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## Research on optimization purchasing logistics of civil aviation manufacturing company based no supply chain management

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**SHANGHAI MARITIME UNIVERSITY**  
**WORLD MARITIME UNIVERSITY**  
Shanghai, China

**Research on optimization of purchasing logistics of C aviation  
manufacturing company based on supply chain management**

By  
**ZHANG ZHONGXI**  
china

A research paper submitted to the World Maritime University in partial fulfillment  
of the requirements for the award of the degree of

**MASTER OF SCIENCE**

**In**

**INTERNATIONAL TRANSPORT AND LOGISTICS**

**2013**

## DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

ZHANG ZHONGXI

.....

.....

Supervised by

Professor Wei Liu

Shanghai Maritime University

## ACKNOWLEDGEMENT

First of all, I'd like to show my great respect and sincere thankfulness to Professor Shuo Ma for giving this chance for me to study in ITL as a postgraduate. During this two-year study, I appreciate the continuous help and care from Ms. Fangfang Hu and Ms. Zhengfei Jiang, who are in charge of ITL program as the representatives from Shanghai Maritime University. Moreover, I want to show my deepest appreciation to all the professors both from World Maritime University and Shanghai Maritime University who used to provide me all these marvelous and meaningful courses. Their knowledge will lead me to reach the higher level of study.

Secondly, I want to express my thanks to Professor Wei Liu, who is my supervisor to guide me to finish my dissertation. I am very grateful that Professor Wei Liu gives me a lot of important and constructive help during my writing the paper.

Last but not least, I want to say thanks to all my classmates for sharing not only knowledge but also these happy two years together. After the graduation we may be go to different cities or even different countries but the joyful memory of studying together will be with us lifelong. Above of all, I want to show my greatest thankfulness and deepest love to my family who always gives me the most important help, support and love to finish my master course. All my successes are dedicated to them.

## **ABSTRACT**

**Title of research paper: Research on optimization of purchasing of C aviation manufacturing company based on supply chain management**

**Degree: Master of Science in International Transport and Logistics**

Civil aviation manufacturing is a new industry for China. It is a typical knowledge intensive, technology intensive and capital-intensive industry so purchasing is a new challenge for Chinese Aviation Company. This dissertation describes the purchasing of the aviation industry by analysis an aviation C company. Use some supply chain principles and decision-making models to research the company status of purchasing and logistics. After analysis, this dissertation suggests some special advices for the present situation of the company. The aim of the dissertation is improving the efficiency of aviation manufacturing purchasing process and saving the resources and capital.

**KEYWORDS:** Purchasing, Supply Chain, Aviation, Optimization

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## **Chapter One Introduction**

### **1.1 Research Background**

Under the background of the global integration of economy and the international market competition, the Chinese manufacturing has been in high speed development period and much more international manufacturing transfer to China. The China not only manufacturing industry plays an important role in the domestic economy but also has become the international manufacturing center.

This dissertation mentioned civil aviation manufacturing is the industry that China has just been joining in and the industry has just started. The civil aviation manufacturing is oligopoly industry. Its global market is monopoly by the two firms which are Boeing Co and Airbus SAS. What's more, the China's manufacturing environment is the low level of technology and equipment, the backward logistics condition. Additional, the management level and the personnel quality level is not high.

However, civil aviation manufacturing is a typical knowledge intensive, technology intensive and capital-intensive industry. This strategic industry has several features which are the high technology, high added value, high risk, and long period. Those features determine the civil aviation industry products must be facing the global market from the beginning of development. For an international industry, it is very important to survive and have a place in the fierce international competition. So it is a big challenge for China.

For china, Supply chain also a new concept and the development of supply chain is fast. So combining the civil aviation manufacturing, a new industry and the supply chain, a new concept, adapt to the development of china today. It is best choice. Supply chain management are showing its importance both in good times and economic recession .Procurement, as a link cannot be ignored in the whole supply chain structure, has the wind vane role of the supply chain process. The functions of

purchasing extend from the original bargaining and buy gradually to demand forecasting, procurement strategy analysis, supplier development, inventory management and etc. Purchasing is not only is the enterprise internal behavior, but also a coordination function of the internal organization and external resource management. In the modern manufacturing, supply chain procurement has gradually replaced the traditional procurement. The purchasing information not only shows the essential relationship between market supply and demand, and also the important reference to make strategic policy for an enterprise.

## **1.2 Research Purpose**

It is obviously to explore and research the new fields or methods for such an industry. Author will use the knowledge of supply chain to analyze the new industry, especially the process of purchasing, which is the top of the list. The procurement based on supply chain management is very suitable for this new industry. Civil aviation manufacturing is a typical knowledge intensive, technology intensive and capital-intensive industry. As a plane, it will need 5 million components and parts. Civil aviation manufacturing industry, as a carrier, research based on the supply chain civil aviation manufacturing purchasing. The aim of the dissertation is improving the efficiency of aviation manufacturing purchasing process and saving the resources and capital.

And then, from point to plane, make reference and use the decision-making way to the whole manufacturing purchasing.

## **1.3 Literature review**

First, research on basic theory of supply chain and purchasing is abundant. The concept of supply chain is origin form 'Economic chain' to 'value chain', evaluate to the 'supply chain' finally.

Supply chain is including from the supplier one and supplier two to the customer one and customer two, a process between all the production and sales related activities.

This definition is described at the abroad research like Chopra, S. and Meindl, P. et al. (2001), Shah N. et al. (2004).

The definition of supply chain is that in the production and circulation process, it is a network chain structure that the involving product or service will be provided to the end user which created by upstream and downstream enterprise. This definition could be found in Chinese article from Gao Aiyong, et al. (2009), Wang Chen, et al. (2012), Li Hui, et al. (2009).

Although, there are two views about supply chain, one is process, another is network. The same is the supply chain is system. As Wikipedia shows that a supply chain is a system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer.

Second, research the information about manufacturing industry purchasing like aviation manufacturing, automobile manufacturing or electronics manufacturing. Research the environment of the manufacturing, like Li Hui, et/ al. (2009), shows the Chinese manufacturing industry. Wang Chen, et al. (2012) ,Wu Bing et al. (2011) Pasquale Legato , Rina M.Mazza, et al. (2012), Chen Yuan, et al. (2007) and Zhang Hui, et al. (2008), which describe the Status and problems of aviation manufacturing. Dou Lan, et al. (2007) which describes the features automobile manufacturing. Compare to the three parts, we can be more intuitive to know this industry

Third, some optimization ways have been introduced into the purchasing process. The optimization ways divide into two parts. One is purchasing process optimization, another is purchasing content optimization. For process optimization, there are more strategies and policies. Zhao Jing, (2006),Cai Lili, (2008),which describes CPFR strategy. For content optimization, it tend to data analyze or create the modal. Zhao Jing, et al. (2006) describes the purchasing cost modal, quantity discounts modal, Sourcing modal. LI Yun-He, et al. (2011). ZHANG Wei- na, WANG Xiu- lai, et al.

(2010).

#### **1.4 Research Methodology**

This dissertation will use some supply chain principles and decision -making models. Those principles are mainly research by the data base from SUM. Using literature research methods summarizes some concepts or principles to support theory basis.

This dissertation will apply a firm sample to support the practical part. The dissertation will supply the logistic information of the firm and some real data itself about purchasing. So the dissertation will analyze the data and use the decision-making model to optimization the purchasing process which is AHP model. The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions. Based on mathematics and psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.

The AHP helps decision makers find one that best suits their goal and their understanding of the problem. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions.

## Chapter Two Summarization of the supply chain and purchasing logistics

### 2.1 Supply Chain

The concept of supply chain is origin form ‘Economic chain’ to ‘value chain’, evaluate to the ‘supply chain’ finally. Supply chain is including from the supplier one and supplier two to the customer one and customer two, a process between all the production and sales related activities. <sup>1</sup>

According to the national standard ‘logistics term’ definition: Supply chain is that in the production and circulation process, it is a network chain structure that the involving product or service will be provided to the end user which created by upstream and downstream enterprise. As shown in Figure 1, supply chain starts from the procurement of raw materials, made the intermediate products and finished products, finally to sales to the consumers' hands by the control of information flow, material flow, cash flow. Its purpose is to make the whole supply chain benefit maximization and meet the needs of the users. Its goal is delivery the right product to the right place at the right time, right quantity, right quality, and make the cost to optimization.

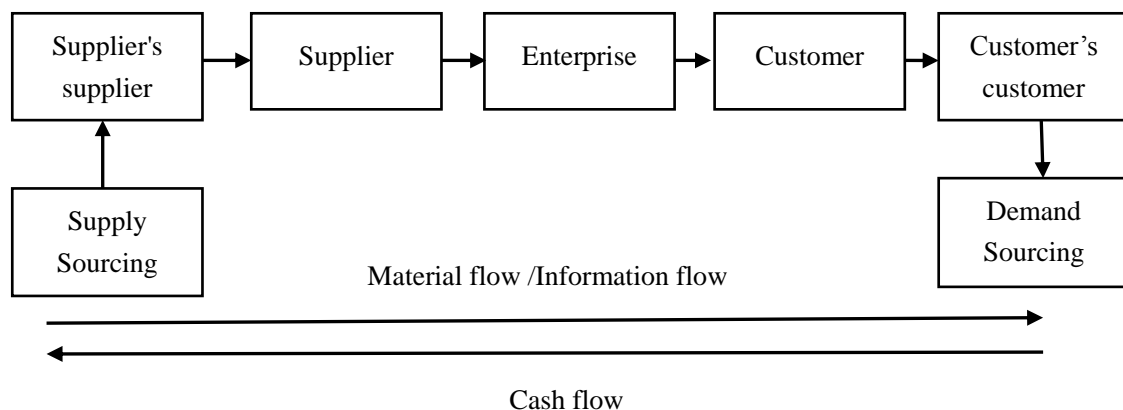


Figure 1 Supply chain network structure model

Figuratively speaking, we can describe the supply chain as a wide spreading tree. The

<sup>1</sup> This definition is described at the abroad research like Chopra, S. and Meindl, P. et al. (2001), Shah N. et al. (2004).

production enterprises constitute the root. The agent is the main rod. Distributors are branches. Full of leaves and flowers are the final customer. In the node between root and the main stem, branch and stem, there are many circulations.

The relationship between each enterprise on the supply chain is similar to the food chain in biology. In a simple food chain like ‘grass – rabbit- wolf –lions’, if we killed all the rabbit, the grass will tend to rise. The wolf also will be starved to death due to the extinction of the rabbit, even the strongest lion also slowly starved to death over the death of the Wolf. It is clear that every kind of creature in the food chain are interdependence. Destroying any kind of organism in the food chain will inevitably lead to the chain out of balance, and eventually damage the ecological environment.

Similarly, in the supply chain model ‘Enterprise A - Enterprise B - Enterprise C’, the enterprise A is B's raw material suppliers and enterprises C is B's products distributor. If company B ignored the interdependence elements of the supply chain and focus on internal development, improve the capacity of production continuously, what's more, the enterprise A cannot timely provided raw materials to B or the enterprise C sales capacity cannot keep up with enterprise B, we can conclude that enterprise B cannot adapt to the overall efficiency of the supply chain.

## **2.2 Purchasing logistics**

Purchasing logistics covers the two concepts which are procurement and logistics. Purchasing is a word used more widely, commonly used in manufacturing industry. There are several kinds of typical expression of purchasing. Potter think Purchasing refers to the activity to buying the enterprise value chain. The president of NEVI thinks purchasing is a basic activity to operating, maintenance and managing the company. Wikipedia think purchasing refers to a business or organization attempting to acquiring goods or services to accomplish the goals of its enterprise.<sup>2</sup>

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<sup>2</sup> <http://en.wikipedia.org/wiki/Purchasing>

This dissertation involved purchasing logistics means all production materials purchasing strategy, transportation, warehousing, inventory management, materials management and supply management.

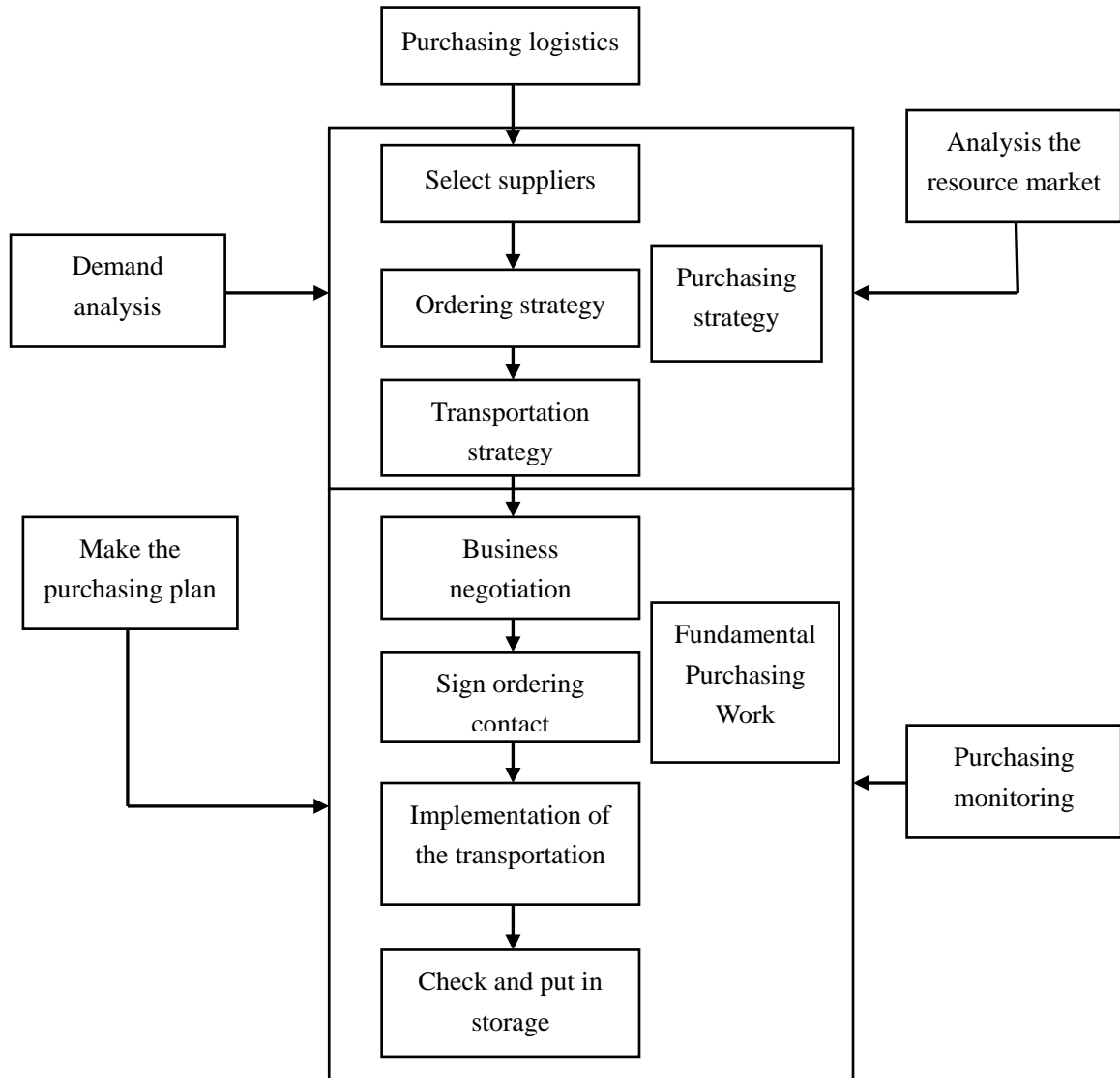


Figure 2 Purchasing logistics model

The process of purchasing logistics is different because of the different enterprises, the different supply system and different supply chain. This difference is determined the enterprise purchasing logistics appeared many different kinds of patterns. However, the basic process of procurement logistics is the same despite that the different pattern in some link has the very complex characteristics.

### **2.3 The traditional purchasing model**

The traditional purchasing management mainly focuses on how to take the commercial transactions with supplier. The traditional model takes emphasis on price negotiation and attaches great importance to the deal in the process of suppliers' price comparison. Last, choose the supplier who provide lowest price as collaborators by suppliers' competition. While quality and delivery time is also important factor in purchasing process, but in traditional way, quality, and delivery time and so on are controlled by afterwards check like express delivery. So in between supplier and purchasing department

So there are negotiations between vendors and purchasing department including several quotations, inquiries and bargaining. Finally from multiple choose one of the lowest price vendors to sign the contract.

#### **2.3.1 The disadvantages of the traditional purchasing model**

##### **(a) Information asymmetry**

Supplier selection is a primary task in the traditional purchasing activities. In the process of purchasing, purchaser always tends to keep private information to choose the best of suppliers from multiple competing suppliers. Because if the purchaser provide the more information, the greater the competition chips supplier will have. So purchasing side will hide the private information as far as possible and supplier also conceal the information in the competition with other suppliers.

There is no effective information communication with each other. This is the information asymmetry like gamble.

##### **(b) Not benefit to the quality control of purchasing items**

Quality and delivery time are two important factors to consider for purchasing party. However, in the traditional purchasing mode, it is difficult to participate in supplier quality control activities and production organization for purchasing side because each work is not transparent. So it needs to check and accept by all sorts of relevant



standards such as the international standards, national standards. It leads to increase the difficult to control the quality purchase items for purchasing department due to the lack of cooperation.

(c) Purchaser and supplier are temporary or short-term cooperation relationship

In traditional purchasing mode, the relationship between the purchaser and supplier are temporary or short-term, and more competition than cooperation. Due to the lack of cooperation and coordination, all sorts of complaints and wrangling mood are more in purchasing process. A lot of time consume on solve problems in daily life. There is no more time to forecast long-term plan and increased a lot of uncertainties in operation in no cooperation atmosphere.

(d) Unable to meet customer demand in time

The supplier and purchaser are lack of timely communication and feedback, and the purchaser can not to change existing contracts with suppliers. So in the case that the demand changes in market, it can easily lead to reduce inventories when demand increases or the demand exceed supply. Moreover, if purchaser want to order again ,it will increase negotiation costs .Therefore both sides didn't make a synchronous response to changes about customer requirements and be lack of ability of cope with changes in demand.

### **2.3.2 Problems research in the traditional purchasing model**

Enterprise focuses on sales link and despise purchase link. Purchasing and sales is two important strategic factors in the enterprise value chain. However, Chinese enterprises have the different attitude for those two factors, most of enterprises are attach importance to how to make the product sales out, and ignore to manage the purchasing link. For a long time, Business has been the "procurement" as an assist job rather than important industry business activities ignored the purchasing direct contribution to the enterprise production and marketing activities.

Enterprises attach importance to their own economic interests and oppressed suppliers. Chinese enterprises have a misunderstanding in purchasing concept which is only consider savings, more considerations of self-interest. The target of purchasing is keep the suppliers' price down and lack of long-term development and cultivate the business strategic cooperative relations. Many enterprises are in pursuit of economic interests while ignoring its own reputation in business. Some famous enterprises depend on its brand to oppress suppliers and overdue payment for goods. These short-term purchasing behavior won't bring the long-term benefit to the enterprise. For example, when the enterprise exploits the new product, it will be confronted with several problems like lack of suppliers and development is slow or high cost. It will affect the sustainable development of enterprises.

#### **2.4 Purchasing logistics basic on the supply chain**

Purchasing is a subsystem which has strong independence in logistics system. And it is closely linked with production system, financial system, external resources market and transportation departments. Purchasing logistics is logistics activity that supplies raw materials, auxiliary materials, spare parts, fuel in order to ensure the enterprise production rhythm. The activity can play a security role in enterprise production and high efficiency. Enterprise should not only achieve the goal which guarantee supply, but also reduce the cost, less consumption and increase high reliability ,so it is so difficult.

Hence, this dissertation refers to the purchasing basic on the supply chain. Enterprises purchasing basic on supply chain includes a wider range of meaning. This dissertation argues that: purchasing basic on the supply chain refers to the enterprises take the demand of downstream customer as the guidance and obtain goods, services, technology, ability, knowledge from external suppliers to enhance their core competitiveness. This is a process of integration enterprise internal and external resources. It is benefit to the development of the cooperative partnership between enterprises and to achieve their win-win purpose.

Supply chain management to help enterprises to strengthen the systematic and integration of the supply chain; improve enterprise's sensitivity and responsiveness with purchasing management. Among the process the management also puts up a bridge which is for purchase, production and cooperation of the enterprise's raw materials and semi-finished products on the supply chain, improves the communication between production demand and supply. To achieve the seamless connection of the supply chain system, improve the synchronization operation efficiency of enterprise on supply chain, it must strengthen the procurement management; guarantee the quantity, time, place, price, appropriateness of sources. These are challenges to the traditional procurement which also requires enterprises must adapt to the innovation design of supply chain management in the purchasing process.

## Chapter Three The analysis of the aviation C company and its logistics process

### 3.1 Brief introduction of the C Company

The C Company functions as the main vehicle in implementing large passenger aircraft programs in china. It is also mandated with the overall planning of developing truck liner and regional jet programs and realized the industrialization of civil aircraft. The company is engaged in the research, manufacture and flight tests of civil aircraft and related business such as marketing, servicing, leasing and operations of civil aircraft. The C company carry out a ‘main manufacturer – supplier’ project model and focus on strengthening the plane design integration, assembly manufacturing, marketing, customer service and airworthiness forensics etc. It will be dedicated to safety, economy, comfort, environmental protection of large aircraft.

### 3.2 Introduction of logistic center and purchasing department

The figure 3 shows the structure of the logistics center.

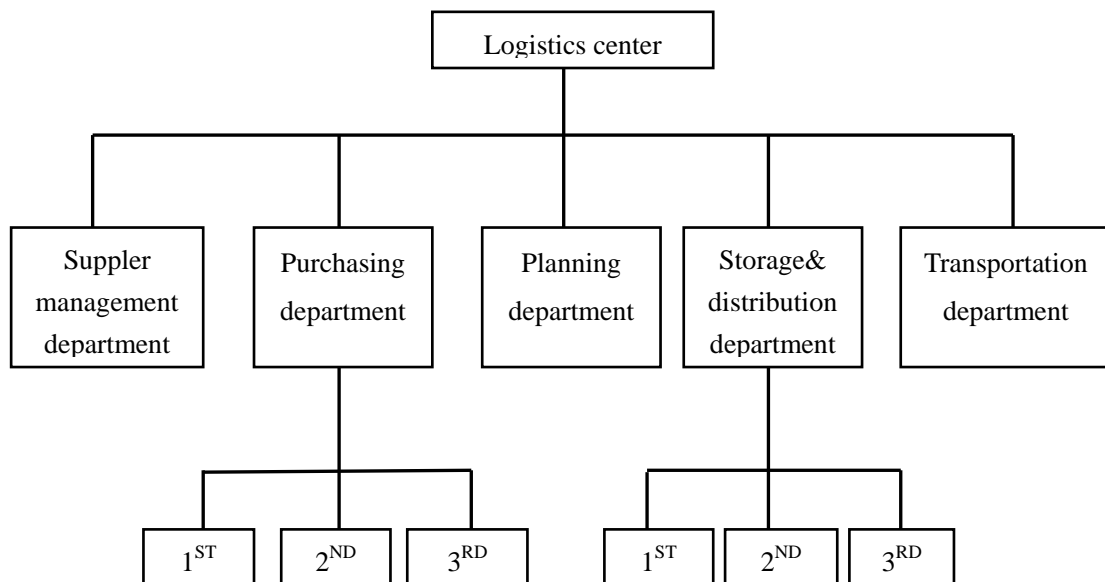


Figure 3 The Structure of the logistics center

The logistics center of the company A includes supplier management department, purchasing department, planning department, storage&distribution department and

transportation department. The main duty of supplier management department is contract management and vendors' management. The storage&distribution department are responsible for bonded warehouse, oil chemical group, the regional aircraft metal group, Boeing metal group. Responsibilities of planning department are transfer production information; ensure material supply, equipment receiving, coordination work, maintenance equipment, management and tracking the controlled equipment. The responsibilities of transportation department are the daily dispatch and operation the vehicles, big parts transportation, off-site logistics management, vehicle maintenance and repair

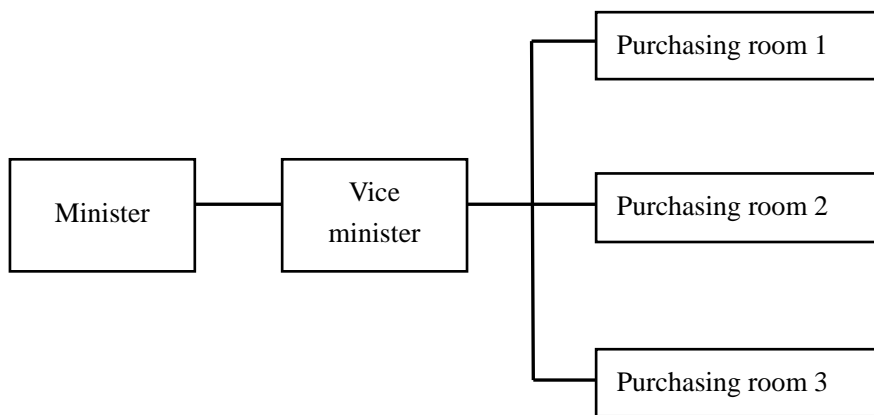


Figure 4 Organization structure of purchasing department

The figure 4 shows organization structure of purchasing department. It total has about 30 buyers. The 1st purchasing department is responsible for subcontracting project equipment purchasing including metal materials, chemical materials, tools, measuring tool, cutting tool, all kinds of production materials, standard parts, etc. It is also responsible for supplier management work of subcontracting project including supplier evaluation, supplier promotion, supplier development, etc. The main obligation of the 2nd purchasing department is purchasing cutting tools, measuring tool, IT equipment, CE/PTE and electrical repair parts. It is also responsible for the development of related suppliers. The main obligation of the 3rd purchasing department is purchasing the ontology of materials including metal materials, chemical materials, fuel, standard parts, production of auxiliary materials and supplies,

labor protection supplies, office supplies and furniture, etc. It is also responsible for the development of related suppliers.

The C Company attaches great importance to the product production. For purchasing, It is still in the idea of the traditional purchasing mode rather than thinking and operation mode under supply chain management. The C Company take the purchasing department as an assist department to help manufacturing and its purpose is to ensure normal operation of production. Purchasing department is just a functional department, rather than take purchasing as a part of the company's core competitiveness.

### **3.3 Audit and selection supplier process of C Company**

The C Company have the total number of 564 suppliers which can classify as tools, chemical products, office furniture, printing category, IT products, electrical mechanical, printing supplies, office supplies, metal, nonmetal, transport, recycling etc. There are 12 categories suppliers.

The level of the company's supplier can be divided five grades.

A class—— Long-term cooperation good suppliers

B class——Long-term cooperation qualified suppliers

C class——Qualified suppliers

D class——Being investigated supplier (probationary period)

E class——Sporadic suppliers (low frequency purchase)

The C Company has the standard of supplier audit before selecting the supplier. The selected vendor must be in the supplier list. Inquiry and price comparison sheet of vendor must be real and effective; the price must be within the valid term. Indirectly manufacturer needs to review its presence of authorization certificate and related documents. Last, check the negotiation about buyer and supplier content.

The above summarize the basic information of the C Company supplier. The figure 5 shows the audit and selection supplier process.

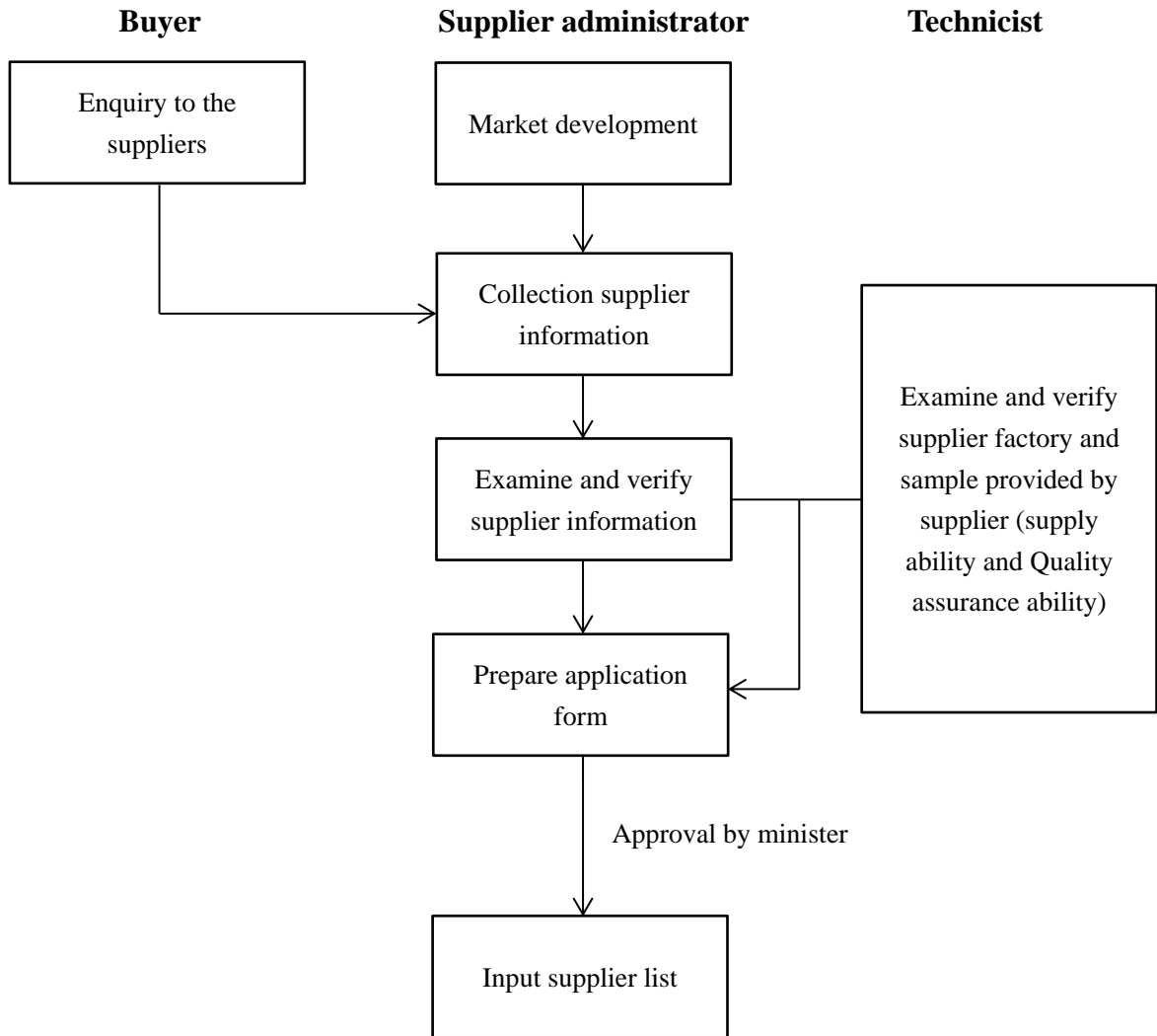


Figure 5 Audit and selection supplier process of C Company

Audit and selection supplier involves the three departments which are purchasing department, supplier administer department, manufacturing department. Those three departments play their important role in this process.

### 3.4 Purchasing material analysis

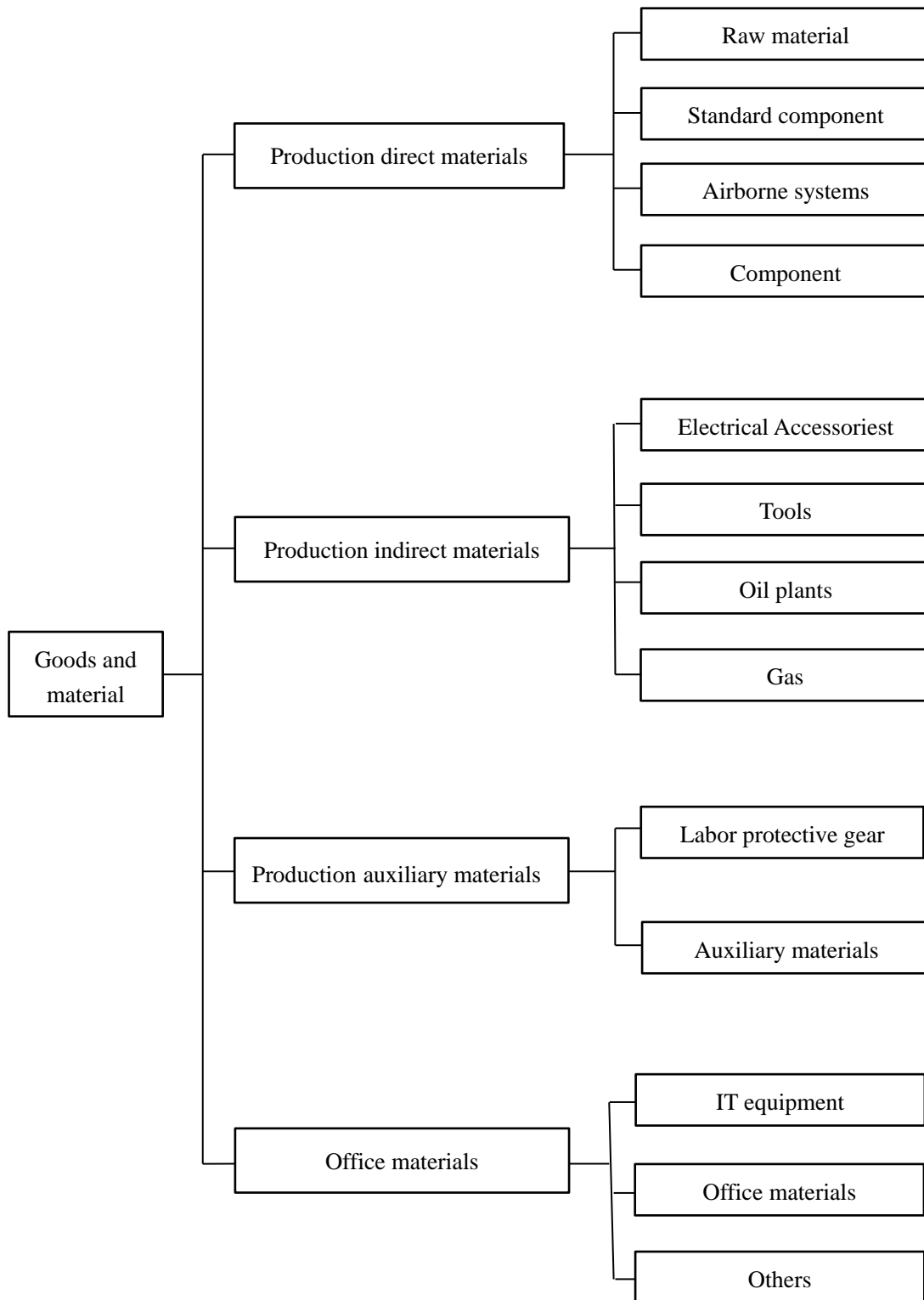


Figure 6 The structure of purchasing materials



The C Company as a large aviation manufacturing enterprises involved production, office, business in all aspects of materials as many as tens of thousands of species. It covered the airborne systems, structural, mechanical and electrical equipment, metal materials, chemical raw materials, office supplies, furniture, transportation equipment and so on .Its supplies is a wide range, the choice of storage conditions and storage of goods maintenance also involves many aspects of professional knowledge. Materials put forward very high demand. Supplies management also is extremely complex, reasonable and effective classification method of materials management which particularly important. The C Company's materials are various. It has the increasing trend with the increase of project and customer. The above figure describes the structure of the purchasing good which include production direct materials, production indirect materials, production auxiliary materials, office materials. The figure covers all material need to purchase.

Now, the C Company uses ABC classification management method to classify material which is the 80/20 principle. That is, the emphasis on purchasing value (80%) and the number accounts for only 20% of the material. The ABC classification method is classify according to the breed and value in inventory management to statistics, arrangement and divided into A, B, C three categories, respectively. The company also according to the ABC classification purchase materials respectively.

The C Company according to this thought on material to classification as follows:

Class A materials, varieties occupy all varieties proportion of 5% -15%; however its purchasing amount accounts form 60% to 80%. Main material: aircraft finished parts, aircraft metal parts.

Class B materials, varieties occupy all varieties proportion of 20% -30%, however, the purchasing amount from 20% to 30%. Mainly include: PVC compound, packaging material.

Class C material, varieties occupy all varieties proportion of 60% - 80%, the purchasing amount accounts form only 5% to 15%. Such as metal small parts,

chemicals, etc.

### 3.5 The purchasing process analysis

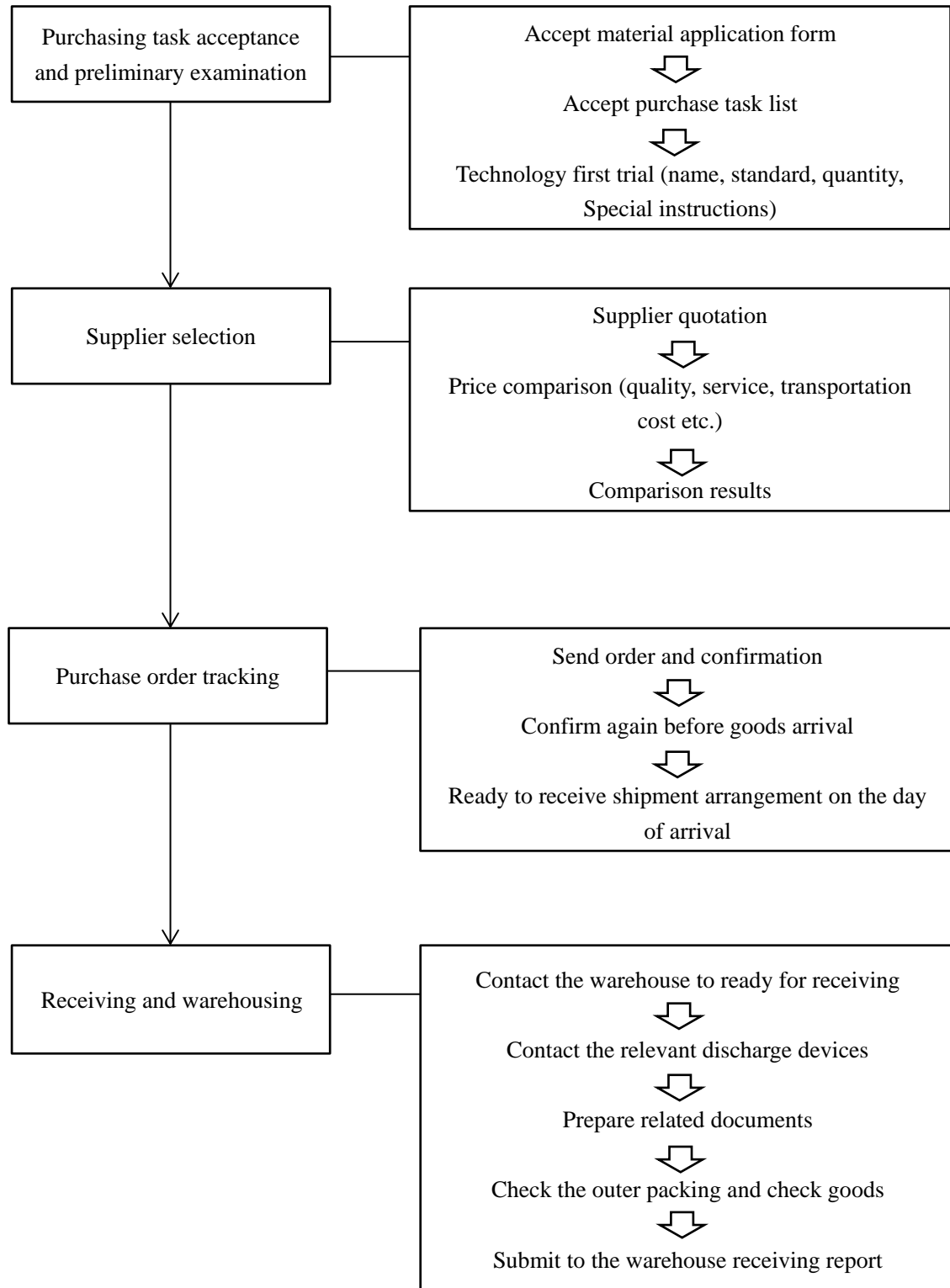


Figure 7 The process of purchasing about C Company

The figure 7 shows the process of purchasing about C Company. There are four main steps mainly include accept task, select vendor, purchase and receiving. Every main step has several detail process. If a buyer purchases some goods, he should according to the above figure process.

Purchasing activities started with receiving demand application, termination on supplier delivery to warehousing as shows in the Figure 4. Purchaser after receipt of the purchase requisition will first confirm whether it is a new material. If it have purchased, it will directly place the order in the system, notify the supplier delivery. If it is a new material, it will look for the suppliers for price negotiation. Generally, suppliers of qualified suppliers list are the priority choice. The means of negotiated price have telephone, fax, MAIL, interview. When buyers bargaining results exceed demand unit budget, it need to call suppliers negotiation face to face. Finally it will negotiate on the price of the letter to vice minister for approval. If the minister or vice minister agreed, the purchaser can notify the supplier delivery the goods.

### **3.6 The purchasing feature analysis of C Company**

For aviation C Company, it has several special purchasing features different to general enterprise purchasing.

#### **3.6.1 High barriers**

The aviation manufacturing industry need to all aspects of the strict quality system certification. Major aviation manufacturing companies in the world are required their supplier should pass the quality system certification and special processing identification, such as Boeing's suppliers are required to obtain a DI-9000 system certification. And most of the suppliers need pass the AS9100 certification. In addition the quality system certification, many manufacturing enterprises should pass the CAAC and FAA appraisal. If the application is not successful, the enterprises will directly lead to the failure to investment.

### **3.6.2 Larger investment, high risk, long-term return**

Have a survey about several joint venture aviation in china: BoHai aviation composite material parts co., LTD. : founded in 1999, is located in Tianjin and a total investment of \$52 million, starting to getting profits in April 2002. Its product has passed the certification of Boeing, Hexcel and its annual sales are about \$50 million.

On March 25, 1996, airbus invested \$80 million to run an aviation training and support center with China aviation supplies import and export group co.,LTD. nearby the Beijing capital international airport

The Rolls Royce Company invested thirty million to establish Xiluo Aviation Engine Company with xi 'an aviation engine group in 1997. Amount of sales is more than \$60 million in 2004.It is clear that each aviation or maintenance enterprises should invest more than ten million dollars. <sup>3</sup>Only combine with leading enterprises they can create value and avoid risk.

### **3.6.3 Longevity**

Points out that the civilian aircraft can be make its life cycle can be more than 20 years, such as the Boeing 737, 737; be famous for its security of Singapore airlines are also used to 11 ~ 15 years.<sup>4</sup> American airlines, American airlines market is relatively mature, consumers don't care about the age of the aircraft. Many planes were being still in fly for over 30 years.

### **3.6.4 High technology and accuracy**

Aviation is a precision of extremely strict industry. Under the harsh environment can still keep the normal operation of aircraft materials, precision and process has a strict test. Huang Xia etc. (2004) points out that the material connection, for example, there

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<sup>3</sup> Those cases are referenced by Wang Hongke(2005), Analysis the condition of multinational companies in China's aviation industry China Ordnance Industry, Vol.03, 2005

<sup>4</sup> The data is from Wei Yanjie(2011), Aircraft life management technology revolution, Academic journal of China civil aviation university, Vol.29, 2011

are rotating-blade blasting hardening, interference fit connection, stress coining, anti-fatigue sealing riveting, rolling processing thread parts and composite reinforcement of different technological requirements.

### **3.6.5 There are many different kinds of parts and small batch.**

Aircraft are presented the characteristics of the mass production. A plane has thousands of parts, some models have tens of thousands of parts but some special parts just need hundreds.

### **3.6.6 Make to order**

Cost, quality and delivery time are the basic rule of production management. The management not only has to consider the equilibrium of supply and demand, but also pay attention to the resource allocation , market volatility and shorten order cycle because the aviation manufacturing industry is larger investment, high risk, long return period.

## **3.7 Problems analysis of purchasing of the C Company**

Now there are many problems existing in the aviation C company because of the above the analysis of materials and the features.

### **3.7.1 Purchasing plan is not accuracy**

Due to the diverse technical status of aviation product model, the same model in the different batches of product has certain difference. According to quota calculation, the procurement list needs to undertake artificial correction. The planner needs to be integrated in a very short period of time to establish a balance sheet. Each balance sheet compiled by have certain errors.

### **3.7.2 Poor timeliness**

Some reasons lead to change the order or adjusted delivery schedule in a timely manner or number. It need to guarantee that the enterprise internal logistics

information flow between various departments should keep flowing and maintain the supplier communication channels, to minimize supply adjustment's impact on all parties.

### **3.7.3 Evaluation of supplier**

After enterprise determine annual supplier directory, The enterprises cannot be timely know the real-time state of suppliers and timely forecast supplier supply capacity, Due to the lack of real-time assessment of the supplier. Communication between enterprise and supplier can only rely on competent planner, which causes adverse effect to enterprise's production and block continuous improvement with suppliers.

The enterprise should have comprehensive evaluation of several aspects about supplier quality, delivery, price and service annually. The suppliers lower than the target value should be submitted rectification report and take corrective and preventive measures to meet purchaser's requirements.

Current enterprise purchasing management mainly stay in the routine matters in fact which focus on execution order, tracking, supervise, price negotiation and quality problems. There are some shortages about evaluation of suppliers, suppliers, improvement and so on.

### **3.7.4 More sporadic (dispatch) purchasing**

Increasing urgent purchase not only disrupt the normal procurement work more important is easy to result in increasing the procurement costs and accounts payable. Therefore, buyer has no more energy to strengthen the procurement way, investigate the distribution of market resources. They will divert attention from the responsible for the procurement, order tracking and controlling the cost and funding.

### **3.7.5 No suppliers to participate in the new model development**

New model increased the development time and design cost because there is no supplier's participation and material selection should confirm with the customer for

many times. Supplier early to participate in, the quality control of purchasing material, supply security, save cost plays a crucial role.

### **3.7.6 Lack of unified material purchasing information platform**

Enterprise did not establish unified information exchange platform. Quota change information, technical status changes and production scheduling change information cannot achieve synchronization update. There is lack of standardization and up-to-date technology of information communication between companies and suppliers.

## Chapter Four Optimization the purchasing logistics of the C Company

### 4.1 Material optimization

Company divided into several purchasing store operating rooms in charge of different categories. The company adopted ABC classification method which helps the material management, but the standard of this method is too single, not consider degree of purchasing difficulty, monopoly, purchasing lead time, production of dependence.

So using supply segmentation method to optimize material classification. It is from two dimensions, one is the level of the enterprise purchasing material spending, and another dimension is supply risk and complexity. Those are two external factors that affect the difficulty level of purchasing. According to this classification, the material of N C Company can be divided into four categories: strategic material, bottleneck material, leverage material and general material.

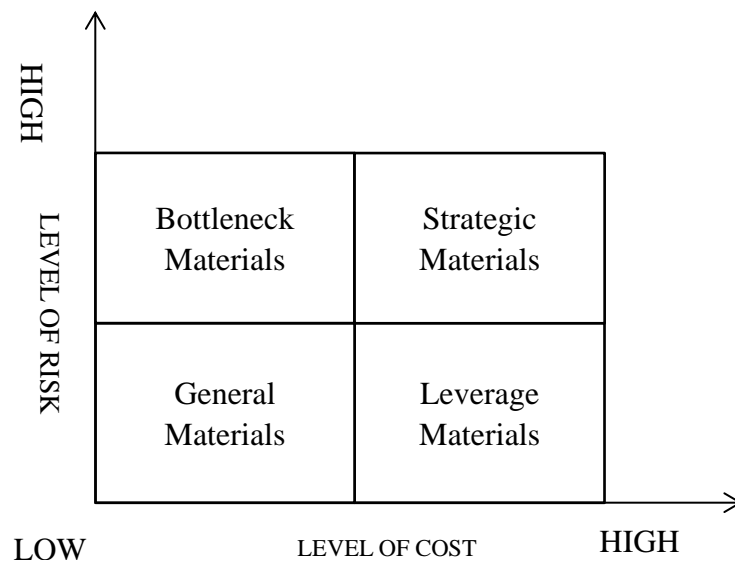


Figure 8 Material classification

The first kind of material is strategic materials which are high risk, complexity, high price. For this kind of material, the purchasing price is high and amount of usage is also big. It is very important for enterprises because fewer suppliers can be chosen. There is a longer option period to change supplier and the cost is higher.



The second type is the bottleneck materials which are high risk and high complexity but low price. For this kind of material, the level of procurement expenditure is not high, but the risk is high because the supplier is less. The time of arrival can influence to the production time and product quality. The purchasing time is long; the replacement of the supplier's risk is very high and switching cost is also high.

The third type is leverage materials which are low risk and complexity but the price is high. For this kind of material, the amount of usage is big. The resources are sufficient to the supply market. In the N company representative materials such as: cure equipment, packaging materials.

The fourth class is general materials which are low risk and low spending. For this material, there are more specifications and the spending of purchasing material is less. More vendors supply this type material on the market. And some material is standardized commodities and plentiful. The C company can use the standardized purchasing process to minimize the manage cost.

## **4.2 Different purchasing strategies**

According to the above material classification, create different purchasing strategy for different types of materials.

### **4.2.1 Long-term contract procurement strategy**

Long-term contract procurement strategy is a way to stabilize the trading relations between the purchasing agent and the vendor by the contract which of time is more than a year. During the contract period, purchaser promises to purchase the required products in the supplier and the supplier promises to meet the buyers' demand in terms of quantity, variety, specifications and models. Meanwhile, the contract also clearly formulated the mechanism of price, payment terms, production capability, quality agreement, shipping terms and proprietary technology to protect

confidentiality agreement, risk-sharing, disputes treatment, termination provisions and other provisions.

This strategy makes the company establish a stable strategic cooperative partnership with suppliers by close cooperation to achieve a win-win situation. It is clear that the long-term contracts can strengthen trust and understanding between the two sides and establish a stable relationship between supply and demand. It can lower the cost of the price negotiation and there is a clear legal guarantee maintains the interests of each side.

#### **4.2.2 JIT purchasing strategy**

JIT (Just In Time), also known as zero inventory or the super market production mode. It is a way of production management at Toyota Motor Corp in the 1960s. Its basic idea is 'only at the time of need, according to the demand of quantity, production the needed product' is the pursuit of a kind of no inventory, or inventory minimum quantity of production systems. The advantage is:

It can significantly reduce the inventory of raw materials. According to the foreign professional institutions, JIT can make material inventory reduce at least 40%, thus to reduce the occupancy of liquid capital and increase the capital turnover. At the same time, save the space of material and reduce inventory costs. JIT purchasing can improve the quality of the purchasing material, so as to reduce the quality cost.

Reduce the total cost of raw materials. The C company can reduce the purchasing price by a long-term regular order and purchasing economies of scale, meanwhile, reduce the process of order and inspection procedures. It can reduce the inventory management cost so that make the purchasing total cost lowest.

Implementation of JIT purchasing strategy not only saved the p the manpower, money, equipment, field resources but also raised the labor productivity of enterprises,

enhance the enterprise market response speed and flexible. To reduce inventory capital takes up and improve the utilization rate of stock funds, In the second half of 2008,the company began to put the JIT into practice. The Boeing subcontracted project refer to all CNC machining aluminum materials were implemented the JIT management.

Implementation of JIT purchasing works as follows: the single usage amount and the production rate are provided to the suppliers and required suppliers to prepare three months inventory. Purchaser noticed supplier the actual next month demand in advance one month. Supplier provided the materials at required data. Company sends logistics and quality assurance personnel to inspect the materials in advance two weeks. After qualified materials, vendors directly transport to company department. It reduces about approximately \$1.4 million inventory. It can be adjusted according to demand changes to the plan in time and reduce the labor for inventory management. Don't have to spend manpower to keep and check inventory. If found unqualified products in the process of inspection, it request supplier to replace the material. It can reduce the time of production delays because of the quality problem.

The followings are the C company measures:

Create JIT team. JIT purchasing team members should be include production staff, warehouse staff, qualitative staff, engineers, management personnel in addition to purchasing personnel and deal with matters related JIT. Make JIT procurement process and planning ensure the effective implementation of the plan.

Create the high-efficiency JIT procurement process by the purchasing business process restructuring. It clearly defines the responsibilities of each member in process JIT purchasing team. Purchasing department releases the blanket order to the supplier. Every week provided demand plan to supplier. Production personnel need four hours in advance notice supplier delivery to the factory according to the production. Purchasing personnel according to the incoming information quote supplier check and do payment every month.

Select high-quality suppliers and establish long-term relations of cooperation. N company in existing packaging material supplier by supplier quality, cooperation degree assessment, capacity and geographic location, etc. is preferred to choose the appropriate suppliers, and training to suppliers, established long-term cooperative relationship.

Quality is on the top of list. Price is the second principle. The quality is very important because JIT purchasing is the immediately used material. Material quality has clear requirements to avoid the extra costs.

For the company, there are some experiences about the JIT. From the JIT pilot purchasing gradually import the comprehensive JIT purchasing. The N companies begin with carton for JIT purchasing. In the pilot process, JIT purchasing team and supplier constantly review its deficiency in the process. Other materials will be implementation of JIT purchasing step by step by the close cooperation of all departments.

#### **4.2.3 Joint purchasing strategy**

Bottleneck of material value is low but greatly influenced by the production and business operation activities of the company. What's more, it has fewer suppliers so purchasing risk is higher. Such materials purchasing strategy is flexibility procurement. Its focus on reduce the risk of purchasing. For this type of material purchasing, improvement measures are as follows:

N Company should keep good relationship with suppliers for small amount material purchasing. Meanwhile, the stock will be appropriate safe line in order to avoid affecting production by supplier delivery delay.

Material with range for the purchase price, the N company uses the joint procurement

strategy. Joint procurement strategy means that the same goods have a lot of buyer's demand. Combine their needs in the form of a purchaser to the supplier orders at the same time under the condition of mutual cooperation in order to expand the purchase bulk and achieve the purpose of reduce the purchase price or purchase cost.

#### **4.2.4 Mixture purchasing strategy**

This type of material has variety kinds and more suppliers but the purchasing amount is less and the risk is small, so the purchasing strategies is focus on reducing management costs and improve procurement efficiency.

For this kind of material, C Company to only use the normal strategies but also used batch material purchasing strategy and the joint procurement strategy. Use the purchasing strategy should selecting appropriate suppliers. The order will be concentrated in the hands of the few suppliers so that suppliers can achieve economic interests by economies of scale; N company also obtains a better price by batch purchasing.

#### **4.3 Decision-making of supplier selection**

The company should not only consider the commercial influence factors also consider supply chain risk factors when suppliers selection.

First of all, the commercial influence factors basically have the following several aspects:

Quality factor mainly refers to the quality of the raw materials provided by the vendor. The product quality is the survival of the supply chain. The value of product is based on product quality. If pay attention to the quality of products, it may decrease the cost. Poor quality products will be lack of market competitiveness, and exit the market soon.

Price factor refers to the price of raw materials provided by the vendor, including material price, production cost, management cost and profit, etc. The product of

supplier impacts on profit margins of manufacturers and sellers. It also determines the price of consumer and the supply chain of input-output ratio.

Delivery punctuality factors mainly refers to the supplier delivery the materials according to customer required time and place and make products sent to the designated place on time. Due to the delay of the material into the warehouse, it will cause a decline the efficiency. It leads to work overtime cost to restore the normal work. If supplier delivery punctuality is low, it will affect to manufacturer's production plan, seller's production plan and lose the trust of the customers to drop in orders. This will cause a lot of waste and the collapse of the supply chain. Therefore, delivery on time is one of the important factors.

Second, the supply chain risk factors mainly include:

(a)Information risk

In supply chain, the prerequisite should establish a through all of the information highway to make rapid response to the end user needs .However, firms in the supply chain often from their own interests, be closed about related information as trade secrets and don't want to share with upstream and downstream enterprises so that the enterprise internal information system is very advanced. Information asymmetry and information flow blocking exists to resulting risk.

(b)Management risk

Supply chain as an extension model of virtual enterprise, is an organizational form between market and enterprises. It breaks the traditional enterprise boundaries, aims to build a kind of resource sharing, information sharing, new organization mechanism of knowledge sharing. However the virtual economy system cannot like enterprise group, the member enterprises effective constraint of opportunistic behavior, also increased the enterprise between "lock", which to some extent, increase the risk of management.

(c) Financial risk

It refers to some enterprise in supply chain financing costs rise, insufficient funds, delay production and lead to the risk of loss due to exchange rate, interest rates change or termination of bank loans, stock market fluctuation and the adjustment of economic policies. The risk directly increases the risk of the whole supply chain operation.

**4.3.1 Establish the AHP model**

Decompose their decision problem into a hierarchy of more easily comprehended sub-problems and build the hierarchy like the figure 6. Synthesize the description above risk , it can be concluded the five effect factors for C Company.

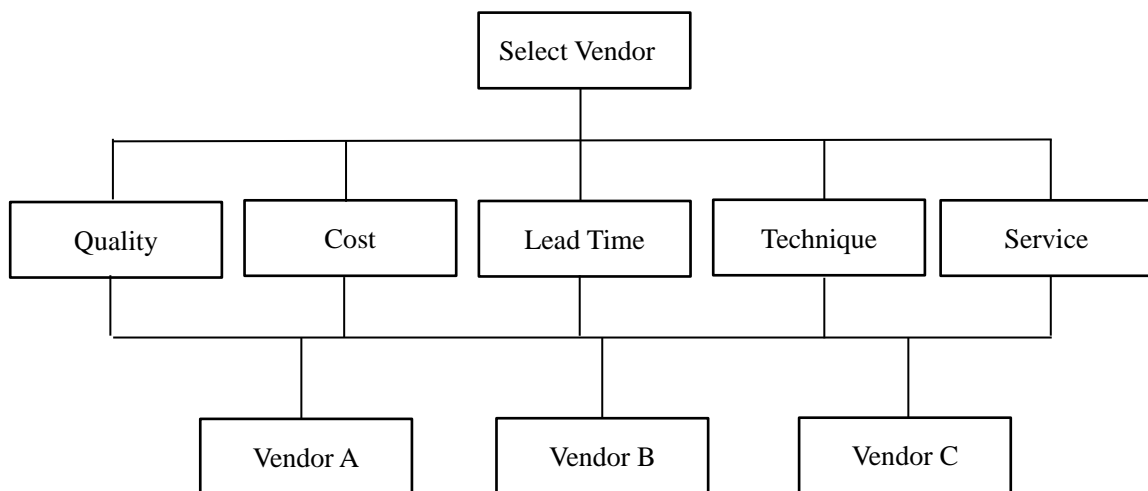


Figure 9 The hierarchy of AHP model

The three commercial influence factors can conclude quality, cost and lead time criterion. The risk factors can conclude the technique and service criterion.

**4.3.2 Determine each criterion’s weight**

Determine each criterion’s weight. Build pairwise comparison matrices A. The entry in row i and column j of A, labeled  $a_{ij}$ , shows how much more (or less) important objective j. For all  $a_{ii}=1, a_{ji}=1/a_{ij}$ .

Formulate the questionnaire according to the hierarchy, inquired several staff in the executive level of C Company and some purchaser of C Company in logistic center.

According to the requirement of the AHP model, I list their opinions about the level of importance of each parameter for C company' developing strategy in pairwise comparison matrix as follows:

A	Quality	Cost	Lead Time	Technique	Service
Quality	1	5	2	3	6
Cost	1/5	1	1/4	1/3	3
Lead Time	1/2	4	1	2	5
Technique	1/3	3	1/2	1	4
Service	1/6	1/3	1/5	1/4	1

Among them, the value  $a_{ij}$  represent the importance when horizontal axis criterion compare with the vertical axis one, for example:

$a_{14}=3$ , then it means the quality of goods provided by vendor is slightly more important than its technique.

$a_{15}=5$ , that represents the quality of goods provided by vendor is strongly more important than its service.

$a_{41}=1/3$ , contrast to  $a_{14}=3$ , shows that the technique of vendor is slightly less important than the quality of goods.

Then, normalized pairwise comparison matrices A to get  $A^*$ .

$$a_{ij}^* = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}}$$

$A^*$	Quality	Cost	Lead Time	Technique	Service
Quality	0.4545	0.3750	0.5063	0.4557	0.3158
Cost	0.0909	0.0750	0.0633	0.0506	0.1579
Lead Time	0.2273	0.3000	0.2532	0.3038	0.2632
Technique	0.1515	0.2250	0.1266	0.1519	0.2105
Service	0.0758	0.0250	0.0506	0.0380	0.0526

### 4.3.3 Checking for consistency

After that, calculate the weight for each criterion .Estimate the weight for criterion i.

$$W_i = \frac{\sum_{j=1}^n a_{ij}^*}{n}$$



W <sub>i</sub>	
Quality	0.4215
Cost	0.0875
Lead Time	0.2695
Technique	0.1731
Service	0.0484

Multiply A with W to compute AW .Get the ratio of each element of AW to the corresponding weight in W and average these ratios, their summation will be  $\lambda_{max}$ .

$$\lambda_{max} = \sum_{i=1}^n \frac{(AW)_i}{nW_i}$$

$$\lambda_{max}=5.1680$$

Compute the constancy index CI

$$CI = \frac{\lambda_{MAX}-n}{n-1}$$

$$CI=0.0420$$

Then, Compute the constancy ratio (CR)

n	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Table 1 Random index for checking the consistency of AHP model

$$CR = \frac{CI}{RI}$$

$$CR=0.0375 < 0.1$$

Satty suggests that if  $CR=CI/RI < 0.10$ , then the degree of consistency is satisfactory. Since the pairwise comparison matrix A has passed the check, it won't exhibit any serious inconsistencies.

#### 4.3.4 Determine the scores of each strategy on each criterion

The next shows a purchasing example. If the C Company wants buy some IT equipment like PC. The buyer gives four vendor main information and their quoted

price.

We can give the scores from 0 to 5 to the four vendors.

	Quality	Cost	Lead Time	Technique	Service
Vendor1	2	2	5	5	4
Vendor2	2	5	3	3	2
Vendor3	3	3	4	5	3
Vendor4	3	5	2	3	1

Table 2 comparison matrix of the principle level

#### 4.3.5 Calculates an overall score for each job, determining the best alternative.

Multiply the score of each strategy with the corresponding weight ( $W_i$ ) and the final answer is the overall score for each vendors. The score is highest one which is the best vendor.

Vendor 1	3.4245
Vendor 2	2.7052
Vendor 3	3.6157
Vendor 4	2.8088

We can see that the vendor 3 is the best choice. From the AHP model, the price is not only uniqueness consideration factor, we should consider all factors. Although the price of the vendor 3 is not lowest, synthesize five factors, he is the best choice.

## Chapter Five Conclusion

Under the traditional Condition, the relationship between enterprise and suppliers is a simple business transaction relationship. And under the condition of the supply chain, win-win partnership becomes a typical relationship between enterprise and suppliers. Win-win partnership is a partnership; it emphasizes sharing information in the cooperation between suppliers and manufacturers, to coordinate the behavior of each other through cooperation and negotiation. It performs that manufacturers supplies help to the suppliers, help suppliers to reduce cost, improve quality, speed up product development progress: through the establishment of mutual trust relationship to improve efficiency, reduce transaction costs; Long-term trust contract replaces the short-term contract: more exchange of information.

For a large enterprise, the purchasing basic on the supply chain can bring a lot of benefits which can help for the long-term development of the enterprise. It can bring some changes for the company. There are a lot of problems about such large enterprises purchasing. This paper focuses on the analysis of the two aspects of the procurement.

First, choose different way of purchasing to purchase the different materials. It is very necessary for aircraft manufacturers because a plane have hundreds of thousands of components and parts. The centralized purchasing or ABC classification purchasing the company used has a lot of problems. It must be detailed the purchasing way. Using different purchasing way can reduce the inventory.

Secondly, Choice supplier reasonably. Use the decision - making techniques to choose the supplier. Not only simply according to price for reference but also comprehensive consideration the supplier by using AHP selection model considering various factors. It can improve the level of supplier which can make the company rapid response to market or strengthen the enterprise's core competitiveness. In supply

chain, strong supplier can bring more benefit to the company.

In today's rapidly changing consumer market, one company with suppliers are all unable to give response in time independently to response to change .It only connected into chain that each supplier's core advantage can be full played so that it will not make business opportunity missed. Enterprise's core competitiveness is to show the enterprise in the research, develop, design, manufacturing, marketing, service, etc. which not easily imitated by competitors and obviously better than the unique ability to meet the needs of the customer value. Companies increasingly focus on their core competitiveness. Get respective advantages of outstanding supplier under the common goal together to share information collaboration, reduce the cost and risk, share interests. In supply chain management, it is emphasis on enterprise strategic cooperative relations with supplier.

## References

- Akio Imai, Etsuko Nishimura, Stratos Papadimitriou, (2003), Berth allocation with service priority, *Transportation Research Part B* 37 (2003) 437 – 457
- Cai Xingbo, (2004), Research on the design scheme of the 2nd phase of coal terminal engineering of Wenzhou Power Plant, Hehai University master degree research paper, *China Academic Journal Electronic Publishing House*, <http://www.cnki.net>
- Cao Xinzhi, (2006), Consumers' Interest Analysis Based on the Decision Tree, Jilin University master degree research paper, *China Academic Journal Electronic Publishing House*, <http://www.cnki.net>
- Chen Tao, Zhang Weihong, (2006), Innovative Technique of Modern Bulk Cargo Wharf Production and Operation Management System, *Port & Waterway Engineering*, Vol.10, 2006
- Decision tree learning, (2008), Wikipedia, Retrieved 18<sup>th</sup> January, 2008 from the World Wide Web: [http://en.wikipedia.org/wiki/Decision\\_tree\\_learning](http://en.wikipedia.org/wiki/Decision_tree_learning)
- Fan Minghong, Liao Jin, Zhang Weihong, (2007), Logistics Management and Control of Specialized Storage Yard of Modern Bulk Cargo Terminal, *Port & Waterway Engineering*, Vol.8, 2007
- Han Xiaolong, Ding Yizhong (2006), Simulation System of Container Terminal Charge/Discharge Operations, *Journal of System Simulation*, No.8, 2006
- Latin American Trade & Transportation Study, (2001) Retrieved Jan 18<sup>th</sup>, 2008 from the World Wide Web:  
[http://www.dotd.louisiana.gov/programs\\_grants/latin/index.shtml](http://www.dotd.louisiana.gov/programs_grants/latin/index.shtml)
- Li Jianzhong, Ding Yizhong, Wang Bin, (2007), Dynamic space deployment model of container storage yard, *Journal of Traffic and Transportation Engineering* Vol.7 June, No.32007
- Liang Huajing, Shen Shen, Chen Haiwen, (2002), The model-design of case selected analysis based on decision tree, *Modern Computer*, Vol.6 2002
- Lu Hongmei, (2007), Review of Classification Algorithm based on Decision Tree, *Journal of Suzhou College*, Vol. 22, No. 2, Apr.2007
- Jean-Francois Cordeau , Manlio Gaudioso , Gilbert Laporte , Luigi Moccia, (2007),

- The service allocation problem at the Gioia Tauro Maritime Terminal, *European Journal of Operational Research* 176 (2007) 1167 - 1184
- Katta G. Murtya, Jiyin Liu, Yat-wah Wanb, Richard Linn, (2005), A decision support system for operations in a container terminal, *Decision Support Systems* 39 (2005) 309– 332
- Pasquale Legato, Rina M.Mazza, (2001), Berth planning and resource optimization at a container terminal via discrete event simulation, *European Journal of Operational Research* 133 (2001) 537-547
- Peng Chuansheng, (2004), Application of Computer Simulation to Modification and Expansion Project of Bulk Terminal, *Port & Waterway Engineering*, Vol.4 Retrieved Jan 18<sup>th</sup>, 2008 from the World Wide Web:  
[http://www.hrcc.com.cn/academic\\_luntan\\_shuiyun/200410/pengchuansheng.pdf](http://www.hrcc.com.cn/academic_luntan_shuiyun/200410/pengchuansheng.pdf)
- Sun Hua, Li Yi, Li Qing, (2007), A Research of Human Resource Value Based on Decision Tree, *AGRICULTURAL EQUIPMENT & VEHICLE ENGINEERING*, No.4 2007 (Totally 189)
- Tu Juanjuan, Liu Tongming, (2007), A Predicting Model of TV Audience Rating Based on the Decision Tree, *Software Sky*, 1008- 0570(2007)09- 3- 0251- 02
- U. Bugaric, D. Petrovic, (2007), Increasing the capacity of terminal for bulk cargo unloading, *Simulation Modeling Practice and Theory* 15 1366 - 1381
- Wang Chaorui, (2004), Development of a Bulk Cargo Loading and Unloading Controlling Simulation System Based on Industrial Controlling Network, *Industrial Control Computer*, Vol.6, 2004
- Yang Shuqin, Zhang Yunjie, Wang Zhiqiang, (2002), A model and its algorithm on container yard problem, *Journal of Dalian Maritime University* Vol. 28 ,Suppl. Aug., 2002
- Zhu Hongwei, (2007), Wuhan iron and steel industrial port's logistics system optimization, Wuhan University of Technology master degree research paper, *China Academic Journal Electronic Publishing House*, <http://www.cnki.net>
- Wang Hongke(2005), Analysis the condition of multinational companies in China's aviation industry *China Ordnance Industry*, Vol.03, 2005

Wei Yanjie(2011), Aircraft life management technology revolution, *Academic journal of China civil aviation university*, Vol.29, 2011

## **Appendix**

1. The weights questionnaire of supplier selection factors

See the word document 'The weights questionnaire'

2. Spreadsheet model of AHP

See the excel table 'AHP model.xls'