

UNIVERSITY OF VAASA

FACULTY OF TECHNOLOGY

DEPARTMENT OF PRODUCTION

Haifeng Song

**THE APPLICATION OF ANALYTIC HIERARCHY PROCESS IN
SUPPLIER SELECTION FOR SPECIALTY PAPER MAKING
COMPANY**

Case Company: Anhui Welbon Gaosen Paper Co.,Ltd

Master's Thesis in
Industrial Management

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ABBREVIATION

AHP	Analytic Hierarchy Process
CP	Centralized Procurement
IB	Invited Bidding
JIT	Just In Time
KPI	Key Performance Indicator
PB	Public Bidding
SCM	Supply Chain Management
SPC	Statistical Process Control
SRM	Supplier Relationship Management
TQC	Total Quality Control
TQM	Total Quality Management
WIP	Work In Process

UNIVERSITY OF VAASA
Faculty of Technology

Author:	Haifeng Song	
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Instructor:	Josu Takala	
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ABSTRACT:

Majority of enterprises choose to implement JIT procurement model to face the marketing fierce competition in recent decades. Single sourcing supplier is the main characteristic in JIT procurement, thence, selecting a suitable supplier become increasingly important. The purpose of the research is to select the most suitable supplier for the case company. More specifical, to identify supplier selection criteria for the case company, then exploiting a flexible analytic model which is AHP to help the case company choose a suitable supplier for implementing JIT Procurement, finally suggestions are given for case company in supplier relationship management, which based on implementing JIT Procurement.

The study begins with literature review of purchasing behavior, supplier related theory and AHP method. Afterwards, qualitative research method of interview and quantitative research method of questionnaires were utilized to identify evaluation criteria and collect pair-wise comparison data for judgment matrixes. Finally, eigenvectors and eigenvalues of judgment matrixes were calculated for ranking priorities and all vectors were passed by consistency verification.

Based on the result from previous research, supplier with the total highest score becomes the most suitable alternative. In addition, suggestions of supplier relationship management are given for the sake of success further implementation of JIT procurement in the case company.

KEYWORDS: JIT Procurement, Supplier Selection Criteria, AHP Method, Supplier Relationship Management

1. INTRODUCTION

With the intensification of economic globalization and marketing fierce competition in recent decades, Just in Time Procurement was utilized by majority of enterprises. JIT Procurement model was evolved by Just in Time management idea. It aims to supply the right quality of items at the right time in the right place to meet buyers' satisfaction with the best and greatly eliminate inventory, thus to decrease purchasing and operating costs. As a result of JIT Procurement take single sourcing supplier, choosing a suitable supplier is particular important, it is the key factor to implement JIT Procurement. Qualified suppliers should have good supply, quality, technology, equipment condition, punctual delivery and high management level; it can guarantee the quality of purchased raw materials and ensure on-time delivery and quantity. Thence, it is particular substantial for decision makers to choose the most suitable supplier from large number of vendors.

1.1. Statement of the problem and objectives

It is not a simple task for decision maker to do the final decision about which vendor they choose by, if decision makers choose an unsuitable vendor, it may directly affect the production process and operation expense of the company.

For the case company, there are three problems need to be solved during JIT Procurement vendor selection process. At first, there is no scientific evaluation system for vendor selection. It may result the decision maker do the final decision with much attention on one evaluation factor or their subjective impression, rather than giving a comprehensive and objective evaluation for all suppliers. Flexible evaluation system missing may lead to unfair and unscientific selection result. Moreover, there are no specific supplier selection criteria in line with the actual situation of company. Besides, how to maintain supplier relationship with selected supplier and potential suppliers during JIT Procurement process is also pre-considered.

In the thesis, the above three problems will be solved; the flexible model of AHP will be applied to make decisions in selecting vendor for case company. Qualitative research method (interview) combine with literature review will be used to collect and accumulate potential criteria for vendor selection. Quantitative research method (questionnaires) will be utilized to collect judgment matrix input data for pair-wise comparison and identifying accurate final JIT procurement vendor selection criteria.

The objectives of the thesis are to identify supplier selection criteria for the case company, then exploiting a flexible analytic model which is AHP to help the case company choose a suitable supplier for implementing JIT Procurement, finally giving suggestions for case company in supplier relationship management, which based on implementing JIT Procurement.

1.2. Thesis framework

The thesis consists of six chapters, the first phrase is Introduction part, and it gives a short description of thesis background, research problems, methodology and the thesis objectives. The second phrase is Introduction of the case company, and it introduces the background of paper industrial, the characteristics of products. The third phrase is Theoretic part; it filled with literature review of purchasing behavior, supplier related theory and AHP method. The fourth chapter is empirical JIT procurement vendor selection process part; it includes qualitative method of interview and quantitative research method of questionnaires to identify evaluation criteria and collect pair-wise comparison data to AHP application. According to the empirical part data collection and calculation, results and discussion chapter comes, the most suitable supplier will be recommended in this phrase, suggestions for how to maintain the relationship with selected vendor will be given by the author. The last part is conclusions chapter; it involves thesis summarize and limitation analysis.

2. INTRODUCTION OF CASE COMPANY

In this chapter, there are three subheadings will be introduced, first part is specialty paper industrial background description, which involves specialty paper function, purpose, variety types and developing history; and the second subheading is case company description, it includes developing history, main products and five year strategies; and the last phrase is related department description, it covers different responsibilities of department in the mission of supplier selection and main work in purchasing department.

2.1. Specialty Paper Industrial background

Specialty paper has special functions and purpose, and it has relatively small amount of consumption but high add value compared with traditional papers. Numerous types of specialty papers which include tissue paper, rice paper, barrier paper, laid paper, separated greaseproof paper, rust-proof paper, banknote paper, thermal paper, tracing paper, filter paper, teabag paper, aluminum foil paper, carbon paper, carbonless paper, wall-base paper, glass paper, coffee filters, cigarette paper, glassine paper, wallpaper semi-conductive paper, battery separator paper, etc.

Variety types of specialty papers are used in different areas, for instance, for living use, building materials, electrical products, industrial filter use, industrial machinery, agricultural use, information use, for optical, culture and the arts, cutting-edge technology with biochemistry use, etc.

Specialty Paper was gradually spread up about the 1960s. It is from the US National Cash Register Company in the year 1945, which Successful development of NCR. Later, other specialty papers continue to launch, and opened up people's vision, changed the traditional perception of the paper. The starting material is no longer limited to the plant fiber, non-plant fibers has been applied. However, the

development of specialty paper facing many difficulties, such as large amount of capital investment and high equipment requirements, technical difficulties, etc. At the same time, many types of specialty paper have narrower application and smaller demand. It remain need to be explored.

Currently, domestic specialty paper production is low, the total amount cannot meet China market requirement. However, due to a wide range of specialty applications, high performance and high added value, domestic small and medium specialty paper production factory is not common to applied academic research units technical support, so that China specialty paper has some obstacles to be development, Specialty paper manufacturer should make an appropriate production planning, keep the direction of product transformation and technology development forward.

2.2. Case Company

Zhejiang Welbon Pulp & Paper Group is a large enterprise groups which covers businesses of pulp & paper import and export trade, specialty paper research and production and the core of the formation is Zhejiang Welbon Pulp & Paper Holdings Limited.

The company currently operates a pulp imports from Canada, Brazil, Chile, Indonesia, Russia, the US, New Zealand, Thailand, Japan and other countries. And also it distributes a variety of domestic pulp, such as Nanning Phoenix Paper Co., Ltd. It has subsidiaries and offices in Shanghai, Guangdong, Shandong, Hubei, Anhui and other provinces and cities. The company's sales network through all of the country; it establishes long-term business relations with more than 200 companies and individual customer units.

Anhui Welbon Ghosn Paper Co.,Ltd was established in Anqin, which is a historical city in Anhui province in China. It belongs to Zhejiang Welbon Pulp & Paper Group.

The Company has a registered capital of 20.04 million Yuan, and the Factory covers an area of 70 acres. Now it existing two 1575mm thin pages specialty paper production line and one 1880mm paper production line, the total investment has reached 90 million Yuan. The Company currently employs more than 210 employees, including 60 engineering and technique management staff, and it has a complete management organization hierarchy.

The main products of the company are specialty papers; it involves filter plug wrap paper, cigarette tipping paper, battery separator paper, High quality tea packaging paper, food packaging paper, aluminum foil backing paper, etc. With an annual capacity of 12,000 tons, sales revenue reached 220 million Yuan. Enterprise products are widely used in cigarettes supporting industry, battery industry and packaging industry. It has a certain reputation in these three industrial areas.

In the following five years, the company plan to further expand its production and scale economics. More specific, the factory covers area from 70 acres to 328 acres; three more specialty paper production line will be invested, and new specialty paper production will be enriched. Then the company will reach an annual production capacity of 45,000 tons of specialty paper, paper processing capacity of 30,000 tons, the annual sales income will reach 1.2 billion Yuan, annual profits will be more than 110 million Yuan.

2.3. Related department description

In the case company, vendor selection and assessment mission was in charged by purchasing department like majority of companies, quality control department, production department, technique research department and other department assist supply selection work. General Manager responsible for approval relevant departments' selected supplier.

For specific, purchasing department in the case company was leading by the General Manager, its main tasks includes:

- Approval the purchasing list, whether the products are necessary to be purchasing, to make sure purchasing product's amount and size are correct, etc.
- To participate in vendor selection work cooperate with other relevant department.
- Implementation of the procurement function, to inquiry, parity, bargaining and order.
- Delivery in time and coordination.
- Materials returns and claims.
- Materials development and price investigation.
- Procurement plan and budget compiled.
- Supplier management.
- Redesign and improvement Procurement systems, processes and forms.

3. LITERATURE REVIEW

In this chapter, three main literature blocks will be reviewed, which are purchasing behavior, supplier selection and AHP. Purchasing behavior involves purchasing objective, purchasing importance, procurement process and JIT procurement. Under the heading of supplier selection, the common models, supplier selection process, supplier selection criteria and supplier relationship management will be covered. AHP background, definition, typical steps and limitations will be illustrated in the last phrase.

3.1. Purchasing behavior

According to Pooler, Pooler & Farney (2014) that purchasing is an unusual and multifaceted work between buyer and seller, which work for meeting the satisfaction for both supply and demand. For individual purchasing, purchasing behaviors mostly refers to the attitude, preferences, intentions and decisions in the market of buyer when buying a product or service. And for company procurement, it indicates the attitude, preferences, intentions and decisions in the buying behavior between company and supplier.

3.1.1. Purchasing objective

Purchasing as one important flow in organizations supplier chain, Pooler (Pooler, Pooler & Farney 2014:3) illustrated two objectives of purchasing involve:

- Ensure economic supply through the procurement process to support company's operation.
- Make effort in minimize product total cost in operation by controlling the price in procurement.

Chunawalla (2008:14-15) thought the purchasing objectives equal to procurement

department objectives, he summarized the purchasing objectives was outlined as:

- To minimize possible costs in purchasing.
- To make sure the continuous supply for production.
- To increase the asset turnover.
- To explore the potential sources of supply.
- To maintain good relationship with suppliers.
- To integrate with other departments in the company.
- To train the personnel.
- To keep record efficiently and paper processing.

To conclude, purchasing objective is through the efforts from staffs in purchasing department to continuously improve utilization of funds and plays positive role in maintain relationship with suppliers and cooperate with other department, ultimately achieving profit maximize.

3.1.2. Purchasing importance

Purchasing as one chain in company's supply chain, it has connections with all chains and it plays important role in the whole supply chain process and final profit.

How does purchasing impact the profitability? The purchasing profit ratio was showed by Pooler Victor, that one dollar saved from purchasing equivalent to one dollars profit from \$14 sales. More specific, the profit leverage of the material cost reduction dollar is 14 times that of the sales dollar. The purchasing profit ratio figure was listed below, it is said that "can be used for any organization by dividing its annual sales volume by profit before tax" (Pooler 2014:8).

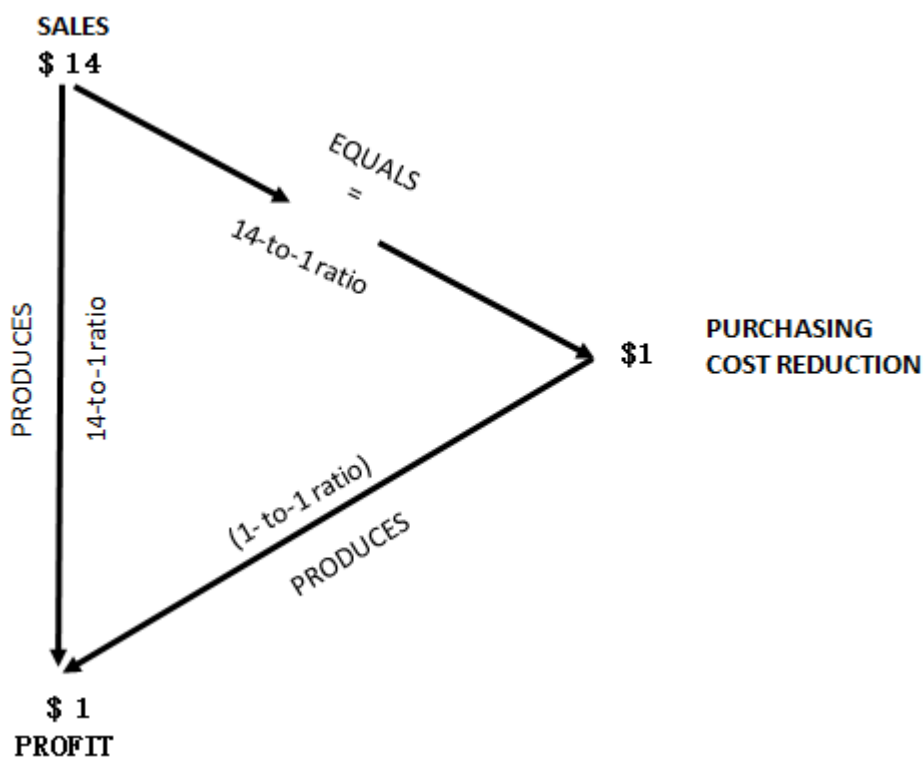


Figure 1. Purchasing profit ratio. (Pooler 2014:8)

3.1.3. Procurement process

Handfield insists that high level purchasing staff must continuously make effort to improve purchasing process to be more efficiency and effectiveness. Purchasing process is utilized to determine requirements effectively and efficiently, examine and appraise suppliers, certify puncture payment and ensure the need was satisfied effectively (Handfield, Monczka, Fiunipero&Patterson 2009: 38).

Ellram (1990) suggested a five-stage model for the development and implementation of “purchasing partnerships”. The five phases are:

- To build a strategic team, and to determine the support of senior management.
- To identify potential partners.
- To look through and select supplier.
- To build relationship with suppliers, pay more attention on key supplier.

- To assessment relationship: continue, expand, or reduce.

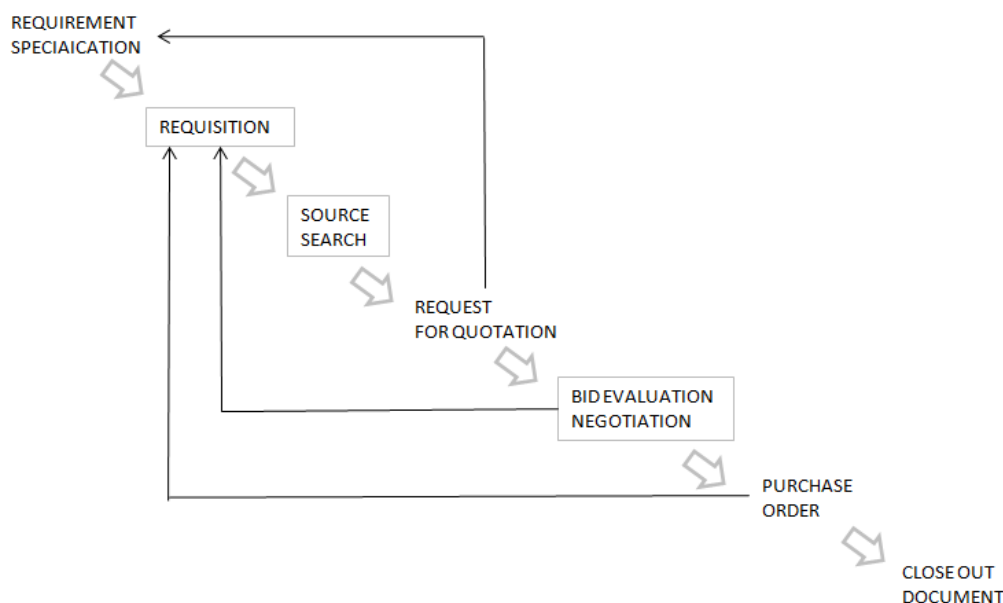


Figure 2. The typical procurement process. (Pooler 2004:10)

Procurement process is comprised of many elements, and these elements will affect the result. The figure above shows the typical procurement process which described by Pooler (2004: 10) that begins with requirement specification, which is the base for purchasing, then followed requisition, source search, request for quotation according to the requirement, bid evaluation negotiation with suppliers, purchase order with qualified supplier, finally is close out document.

3.1.4. JIT procurement

The essence of JIT is determined in the elimination of all waste (Ramasesh 1993). According to Hall (1986), the final goal of JIT procurement is “to have direct receipts into manufacturing which will replace the traditional receiving, inspection, and storage function”.

JIT aims to decrease waste through the whole process in organization’s operation. Specifically, it operates with reducing batch sizes for not only manufactured but also

purchasing items (Niall 1996). According to Niall (1996), the key of JIT is improving quality while decreasing costs and offering flexibility. The supply chain would be more responsive and flexible because flaws are found faster in small batches and costs are minimized due to holding low levels of inventory.

Freeland (1991) and Frazier, Spekman, & O'Neal (1988) state that the main difference between traditional purchasing and JIT purchasing techniques are: JIT purchasing increases the delivery frequency; vendors' selection is based on delivery reliability, price and quality; and a long term relationship would be built with either single or dual sources suppliers. Consequently, a closer relationship between buyer and vendors are built with mutual dependency. Expanding JIT to supply chain would create a win-win outcome to both buyer and supplier benefit.

Ramasesh (1993) states that JIT procurement has two key approaches which are:

- To gradually reduce the massive fixed costs;
- To commitment to be patience and continuous improvement.

3.2. Supplier Selection

One of the key organizational functions which led by the procurement department is supplier selection. Holsapple & Whinston (1996) insisted that supplier selection is a typical unstructured decision problem which involves a number of conditions. In the past three decades, the concept was turned in to broader process from multiple criteria decision making, which serving as a source of knowledge and connections for participants with different perspectives.

3.2.1. Supplier selection models

The majority of companies choosing supplier with one of the following two methods, one is the weighted point method and the other one is cost ratio method.

The Weighted-point Method: Chunawalla (2008: 101) defined the weighted-point

method as: it provides the quantitative data for each evaluation indicators. The weights values are attribute to each evaluation indicators according to the require of the organization.

The Cost-ratio method: Ordoobadi & Wang (2011:633) explained the cost ratio method as: this method is based on the belief that part-cost does not considered to the purchasing parts. The total cost related to quality, delivery, and service are calculated and expressed as a proportion of the total price. The supplier who can offer the lowest cost is the best. However, it requires a comprehensive cost-accounting system to identify the precise cost data.

3.2.2. Supplier selection process

Supplier selection as one essential part in procurement, a bunch of researchers thought the process of supplier selection is quite similar with procurement process, that because the procurement process covers supplier selection, to define a detailed and specific flow for supplier selection is significant necessary in choosing an excellent supplier.

Kumar. Sameer, Hong. Qui S & Haggerty, Linae N (2011:9-10) summarized a supplier selection process flow which involves multi steps:

- “To pre-selection of suppliers.
- To prepare request for quote (RFQ).
- To analyze RFQ response.
- To conduct site visit.
- To purchase and contract.
- To qualify supplier.
- To reevaluate suppliers and contracts” (Kumar 2011: 9-10).

3.2.3. Supplier selection criteria

In order to identify a comprehensive evaluation criterion for all suppliers, many related professional researchers have been done to collect useful criteria, they are large number of existing criteria can be utilized to evaluate suppliers, notwithstanding criteria factors which meet specific company needs still need to serious considered and selected.

One of the most important components of supplier selection is formulation of criteria. Robert (2011:2-3) state there are five main components which should be considered in supplier selection procedure:

- Cost
- Quality
- Time
- Reliability
- Technology

Wang, Huang & Dismukes (2004) present that low cost and high quality are two main suppliers attributes in lean supplier selection, however, in agile supplier selection, elements concentrate to speed, flexibility and quality.

The work of Dickson (1966:6) was one of the previous studies in the supplier selection area. On the foundation of 170 respondents from managers and procurement agent, He confirmed 23 criteria for evaluating the performance of suppliers. According to Sarkis & Talluri (2002:19), a supplier could be evaluated and assessed technically based on amount of indicators involves:

- To stress on products quality
- Design capacity
- Process capability
- To decrease products unqualified rate
- To decrease work-in-process (WIP), lead time, space, flow distance
- To do cross-training for operators and do preventive maintenance

- Operators' ability to present statistical process control (SPC) and quick set up
- Operators able to chart problems and process issues
- Hours of operator training in total quality control (TQC)/JIT
- Parallel design
- Equipment/labor flexibility
- Special capacity
- Production and process innovation

Moreover, L. Abdullah, J. Sunadia & T. Imran (2009) summarized a table of various criteria for supplier selection based on previous research articles. It is comprehensively that covers almost all important research points in this area.

Research articles	Contributions
Dickson	Identified 23 importmentevaluation criteria based on a survey of 273 purchasing manager from United States and Canada
Weber et al.	Reviewed and classified 74 articles addressed the supplier selection problem
Ghodsypour and O'Brien	Stated that cost, quality, and service have considerable effects on supplier selection parameters
Kahraman,Cebeci,and Ulukan	Mentioned that selection criteria typically fall into one of four categories: supplier criteria, product performance criteria, service performance criteria, and cost criteria
Wu and Barnes	Advanced Dempster–Shafer and optimization theories for formulating criteria to use in partner selection decision-making in agile supply chains
Chang et al.	Used fuzzy DEMATEL method for selecting the most effective and efficient criteria. Their research result that the stable delivery of goods has the most influence and the strongest connection to other criteria
Setak, Sharifi, and Alimohammadian	Reviewed supplier selection and order allocation models based on an extensive search in the literature and stated that price, quality, and delivery is the most common criteria used for supplier selection

Figure 3. Supplier selection criteria summarize. (L. Abdullah.et. 2009)

3.2.4. Supplier relationship management

As one of the most important part of supply chain management, supplier relationship management could effectively improve the qualitative and quantitative levels of suppliers, which is a competitive advantage of each company. (Cusumano & Takeishi 1991) Herrmann & Hodgson (2001) state that supply chain management is a procedure which participate in managing favorite suppliers and searching for new

suppliers while decreasing costs, making procurement foreseeable and repeatable, gathering buyer experience and collecting the benefits from supplier partnerships.

According to Handfield et al. (2009: 125-127), supplier relationship can be divided in internal and external relationships, some of the key elements to point out including the following:

- Different people and skills and levels of investment and attention area required by various stages of SRM; the effort which the people required to jump start may not be the best ones to cultivate, manage and maintain it.
- Recruit from the business, managers who have worked in the business, understand the day-to-day pressures, and speak the same technical vernacular the best supplier relationship managers. The business realities for stakeholders and suppliers with the opportunities can be aligned these individuals.
- Intercept internal and external shifts, mechanisms that facilitate readjustment in roles, metrics and project deliverables should be established.
- Schedule regular site-level meetings with vendors and stakeholders to reassess and modify KPIs to reflect the key point in current business.
- Drive people to mental perception and to commitment; be willing to decrease lure on people or directions that aren't in target of strategy.

The methods to evaluate supplier performance could be various, however, a quantitative approach is highly recommended. (Sollish & Semanik 2012: 87-88). "Supplier selection is undeniably regarded as the corner stone of successful purchasing and supply management to maintain and enhance the competitive edge" (Wang 2010). A good supplier selection could bring significant benefits to enterprise, which includes: decreasing operational costs, improving the quality of its products and more rapid response to customer requirement. (Abdollahi, Arvan & Razmi 2014)

3.3. Analytic hierarchy process

Analytical hierarchy process (AHP) is an integrated decision making procedure proposed by Dr Thomas. Saaty, who was the professor at the University of Pittsburgh in 1977. In 1980 and 2001, Dr Saaty continued to improve this technique until AHP became a mature multiple-criteria decision making theory. The main feature of AHP may include analyzing complex decisions with consideration a large number of factors and criteria. AHP decomposes the problem into a hierarchy of simpler sub-problems, afterwards, do comprehensive and independent evaluation on it. Finally, making the decision based on the above analysis. (Tzeng & Huang 2011) ;(Donevska, Gorsevski, Jovanovski & Pesevski 2012); (Ye, Ma & Yang 2008)

AHP is created according to human nature and mind and goes with it. The procedure is an array of judgments (decisions) and individual assessment in a reasonable way. Consequently, AHP may depend on personal impressions and experiences to frame and design a program hierarchically. Besides, all the decision-making and final judgments are mainly depends on logic, understanding and experiences. (Bitarafan, Hosseini, Abazarlou & Mahmoudzadeh 2015)

As one of the excellent multiple MCDM methods, AHP help DMs make decision based on pair-wise comparison between criteria and alternatives. In AHP, a pair-wise comparison is defined in the linguistic scale of crisp value. (Abdullah & Zulkifli 2015)

A typical AHP includes the following four steps

- 1) “Define the evaluation criteria for the decision goal and establish a hierarchical framework.
- 2) Compare the pair-wise decision elements.
- 3) Estimate the relative weights of decision elements.
- 4) Rate the decision alternatives based on aggregated weights of decision elements”.(Yaraghi, Tabesh, Guan & Zhuang 2015)

AHP is considered as one of the most comprehensive systems which fit multi-criteria

decision making since AHP not only offer the possibility to consider a set of quantitative and qualitative criteria in the program but also provide the ability to formulate the questions hierarchically. This procedure includes various options in decision-making with the ability of susceptibility analysis on criteria and sub-criteria. Moreover, AHP is based on pairwise comparison which may promote calculations and decision-making. One of another particular advantage of this technique is AHP could demonstrate the compatibility and incompatibility of the decision. (Bitarafan et al 2015)

However, AHP methodology also has two limitations; at first, AHP presumes that decision makers could give accurate point estimates of the preferences for alternatives, and therefore, is not suitable for synopsis when decision makers' judgment is uncertain. Furthermore, the final scores of alternatives in AHP miss the statistical explanation. Decision makers may not know whether there is any practical significant difference between the two alternatives as long as final scores of two alternatives are close. (Yaraghi et al 2015)

4. JIT PROCUREMENT SUPPLIER CELECTION PROCESS

Arbnor & Bjerke (1997:26) determined the methodological approach as a group of important methods, the structure of reality, the structure of science, and the final idea, which involves the creation of guidelines for knowledge.

Main Methodologies which are used in the thesis includes literature review, quantitative research and qualitative research.

Literature review is a common methodology. It was applied in the thesis to rich related theoretic knowledge background of criteria identification; the consequences of qualitative research were adopted to collect and accumulate research data of existing supplier selection system, JIT procurement potential indicators from purchasing manager in the case company. Furthermore, the main purpose of gathering information is to have a better understanding to the case company and for result analysis. Quantitative researches was also used in the thesis, one of the questionnaires is applied to collect final JIT procurement supplier selection criteria from the evaluation team members of the company. And the second questionnaire is to accumulate input data for pair-wise comparison in AHP model from purchasing manager Mrs. Zhang which is the most professional alternative.

4.1. Selection criteria identification

Qualitative research was used as one research method in the thesis.

4.1.1. Interview method to accumulate company existing supplier selection criteria

One interview was held during the author's internship in the case company. The interview processes were empowered by Purchasing Manager to record by phone.

The purposes of the interview is to collect as much as useful and reliable information

about company's purchasing, supplier introduction, existing supplier evaluation system, indicator system, supplier relationship management, etc. Based on company's requirement and actual situation combine with JIT Procurement requirement vendor selection indicators will be identified to participate in criteria questionnaire of selecting JIT procurement supplier. More specific:

Interviewee: Zhang Jing, Purchasing Manager in the case company

Date: 6th of February, 2015

Location: Mrs. Zhang's office, Anhui Welbon Ghosn Paper Co.,Ltd. NO.36 Gapbeng Road, Anqin.

Tel: +8618055772324

Interview for Mrs. Zhang consists of seven open questions. Interview questions in English and Chinese are supplemented in appendix part. And the results of interview are:

1). Purchasing materials and main material

Mrs. Zhang said the company purchasing materials can be classified as the importance of the impact on final product quality which can be divided into 4 categories, the key material, the important material, the general material and other material.

The key material mainly refers to the materials that have a direct impact on company's final product quality, it includes pulp, starch, calcium carbonate, a dispersing agent, titanium dioxide, talc, rosin, coal, etc.

The important material are little bit less importance compared with the key material which consists of Caustic soda, sodium hypochlorite, aluminum sulfate, aluminum chloride, etc.

General material involves cardboard boxes, end caps, plastic core, stretch film, film, paper core, cork, EPE, plastic woven cloth, etc. And other supplies have a certain influence on the company, but not the final product supplies. It mainly refers to hardware groceries, sporadic materials, spare parts, electrical materials, etc.

Total storage of Material procurement in January 2015		
Unit: RMB		
No.	Name	Price(tax included)
1	Pulp Category	6043652.05
2	Coal Category	374374.00
3	Fuel Category	4111.31
4	Net blankets Category	103114.36
5	Bearing Category	15640.13
6	Chemical Category	1729613.30
7	Packaging Category	498297.27
8	Hardware Category	48200.26
9	Appliances Category	8464.52
10	Pipe Category	8347.60
11	Equipment Category	88700.00
In Total		8922514.80

Figure 4. Total storage of material procurement in January 2015. (Zhang 2015)

From table xx, Pulp category expense 67% of total procurement amount in January 2015, it obviously shows pulp category is the main material.

2) Procurement process of the case company

Different purchasing content have different procurement process, for instance, during main material procurement, centralized procurement is implemented in the enterprise. Main material and some key material procurement in company and factors branch should under the guidance of the Group Procurement (its approval procedures in

accordance with ISO9001 certification execution).

Overall, the procurement process in the company involves requirement identification, inquiry, parity, bargaining, evaluation, samples taking, order decision, coordination and communication, good inspection, and sorting payment.

3). Purchasing manager's responsibility

As Purchasing Manager in the company, her responsibilities are:

- In accordance with the production scheduling, preparation of various types of materials procurement plan, to complete the purchasing task with high quality and quantity, to ensure the normal operation of the production.
- Be good at material procurement tendering according to company's bidding rules, To signed a purchase contract with companies which have low price, good quality, timely delivery, high reputation and popularity and registered by the business sector, with the general taxpayer, have business license under the premise .
- To reduce procurement costs, be strict to quality control of raw materials.
- To perform well in substandard raw materials returns and payment settlement.
- To evaluate vendor's capacity and partnerships.
- Be directly responsible for the purchased material in quality, price, financial and material safety.

4). Vendor selection system and assessment indicators

Mrs. Zhang introduced that they have vendor selection system in their company. Weighting method was utilized in selecting and evaluating vendors.

Their vendor selection process start from establishing a 5 members assessment team; team members should cover marketing department, production department, and

quality department. The purposes of the assessment team not only focus on selecting vendor from variety suppliers, but also have to analysis and consider the qualification and condition of qualified vendors.

For new potential supplier, company need to grasp the basic information of the company.

- General business conditions: the nature of the company, person in charge, registered capital, the number of employees, the main products, financial situation, business license.
- Supply capacity: the new production equipment, whether the production capacity has been fully utilized, the adequacy of plant space, whether the plant site near the purchaser.
- Technical capacity: does technology developed by them or depended on outside, whether the technical cooperate with international renowned institutions, technical evaluation of existing products or trial samples, the number of personnel and educational level.
- Performance Management System: whether their production works smooth and reasonable and how to output efficiency? Whether the material has been computerized process control, is production planning constantly changing, whether the procurement system can really master the material origin and progress, whether the accounting system provide a good basis for costing.
- Quality ability: do they implement quality control system, is it reliable? Do they have quality control manual? Do they have quality assurance program. Do they have the government evaluation rating? Whether they can provide health inspection report issued by the authority periodically?

After comprehending the basic information of company, excluding significantly unsuitable choices, and the left can be added to company's supplier investigate List. Task of picking vendor from company supplier investigate list is also complicated, what they need to make effort is to investigate and evaluate those suppliers.

Then assessment group need to do site visit to some companies, using weighting method to calculate assessment indicators, the check items to all candidates should be the same. It involves delivery, production ability, quality control, technique level and equipment situation. Evaluating table was showed as following; after verifying the candidates, a meeting will be held to discuss supplier's strengths and weakness, listen to supplier's inadequacies interpretation, giving them chance to propose improvement report for further assessment.

Check Items	Investigate Content	Scores					Comment
Production Ability	Production process smooth and achieved Daily production goals.	5	4	3	2	1	
	Appropriate production control.	5	4	3	2	1	
	The adequacy of testing equipment, Whether they calibrate or alignment.	5	4	3	2	1	
	Bad review to improve efficiency.	5	4	3	2	1	
	Checking items and confirms method.	5	4	3	2	1	
Quality Control	The soundness of quality control organization and staff education level.	5	4	3	2	1	
	Work efficiency for customer complains.	5	4	3	2	1	
	Good quality control and have independent inspection.	5	4	3	2	1	
	Quality specifications confirm and unified.	5	4	3	2	1	
Technique Capacity	Company's design capability, Do they have R & D personnel.	5	4	3	2	1	
	Ability to improve quality problems.	5	4	3	2	1	
Equipment Situation	Equipment maintenance capabilities.	5	4	3	2	1	
	Correction system for testing equipment and implementing.	5	4	3	2	1	
	Equipment depreciation and usage status.	5	4	3	2	1	
	Total Score						
<p>Note:</p> <ol style="list-style-type: none"> 1. Fully meet the requirements - score of 5 2. To meet the basic requirements - score of 4 3. Only parts satisfying the requirement - score of 3 4. Related large gap and the not easy to rectification - score of 2 5. Do not have any requirement – score of 1 							

Figure 5. Existing supplier assessment model for the case company. (Zhang 2015)

For the qualified suppliers, the case company will send them inquiry documents with

deadline of giving price, after receiving the respond, purchasing department will do multiple work in parity, bargaining, evaluation, samples taking, order decision, etc. In this stage, lower price is the most important criteria. Normally, supplier with the lowest price wins the bid.

In every beginning of the year, cooperated suppliers will be evaluated as well; weighting method was used again to measure supplier performance. Assessment and evaluation table which was utilized in case company is as following:

Assessment and Evaluation Record				
Items	Evaluation key indicators	Evaluation Result	Scores	Assessment and evaluation summary
1	Product quality(70%)	<input type="checkbox"/> Excellent <input type="checkbox"/> General <input type="checkbox"/> Bad		
2	Delivery control(10%)	<input type="checkbox"/> Excellent <input type="checkbox"/> General <input type="checkbox"/> Bad		
3	Unqualified products control (10%)	<input type="checkbox"/> Excellent <input type="checkbox"/> General <input type="checkbox"/> Bad		
4	Flexible(10%)	<input type="checkbox"/> Excellent <input type="checkbox"/> General <input type="checkbox"/> Bad		
Total Score				

Figure 6. Assessment and Evaluation Record for suppliers from the case company. (Zhang 2015)

All cooperated suppliers will be evaluated and after the analysis process, each vendor will get an assessment and evaluation record, all cooperated suppliers will get final score from evaluating, the final score will decide whether the vendor qualified during this year and will continue be supplier next year.

5) Opinion about existing supplier selection system and indicator system

Mrs. Zhang thought the company supplier selection system and evaluation indicator system are not comprehensive enough, and both of them should be improved. First of all, our supplier selection process is very complicated. Supplier selection task is importance attached by the company, a large amount of labor resource and financial resource were invested during the process, the selection process last long and cost much every year, that's why JIT procurement will be utilized in the company. Moreover, weighting method which was used during the process depend more on evaluation team member's individual thought, it is not scientific enough.

For the indicator system, it is showed in the table that production ability, quality control, technique level and equipment situation are four main indicators in choosing supplier, but actually, other indicators for example: supply capacity, environmental friendly, flexibility were also evaluated during the assessment; it should be enriched in the assessment table and achieved a certain percentage. Moreover, the percentage weight of indicators are inconsistent with the practical, more specific, price index almost 100% decide the result in the last period of selection. All passed candidates should not be seemed equal because they get different scores in site visit stage.

6). Traditional procurement model vs. JIT procurement

Mrs. Zhang explain that company existing procurement model belongs to traditional model, while JIT procurement model is new and advanced one, compared with JIT

Procurement, the strengths of traditional procurement model are:

- Having multiple suppliers to choose, then purchasing in the lowest price.
- Relatively lower frequency in distribution and delivery.
- Always have material in stock, don't have risk of suspending production due to delivery delay.

Weaknesses of traditional procurement model are:

- More suppliers to choose may lead relatively relationship loose and unstable material quality.
- Traditional procurement inspection may lead information asymmetry and black case.
- Traditional procurement cause additional inventory expense and resource waste.

7). Outstanding suppliers participated in JIT procurement supplier selection

Mrs. Zhang answers that methods of public bidding and invited bidding are two main models which were used in their company, so it is hard to say how many vendors they have in total, they have potential supplier all around the world. For main material suppliers, they have cooperated with 10 potential vendors so far, during the supplier selection process, price normally plays key role in final decision, supplier with lowest price have high possibilities to win the bid.

Supplier assessment group in our company use our assessment model to give cooperated supplier performance scores every beginning of the year, according to the previews records, Mrs. Zhang said they have 4 material suppliers can be seen as the most outstanding vendors, they all perform well during the cooperation period, and the case company still keep cooperation relationship with those suppliers until now. So the best supplier for JIT procurement will comes out from these four alternatives. Case company's requirement of keeping business secret, it is not convenient to

disclose the vendor name here, so the thesis author uses the capital letter ABCD instead of the suppliers' name. Four companies are Supplier A, Supplier B, Supplier C, and Supplier D.

4.1.2. Streamlining potential alternatives to determine the final selection indicators

After literature review of JIT Procurement supplier selection criteria and one interview was held to collect more information about the actual requirement of case company, moreover, considering the requirement of supplier for JIT Procurement. 15 potential vendor selection indicators were identified by the author. It consists of price, quality, punctual delivery, risk management awareness, etc.

Among these 15 potential criteria, several main criteria will be identified; here questionnaire method was utilized to collecting the main criteria, the topic of questionnaire is evaluation the importance of criteria JIT procurement. 6 copies of questionnaire were sent in the case company in February 2015, one for general manager, and other 5 respondents are assessment team members. The questionnaire paper in Chinese and English both can be found in the Appendix chapter.

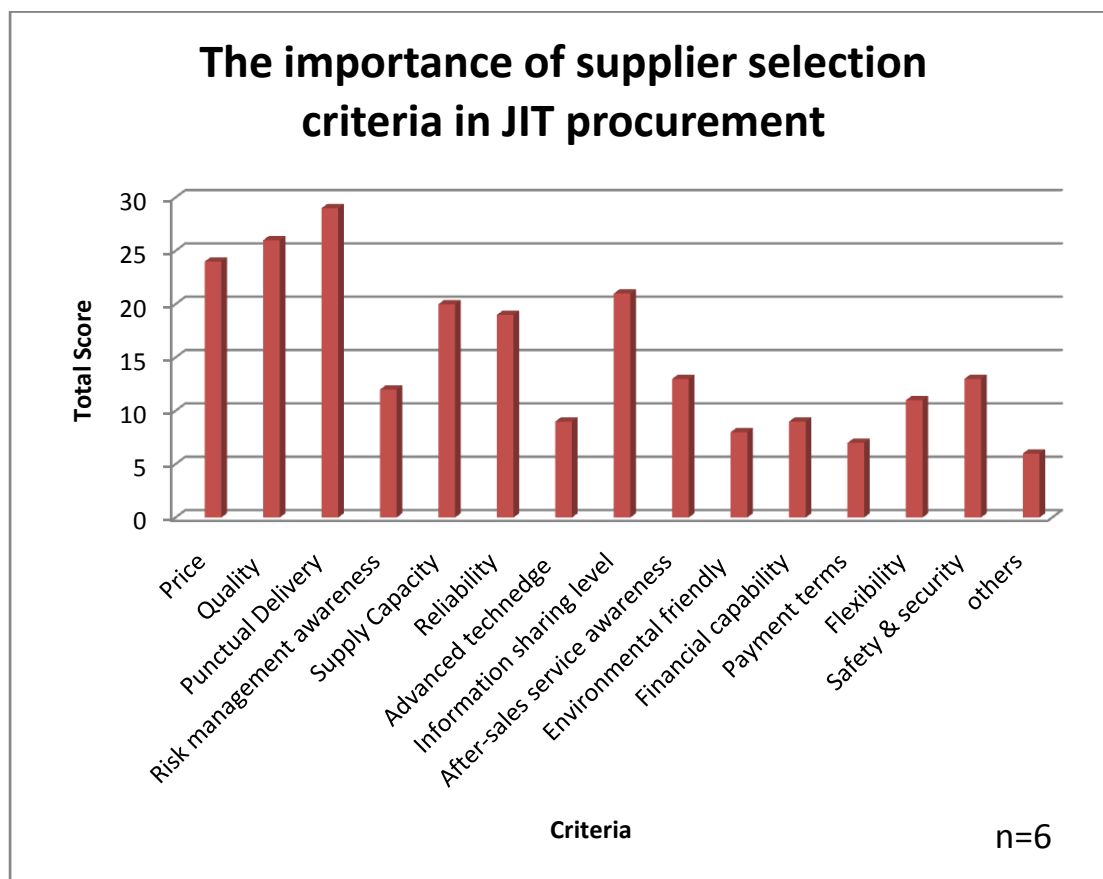


Figure 7. The importance of supplier selection criteria in JIT procurement.

There are 6 respondents participated in this survey; in figure xx, it is apparently shows that total score of punctual delivery almost reach the peak, it is extremely important for supplier selection, price and quality almost approach total score of 25, which are significant important as well. Supply capacity, reliability and information sharing level got total score of 19, 18, and 21, respectively. Risk management awareness, after-sales service awareness, flexibility and safety& security get total score between 10 to 15, which mean they are less important criteria. The importance of the rest indicators are even less than the previous elements.

According to the result of quantitative research, six criteria which achieved total score ranking in front of other indicators are selected finally. Six assessment indicators are:

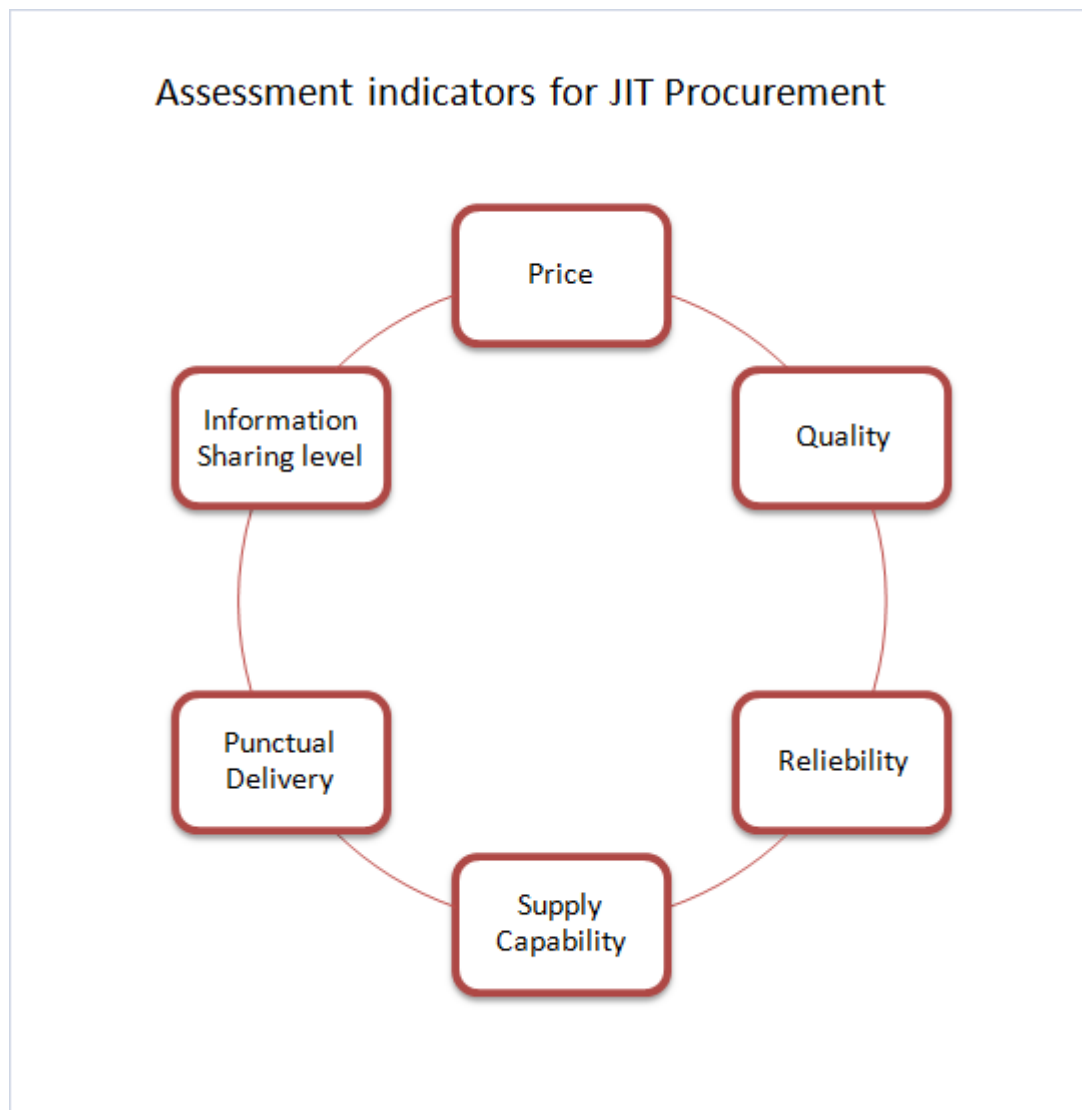


Figure 8. Final supplier selection indicators identify.

- Price is the value which buyer side pays the seller for goods. For all manufacturing company, the price of raw material belongs to the costs; it directly affects the cost of product, thereby affecting the product price and marketing sales volume, and ultimately affects corporate profits. So it is always an important criterion in business.
- Quality is prerequisite in selecting supplier. All manufacturing companies are eager to grasp opportunities to cooperate with suppliers, because the quality of raw material decide the quality of end product, thus affecting product sales price and marketing sales volume. During the vendor selecting process, quality is the

most important factor to consider , particularly when implementing JIT Procurement, single sourcing supplier model have higher standard in quality control for supplier.

- Reliability refers to supplier’s ability of fulfilling commitment, treating buyers with honest; having good reputation in the field, cooperating with higher reliable supplier means a relatively certain guarantee of success. Due to the characteristic of single sourcing supplier in JIT procurement, high reliability supplier is essential required to maintain long term relationship.
- Punctual delivery capability is much more important than price indicator during JIT Procurement, due to the fact that the character of JIT Procurement is lower inventory or no inventory to decrease business cost, which means all production process, will stop for waiting delivery delayed material, hence, having punctual delivery capabilities is particularly important.
- Information sharing level refers to the ability to share information between buyer and supplier. In JIT Procurement model, small quantity-multi frequency procurement method was used, this approach requires information between supplier and manufacturing company must be extremely high sharing, to ensure the accuracy and timeliness of supply and demand. Partners information exchange must be strengthens in JIT Procurement,
- Supply capability indicator is used to identify whether the vendor has the ability to meet manufacturing company’s requirement any time, it’s the base for suppliers to keep delivery punctual. In view of long-term cooperation and single-source supply feature in JIT Procurement, production capacity must be ensure to decrease operation risk of manufacturing company.

4.2. Empirical approaches to making decisions-AHP Application

“Analytic Hierarchy Process is a flexible model that will enable individuals or organizations to mold ideas and make their own hypothesis, and from the solutions

they require to define the issue, it also enables people to test solutions, or the results of sensitive , so as to change information” (Saaty 1982:22).

In the thesis, the Judgment matrix calculation method was utilized to help purchasing group making decision on which vendor will be selection for the case company as single sourcing supplier.

4.2.1. Structuring vendor selection Hierarchy

“A hierarchy is a more or less faithful model of a real-life situation; it represents our analysis of the most important elements in the situation and of their relationships” (Saaty 1980:17).

A Three levels hierarchy structure will be established in the thesis, which are target layer, criterion layer and solution layer. Target layer is to select the best supplier for case company’s JIT Procurement. Criterion layer consists of six criteria which were replaced by B1 B2 B3 B4 B5 and B6. Solution layer is composed by four potential suppliers ABCD. In the analytic hierarchy model, straight lines are used to indicate interrelated between factors in upper layer to down layer. If the layer have associated with all elements in down layer, which mean these two layers have full level relationship. The hierarchy structure is the base for further analysis.

The specific evaluation indicators corresponding model showed as below:

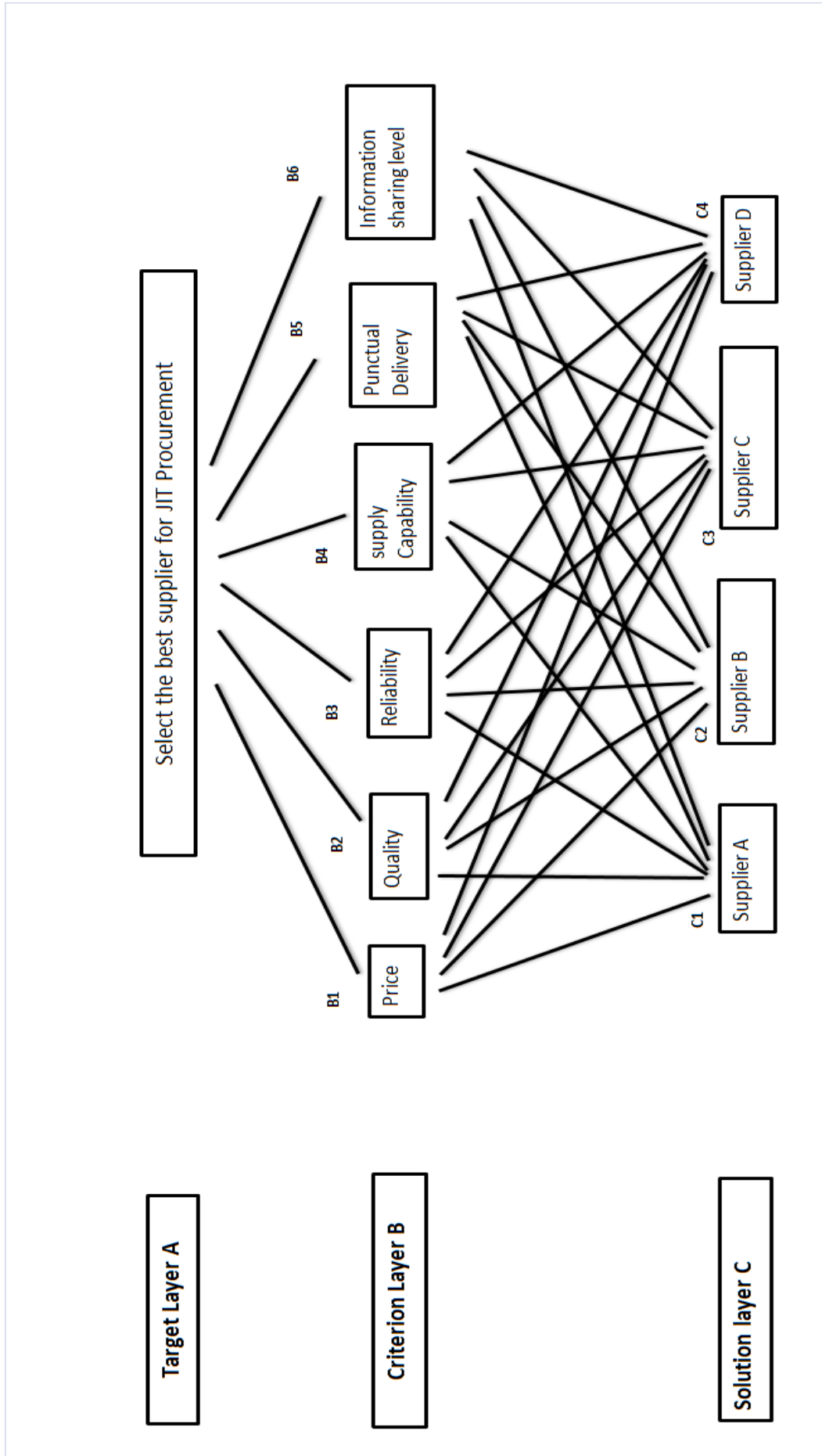


Figure 9. Vendor selection hierarchy.

4.2.2. Judgment Matrix for Pair-wise comparisons

After structuring the hierarchy, the step of collecting input data by pair-wise comparison comes for establishing judgment matrix.

Dr. Thomas Saaty (1980) had recommended a scale of 1 to 9 when comparing two factors, with a score of 1 refers to there is no difference between two factors and 9 represents one factor is extremely important than the other one. On the other hand, if a factor has weaker impact, the range of scores will be from 1 to 1/9, where 1 represents indifference and 1/9 represents the factor is extremely unimportant than the other one.

Scale of Relative Importance		
Intensity of relative importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective.
3	Moderate importance of one over another.	Experience and judgment slightly favor one activity over another.
5	Essential or strong importance.	Experience and judgment strongly favor one activity over another.
7	Demonstrated importance.	An activity is strongly favored and its dominance is demonstrated in practice.
9	Extreme importance.	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8,	Intermediate values between the two adjacent judgments.	When compromise is needed.
Reciprocals of above non-zero numbers.	If an activity has one of the above numbers compared with a second activity, then the reciprocal value when compared to the first.	

Figure 10. Scale of Relative importance (Saaty 1980)

It is very important to fill the judgment matrix. Seven judgment matrix table was finished by Purchasing Manager Zhang, the method for filling the matrix were

repeatedly asked participant the level of importance between element in matrix according to the table scale of relative importance.

From the hierarchy, it is obviously that 7 pair-wise data need to be collected, which are pair-wise comparison for criteria in layer B, pair-wise comparison for solutions based on price, pair-wise comparison for solutions based on quality, Four pair-wise comparison for solutions based on other four criteria, respectively. For instance the filled pair-wise comparison for criteria in layer B is as follows:

Comparison of supplier selection criteria						
A-B	B1	B2	B3	B4	B5	B6
B1	1	1/2	4	2	1/3	2
B2	2	1	5	3	1/2	3
B3	1/4	1/5	1	1/2	1/6	1/2
B4	1/2	1/3	2	1	1/5	1
B5	3	2	6	5	1	5
B6	1/2	1/3	2	1	1/5	1

Figure 11. Comparison of supplier selection criteria.

Filled judgment matrix has following properties:

- 1) $a_{ij} > 0$
- 2) $a_{ij} = 1/a_{ji}$
- 3) $a_{ii} = 1, (i, j = 1, 2, 3, 4, \dots, n)$

According to the characteristics above, judgment matrix has symmetrical and transitive.

4.2.3. Eigenvector and Eigen value

According to the filled out judgment matrix above, a certain mathematic methods will

be used to calculate its Eigenvector and Eigen value.

Eigenvector E_i

First of all, to multiply all values in the row:

$$M_i = a_{i1} + \dots + a_{ij} = \sum_i^n a_{ij} \quad (i,j=1\dots n, n=6), \quad (1)$$

$$W = \sqrt[n]{M_1} + \dots + \sqrt[n]{M_i} = \sum_i^n \sqrt[n]{M_i} \quad (i,j=1\dots n, n=6), \quad (2)$$

$$E_i = \sqrt[n]{M_i} / W \quad (i,j=1\dots n, n=6) \quad (3)$$

After normalized by each column, the priority vector for criteria was achieved.

$$\text{Eigenvector } E_i = (0.151, 0.242, 0.046, 0.082, 0.398, 0.082)$$

The sum of six values equal to 1, and these six specific values refers to the proportions of six criteria to the target factor, respectively.

To multiply the judgment matrix A with eigenvector E_i to achieve AE_i for further calculation.

$$AE_i = \begin{bmatrix} 1 & 1/2 & 4 & 2 & 1/3 & 2 \\ 2 & 1 & 5 & 3 & 1/2 & 3 \\ 1/4 & 1/5 & 1 & 1/2 & 1/6 & 1/2 \\ 1/2 & 1/3 & 2 & 1 & 1/5 & 1 \\ 3 & 2 & 6 & 5 & 1 & 5 \\ 1/2 & 1/3 & 2 & 1 & 1/5 & 1 \end{bmatrix} * \begin{bmatrix} 0.151 \\ 0.242 \\ 0.046 \\ 0.082 \\ 0.398 \\ 0.082 \end{bmatrix} \quad (4)$$

$$AE_i = (0.914, 1.462, 0.280, 0.491, 2.426, 0.491)$$

$$\text{Eigenvalue } \lambda_{max} = \frac{\sum_i^n AE_i / E_i}{n} = 6.054 \quad (5)$$

4.2.4. Consistency Verification

After calculating Eigenvector and Eigenvalue, the next step is Judgment matrix consistency verification, for the purpose of explaining the judgment matrix is reasonable in logic. Only if judgment matrix has passed the consistency verification, eigenvector and eigenvalue can estimate the weight of indicators. And it is meaningful to continue analysis and to obtain the final result based on the previous data. The steps for consistency test are as following:

Firstly, to calculate Consistency index C.I.

$$C.I. = \frac{\lambda_{max} - n}{n-1} = \frac{6.054 - 6}{6-1} = 0.011 \quad (6)$$

Secondly, to determine corresponding average random consistency index R.I. by check the table below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Figure 12. Corresponding average random consistency index R.I. (Saaty 1982)

From the table we can see that different matrices have different values, for instance, for 6 matrices, R.I. =1.24.

Thirdly, to calculate consistency ratio C.R., then to judge whether the judgment matrix satisfy the requirement of consistency.

$$C.R. = \frac{C.I.}{R.I.} \quad (7)$$

The judgment matrix consistency is acceptable if $C.R. < 0.1$, otherwise, the judgment matrix does not meet the requirement of consistency, the judgment matrix should be modified.

For supplier selection criteria matrix, $C.I. = 0.011$ and $C.R. = 0.009 < 0.1$, so the

judgment matrix is acceptable. The importance of six criteria to the target is:

Punctual delivery > Quality > Price > Production capacity = Information processing capacity > Reliability.

4.2.5. Calculating the relative importance of elements in single criterion

The relative importance of criteria for selecting supplier was done based on the AHP calculation method above, for the solution factors to Layer B. There are still have six judgment matrixes need to be calculated and consistency tested by following the above calculation process. Six filled out judgment matrixes, their eigenvalues, consistency indexes and consistency ratios are:

B1-C	C1	C2	C3	C4
C1	1	1/2	3	4
C2	2	1	4	5
C3	1/3	1/4	1	1/2
C4	1/4	1/5	2	1

Figure 13. Four alternatives judgment matrix based on price.

$$\lambda_{max} = 4.138$$

$$C.I. = 0.046$$

$$C.R. = 0.015$$

B2-C	C1	C2	C3	C4
C1	1	2	3	1/3
C2	1/2	1	2	1/4
C3	1/3	1/2	1	1/5
C4	3	4	5	1

Figure 14. Four alternatives judgment matrix based on quality.

$$\lambda_{max} = 4.051$$

$$C.I. = 0.017$$

$$C.R. = 0.019$$

B3-C	C1	C2	C3	C4
C1	1	1/2	4	1/2
C2	2	1	5	1
C3	1/4	1/5	1	1/5
C4	2	1	5	1

Figure 15. Four alternatives judgment matrix based on reliability.

$$\lambda_{max} = 4.028$$

$$C.I. = 0.009$$

$$C.R. = 0.010$$

B4-C	C1	C2	C3	C4
C1	1	1/3	1/2	1/2
C2	3	1	1/2	1/2
C3	2	2	1	1
C4	2	2	1	1

Figure 16. Four alternatives judgment matrix based on supply capability.

$$\lambda_{max} = 4.153$$

$$C.I. = 0.051$$

$$C.R. = 0.057$$

B5-C	C1	C2	C3	C4
C1	1	1/3	2	1/2
C2	3	1	4	3
C3	1/2	1/4	1	1/3
C4	2	1/3	3	1

Figure 17. Four alternatives judgment matrix based on puncture delivery.

$$\lambda_{max} = 4.087$$

$$C.I. = 0.029$$

$$C.R. = 0.032$$

B6-C	C1	C2	C3	C4
C1	1	2	1/3	1/2
C2	1/2	1	1/4	1/3
C3	3	4	1	2
C4	2	3	1/2	1

Figure 18. Four alternatives judgment matrix based on information sharing level.

$$\lambda_{max} = 4.031$$

$$C.I. = 0.010$$

$$C.R. = 0.011$$

4.2.6. Vectors integrated for priority ranking

Consistency ratios for seven matrixes were tested acceptable. So eigenvectors and eigenvalues which were calculated in criteria layer and solution layer are reasonable in logic. All achieved vectors and values were formed as the table below for calculating the final result, the matrix multiplication gives the rate for four suppliers from which alternative should be chosen. All eigenvectors are showed as follows:

Eigenvector for all scale							
Criteria	B1	B2	B3	B4	B5	B6	Priority
Criteria eigenvector	0.151	0.242	0.046	0.082	0.398	0.082	Ranking
Suppliers							
C1	0.307	0.233	0.205	0.125	0.157	0.160	0.198
C2	0.494	0.138	0.365	0.217	0.505	0.095	0.351
C3	0.089	0.084	0.065	0.329	0.093	0.467	0.139
C4	0.110	0.545	0.365	0.329	0.245	0.278	0.312

Figure 19. Integrating eigenvector for priority ranking.

The calculation method for achieving each supplier's priority ranking values was:

$$\begin{aligned}
 Ec1 &= E_{c11} * E_{B1} + E_{c12} * E_{B2} + E_{c13} * E_{B3} + E_{c14} * E_{B4} + E_{c15} * \\
 E_{B5} + E_{c16} * E_{B6} &= 0.307 * 0.151 + \dots + 0.160 * 0.082 = 0.198 \quad (8)
 \end{aligned}$$

Total value for Ec2, Ec3, and Ec4 are calculated in the same way. And suppliers A, B, C, D four priority ranking values are 0.195, 0.351, 0.139, and 0.312, respectively.

$$0.351 > 0.312 > 0.195 > 0.139$$

According to the figures in the table above, it is clear that the alternative supplier B get the highest total score which is the best choice for the case company in selecting JIT Procurement supplier, the second alternative supplier is D. The next is supplier A, and then supplier C is the last alternative.

5. RESULTS AND DISCUSSION

Supplier selection is the foundation of JIT Procurement partnership operation. Based on the result from previous research, supplier B should be selected as the best alternative for the case company. Supplier B will be chosen as strategic supplier in JIT procurement rather than disposable cooperation in traditional procurement.

According to JIT Procurement characteristics and the case company's actual situation, suggestions for supplier relationship management are given as following:

To start with, it is very important to pick few suppliers or even single source supplier to establish strategic alliances. More specific, in preliminary period of implementing JIT procurement for the case company, it is very difficult to transform from multiple suppliers to single sourcing supplier directly and comprehensively, for instance, in the beginning of cooperation, due to miscommunication, the normal risks of delivery unpunctually may cause production disruption. So it would be better to select two suppliers at the beginning, one is main supplier, and the other one can be utilized as backup alternative to eliminate risks. Building beneficial business partnership refers to active communication, information sharing, mutual trust and long term collaboration. It's a foundation for developing common goals and benefits.

Secondly, the case company has to improve supplier training as well as identify the common goals. JIT procurement is a mutual business activity for both supply and demand sides, successful implementation of JIT procurement not only rely on the effort of purchasing department, but also require supplier's support. Only if supplier had comprehensive understanding of strategies and operation methods of JIT procurement, then vendor's support and cooperation will be just-in-time. So it is necessary to organize relative training for provider. Common goal will be identified through the training, which contributes to mutual work in JIT procurement.

Moreover, for the purpose of consolidating partnership, the case company should establish mutual beneficial contractual mechanisms with supplier. Mutual benefits

include commitment, trust and persistence, which are most important principle in business activities. Long term relationship cannot be established without trust between supplier and buyer. Persistence is assuring for partnership. Demand and supply relationship will be destructed if sincerity of improvement and disbursement missed.

Last but not least, after long period of cooperation, when delivery punctually, product quality verified, reasonable price and information sharing are fulfilled. The product exemption certificate could be issued to supplier. JIT procurement differs from traditional procurement, that buyer does not require too many product inspection procedures in order to reduce operation cost and time. So assuring product exemption certificate is extremely critical step in JIT procurement, and it's on the premise of qualified product which offered by supplier. For this reason, when the certificate issued, supplier has to provide the newest, correct, complicated product quality documents, it must includes blueprints, specifications, test procedures and other necessary key elements. After reaching the target by long-term test, all purchases of goods can be shipped directly from unloading point to the production line.

To conclude, some suggestions were given for the case company in supplier relationship management, for implementing JIT Procurement, the case company should discuss the target and related measures of JIT Procurement and keep frequently information communication with supplier B. Suitable amount of training can help supplier have a better understanding and knowledge of case company, thus to integrate and participant more agility in the business and production process of case company. Supplier B early involvement decides whether JIT Procurement can be implemented efficiency. Furthermore, through issuing supplier certificate and Streamline the transaction process, the case company could save cost, improve marketing competitiveness and achieve maximize profits.

6. CONCLUSIONS

There are three main aspects will be elaborated in conclusions chapter, the whole thesis from start to finish will be briefly summarized, author's work will be self evaluated, and the thesis limitations will be pointed out.

The structure of thesis was divided into six sections which consist of introduction, introduction of case company, literature review, JIT procurement supplier selection process, results and discussion, and finally conclusions.

In the first introduction part, the author gives a short description of thesis background, problems which the case company facing and thesis objectives were stated, research methods were mentioned and the framework of the thesis was introduced. In introduction of case company chapter, the author presented specialty paper industrial background, the basic information of case company and related department description. In literature review chapter, three main theory plates were reviewed, which are purchasing, supplier selection and AHP method, purchasing plate involved purchasing behavior, purchasing objectives, purchasing importance, procurement process and JIT procurement; supplier selection part included supplier selection models, supplier selection process, supplier selection criteria and supplier relationship management; AHP method combined definition, typical application process and theoretical limitations. JIT procurement supplier selection process consisted of supplier selection criteria identification and AHP application, both questionnaires research and interview research methods were utilized to accumulate data and information for the goal. After practical research and calculation, results and discussion phrase comprised of results analysis and supplier relationship management suggestions for JIT implementation, which combined with the results and realistic situation of the case company.

Concerning the question on no scientific evaluation system for vendor selection, AHP method as a scientific and logic system was utilized for selecting vendor, quantitative

research of questionnaire was used to accumulate input data for pair-wise comparison, eigenvectors and eigenvalues of groups' judgment matrixes were calculated for ranking priorities. All vectors were passed by consistency verification. The question of no specific supplier selection criteria in line with the actual situation of company was solved by using literature review, qualitative research and quantitative research, more specific, accumulating amount of indicators through literature review, collecting company procurement information through interview method and identifying final selection criteria through questionnaire method. Regarding the question on how to maintain supply relationship during JIT implementation, the author gave four specific suggestions in supplier relationship management.

Based on previous research process, the limitation of the thesis were, firstly, related small amount of interview participant and questionnaire fulfilling respondents as the result of limited time and condition, if participants and respondents increased, the final result will be more persuasiveness. Secondly, the limitation of thesis was the limitation of AHP methodology that the final score missing practical explanations, for instance, the decision makers may not know the significant difference between two alternatives when their final score are close.

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APPENDICES

APPENDIX 1. Interview questions for purchasing manager in the case company (In English)

- 1) What is your company purchasing material, and what are the main materials?
- 2) What is the procurement process in your company?
- 3) What is your main responsibility in the procurement process?
- 4) Does your company have vendor selection system? If yes, what is it and what are the evaluation indicators?
- 5) Do you think your company's evaluation indicator System for vendor selection is comprehensive enough? If no, which indicator should be enriched?
- 6) What are the strength and weakness of your procurement model compared with JIT Procurement?
- 7) How many pulp suppliers does your company have so far? How many outstanding alternatives will participate in JIT procurement supplier selection?

APPENDIX 2. Interview questions for purchasing manager in the case company (In Chinese)

1. 贵公司采购货品主要有哪些, 主材货品是什么?
2. 贵公司的采购流程是怎样的?
3. 在采购过程中您的主要职责是什么?
4. 贵公司有供应商选择和评估系统吗, 如果有, 对供应商的评估指标有哪些?
5. 您认为贵公司的供应商选择和评估指标体系足够全面吗? 如果不, 哪些指标可以被加入?
6. 和 JIT 采购模式相比较, 贵公司现有的采购系统的优势和劣势?
7. 贵公司目前为止有多少个纸浆供应商, 参与 JIT 采购供应商选择的备选供应商有几个?

APPENDIX 3. Questionnaire of picking supplier selection criteria for the case company (In English)

Evaluation the importance of criteria in JIT procurement

Criteria	The level of importance				
	5	4	3	2	1
Price	5	4	3	2	1
Quality	5	4	3	2	1
Punctual Delivery	5	4	3	2	1
Risk management awareness	5	4	3	2	1
Supply Capacity	5	4	3	2	1
Reliability	5	4	3	2	1
Advanced technedge	5	4	3	2	1
Information sharing level	5	4	3	2	1
After-sales service awareness	5	4	3	2	1
Environmental friendly	5	4	3	2	1
Financial capability	5	4	3	2	1
Payment terms	5	4	3	2	1
Flexibility	5	4	3	2	1
Safety & security	5	4	3	2	1
others	5	4	3	2	1
Note:					
5: Extremely important					
4: Very important					
3: Moderately important					
2: Less important					
1: Unimportant					

APPENDIX 4. Questionnaire of picking supplier selection criteria for the case company (In Chinese)

评价以下供应商选择指标在JIT采购中的重要性

评选标准	重要度				
	5	4	3	2	1
价格	5	4	3	2	1
质量	5	4	3	2	1
准时交货	5	4	3	2	1
风险管理意识	5	4	3	2	1
供应能力	5	4	3	2	1
信用度	5	4	3	2	1
先进技术	5	4	3	2	1
信息共享度	5	4	3	2	1
售后服务意识	5	4	3	2	1
环境友好	5	4	3	2	1
财务能力	5	4	3	2	1
付款方式	5	4	3	2	1
灵活性	5	4	3	2	1
安全	5	4	3	2	1
其他	5	4	3	2	1
注意:					
5: 极度重要					
4: 非常重要					
3: 中等重要					
2: 不太重要					
1: 不重要					

APPENDIX 5. Questionnaire of collecting input data for pair-wise comparison (In English)

Comparison of supplier selection criteria						
Criteria	Price	Quality	Reliability	Supply C	Delivery	Information
Price						
Quality						
Reliability						
Supply C						
Delivery						
Information						

Comparison of suppliers based on six selection criteria									
Price	Supplier A	Supplier B	Supplier C	Supplier D	Quality	Supplier A	Supplier B	Supplier C	Supplier D
Supplier A					Supplier A				
Supplier B					Supplier B				
Supplier C					Supplier C				
Supplier D					Supplier D				
Reliability	Supplier A	Supplier B	Supplier C	Supplier D	Supply C	Supplier A	Supplier B	Supplier C	Supplier D
Supplier A					Supplier A				
Supplier B					Supplier B				
Supplier C					Supplier C				
Supplier D					Supplier D				
Delivery	Supplier A	Supplier B	Supplier C	Supplier D	Information	Supplier A	Supplier B	Supplier C	Supplier D
Supplier A					Supplier A				
Supplier B					Supplier B				
Supplier C					Supplier C				
Supplier D					Supplier D				

APPENDIX 6. Questionnaire of collecting input data for pair-wise comparison (In Chinese)

供应商选择标准比较

标准	价格	质量	信用度	供给能力	准时交货	信息共享能力
价格						
质量						
信用度						
供给能力						
准时交货						
信息共享能力						

供应商分别基于6个选择标准的比较

价格	供应商A	供应商B	供应商C	供应商D	质量	供应商A	供应商B	供应商C	供应商D
供应商A					供应商A				
供应商B					供应商B				
供应商C					供应商C				
供应商D					供应商D				
信用度	供应商A	供应商B	供应商C	供应商D	供给能力	供应商A	供应商B	供应商C	供应商D
供应商A					供应商A				
供应商B					供应商B				
供应商C					供应商C				
供应商D					供应商D				
准时交货	供应商A	供应商B	供应商C	供应商D	信息共享能力	供应商A	供应商B	供应商C	供应商D
供应商A					供应商A				
供应商B					供应商B				
供应商C					供应商C				
供应商D					供应商D				