sen. *Supply chain collaboration performance assessment and its application* [J]. *Journal of Northeastern University (Natural Science Column)*, 2007, 27(6): 706-708.

Zhang Jiayi. *Research of impact of supply chain integration on corporate performance of auto parts enterprises* [D]. Master's thesis, Shanghai Jiaotong University, 2013.

Zhang Qing & Liu Zhixue. *Supply chain collaboration and application of agent in it: research summarization* [J]. *Computer Application Research*, 2008, 25(8): 2265-2269.

Zhang Wei. *Research on the models of collaboration and innovation between supply chain enterprises* [D]. Master's thesis, Chongqing University, 2009.

Zhang X. *The Value of Information Sharing and Coordination in a Two-level Supply Chain*[J]. *Chinese Journal of Management*, 2007, 4(1): 32-39.

Zhang Xiangxian, Guo Jia & Ma Jie. *Research on information collaboration model of enterprise information eco-system* [J]. *Intelligence Theory and Practice*, 2010, 33(4):10-13.

Zhang Xin & Ma Shihua. I*mpact of information sharing and collaboration on two-stage supply chain* [J]. *Chinese Journal of Management*, 2007, 4(1): 32-38.

Zhang Xumei, Chen Wei & Zhang Yingxiu. *Empirical research on influencing factors of knowledge sharing between supply chain enterprises* [J]. *Chinese Journal of Management*, 2009(10): 1296-1301.

Zhou H, Jr W C B. *Supply chain practice and information sharing*[J]. *Journal of Operations Management*, 2007, 25(6): 1348-1365.

Zou Huixia. *Supply Chain Collaboration Management: Theories and Methods* [M]. Beijing: Peking University Press, 2007.

Appendixes

Questionnaire on Relation between Manufacturing Supply Chain Control Tower and Corporate Performance

Dear Sir/Madam,

I am a PhD student applying for EDBA, Université Paris-Dauphine. This questionnaire is to learn manufacturing supply chain control tower and its relation between corporate performance, as to provide theoretical guidance and policy suggestions for the improvement of the supply chain management of machinery manufacturing enterprises and the corporate performance. Supply chain control tower in essence is a supply chain collaboration control model adopting “overall information view and comprehensive collaboration and control”, which refers to the process in which node enterprises have a common goal, adopt advanced information system technology and unified information standard to rapidly obtain, share and integrate internal and external information resources to realize the time, cost and financial advantages of supply chain and thus improving the overall competitiveness of supply chain.

As a manufacturer in the machinery manufacturing industry that pursues excellence, your opinions are of great importance for our research. We promise that this research shall only be used for academic research and that we shall keep strict confidential of the questionnaire. We are looking forward to your response. This questionnaire adopts the means of anonymous survey so it does not involve your or your company name. All information obtained will only be used for research. I will strictly stick to the moral rules of academic research and keep strict confidential of the questionnaire, so please feel at ease to fill out the questionnaire. Your choices will not be subject to the right/wrong rule, so please write down your true feelings or opinions.

If you want to know the research result, please inform me of your e-mail address and I will send it to you for your reference.

Address: Jiangsu Sinoway Machinery Company Limited, NO.32, Xinxin Road, Tongshan New Area

Postcode: 221000

Contact Person: Zhu Huadong

E-mail: jszhmyfz@sina.com

I. Basic Information of the Company

Please tick in □:

1． Years of founding of your company: years.

2．Nature of ownership of your company: □SOE; □Private; □Foreign; □Others

2． Economic scale of your company (sales income): □Above scale (annual sale income above 20 million yuan); □Below scale (annual sale income below 20 million yuan)

As for the following questions, please score (5-point system) by ticking at corresponding number:

Score rules: 1. Very bad; 2. Bad; 3. Average; 4. Good; 5. Very good

II. Supply Chain Control Tower

Variable	NO.	Item		Very good	Good	Ave-rage	Bad	Very bad
Information integration capacity	1	IT personnel quality	IT personnel allocation	5	4	3	2	1
			IT personnel capacity	5	4	3	2	1
			IT personnel training	5	4	3	2	1
	2	Business process standardization	Standardization of coding of technical data, enterprise information and transactional data	5	4	3	2	1
			Standardization of procedures for information exchange, retrieval and release	5	4	3	2	1
	3	Information system construction	Construction of ERP and other information management systems	5	4	3	2	1
			Consistency of information management systems of the enterprises and other key node enterprises	5	4	3	2	1
			Operating efficiency of information management system	5	4	3	2	1
Information collaboration mechanism	1	Security and confidentiality mechanism	Obtainment of information security system verification	5	4	3	2	1
			Signing confidentiality agreement with supply chain members	5	4	3	2	1
			Establishment of corresponding management mechanism for information at different security levels	5	4	3	2	1
	2	Incentive mechanism	Signing of information coordination and income sharing agreement with supply chain members	5	4	3	2	1
			Incorporation of information coordination into personnel assessment of the enterprise	5	4	3	2	1
	3	Organiza-	Support of top management for supply	5	4	3	2	1

		tional support mechani-sm	chain information collaboration					
			Degree of employee involvement in information collaboration	5	4	3	2	1
			Establishment of an information collaboration mechanism with supply chain members	5	4	3	2	1
Informa-tion sharing level	1	Degree of informa-tion sharing	Sharing order information with supply chain members	5	4	3	2	1
			Sharing material or product inventory information with supply chain members	5	4	3	2	1
			Sharing production arrangement information with supply chain members	5	4	3	2	1
			Sharing order prediction information with supply chain members	5	4	3	2	1
	2	Quality of informa-tion sharing	Sharing information with supply chain members timely	5	4	3	2	1
			Sharing information with supply chain members accurately	5	4	3	2	1
			Sharing information with supply chain members totally	5	4	3	2	1

III. Impact of Supply Chain Control Tower on Plan and Process Control

Variable	NO.	Item	Very good	Good	Average	Bad	Very bad
Time saving	1	Shorten production lead time	5	4	3	2	1
	2	Shorten order lead time	5	4	3	2	1
	3	Shorten order response time	5	4	3	2	1
	4	Effectively shorten new product development cycle	5	4	3	2	1
Cost reduction	1	Save purchase transaction cost	5	4	3	2	1
	2	Reduce inventory cost	5	4	3	2	1
	3	Reduce transportation and distribution cost	5	4	3	2	1
Uncertain-ty reduction	1	Reduce demand uncertainty	5	4	3	2	1
	2	Reduce production uncertainty	5	4	3	2	1
	3	Reduce supply uncertainty	5	4	3	2	1

IV. Corporate Performance

Variable	NO.	Item	Very good	Good	Average	Bad	Very bad
Market growth	1	Market growth rate	5	4	3	2	1
	2	Market share growth rate	5	4	3	2	1
Profitability	1	Sales profit margin	5	4	3	2	1
	2	Return on investment	5	4	3	2	1
	3	Profitability against competitors	5	4	3	2	1
New product innovation	1	Sales income percentage of new product	5	4	3	2	1

	2	Innovation of process flow	5	4	3	2	1
	3	Improvement of product quality	5	4	3	2	1

V. Environmental uncertainty

Variable	NO.	Item	Very good	Good	Average	Bad	Very bad
Environmen-tal uncertainty	1	Change in customer needs is hard to predict	5	4	3	2	1
	2	Competition becomes fiercer	5	4	3	2	1
	3	Behavior of competitors is hard to predict	5	4	3	2	1
	4	Production/service technology changes frequently	5	4	3	2	1

End of the questionnaire, and thank you for your time!

Outline of Case Study on the Relation between Manufacturing Supply Chain Control Tower and Corporate Performance

1. General of enterprise development

Including time of establishment of the company, industry, main businesses, industry position, total asset, income of main businesses, competitive advantages, problems facing, etc.

2. Internal supply chain collaboration

(1) Enterprise attention degree on supply chain collaboration

Including top management's support for supply chain collaboration, employees' involvement in supply chain collaboration, enterprise incorporating supply chain collaboration into employee assessment, etc.

(2) IT personnel

Including IT personnel allocation, IT personnel capacity, IT personnel training, etc.

(3) Information system construction

Including the construction and maintenance of ERP and other information management systems, the operating efficiency of information management system, etc.

(4) Business process standardization

Including the standardization of coding of technical data, enterprise information, transactional data, etc.; the standardization of procedures such as information exchange, retrieval and release, etc.

(5) Information security and confidentiality

Including the obtainment of information security system verification, and the establishment of corresponding management mechanism for information at different security levels, etc.

(6) Customer relation management

Including the prediction of customers' needs by using of sales point data system and key customer information, and the improvement of customer service, etc.

(7) Demand management

Including the obtainment of supply-demand information to coordinate the relation between market demand and production capacity, to synchronize demand and production, and to provide real-time inventory information, etc.

(8) Manufacturing process management

Including the utilization of information management system to promote the transformation of the production plan based push-type production model into a customer needs based pull-type production model; the utilization of information management system to reasonably develop production plans, shorten production cycle, lower product inventory, etc.

(9) Order implementation

Including the utilization of information management system to integrate the manufacturing, distribution and transportation, and to rapidly and flexibly execute customers' orders.

3. Supply chain collaboration between enterprises

(1) Key supply chain node enterprises

(2) The consistency of information management systems of the enterprise and its supply chain key node enterprises; the signing of confidentiality agreement with its supply chain members; the signing of information collaboration and income sharing agreement, etc.

(3) The establishment of an information collaboration mechanism with supply chain members

(4) Sharing of information with supply chain members

Including sharing order handling, material or product inventory stock, production arrangement information, order prediction information, etc., and the timeliness, accuracy and completeness of information that is shared.

4. Impact of supply chain collaboration

(1) Impact of supply chain collaboration on plan and process control

Including use supply chain collaboration to shorten production lead time, order lead time, order response time, new product development cycle, to save purchase transaction cost, reduce inventory cost and transportation and distribution cost, reduce demand, production and supply uncertainties, etc.

(2) Impact of supply chain collaboration on corporate performance

Including use supply chain collaboration to improve sales growth rate, market share growth rate, sales profit rate, return on investment, profitability against competitors, etc., and let customers and suppliers involve in new product development to shorten new product time-to-market, and produce the products needed by customers with the fastest speed, etc.