Improving Supplier Selection and Evaluation Process in Processed Chicken Food Factory

Miss Puncharas Nanthiyanuragsa

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By	Miss Puncharas Nanthiyanuragsa
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Thesis Advisor	Associate Professor Jeerapat Ngaoprasertwong

Accepted by the Faculty of Engineering, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

.....Dean of the Faculty of Engineering

(Associate Professor Supot Teachavorasinskun, D.Eng.)

THESIS COMMITTEE

.....Chairman

(Professor Parames Chutima, Ph.D.)

.....Thesis Advisor

(Associate Professor Jeerapat Ngaoprasertwong)

.....Examiner

(Assistant Professor Somchai Puajindanetr, Ph.D.)

.....External Examiner

(Assistant Professor Boonwa Thampitakkul, Ph.D.)

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การคัดเลือกเลือกผู้จัดจำหน่ายเป็นปัญหาที่ซับซ้อนและเป็นกิจกรรมเชิงกลยุทธ์ของแผนกจัดซื้อในห่วงโซ่อุปทาน การคัดเลือกผู้จัดจำหน่ายไม่ได้ให้ความสำคัญแต่เพียงเฉพาะเกณฑ์ในด้านราคาของวัตถุดิบเพียงด้านเดียว แต่ยังขึ้นอยู่กับอีกหลายๆเกณฑ์ ทั้งเกณฑ์ในเชิงปริมาณและเชิงคุณภาพ การแลกเปลี่ยนระหว่างเกณฑ์เชิงคุณภาพและเกณฑ์เชิงปริมาณเหล่านี้ จะทำให้สามารถเลือกผู้จัดจำหน่ายที่ดีที่สุดจากผู้จัดจำหน่ายรายอื่นๆ ซึ่งตรงกับความต้องการของบริษัทมากที่สุด วิทยานิพนธ์นี้ประกอบด้วยการใช้การตัดสินใจด้วยวิธีการวิเคราะห์เชิงลำดับชั้น วิธีการนี้เป็นมีวิธีที่ให้ความสำคัญกับการใช้เกณฑ์การประเมิน เพื่อคัดเลือกผู้จัดจำหน่ายที่เหมาะสม โดยขึ้นอยู่กับน้ำหนักของแต่ละเกณฑ์ วิทยานิพนธ์นี้ใช้แบบจำลองการคัดเลือกผู้จัดจำหน่ายด้วยการใช้การตัดสินใจวิธีการวิเคราะห์เชิงลำดับชั้นและนำไปใช้กรณีศึกษาจริงสำหรับบริษัทผู้ผลิตไก่สดแช่แข็งอาหารในประเทศไทย โดยใช้รูปแบบการตัดสินใจหลายเกณฑ์ และการประเมินให้คะแนนผู้จัดจำหน่าย ซึ่งสามารถลดเวลาและความพยายามในการคัดเลือกผู้จัดจำหน่าย รวมทั้งสามารถปรับปรุงกระบวนการตัดสินใจในการแก้ปัญหาการคัดเลือกผู้จัดจำหน่ายอีกด้วย

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		ลายมือชื่อ อ.ที่ปรึกษาหลัก	.....
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Supplier selection is a complex problem and a strategic activity of a purchasing department in a supply chain. Suppliers are not selected based only on price but also selected based on multi-criteria both qualitative and quantitative criterions. A trade-off between these tangible and intangible factors finally provides the best supplier who offers the best deal among others. The study incorporates AHP in selecting the best supplier. This approach provides an explicit way of criteria evaluation to select the right supplier, depending on its importance. For this study, an AHP supplier selection model is formulated and applied to the real case study for frozen chicken-food manufacturing company in Thailand. Using the AHP-based multi-criteria decision model via scoring suppliers performance reduces time and effort in supplier selection as well as improves decision making process of solving the supplier selection problem.

Department:	Regional Centre for Manufacturing Systems Engineering	Student's Signature	.....
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Chapter 1 Introduction

1.1 Background of thesis

Supplier management is one of critical key issues in supply chain management since raw material cost constitutes the main cost of a product and most of companies have to spend significant amount of sales revenues on purchasing raw materials. Thereby, supplier selection is one of the most important decision making issue because choosing the right suppliers considerably reduces the purchasing costs and increase corporative competitiveness. Most industries especially manufacturing companies, the raw material cost constitutes the majority of product cost, in some cases it can be accounted for up to 70%, [1]. For this situation, a good supplier selection decision of purchasing department plays an essential role in cost reduction. In today's intensive competitive environment, an effective supplier selection is a very important strategic process to any organization's success [2].

In particular framework discussed in this study, known as the ABC Company is a Thai poultry company which sells frozen chicken parts, processed chicken such as chicken sausages, chicken balls and bolognas and other chicken frozen foods such as chicken sandwiches domestically for about 30 years. In order to manufacture products, several raw materials are required, for instance fresh chicken parts, ingredients, vegetables, spices and casing. The firm works with a number of both local and

international suppliers for its raw materials. Some of raw materials are supplied from many sources and some of raw materials are supplied from a single source. In this study, raw materials which were selected from Pareto Analysis will be taken to the consideration. The selected raw materials are chicken parts, casing and spices since these raw materials constitutes approximately 90 percent of the total raw material cost.

Supplier selection is a complex and difficult process since different suppliers have different strengths and weaknesses which the purchasing department has to carefully assess to select the best supplier. Actually, it would have been easier if the supplier selection is done based only on one criterion such as price. Nevertheless, buyer-supplier relationship that based only on price isn't appropriate for recent supply chain management. Strategic and operational factors such as delivery, quality and services should also be carefully considered.

Supplier selection together with multiple criteria decision making (MCDM) involves trading off among multiple criterions both tangible and intangible based on purchasing situations which may leads to conflicts [3]. Since there are many criterions, it is essential to identify how far each single criterion affects the decision making process, either they are all weighted equally or differently, depending on type of criteria [4].

The analytic hierarchy process (AHP) is an effective decision-making method for ranking alternatives by weighting multi criteria or even sub criterion which has many widespread applications in decision making problem [2]. AHP approach allows decision

makers to structure complex problem with multiple factors in terms of easy-understanding hierarchy [5] which facilitates the decision making for optimal supplier combination [6]. The approach is very useful for many decision makers with different conflicting factors to reach the consensual decision [7].

The advantage of AHP method is that both quantitative and qualitative criterion can be applied and the result of method is represented in terms of numeric which is easy to understand and compare as well as applicable for further applications. Furthermore, the pair-wise comparison provides consistent computation. Therefore, the method is an effective, reliable and powerful decision-making methodology which provides results that match with the objective as much as possible. AHP can also eliminate prejudiced decision making and applicable for both single and multi-decision makers.

1.2 Statement of problem

There are 438 different raw materials to be purchased and responsible by ABC procurement team. Since the number of raw material is huge, some of raw materials are not well organized in terms of planning and appropriate purchasing and negotiation strategy. Even though ABC procurement team obtains the whole year manufacturing plan from the factory department, the team still proceeds procurement operations as monthly routine works, not a long term. This means proper strategy isn't applied to purchasing process. Moreover, there are too many suppliers for just one raw material, see Table 1. Thereby, although ABC Company has considerable bargaining power due

to large volume order, the company didn't take full advantage from its strength. Losing bargaining power of procurement team for manufacturing company leads to higher unit cost as well as cost of goods sold and less profit.

The selected raw material types to improve supplier selection and evaluation process are as follow; (referred to Pareto Analysis from the appendix 9.1, these 3 raw material types account for about 80% of the total expense of whole purchased raw materials)

1. Chicken parts
2. Casing
3. Spices

Chicken Parts

As ABC Company produces frozen chicken foods thereby chicken parts are raw material that primarily used in the production, which accounted for 50% of total raw materials every year, see Fig.1 and costs approximately 500 million Baht annually.

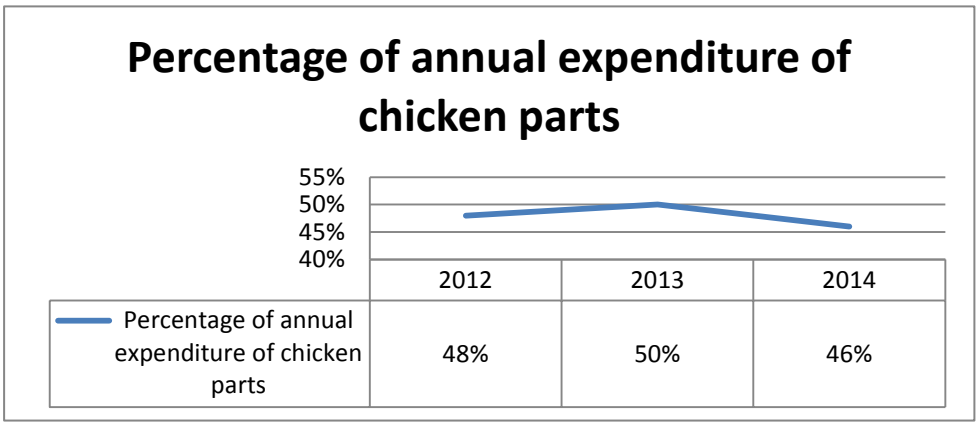

Figure 1 percentage of annual expenditure of chicken parts

Therefore, chicken parts are the main raw material which should be considered closely in strategic purchasing. Chicken parts are procured for the production from many different suppliers and different purchasing quantity. In 2014, the purchased quantity of chicken parts can be classified as follow.

Table 1 Suppliers and purchasing ratio for carcass without tail in 2014

Supplier name	Purchasing quantity : Kg	Purchasing quantity ratio : %
G	3,427,450.00	35.86
E	2,865,682.61	29.98
B	2,052,580.00	21.48
C	1,110,170.00	11.62
U	48,750.00	0.51
V	22,480.00	0.24
W	19,000.00	0.2
X	6,000.00	0.06
Y	3,600.00	0.03
A	1,000.00	0.01
Z	500.00	0.005
Others	470.00	0.0049
Total	9,557,682.61	100

From Table 1, it can be seen that there are 12 suppliers for just one raw material which are too many and led to decrease in bargaining power for volume negotiation. Furthermore, because the raw material was procured monthly without a long-term planning or good relationship with suppliers, this raw material wasn't enough for production plan. Thereby, the procurement team tried to purchase the rest with minor suppliers. Unfortunately that the company didn't have a close relationship with these minor suppliers, the procurement team had to buy the rest trickingly.

Casing

The second raw material that will be used for this study is casing. One of the main product families is sausage which requires casing for its production. Casing accounts for more than 20% of total raw material expenditure or at least 318 million Baht annually see Figure 2.

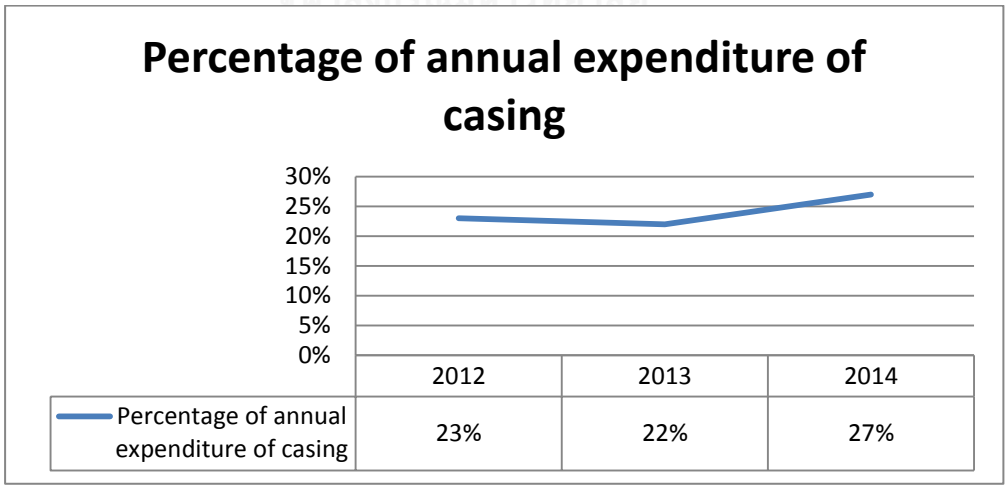

Figure 2 Percentage of annual expenditure of casing in 2014

The casings that have used for the production are imported from different countries such as France, Japan and Spain since there are two types of casing: cellulose and collagen and each type of casing has many sizes and specifications. Some of suppliers have only cellulose casing and some suppliers have only collagen casing and some have both. Furthermore, each supplier has different ranges of casing size. Nevertheless, there are not many vendors who supply sausage casing. Actually there is Chinese casing provider that offered reasonable price but the specification and the quality of purchased casing were very poor.

From Table 2, according to Pareto Analysis there are 11 casings in Class A. From that, six casings (about 175 million Baht annually or about 54% of casing) are purchased from only B.O.T. Company which is a Japanese dealer which are Amiflex 37, yellow collagen 22, collagen 22, number 26 and 28.

Table 2 List of casing that purchased from only one single supplier in 2014

Item	Purchasing quantity : Kg	Purchasing quantity ratio : %
Amiflex 37	21,960.00	100
no. 22 Yellow Collagen	1,015,470.00	100
no. 22 Collagen	1,122,660.00	100
no.26	179,865.00	100
no.28	117,684.00	100

Sourcing from only one supplier or monopoly supplier leads to losing bargaining power as there wasn't competition atmosphere in terms of price, quality and service to supplier and high risk of supply since there is only single source.

Spice

Spice is considered as the third highest expense for raw materials at about 238 million in 2014. Baht per year or approximately 20% of total raw material expenditure annually, see Figure 3. There are 98 spices for production since there are many SKUs. For this study, according to Pareto Analysis, there are 5 spices in Class A which are modified starch, soy protein, potato flour, dough and granulated sugar.

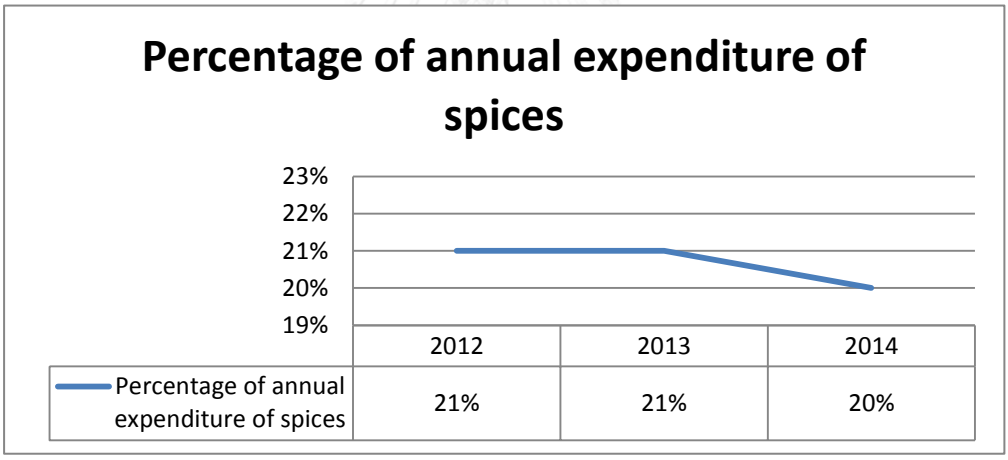

Figure 3 percentage of annual expenditure of spices

This 5 items account for 63% of total spice expense or about 151 million Baht in 2014. For spices such as soy protein and granulated sugar they are also bought from a single supplier as well, see Table 3. Consequently, a monopoly supplier leads to less

bargaining power of the procurement team because there wasn't a price, quality or service competition and high risk of supply since there is only one available supplier.

Table 3 Suppliers and purchasing ratio for soy protein and granulated sugar in 2014

Item	Supplier name	Purchasing quantity : Kg	Purchasing quantity ratio : %
Soy protein	Ultimate Wild Chemical	375,000.00	100
Granulated sugar	Cheuchaloen	656,000.00	100

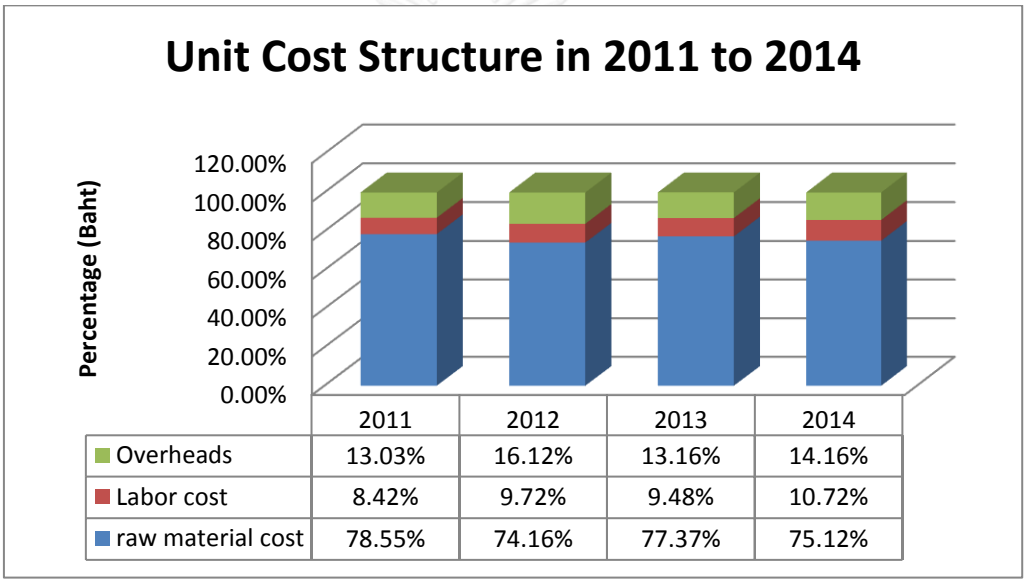

Figure 4 Cost structure per unit year 2011 to 2014

Furthermore, according to Figure 4 it's clear that approximately 80% of cost of goods sold comes from raw material cost and tend to be increased every year. In 2012 fresh chicken parts, which used the most, couldn't export to other countries due to the bird flu in many countries such as European Union, Gulf Cooperation Council (GCC) and South Korea which caused oversupply of fresh chicken parts in Thailand and drove the

price down. Fortunately, in the following year some countries such as Japan, Bahrain, Oman, Qatar, United Arab Emirates and European Union cancelled the restriction and allow Thai fresh chicken parts to be imported which drove the cost up again. Because of expensive raw material due to supply situation and inefficient procurement process, cost of goods sold is increased. In addition, due to high cost of goods sold, in order to maintain profit level the selling price is increased as well which affects the competitiveness. Most of products are sold with higher price than competitors, see Figure 5 and Figure 6. Higher selling price leads to lower sales due to less competitive price with the same quality standard.

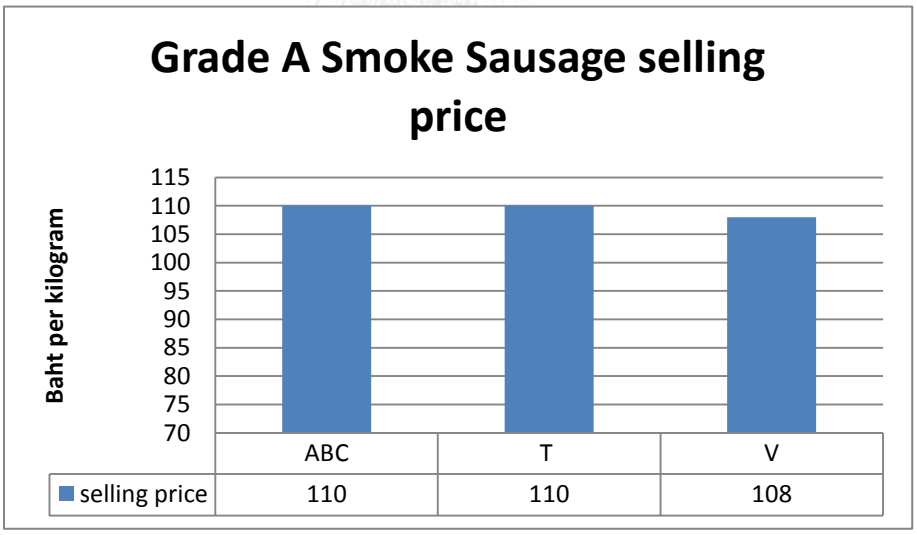

Figure 5 A selling price comparison of grade A smoke sausage between ABC and competitors

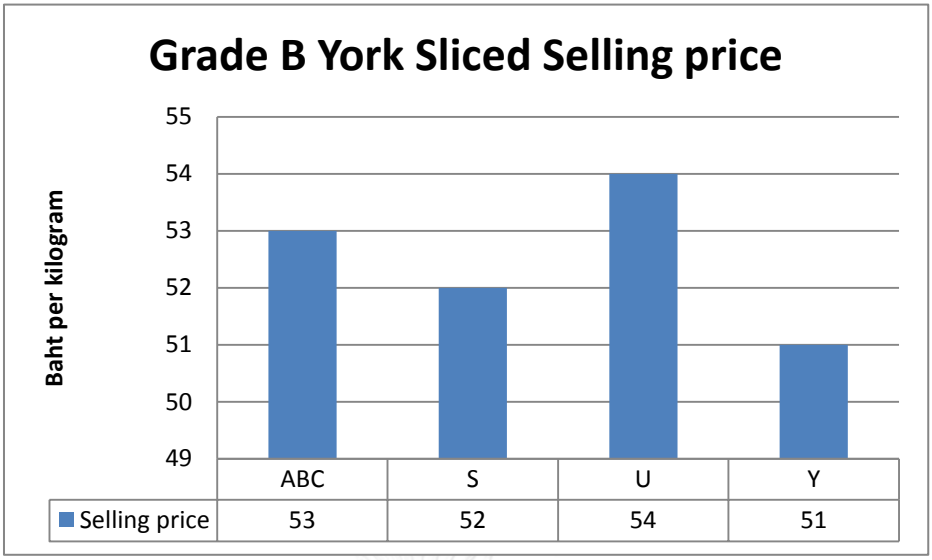

Figure 6 A selling price comparison of grade B Frank Smoke Sausage between ABC and competitors

These three raw material type will approximately cost a billion per year. In the same way, in Appendix A, according to Parato Analysis all of raw materials are ordered from the percentage of total annual expenditure in order to classify raw materials into 3 classes: A, B and C. It's obvious that there are only 3 types of raw material in class A which are chicken parts, casing and spices. Therefore, the selected raw materials for studying are these types in class A as they provide the highest impact on raw material costs.

According to Pareto Analysis, there are 27 items in class A: 11 items from chicken parts, 11 items from casing and 5 items from spices as follow;

Chicken parts: Casing: Spices:

No.	Material List	Amount
1	Carcass without tail	131,788,341.80

2	Boneless Breast meat (yield 3%)	79,926,244.27
3	Breast meat (yield 3%)	75,852,900.00
4	Casing no.22 YELLOW CALLAGEN	75,624,435.00
5	Casing no. 22 CALLAGEN	65,800,673.40
6	Breast meat	55,286,233.55
7	Modified Starch	52,249,500.00
8	Breast skin	44,852,132.75
9	Soy protein	39,135,000.00
10	Fillet (yield 3%)	35,447,827.97
11	Skin leg (yield 10.95%)	32,315,583.52
12	Casing no. 29	26,900,523.94
13	Carcass	25,386,963.14
14	Potato Starch	24,579,000.00
15	Wheat Flour	23,945,134.50
16	SBB Shoulder off (yield 3%)	20,414,957.50
17	Casing no.21 CELLULOSE	19,513,161.16
18	Casing no.19	15,418,784.12
19	Casing no. 26	14,168,857.50
20	Casing no.16	13,611,483.59
21	Granulated Sugar	13,398,720.00
22	Casing no. 22	12,319,098.20
23	Fillet	12,195,426.63
24	Boneless Breast meat	11,571,790.39
25	Casing no. 20	10,911,009.84
26	Casing no. 28	9,828,756.00
27	Casing Amiflex Tp#37	8,445,105.00

Raw materials that are supplied from the suppliers will be inspected for ISO 9000 standard. There are a set of procedure to audit and certify raw materials in order to be in conformance with ISO standard For example, in terms of quality, quality target commitments are set. For ABC Company, raw material specification, proportion of ingredient, quality of package, unwanted chemicals and adulterated things are inspected according to ISO as follow;

Material inappropriateness	less than 3 times/month
Wrong proportion of ingredient	less than 5 times/month
Packaging and carrying incapability	less than 5 times/month
Unwanted chemicals	less than 3 times/month
Adulterated things	less than 5 times/month

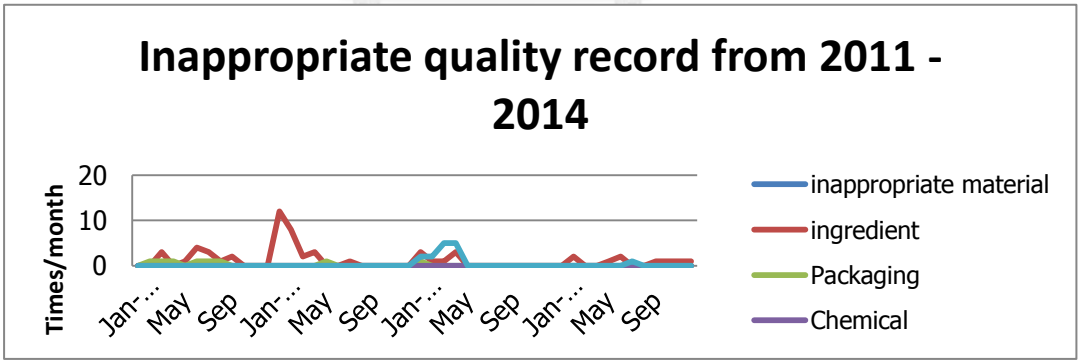

Figure 7 Inappropriate quality record from 2011 to 2014

According to Figure 7, there were few inappropriate quality records. Most of improperness is proportion of ingredient of raw materials since it's a sensitive area.

Nevertheless it will not be a significant concern for this research as all of the selected raw materials are a fresh part of chicken or unprocessed.

In terms of service, ordered raw materials should be supplied from suppliers at the right quality and on the due date. For ABC, ordered raw materials have to be sent within 10 days after the purchase orders issue and within 45 days in case of made-to-order. ABC procurement team set a quality performance commitment level at 98%. Some example recorded results are as follow.

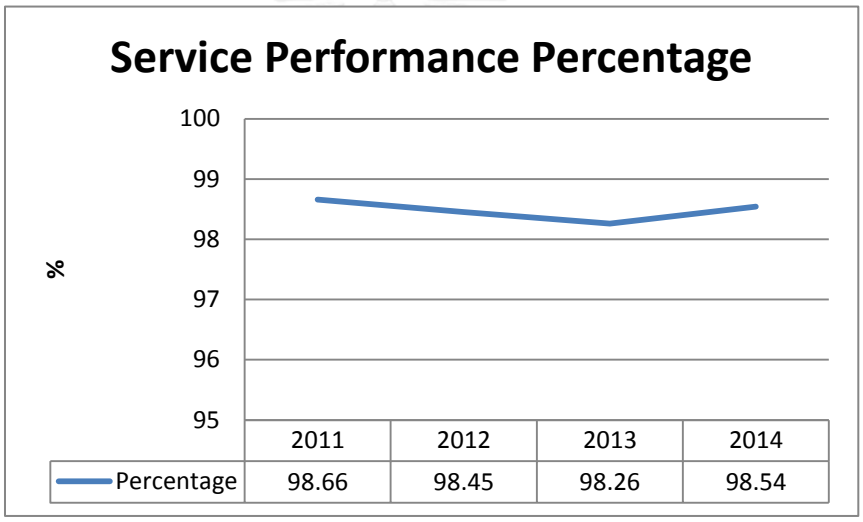

Figure 8 Service performance percentage from 2011 to 2014

According to Figure 8, it is clear that most of ABC's suppliers are reliable. They have supplied ordered raw materials mostly within the agreed due dates. There was approximately 1.5 % for late deliveries. The ABC consistently achieves its goal at 98% supplier service performance and the company would like to maintain this level of goal. If order materials are delivered late, it will affect production lines. Because of raw

material shortage, production lines are interrupted. The productions may be paused for a while until the ordered raw materials arrive in case of acceptable late deliveries or may be stopped if the delivery lead time is long or the distribution center is far away. For both case, late deliveries decrease production efficiency and stopped production costs a considerable amount of money. This means higher cost of goods sold with less profit.

1.3 Objective of thesis

To improve procurement efficiency through sourcing and purchasing raw materials using supplier selection through AHP technique

1.4 Scope of study

1.4.1 Only 3 types of raw material will be used for this thesis (chicken parts, casing and spices).

1.4.2 According to Appendix A, raw materials that are classified only in class A will be used.

1.4.3 All of suppliers for each raw material will be listed and weighted from Analytic Hierarchical Process (AHP).

1.4.4 Selecting criteria and scoring supplier will be operated under ABC procurement team's favor.

1.4.5 Selected and appropriate suppliers for performing contracts will be indicated.

1.5 Proposed methodology

The study is conducted according to these steps;

1.5.1 Calculated the total annual expenditure of each raw materials in every type of raw material

1.5.2 Classify these raw materials into 3 classes from the annual expenditure by using Pareto Analysis

1.5.3 Conduct supplier evaluations and selections using Analytic Hierarchical Process (AHP)

1.5.4 Review selected suppliers and make suggestions for each types of raw materials

Chapter 2 Literature review

2.1 Supplier selection criteria

Supplier selection criteria are an important strategic function for a purchasing department and it is complicated because several criteria have to be considered in decision making process. The criteria identification for supplier selection and supplier performance evaluation has been emphasized by many scientists and purchasing operators since 1960's.

An interesting study, which has referenced widely in supplier selection problem papers, was proposed by Dickson [8]. His work was based on a questionnaire which was sent to 273 respondents who are purchasing agents and managers. These

respondents were chosen from the member list of the National Association of Purchasing Managers and purchasing agents and managers from the United States and Canada. In the questionnaire, he asked the respondents to rank accordingly with the importance of 23 criteria on five levels which are extremely, considerable, average and slight importance. At that time, the most essential criteria were the quality of products, the on-time delivery, and the performance history of the supplier and the warranty policy of the supplier.

Weber proposed a classification of 74 papers based on the treated criteria from 1966 to 1991 [9]. The output of his study suggested that price, delivery, quality, production capacity and geographical location of the supplier are most often treated in the literature for supplier selection criteria. The geographical location was ranked as 20th in 1966 of Dickson's work, but became one of the top ranks criteria. In the same way as Weber's work, [10] collected 49 articles about supplier selection criteria between 1991 and 2003. The study was concluded that a net price, quality and delivery of the supplier were the most important criteria for supplier selection.

In the same year of Weber, [11] also sampled 80 manufacturing companies about supplier selection criteria and found that the essential criteria are quality, price, technical service, delivery, reliability and lead time. In 1990, [12] proposed 3 main criteria with sub criteria for selecting supplier which are the financial statement of supplier, the organizational culture and strategy of the supplier, and the technological

state of the supplier. In 1997, Barbarosoglu and Yazgac concluded that the performance of the supplier, the technical capability and financial of the supplier, and the quality system of the supplier are the three important criteria [13].

In general, since 1966 the 23 criteria proposed by Dickson have still covered most of the supplier selection criteria proposed in the literature today. Nevertheless, the industrial environment has evolved and it changes the degree of importance of these criteria. The definitions of Dickson's 23 criteria have been expanded and new criteria have emerged according to needs of new business. Besides the traditional criteria such as price, quality, etc. criteria such as communication system, management and organization which were ranked as 10th and 13th in Dickson's study may be considered by the fact that actual industrial environment requires close and effective coordination between parties within the supply chain [14]. [15] proposed 5 important criteria which are cost, quality, service, relationship and organization.

After Weber's study, many researchers have focused more on supplier selection criteria in particular industries or particular countries. Recently, environmental issues such as global warming are becoming one of supplier selection criteria. To enhance their relations with the environment, firms must contribute towards a reduction in natural effects from their supply chains, encouraging changes in their suppliers' environmental performance ([16]; [17]; [18]; [19]; [20]).

There are many studies of supplier selection criteria that have been conducted in the literature over the years, the works of [8], [9] and [10] are still considered as the most cited and comprehensive studies for supplier selection criteria.

2.2 Supplier selection with AHP model

There are many evaluation systems that can be used for supplier evaluation and selection. According to [21], there are three main common supplier evaluation systems which are Categorical method, Cost-Ratio method and Linear Averaging. Categorical method is an approach for categorizing suppliers by grading specific variables such as good, neutral or unsatisfactory. It is a simple and informal method which doesn't provide in depth details and concrete supporting data. Experience is essential. The Cost-Ratio approach is a cost analysis method which requires in depth of internal relevant costs associated with quality, delivery and service of each supplier. The method calculates ratio between benefits and costs and use it for supplier's quoted unit price in order to get the net cost figure. It's good to get the final result in terms of cost however this evaluation system considers only on cost perspective and may be hard to implement as there may have difficulty in gathering all relative costs and high cost of implementation. Other perspectives aren't involved in calculation. The Linear Averaging is the most widely used method because both qualitative and quantitative factors can be applied and calculation is simple. Selected factors are weighted and rating and then the final scores are counted.

Further techniques such as mathematical programming, statistical approaches or artificial intelligence techniques are also widely integrated with the main evaluation system mostly for better precision and getting exact result. However, though there are many techniques for supplier evaluation and selection, the higher integration of techniques the more complicated calculation which requires fully understanding and expertise to carry out.

For this study, Analytical Hierarchy Process (AHP) is used for determining the appropriate suppliers because AHP provides reliable results than other methods as it uses the comparative couple of decisions before answer questions. Complicated problems are structured as a hierarchy chart, which mimics human cognitive processes, making it easy to use and understand. The numeric results make AHP easy to prioritize and such outcomes can also be compared or used as a benchmark with other departments. This approach can eliminate bias or unjust decision making and can be used for both a single and group decision making. Furthermore, AHP encourages reconciliation and referendum and doesn't require a specialist operator.

In literature, there are studies which use AHP for supplier selection which can be summarized as follow. [22] developed AHP system in form of website for supplier evaluation using different 18 criterions. Suppliers are required to enroll and fill a web form their specifications. Weight of each criterion is determined and rating is done by buyer in order to evaluate suppliers via pair-wise comparison. [23] proposed an AHP

model with 5 steps for rating and selecting suppliers with respect to 9 factors. Personnel from several departments are involved in the implementation such as purchasing, quality control and warehouse. [24] proposed an interactive AHP model for supplier selection. It is called an “interactive” model since subjective human judgment was eliminated while determining the relative importance of criterions. AHP was used just for final score calculation. [25] used AHP with 6 criterions and 20 sub-criterions for evaluating and selecting suppliers. Weighting of criterions was done based on customer requirements. [2] applied AHP for supplier selection similar to [26] but they used Noguchi’s voting and ranking process instead of using pair-wise system. [27] used AHP together with sensitivity analysis to see the result of alternatives when the relative important rating of criterion changed.

Chapter 3 Model development

The objective of the study is to improve procurement efficiency through sourcing and purchasing raw materials using supplier selection model through AHP technique. This methodology has been used widely in the supplier selection areas. The selected quantitative and qualitative criteria are evaluated for AHP supplier selection model which can be applied with the frozen chicken food manufacturing company. For this study, three types of raw material are involved which are fresh chicken parts, spices and

casings. Six steps are performed in order to ensure successful implementation according to [28] and [29] as follow.

3.1 Define criteria for supplier selection

The first step of supplier selection is to identify the relative important criteria to be applied for the supplier evaluation. Based on study of [8]; [9]; [30]; [31]; [1]; [4]; [7]; [17]; [10]; [32]; [6]; [2]; [33]; [34]; [35] and [28], 13 essential criteria were selected according to [28].

The author conducted a survey involving 8 high-experienced staff members from different functional departments of the ABC Company who are directly involved in the supplier selection process or stakeholders of the process, namely 3 senior purchasing staffs, the quality control manager, the production manager, the inventory manager and 2 senior accounting staffs.

Table 4 a respondant list

Department	Position	Experiences
Purchasing	Chief Purchasing Executive	29 years
	Purchasing manager	20 years
	Purchasing officer	13 years
Quality Control	Quality control manager	15 years
Production	Production manager	25 years
Inventory	Assistant Inventory manager	16 years
Financial	Chief Financial Executive	23 years
	Financial manager	20 years

These staffs are represented by R1 to R8 respectively as shown in Table 4. The survey was sent to the respondents to identify the importance of each criterion by using the nine point of scale of "Not important (1 to 3)", "Some-what important (4 to 5)", "Important (6 to 7)" and "Very important (8 to 9)" [7] and [28].

The results of the survey were then mailed to the respondents and they were asked about their opinions towards the results. Though criteria were defined and averaged, having to many criteria leads to a complexity of implementing pair wise comparison and time consuming. To overcome these difficulties, the cut-off value is set

in order to narrow down the number of selected criteria [7]. According to [28], the acceptable average score of the criteria is above 7. Finally, the effective, relative and very important criteria are quality, delivery, cost and management and organization.

Table 5 Factors affecting the selection of a frozen chicken foods manufacturing company, [28]

Criteria	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	Average
1. Quality	9	8	5	8	8	9	8	8	7.875
2. Delivery	8	7	9	7	8	6	5	8	7.25
3. Direct cost	9	7	9	7	8	6	5	9	7.5
4. Trust	8	7	6	6	6	6	7	6	6.5
5. Responsiveness	7	6	8	8	8	6	6	7	7
6. Discipline	5	5	6	7	6	6	6	8	6.125
7. Financial	5	7	9	5	6	6	8	7	6.625
8. Management and organization	9	8	7	7	6	6	8	7	7.25
9. Technical capability	5	6	7	7	8	8	6	5	6.75
10. Facility and capacity	7	7	9	5	7	6	3	7	6.625
11. Performance history	4	7	8	6	7	6	3	8	6.25
12. Warranty	7	7	8	6	8	7	7	6	7
13. Environmental performance	4	5	6	6	6	6	4	3	5

3.2 Define sub-criteria for supplier selection

In this section, the second survey was conducted which was similar to the first survey. The respondents were asked to define relevant sub criteria according to the proposed 4 main criteria (level2). Finally, 9 sub criteria were identified for supplier selection model in level 3 and 4, respectively as shown in Figure 9.

3.3 Definition of criteria and sub criteria

3.3.1 Definition of quality

Quality is a criterion which frequently used for operational performance criteria of supplier selection. However the definition and interpretation of quality varies among authors in literature. There are many well-known quality definitions have developed over time. [36] defines quality as ‘’conformance to requirements’’, where the yield has to comply with configuration and price must adjust to customer desires. [37] describes quality as "fitness for use", and the fitness is defined by customer while ISO defines quality as "degree to which a set of inherent characteristics fulfills requirements", where the requirements are needs or expectation.

The goods which are delivered by supplier have an effect on the quality of manufacturing which has an impact on the out bounce goods for the customer. Therefore, quality definition for the supplier selection can be described as the suppliers’

ability to deliver goods according to the predetermined quality specification which conform to both external and internal customer expectations.

Suppliers are expected to provide a good quality product with some acceptable food standards to the firm such as GMP, HACCP. The quality product also covers a product warranty. Suppliers are expected to offer the quality assurance for example in case of misspecification; suppliers are in charge of product replacement without extra charging or paying penalty costs as written in the contract.

Food standards

Since the ABC Company is a food manufacturer therefore every raw material that ordered has to pass some fundamental food standards. The food standards that the company requires are Good Manufacturing Practice: GMP, Hazard Analysis Critical Control Point: HACCP, International Standardization and Organization: ISO and HALAL.

Warranty

The product warranty generally means a promise that suppliers give to the firm they will provide good product quality with the right specification. If the promise isn't followed the ABC Company has legally right to get a remedy as written in the contract. If suppliers send unacceptable poor products, for instance, which results in damages in many ways such as stopped production line due to raw material shortage and costing money. The ABC Company has the right to send back the poor products and as a result

the suppliers are responsible for replacing the new products without extra charging or paying a penalty cost as written in the contract.

3.3.2 Definition of cost

Cost criterion considers elements of cost associated with purchasing such as a product price, transportation cost, and taxes and duration of credit given by suppliers.

Net price

A net price is a price of product including delivery cost, ordering cost and taxes as well as discounts.

Credit term

A credit term means standard or arranged terms offered by a vender to a purchaser that control the month to month and aggregate credit sum, a maximum time considered reimbursement, rebate for money or early installment, and the sum or rate recently payment remedy.

3.3.3 Definition of delivery

Delivery is one of the operational performance criteria used for supplier selection. Delivery may simply be defined as the supplier's ability to fulfill customer requirements based on delivery time. Nevertheless, there are sub criteria related to an on-time delivery. Lehtonen et al. (2006) stated that a delivery can be completed when the other conditions are met such as quality, quantity and problems. Delivery can be described as a combination of performance criteria. Thereby, delivery can be defined

as the supplier's ability to deliver goods on-time with compliance with quantity according to the order quantity, compliance with due date according to the predetermined date, a time taken for delivery products as well as locations of supplier distribution center.

Lead time

A lead time is the time from when the company places an order to a supplier to when the order is delivered. It shows an effectiveness of communication between the parties, especially oversea suppliers. The lead time should be short.

Percentage late delivery

Percentage of late delivery means the number of delivery that didn't meet the predetermined due date (late) from the total amount of delivery. The supplier should deliver materials at the expected quality and at the time which is specified on the contract.

Location

A location means the location of suppliers' distribution center whether it's near or far from the ABC factory. The firm has to consider advantages and disadvantages in choosing suppliers from a particular region or country. There are potential risks to be assessed such as transportation cost, shipment quality, currency fluctuation, market changes, accompanying domestic and international regulations that result. In addition,

suppliers who have a good sale network are desirable. It is expected that materials are supplied from the nearest location of the supplier's sale network.

3.3.4 Definition of management and organization

Management and organization criterion is to do with supplier's flexibility when immediate changes occur as well as day-to-day customer interaction and service as well as suppliers' capability to produce desire products.

Responsiveness

Responsiveness of suppliers means taking care of their customers on daily basis interaction as well as the quick and appropriate response to the changes related to ordered materials.

Capacity

A capacity means the highest reasonable yield rate (greatest number of units every day) that can be accomplished with current assets.

3.4 Structure the hierarchical model

This step associates with developing the AHP hierarchy model and calculating the weight of each criterion in every level of the model. The AHP model is developed based on the proposed goal, criteria, sub criteria and alternatives as shown in Figure 9. The goal of supplier selection problem for the ABC Company is to find the best supplier which is presented as the first level of the hierarchical model. The second level consists of main criteria which are quality, cost, delivery and management and organization. The

third and fourth level of the model contains 9 sub criteria. The lowest level of the model is alternatives which are different suppliers to be evaluated in order to get the best supplier. According to Figure 9, the AHP model is ordinarily applicable to any supplier selection problems of ABC frozen chicken foods manufacturing company since the model covers the important criteria and the relevant sub criteria.

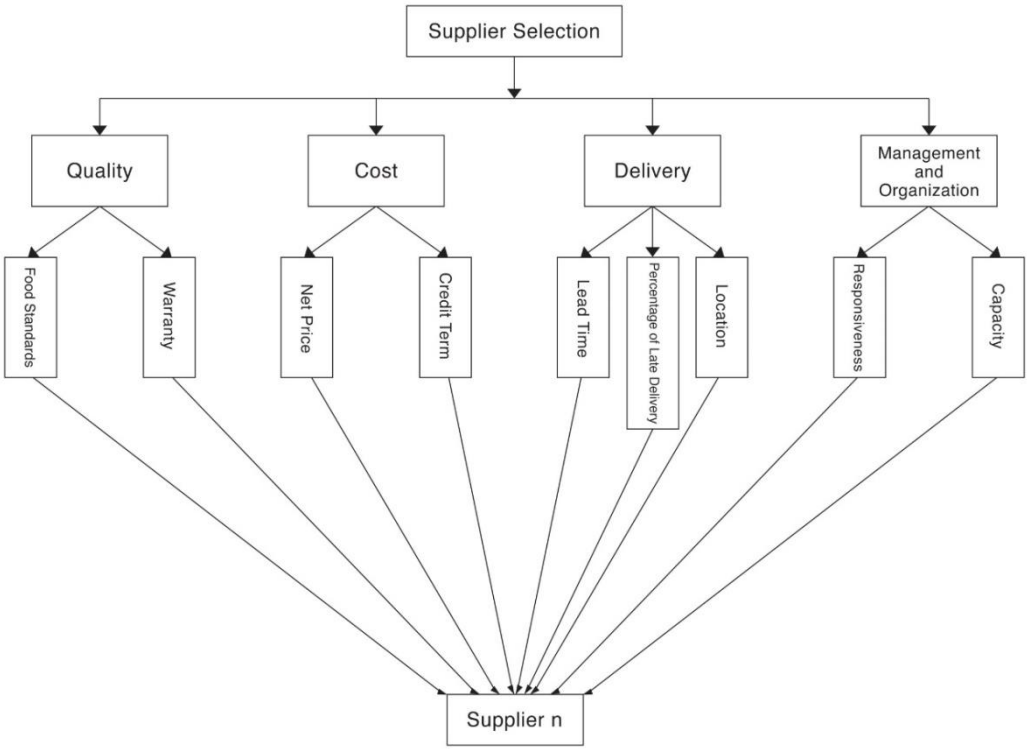

Figure 9 an illustrative decision hierarchy for supplier selection

To finish the model, the weights of each criterion in every level need to be calculated and prioritized. The third survey was conducted with the same set of respondents to gather the pair-wise comparison judgment information. The function of

the pair-wise comparison is to compare the relative importance of the criteria by using the nine-point scale of [38] as presented in Table 6. The criteria were rated from equal, moderate, strong, very strong to extreme level represented by 1, 3, 5, 7 and 9 respectively. The intermediate value between the two next numbers was presented as 2, 4, 6 and 8.

Table 6 Measurement scales, [38]

Verbal judgment or preference	Numerical rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1
Intermediate values between two adjacent judgments (when compromise is needed)	2,4,6, and 8

A sample matrix of the pair-wise comparison in Table 7 represents that the input of the four rows and the four columns provides an importance of that row's criterion relatively to that column's criterion.

Table 7 A sample matrix of the pair-wise comparison

Criteria for supplier selection	C	Q	D
Cost (C)	1	3	5
Quality (Q)	1/3	1	3
Delivery (D)	1/5	1/3	1
C.R. = CI/RI	0.033		

For example, according to Table 7, cost is equally important compared to cost (represented by the value of 1) and slightly more important than quality (represented by the value of 3). Cost is also strongly more important than having a good delivery (represented by the value of 5). Having a good quality performance is moderately important than having a good delivery (represented by the value of 3).

Since the criteria are matched in pair so decision makers don't require filling out the whole matrix. The matrix needs to be filled in just the upper half part because the lower half part is an inverse of the upper part's value. For example, cost is slightly more important than quality which represented by the value of 3 or equivalent to 3 to 1 ratio, thereby the importance of quality to cost is 1 to 3. The number 1 in the matrix is assigned where the row and the column are the same such as cost is equally important compared to cost which represented by the value of 1.

After gathering the pair-wise judgment the next step is to calculate a vector of priorities of elements in the pair-wise comparison matrix. This vector is called an

eigenvector in terms of algebra. To calculate the eigenvector, the matrix is squared and the numbers in the same row are added to find the total value. Then the matrix is normalized by dividing each row sum by the row total. Finally, the results are the eigenvector of each criterion which will be used for prioritizing the criteria.

Prof. Saaty demonstrated that for consistency reciprocal matrix, the highest Eigen value is equivalent to the size of comparison matrix, or max λ = n. At that point he gave a measure of consistency, called Consistency Index as deviation or level of consistency by using the equation below.

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

The consistency ratio (CR) is an important feature of AHP approach since it is used to eliminate inconsistency of the criteria weight which is possible to occur. According to (Saaty, 1980), a CR equals to 0.10 is acceptable or reasonably consistent. It the CR is less than 0.10 means the weights are valid and consistent but if the CR is more than 0.10 means the weights are inconsistent and required further analysis.

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

Where CI is Consistency Index

CR is Consistency Ratio

RI is Random Inconsistency Index (depends on the depth of the matrix, see Table 8)

n is a depth of the matrix

Table 8 Random Inconsistency Index (RI), [39] and [38]

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.46	1.49	1.51	1.48	1.56	1.57	1.59

Chapter 4 Analysis of result

4.1 Chicken supplier selection

4.1.1 Prioritize the order of criteria or sub-criteria and measure chicken supplier performance

Table 9 a matrix of paired comparisons for chicken supplier selection

Criteria for supplier selection	Quality	Cost	Delivery	Management and organization
Quality	1	2	4	6
Cost	1/2	1	2	3
Delivery	1/4	1/2	1	2
Management and organization	1/6	1/3	1/2	1
CR	0.11			

According to Table 9, there are 4 major criteria for consideration of supplier selection. The result shows that the company values quality of product the most at 0.519, follows by cost of material at 0.259 service delivery at 0.139 and then management and organization at 0.080. In addition, according to [38], though there are

some inconsistency since the CR value is more than 0.1, it is acceptable for this study. This is due to the fact that the weights, which were carefully given to every main criterion and compared against the others, were provided reasonably and accordingly in a pattern of decreasing by 2 units from the management and organization criterion to the quality criterion and vise versa.

Table 10 Composite priority weights for sub criteria of chicken supplier selection

Criteria	Local weight	Sub criteria	Local weight	Global weight
Quality	0.51952	Food standards	0.75	0.38964
		Warranty	0.25	0.12988
Cost	0.25976	Net price	0.75	0.19482
		Credit term	0.25	0.06494
Delivery	0.13995	Lead time	0.62501	0.08747
		% Late delivery	0.23849	0.03338
		Location	0.13650	0.01910
		CR = 0.01		
Management and organization	0.08077	Responsiveness	0.75	0.06058
		Capacity	0.25	0.02019

The result is significantly according with the company purchasing focus that the quality of product comes first as a food manufacturing company. The company essentially concerns about food standards (0.625) since a good input yields a good output. Purchasing a good quality material also helps reduce misspecifications, scraps and reworks which are unwanted costs of production. Every chicken supplier is

expected to provide a level of warranty (0.238) since it is a fundamental agreement of the trading contract of the company. Misspecification materials such as a material weight is less than the predetermined order or poor quality material are sent back to the suppliers and will be replaced with a new good one without charging.

Cost of material is the second criterion that the company focuses. A main attention goes with a net price (0.8) of material because if the company is able to purchase inexpensive materials, raw material cost which accounts approximately 80% of product cost can be minimized. Thereby, the company is making more profit with lower material cost while selling the same price and the working capital is also untighten which increases company's liquidity. A credit term is less significant (0.2) yet shouldn't be disregard. A credit term is the maximum time for reimbursement therefore if the company is offered a credit term of 1 month means the company can buy materials from the supplier and pay the price a month after. The credit term is as good as the longer the credit term is the more liquidity the company has. During the credit term the company can use the purchased materials to produce goods, sell them and earn some money. When the credit term ends the company pays its bill with more flexibility than paying the bill right away. Furthermore, the company may use the money to buy non creditable materials which are also required to run the production lines.

Delivery come the third. Besides getting the right quality of materials at the right cost, a good product delivery is also important. Lead time is concerned the most at

0.625 since chickens are perishable especially when buying fresh chicken. Fresh chicken are ordered daily and will be picked up by the company's vehicles at the supplier place and then will be sent directly daily to the factory for the production without keeping a stock. Therefore, chickens are ordered and picked up daily which means the lead time is more about waiting to pick the ordered materials up at the supplier place rather than waiting the supplier to deliver orders at the company site. As a result, the lead time is depended on how fast materials can be loaded. In reality, after ordering the supplier will estimate a suitable pick-up time with a queue number of the dock. Thereby, if there are many docks for loading orders the lead time will be short but if the docks aren't enough there will be a long way of waiting. In addition, a due date of delivery (0.238) should as well be met since fresh chicken are purchased day to day for a daily production. If there is a late delivery, production lines may be stopped and cost considerable amount of money. Furthermore, location of distribution center (DC) of suppliers also plays a role (0.136). Ideally, the company would like to buy materials from a supplier who has the nearest DC to the company's factory because the shorter the travelling distance is the higher yield of material and the lower the transportation costs. Moreover, a supplier who has more than 1 DC or a sale network tends to has advantages than suppliers who have only 1 DC.

The management of supplier and its organization comes last. Responsiveness is the issue which has the highest weight at 0.75. This means that supplier's

responsiveness is the primary concern. Responsiveness refers to supplier's flexibility including an ability to react and cope with changes of plans timely (increase or decrease in purchasing quantity and adjustment of the time of delivery) as well as the awareness to disturbances in the business environment. Responsiveness also means an ability to demonstrate a proper interaction and maintain ongoing business relationship as well as provide actively supports and demonstrate a high level of commitment to the firm. Finally, a capacity (0.25) of each supplier can also make differences between existing suppliers. Normally, suppliers who have a flexible capacity tend to win an auction. Besides, a fit-for-purpose capacity is considerable. If the firm chooses a supplier who has too high capacity, certainly this supplier is able to deliver orders but the firm isn't a premium customer for the supplier. Thereby, the firm may lose bargaining power and the supplier may not treat the firm appropriately.

4.1.2 Identify chicken supplier priority and selection

Table 11 the AHP final result of chicken supplier selection

Potential supplier	weight
A	0.16856
B	0.13250
C	0.13143
D	0.11439
E	0.10849
F	0.10574
G	0.09050
H	0.08214
I	0.06625

According to the AHP analysis, the first supplier the ABC Company should trade with is A (0.159). Overall, A supplies a good product quality with required food standards, product warranty and package of goods. The company has been running a joint venture with a foreign organization therefore the company has a very strict quality control policy compared to other Thai companies. The company's products are mainly exported due to its high standard and quality. As a result, the price is moderate. However, the company doesn't provide a credit term. Every order is paid by cash before the order is delivered. A owns 2 plants: Pathumthani plant and Lumlukka plant and both of them are located at the center of Thailand which is quite convenient in terms distribution points. They act like distribution hubs which easily distribute goods to the

other stores in different parts of Thailand. Since the ABC Company owns many regional stores in Thailand therefore A is a good choice in terms of supply network. In addition, the ABC factory is located in Lop Buri which is quite near to A's plant. As a result, the lead time of delivery is short and on-time delivery is much possible. Moreover, the company's customer management is very good. The ABC Company has received a privilege care from A. Every order is delivered on-time with the right quality and quantity since the ABC Company has bought big volumes from the company for many years and pays the bill on time. Furthermore, A also has a desirable capacity at 120,000 chickens/day at Pathumthani plant or 90,000 chickens/day at Lumlukka plant which is very flexible and good for demand fluctuation.

The second choice is B (0.138) who is also a private hold, Multinational Corporation. Therefore, their products are very high standard and quality with good packaging and product warranty. The company focuses mainly on exporting, nearly the same as A. However, unlike A, their products are sold very expensively as they are ranked at the bottom in both cost and net price criteria. For the credit term, the ABC Company also has to pay bills by cash right away before orders are supplied. B as well owns 2 plants which are located at Saraburi (central region) and Nakhon Ratchasima (the north east) which is quite convenient for transportation and supply network. The Saraburi plant's capacity is 200,000 chickens/day and the Nakhon Ratchasima plant's capacity is 150,000 chickens/day which make B a quite high-volume producer.

Nevertheless, their management and customer service are poor since they focus largely on exporting. By-products, that are not able to be exported, will be sold domestically. As a result, sometimes orders are not totally fulfilled. Furthermore, they will manage their internal operation first after that they then take care customers.

The third place is C (0.135) which has few differences from B. Though C is a Thai manufacturer, they are a professional in poultry industry. C provides goods in 3 different grades: an export grade, a supermarket grade and a wholesale grade. The ABC Company buys the wholesale grade. C provides a good product quality with good packaging but they used to have a big issue about infringing the HALAL. Since the ABC Company is very serious about HALAL as it's a primary distinctive objective which set the company different from the others. Thereby, although the issue was solved, but Muslims, who are quite strict to their religious dogma and the main target customer of ABC Company, lose trust in C's manufacturing processes. Nevertheless, C's products have a good quality that the ABC Company rarely claims for replacement and their manufacturing processes are very accurate. C also sells their products in high prices and higher than B. There is no credit term for purchasing materials. C has 4 plants in Thailand which are located in Nakhon Ratchasima, Minburi, Bangna and Saraburi which make C the strongest distribution networks. Each plant has its capacity at 334,000, 190,000, 65,000 and 273,000 chickens/day respectively. As a result, C is ranked as the first place of capacity criteria. At first C didn't willing to trade with the company because

C thought that the company is a subsidiary of a firm which has bankrupted. At last, C understands and trades with the company in ordinary manner likes other casual customers.

The fourth place is D (0.090) which is a Thai company who has 2 plants. The first plant is located in Kanchanaburi and the second plant is located in Prachinburi. D originally focused only on domestic sales and recently makes an effort by renovating their plants and manufacturing processes in order to be able to export their products. Nevertheless, the products still cannot be exported due to international quality and standard problems. Although D has all domestic chicken producer licenses, purchased products sometimes are having difficulty in quality problems. For example, occasionally the delivered order was poor in quality that it was rejected and needed a replacement. Sometimes chickens were adulterated with prohibited chemicals. Anywise, they offer a product warranty and the packaging is acceptable. D is the company who offers the lowest prices among the other companies since they can only sell their products domestically which also means that they have high variety of products with high volumes. Moreover, D is the only company who has provided 1-day credit term for two years which is a favorable reason of buying materials from this company. In terms of delivery, as both plants are far from the ABC's plant thereby, traveling costs is high, product yield is decreased and the lead time is long. Nevertheless, these two plants give D 430,000 chickens per day which is one of potential suppliers. Management and

customer service are very good since both sides have known each other very well and have traded for 20 years. The owners of D used to be a farmer who reared live chickens and supplied to the ABC's plant. The ABC Company used to help buying surplus live chickens from D in a huge amount. This amount of money helped improve D's liquidity so much that D, until now, feels grateful and always provides full customer service supports to the ABC Company.

The next supplier which ABC should make a trade with is E (0.1035). E is a Thai manufacturer which owns 2 manufacturing plants: Samut Prakan and Chonburi plant. They supply a good product quality nearly the same as A, B and C. Their products are qualified according to the required food standards and guaranteed. The packaging is appropriate. E sells their goods in lower prices compared to B, C and F but still higher than A. E, likes most of the others, doesn't offer a credit term for ABC. Orders will be sent after the bills are paid. Since E has 2 plants the Chonburi plant is very near to the ABC plant while the another plant is located in central region which is suitable for distributing materials to other regional stores of ABC in Thailand. These two plants give 258,000 of capacity per day which is a medium capacity supplier. For trading performance, they support their customers well. One of E's personnel is a secretary of Thai domestic chicken manufacturer association and the company has known and traded for many years; thereby E is willing to provide both general information and in-depth details of the market. They also introduce their products regularly and ask for help

when they have too many stocks. If a total order isn't met, E tracks the order and provides the rests in the next day. Sometimes the company ordered in a high volume, E offered free freeze spaces as the same as F does but the order has to be paid first.

The sixth place is F which has all required food standards, product warrant with a suitable packaging as the others. They sell their products in quite high prices but cheaper than C and B. However, they are willing to offer a 1-day credit term for purchasing their goods. An Approval of the credit term is under consideration. F has a plant located at Phetchabun, lower north of Thailand which is considerable far from the ABC's factory. The location of F has an impact to the transportation cost and a long lead time. Nevertheless, there are many docks available for loading so if the container arrives, the container won't have to wait for a long time for loading orders. Moreover, F specially provides the dock for only ABC's containers which help facilitate loading materials and improve the lead time. F's capacity is 270,000 chickens per day which is moderate. F is a responsive supplier for instance they are available and ready to supply an immediate order to the ABC when there is a sudden raw material shortage. F looks after their customers in a good manner and provides a good coordination on daily basis. For example, the ABC Company can order materials, pay the bill and let F keeps the stock. Actually, keeping a stock by freezing costs 1 baht per day but F not only keeps stocks for ABC but also not charging. The ABC just has to give F a withdraw plan when the stocks will be withdraw and how many. This is very beneficial for ABC company

because the firm not only doesn't need to pay freezing charges but also having more spaces in the inventory to keep stocks of other goods and having a better facilities control when peak demands come. F takes care and maintain relationship with their customers well. They regularly introduce products to the ABC firm both new and existing ones, track customers' order progress and sometimes when they have too many inventories they ask the ABC to help purchasing these inventories in bargaining price. Furthermore, they are willing to share their necessary information such as a stock level to the firm which really helps minimize supply chain bull-whip effect and encourages a win-win relationship.

The seventh place is G (0.085) who is also a Thai chicken producer and has a primary objective of running business as the same as the ABC Company which is producing chickens strictly under the HALAL in order to sell products to Muslims who is the target market. As a result, G is the strongest brand in terms of having HALAL. G is another company who mainly focuses on exporting. Disconformities are sold domestically. Because G uses water shield system for packing products, the products' quality is low. There is sometimes lots of water in packages, yet the packages have capability of carrying. G sells their products in high prices as the same as F's pricing. G is offering a 1-day credit term and an approval is under consideration. G's plant is located at the nearest location which is 5 kilometers far from the ABC's plant. Thereby, purchasing with G gives the shortest lead time and the lowest transportation costs

compared to the others. Furthermore, they as well specially provide the private dock for the ABC's containers. Nevertheless, there won't be just one ABC's container at a time loading orders and G doesn't have enough docks provided for their customers. As a result, the lead time may not that short, yet the quickest. G has a capacity at 180,000 chickens per day which is moderate to quite high. Their customer management is bad. Coordinators performance has been very poor. They interact with customers in a very rude manner and don't track an order progress. When there was a quality problem such as weight loss, front liners are realized but they don't have enough potential to solve the problem since the executive's policy doesn't support.

The eighth place is H (0.1004) which has a few differences to E. H is another Thai company who owns one factory located in Sarubiri which is really close to B's and ABC's plant. They primarily focus on international exporting since they produce quality products. If products are unable to be exported, they then sell the products domestically. Their product's package is acceptable and there is a product warranty. H sells their products in medium prices or a little high and there is no credit term provided. Because H plant is near the ABC's plant, the lead time is quite short but still has to wait and follow the queues. Yet the transportation cost is cheap and the due date is met. Nevertheless, their plant has an ability to produce at 100,000 chickens per day which is rather low compared to the other companies. H will keep stocks for the materials which are ordered in advance but they don't provide a free freeze space for deposit the

materials since they have a limited store spaces. Nevertheless, they used to allow for materials deposit when there was a strike at the ABC's plant. Occasionally, when H has too many stocks and would like to sell those stocks they offer a bargaining price. The relationship is reciprocity but not that interdependent.

The last place is I (0.776) who is a small Thai chicken manufacturer. I sells their products only domestically. I has all domestic chicken producer licenses and standards but doesn't have an international standard; therefore, I's product quality isn't as good as the others. They provide product warranty and their package is acceptable. They sell their product in medium to low prices but very low product quality. Purchasers may perceive this situation as a high price compared to the product quality. There is no credit term provided. I's plant is located in Suphanburi which is considerable far from the ABC's plant. I set their price quite high with low product quality because the area where the plant is located has few competitors. In addition, since there is a long distance between the plants, the lead time is long and the delivery cost is high. I's plant has an ability to produce just 65,000 chickens per day which is the lowest capacity compared to the other firms. They manage their customer well and have a good relationship with the ABC Company.

For the CR value of the alternatives of the chicken supplier selection are represented in the appendix B.

4.2 Casing supplier selection

4.2.1 Prioritize the order of criteria or sub-criteria and measure casing supplier performance

Table 12 a matrix of paired comparisons for casing supplier selection

Criteria for supplier selection	Quality	Cost	Delivery	Management and organization
Quality	1	3	2	2
Cost	1/3	1	1/2	1/2
Delivery	1/2	2	1	1
Management and organization	1/2	2	1	1
CR	0.10			

For the casing supplier selection, the selection is divided into two sub selections based on types of casing which are cellulose casing and collagen casing, respectively. From Table 12, the four criteria are also used for both casing supplier selections as the same as the chicken supplier selection but each criterion is weighted in different importance based on sausage casing purchasing.

For both casing supplier selection, according to Table 13, the result demonstrates that the company still values product quality largely at 0.424 follows by service delivery and management and organization which are weighted equally at 0.227 and then cost of material at 0.122.

Table 13 Composite priority weights for sub criteria of casing supplier selection

Criteria	Local weight	Sub criteria	Local weight	Global weight
Quality	0.42359	Food standards	0.66667	0.28239
		Warranty	0.33333	0.14120
Cost	0.12232	Net price	0.66667	0.08155
		Credit term	0.33333	0.04077
Delivery	0.22704	Lead time	0.5	0.11352
		% Late delivery	0.25	0.05676
		Location	0.25	0.05676
		CR = 0.00		
Management and organization	0.22704	Responsiveness	0.75	0.17028
		Capacity	0.25	0.05676

4.2.2 Cellulose casing supplier selection

Casing is the raw material which ranked as the second most purchased material among others in a whole year. All of casing which has been purchased is imported. There is no Thai supplier who produce casing. As the same reasons as in chicken supplier selection, the ABC Company is a food manufacturer thereby the raw material quality is an essential criteria for supplier selection. Good raw material quality may be expensive but it is worth purchasing them since good raw material is likely to provide good quality of output as well. Furthermore, the cost of buying good expensive raw material is significantly lower than the cost of scraps and reworks. Casing suppliers are

highly expected to supply casings with required food standards (0.667). The supplied casings should also have to have an acceptable product quality as well. For example, an ordered casing should work or fit with the sausage without problems such as laceration and washed-out of casing's color. As a result, suppliers are also expected to provide a level of product warranty (0.333) in case of misspecification or disconformity according to the trading agreement.

Service delivery and management and organization are both weighted equally. In terms of service delivery, ordered casings are fundamentally expected to be shipped in an appropriate lead time (0.50). Normally, the number of casing which will be supplied for the annual and monthly production is estimated. This information will be then sent to the suppliers so that they can plan their production and facilities schedules. Furthermore, sausage casing isn't a commodity product. It is manufactured to order. Different sausage producers demand different sizes of casing's mold. Changing molds makes the production takes quite a long time. The lead time after placing order is studiously calculated from the time takes for productions, letter of credit approval and the shipment period. As a result, orders have to be placed in advance and the orders will arrive before the productions start, therefore there is no late delivery in this case (0.250). Nevertheless, since casing is not perishable therefore sometimes, the company keeps some stocks but just enough for the production in order to avoid stopped production line. Consequently, because lead time is considerably important the criterion

that has an effect on the lead time is the location of the factory or the distribution centers (0.250). All casing has to be manufactured aboard which makes the lead time longer. As a result, choosing the supplier who has the nearest factory or beneficial distribution network is an important issue. The nearer factory is located the shorter lead time. Although these foreign suppliers have their representative company in Thailand, these company normally don't hold stocks. They mainly operate with paper works or services.

In terms of management and organization, the company gives the main attention to supplier's responsiveness (0.75) because casing is a sensitive raw material. There are not many supplier of casing in the world, especially the supplier who is able to produce the casing according to the company's requirement. Different casing producers can manufacture different size and type of casing. For example, Supplier A is able to produce a casing number 20 and 22 using collagen but supplier B can only produce a collagen casing at number 25. Moreover, sausage casing is very sensitive in terms of applying chicken into the case to make a sausage. As a result, the company expects suppliers to be very responsive. For instance, if there is a problem with quality of casing the supplier are called to solve the issue. Fortunately if the supplier has the representative in Thailand thus the communication and coordination is much easier but unfortunately if the supplier doesn't have a representative in Thailand the communication to solve problems takes time. Actually, even there is a representative; the representative still requires times to coordinate with their head quarter. Problems have to be solved as

soon as possible. As mentioned before that orders have to be placed in advance so the company shares the monthly and yearly volume with the suppliers so that the suppliers can manage their capacity more efficiently. Nevertheless, the company doesn't have a visibility of supplier's capacity. The company just knows that if the placed order is rejected means the supplier cannot produce it.

4.2.3 Identify cellulose casing supplier priority and selection

Table 14 the AHP final result of cellulose casing supplier selection

Potential supplier	weight
J	0.42344
K	0.31711
L	0.25945

According to the AHP result from Table 14, the first potential cellulose casing supplier the Company ABC should trade with is J. J is a cellulose casing manufacturer which was founded in Chicago, Illinois in 1925. The founder of the company is the inventor who invented the cellulose casing which could be replaced the using of animal intestine casing. At present, the company is a worldwide cellulose casing supplier who has 8 manufacturing plants in 4 continents which are Europe, North America, South America and Southeast Asia, 77 distributors in every continents and 9 sales offices around the world. The company has continuously improved its product quality by investing in R&D with new innovations as it is company's mission statement. As a result, ordered casings from J are high product quality and required food standards. The

company provides a product warranty as a fundamental condition of trading. J sells their product in a reasonable price with a high product quality. The Company ABC used to be supplied the casing from the plant in France which was the nearest plant to Thailand. Nevertheless, it still takes times for shipping the materials to Thailand. Fortunately, since J is the company who stated their business philosophy that they are a true partner for their customers, they have recognized continuous demands growth around the world thereby they have invested in their capacity to meet the demands by investing in new facilities to provide better customer service around the world. They established a new facility in Philippines which helps the ABC Company in many ways. Because Philippines is a country in ASEAN Economic Community (AEC), Thai companies like the ABC Company gets 5% discount from importing tax which is an essential advantage to be considered. For the credit term, J and the ABC Company have agreed to use a documentary letter of credit at 90 days. Furthermore, building the Philippines base also helps significantly reduce the lead times for customers in this region, including the ABC Company. Normally, it will take approximately 1 month for shipment from Europe. However, Supplying from Philippines base takes only about 20 days. Certainly, the Philippines base of J is the nearest cellulose casing supplier location compared to the others. In terms of responsiveness, J has a Thai representative named Win Chance Industries co., ltd. which is located near the head office of the ABC Company. As a result, daily communication and coordination are very convenient as well as paper

works. Besides, when there is problem the ABC Company has received a good and fast customer service because the Thai representative is able to deal with the problem directly and there is no language barrier and time difference that might obstruct the problem solving. The ABC Company places an order directly to the J office as the company realizes that buying from the manufacturer makes the company gets the materials in lower price. Win Chance will be responsible for coordination and customer service and receive commission from J. Win Chance holds few stocks so if there is a raw material shortage Win Chance may not be able to solve this kind of problem. Nevertheless, they try to compromise the problem for example they will fairly share customers' order so that can help reduce the impact of raw material shortage. For the capacity, although the company doesn't have a visibility on the supplier's capacity, it is clear that they are a potential supplier and have enough capability to cope with the ABC Company's demand. Overall, they seem achievable on their mission that they not only deliver casing but also provide excellent customer service, quality and innovation (J® Companies, Inc., 2015).

The second place is K which is formed from the big merger of VK and TK in 2007. Originally before the merger, VK was found in 1952 in Finland and produced only cellophane casing which made from cellulose. At present, K consists of the former VK, TK's European operations and Nova plastic casing which is the world leading casing makers with 2 manufacturing plants in Europe and Central America who produce

fibrous, cellulose and plastic casing as well as packaging materials. They claim that they have the biggest partner network in this business so that they can offer their products to 100 countries with 4 sales offices (K, 2015). K has supplied a good product quality with product warrant to the ABC Company. The price of their products is just a little bit higher than J's and they also agree to receive payments by using documentary letter of credit at 90 days as the same as J. K has implemented a policy that they won't allow their oversea customers to buy directly with them. They give the right to their representatives in those countries. For this reason, the price of materials is a bit higher than the other companies who allow their oversea customers to buy directly from them. For now the plant that manufactures cellulose casing is located in in Lommel, Belgium. As a result, the lead time of shipping material is quite long, approximately at least 1 month. Therefore, in terms of location, Belgium is considerably far from Thailand which directly affect the delivery lead time. Although they have 2 plants which are far from the ABC Company in Thailand, they have many representatives around the world, including Thailand named B.O.T. co ltd in Bangkok. Having the Thai representative absolutely helps improve efficiency of coordination and communication in daily basis. Furthermore, in case of having difficulties the Thai agents are able to respond and handle the situation immediately. B.O.T. is an incumbent of casing distributors in Thailand for more than 30 years therefore they have their warehouse to keep stocks. As a result, when there is a shortage customers are able to be supplied immediately. K also claimed that

they are able to produce the widest diameter range of products including both biggest and smallest casing in the world (K, 2015). Furthermore, they as well offer several coating, color and printing options to maximize customer customization in order to meet any customer requirements. Moreover, the company is also very flexible and responsive since they stated that with their existing partner network they are willing to provide an optimal and productive casing solution to their customers which is Taylor-made and supportive to customer's business requirements (K, 2015).

The third place is L is a Spanish artificial casing solution manufacturer which was found in 1975 who distributes its product to over 100 countries around the world. L is the only casing maker in the world utilizing innovation for all classes of casing types: cellulose, collagen, fibrous and plastic. The company has casing production plants in 9 countries with 14 sales offices. Each plant produces different types of casing. For the cellulose casing, they are manufactured mainly in Spain and China where ordered casings are shipped to the ABC Company. The product quality of L is quite variable for example sometimes; there were many tiny holes on casing after processed. Besides, during processing the ordered casing broke while putting chicken into it. L also provides a product warrant as the same as the other companies. For pricing, L sells their product in a good price just a little bit different from the others. Nevertheless, in the past the ABC Company used to place high volume of orders with L for a period of time. For a while L thought that the ABC Company would order like this for sure, and then they increased

the price. The ABC Company noticed the situation, found the new supplier and didn't trade with L anymore. However, L now realized the change and wants their market share back thus they sell their product in lower price which is more competitive. For the credit term, L agrees to be paid by the documentary letter of credit at 90 days as the same the others. Although the location of the cellulose casing production plants seem better (Spain and China) than K (Belgium), the lead time still at least about 1 month. L also has a Thai representative named IPS which located in Bangkok as the same as K. As a result, the communication and cooperation in daily basis are quite convenient since there is no difficulty in language and time zone. The ABC Company used to buy the materials from the representative since at that time the company was just established so a bank didn't approve a documentary letter of credit and the order had to be place in a high volume which the company couldn't afford the expenditure. But now the company has been expended a lot and orders the material in big volumes every year. L now recognizes that the ABC Company is a potential customer so they allow the company to buy directly from them with a lower price. However, the sales manager of IPS used to be an employee of C which is the potential competitor in the market. Consequently, the ABC Company hasn't received a good customer service as it should be.

4.2.4 Collagen casing supplier selection

For collagen casing supplier selection as mentioned before that all of the criteria are weighted as the same as the cellulose casing supplier selection, see Table 12.

According to Table 15, there are 2 potential suppliers for the collagen casing supplier selection since the other 3 companies which will be mentioned respectively didn't pass the quality test. Consequently, the ABC Company doesn't sign a trading contract with them thereby some of these companies' information are not visible as it's a limitation of study. As a result, these companies cannot be assessed in supplier selection process.

4.2.5 Identify cellulose casing supplier priority and selection

Table 15 the AHP final result of collagen casing supplier selection

Potential supplier	weight
M	0.63050
L	0.36950

The collagen casing supplier that the ABC Company should mostly trade with is M. M is a Japanese collagen casing producer which was found in 1907 in Tokyo. The founder of M is the inventor who discovered the solubilization technology of collagen fiber which was patented in 1960. Besides producing collagen casing, M also manufactures several product lines for example high grade gelatin, collagen peptide, collagen cosmetics and high quality leather. The corporate philosophy of the company is 'Quality First' thereby the company has invested a lot in new innovations and researches in order to produce the highest quality product. For this reason the M's collagen casing is not only produced with the highest quality but also has many advantages such as M casings are suitable for all type of sausages (cooked, fresh or

dried sausages) and has a consistency in both wall thickness and diameter which helps reduce give-away and achieve higher yield. Because of this greatest uniformity makes M casings the most trouble-free casing compared to the others and they also provides a product warrant which the ABC Company has never claimed as their product has a very good quality. Since they produce a very good quality product, they sell their product in high price but just a little bit higher than L's price. M agrees to be paid by the documentary letter of credit at 60 days.

M has 2 manufacturing plants both located in Japan with 2 sales offices in Canada and China. In Thailand, there is a M's representative named B.O.T. co ltd in Bangkok which is the same representative of the cellulose casing makers, K. Therefore, the policy is the same that oversea customers have to purchase the material from the representative in their countries only. As a result, the price is higher than buying directly from the manufacturer. Fortunately, buying from the Thai representative makes the lead time significantly shorter since the location of the B.O.T. warehouse is very near to the ABC Company plant, just 3 hours. B.O.T. has more experiences than the other representatives as they have operated for more than 30 years thereby they know how to provide a good customer service to their customers. Moreover, as already mentioned before, B.O.T. also keeps stock for their customers in case that their customers order unexpectedly for example when peak demands come which provides flexibility and responsiveness to their customers. Furthermore, because B.O.T. has continuously

improved their product quality and invested in many collagen researches, they offer a printing on collagen casing both alphabets and pictures using the eatable ink in order to Taylor-made and meet customer requirement. Moreover, exclusively only for the ABC Company M signed a contract that they will produce and sell yellow collagen casings to the ABC Company only which is their new product. This new casing after production will provide a very attractive golden sausage skin which has never had before in the market, thus the ABC Company's sales has been increased continuously.

The second place is L who produces wide range of casing products. Besides, producing cellulose casings they also manufacture collagen, fibrous and plastic casing as already mentioned before in the cellulose casing supplier selection. The things which different from the information that are already mentioned in cellulose casing supplier selection are the quality of product and the manufacturing plant. The quality of collagen casing of L is very variable for example the color of casing wasn't equable. There were many tones of color in one piece of casing and within the same dozen; the color of casing wasn't equable as well. Sometimes, there were many tiny holes on casing after processed which made processed sausage unsmoothed. Because of variable product quality, the ABC Company lost a lot of money and sent the ordered casing back to L as well as asked for a proper compensation. For the collagen manufacturing plant of L is located in Czech Republic. As a result the lead time is the same as shipping cellulose casing, approximately 1 month. For the Thai representative, IPS is the Thai

representative for both cellulose and collagen casing for L therefore the customer service is the same as well.

4.3 Spices supplier selection

4.3.1 Prioritize the order of criteria or sub-criteria and measure supplier performance of modified starch supplier selection

Modified starch is the raw material which is used the most among the others in spices group at about more than 2,000 tons annually which costs around 50 million Baht per year or 20% of spices expense. From Table 16, the four criteria are also applied to the modified starch supplier selections.

Table 16 a matrix of paired comparisons for modified starch supplier selection

Criteria for supplier selection	Quality	Cost	Delivery	Management and organization
Quality	1	2	4	6
Cost	1/2	1	2	3
Delivery	1/4	1/2	1	2
Management and organization	1/6	1/3	1/2	1
CR	0.11			

According to Table 16, the result demonstrates that the company still values product quality largely at 0.51952 follows by cost of material at 0.25976, service delivery at 0.13995 and finally management and organization at 0.08077. In addition, the CR value is more than 0.1 which indicates some inconsistency, nevertheless it's acceptable

for this study as they were weighted reasonably and accordingly in a pattern of decreasing by 2 units from the management and organization criterion to the quality criterion and vise versa. Every row and column were weighted in the same proportion.

Table 17 Composite priority weights for sub criteria of modified starch supplier selection

Criteria	Local weight	Sub criteria	Local weight	Global weight
Quality	0.51952	Food standards	0.75	0.38964
		Warranty	0.25	0.12988
Cost	0.25976	Net price	0.66667	0.17317
		Credit term	0.33333	0.08659
Delivery	0.13995	Lead time	0.29696	0.04156
		% Late delivery	0.16342	0.02287
		Location	0.53961	0.07552
		CR = 0.01		
Management and organization	0.08077	Responsiveness	0.66667	0.05385
		Capacity	0.33333	0.02692

Besides using chickens, modified starch is the one of main ingredients in producing sausages and balls. As the same reason as before that food manufacturing companies primarily values the quality of their ingredients including food standards (0.75) and product warranty (0.25). Before the ABC Company trades with their suppliers, they let the potential suppliers send some samples of their products to be tested by ABC's R&D department first to see whether the products valid in terms of required food standards, nutrition and sanitation. There is a certain specification for every spice that

will be used in productions which is determined by the R&D department. For example, the modified starch sample must contains protein no more than 0.5% of dried weight and the net weight loss after drying must not exceed 14%. If the sample sent by a supplier doesn't pass the test, this supplier will be rejected and will not involve in a price quotation due to misspecification. Besides providing the right specification of material, every supplier is also expected to provide a product warranty and responsible for any disconformity according to the issued purchasing order as a fundamental condition of trading.

Cost of material is considered as the second place. Since modified starch is one of the main ingredient of producing sausages and balls, a little bit expensive unit cost can cause a considerable amount of money when orders in a bulk volume. The strategy that the ABC Company has implemented for sourcing spices especially the spices that are agricultural crops is purchasing them within the harvest time. Modified starch is made from potatoes which is agricultural crops. Buying modified starch in the harvest time provides a significant advantage in terms of unit cost (0.66667). The unit cost during the harvest time is lowest compared to the other periods of the whole year as there will be many surpluses of crops at that time which exceed demands. Furthermore, in order to take the most advantages the ABC Company will buy modified starch in a bulk volume. This means that the production department will report the number of modified starch which required for the whole year production to the purchasing

department. The purchasing department then uses this bulk volume to negotiate with potential suppliers and let them quote a price for that quantity which will be enforced for a whole year. This way even though the unit price of modified starch may increase during a year, the company still buys the material in a good price. Nevertheless, there were cases that some suppliers who were not willing to take risks by fixing their price for the whole year even they won the auction. This problem is eliminated by informing all potential suppliers who demonstrate intention to participate in the auction that if they would like to bid in the auction they must commit to fix the price for the whole year else they aren't qualified and won't be eligible for bidding. Another scenario is that when two potential suppliers quoted the same best price, then the company has to divide the volume equally to these two suppliers. Having two suppliers can be good point in the perspective of reducing risk of supply. Besides the net price, a credit term is also considered (0.33333). Ideally, the company would like to trade with a supplier who give the longest credit term in order to keep the healthiest cash flow.

Besides a good product quality which can be bought with a good price, delivering purchased products is also important. The ABC Company specifies the way that ordered modified starch have to be delivered. According to the raw material specification, modified starch has to be packed up by using layers of paper bag and each bag contains exactly 25 kilo grams of modified starch. Because packing starch with plastic (PP or PE) may cause impurities such as pieces of plastic. Furthermore,

these bags have to be carried using sealed, dried and clean vehicles. In terms of lead time (0.29696), normally the time taken for delivery is within 1 day after launching the purchasing order for every supplier because their plants are considered just 3-hour far from the ABC's plant and the ordered starch will be sent to the ABC's plant by using supplier's vehicle. In case of raw material shortage, the ABC's plant always keeps a 1-day stock or just enough to run a daily production. Moreover, the purchasing department specifies the date of delivery in the purchasing order which will be 1 day ahead of production schedule. Thereby, late delivery isn't highlighted (0.16342). The most highlighted sub criterion goes to the location of suppliers' plant (0.53961). Because the further the distance between the pants, the higher the cost of transportation.

The company puts management and organization as the fourth place. Responsiveness is weighted at 0.66667 which means that the company primarily concerns about the supplier's responsiveness rather than their capacity (0.33333). The company expected a level of resilience when working with its suppliers including abilities to respond and manage changes in a timely manner for example changing in agreed delivery quantity and time due to demand fluctuation. The company also expected a supplier who demonstrates a level of commitment to a firm, an effective communication and a long-term business relationship as well as supportive actions where's proper. Lastly, a capacity of supplier is also an issue which can contribute to

differences of trading. Ideally, the company would like to trade with a supplier who has a flexible and fit-for-purpose capacity. Choosing a supplier that owns too many exceed capacities may lead to both of losing a bargaining power and an exclusiveness of being a big-volume customer. Another issue which also should be considered is that buying from a representative who has many small customers may provide more advantage than buying directly from a producer. Since the representative accumulates small batches from its customers and then the whole order gets bigger and it's big enough to negotiate with the producer in order to get a much lower price. The producer is likely to welcome high-volume customers thereby a company with a small volume may purchase a material in a high price. On the other hand, a representative tends to have more small-batch customers than the producer. A group of small-batch customers can make a very high volume and even higher than high-volume customers of the producer. The representative then gathers the total volume of its customers to negotiate and buy a material from the producer. This way buying the material from the representative gives a better price compared to buying from the producer.

4.3.2 Identify modified starch supplier priority and selection

Currently, there are 3 potential modified starch suppliers that the ABC Company used to buy modified starches which are N, O and P. Table 18 shows the AHP result which indicates the suitable potential suppliers by ranking the weight from the highest to the lowest weight.

Table 18 the AHP final result of modified starch supplier selection

Potential supplier	weight
N	0.43493
O	0.31776
P	0.24731

From Table 18, according to the AHP result the first modified starch supplier that the company should trade with is N. Nis a Thai starch dealer who sells several kinds of starch such as modified starch and potato starch. N has all required food standards, product warrant with an appropriate paper packaging at 25 kilograms per bag. They have never had any problem about their product quality. They sell their product in the lowest price compared to the other suppliers and the quote price wasn't included 7% of vat. However, they offer 25 days of a credit term after the invoice date which is the shortest credit term compared to the other suppliers. N's warehouse is located at Chonburi, East of Thailand which is not very far from the ABC's plant. Nevertheless the N's warehouse is the furthest location among the others. The location of N has an impact on the delivery cost and longer lead time. N didn't specify their lead time in their sales quote. However, N has never delivered the order late. Actually, it takes only 1 day to deliver the order. In terms of responsiveness, N has treated the company in a good manner. They are willing to support and service as possible as they can. BGD tracks a progress regularly in order to optimize their service. Although they are a dealer company, they also share where they have sourced the material from to demonstrate

their visibility and open-minded. They shared that they have sourced the starch from a manufacturer named Iam Heng Modified Starches co., ltd which is located in Nakhon Ratchasima. They are willing to quote a fix whole-year price as the ABC Company requested and keep stocks for the ABC Company in a whole year in condition that the ABC Company has to provide a stock withdraw schedule to BSG so that BSG can know the exactly the date and time as well as amount of stocks that will be withdraw. This way N is able to manage its capacity space and delivery system efficiently. N also gives flexibility of their delivery service in order to cope with increased demand. For N's capacity, they are able to produce modified starch at 12,000 tons per month which is the highest capacity compared to the other companies.

The second place is the company called O. O is also a Thai starch dealer who sells many types of starch for example modified starch and potato starch like N company. They have sourced modified starch from a company called Sangongwong Starch co., ltd in Nakhon Ratchasima. O has provided products with all required food standards, layers of paper bag at 25 kilograms per bag and never had an issue with the product quality as well. They also provide a product warranty in case of unconformity. O quoted the price higher than N and equals to the price quoted by P. For the credit term, O offers 30 days of the credit term as the same as P which is 5 days more than the offer of N. O's warehouse is located at Samutsakorn which is nearer to the ABC's plant than N's warehouse but farther than the P's warehouse. O wrote their delivery lead time on

the purchasing order that they are able to deliver the order within 3 – 5 days after receiving the purchasing order. In terms of responsiveness, O has maintained a good relationship with the ABC Company and tracked working progress daily. O also committed to take risk with the ABC Company by fixing the whole-year price as the company requested and is willing to keep the whole year stocks for the company as well but like N that the company has to give them a withdraw plan weekly and monthly for the whole year when and how many the material will be withdrawn. In case of peak demand such as the New Year festival, O understands the situation and welling to provide a level of flexibility of their delivery service such as increase the agreed delivery quantity to cope with increased demand. O is able to produce modified starch at 10,000 tons per month which is equal to the capacity of P.

The third place is the company named P. P is another Thai starch dealer who sells various kinds of starch as the same as the others. They have sourced the starch from Star Pro co., ltd in Nakhon Ratchasima. In the past, P used to be the dealer who always quoted the lowest price with the good product quality among the others. Nevertheless, there were issues about product quality recently. The situation was that P didn't have enough modified starch to supply to the ABC Company as they promised in the purchasing order and they didn't report to the company. Instead, they mixed modified starch with the lower starch grade in order to deliver to the company at the agreed quantity. After that the quality control officers found that the processed sausages

and balls which had used this starch batch were limp and not conform to the specification. Although the company reported this problem to P, they didn't provide a product warranty or pay for the damages as they have promised. Furthermore, they quoted the highest price compared to the other companies and they offer 30 days of the credit term as the same as O. In terms of delivery service, P's warehouse is located in Bangkok which is considered to be the nearest warehouse to the ABC's plant. Thereby, the transportation cost and the lead time will be an advantage and they have never delivered the order late. However, as mentioned before the actual lead time of these 3 dealers are exactly the same at 1 day ahead of production schedule and they have never been late to deliver the order. Therefore, for this reason the location of P isn't that good. For their management, P doesn't act differently from the others. They offer the fix price for a whole year trading, spaces for annual inventory and track working progress. However, unlike the other two companies P doesn't have a resilient delivery service. For example, when there was a raw material shortage due to increased demand in peak periods of the year, P was not able to supply and service for this fluctuated demand. For its capacity, P is able to produce modified starch at the same level of O at 10,000 tons per month.

4.3.3 Prioritize the order of criteria or sub-criteria and measure supplier performance of soy protein supplier selection

Table 19 a matrix of paired comparisons for soy protein supplier selection

Criteria for supplier selection	Quality	Cost	Delivery	Management and organization
Quality	1	2	4	4
Cost	1/2	1	2	2
Delivery	1/4	1/2	1	1
Management and organization	1/4	1/2	1	1
CR	0.11			

From Table 19, the four criteria are applied to the soy protein supplier selections. According to Table 20, the result illustrates that the company still values product quality primarily at 0.50 follows by cost of material at 0.25 and service delivery and management and organization are weighted equally at 0.1250. In addition, according to [38], though the CR value is more than 0.1, it is acceptable for this study since the weights, which were given to every main criteria and compared against the others, were provided reasonably. The quality criterion is the most important criterion among the others and the cost criterion is weighted as the second place which means 2 times less important than the quality criterion. Finally, the participants would like to give the weight for the delivery and the management and organization criterion equally but 2 times less

than the cost criterion. It can be seen that the weights are provided accordingly in every row and column, thereby it's acceptable to give the weights as shown in Table 19.

Table 20 Composite priority weights for sub criteria of soy protein supplier selection

Criteria	Local weight	Sub criteria	Local weight	Global weight
Quality	0.5000	Food standards	0.75	0.37500
		Warranty	0.25	0.12500
Cost	0.2500	Net price	0.75	0.18750
		Credit term	0.25	0.06250
Delivery	0.1250	Lead time	0.50	0.06250
		% Late delivery	0.25	0.03125
		Location	0.25	0.03125
		CR = 0.00		
Management and organization	0.1250	Responsiveness	0.66667	0.08333
		Capacity	0.33333	0.04167

Soy protein is the second most used raw material in the raw materials of spices group at around 300 tons per year which will cost the company approximately 40 million Baht annually or 17% of spices expenditure. Soy protein is one of the main ingredients for sausages and ball production. As the same reason as mentioned before, food manufacturers like the ABC Company highly value the quality of raw materials, especially the required food standards (0.75). There are 2 majored types of soy protein which are GMO soy protein and Non-GMO soy protein. Since the GMO issues have been argued and haven't reached an agreement yet, the ABC Company decided to use

the Non-GMO soy protein for its production in order to be able to sell its products without the argument. As the same as the modified starch, the R&D department also set the specification for supplied soy protein as well. Likewise, every supplier who would like to involve in price quotation has to send samples of their soy protein to test whether their product has all required food standards and meet the specification. For example, Coliform must not be detected and the sample has to contain protein dry basis at least 90%. In terms of physical condition, soy protein must be produced as fine powder, creamy colored with mild soybean odor. The ABC Company also expects its suppliers to provide a proper product warranty in case of misspecification or unconformity (0.25).

Buying a good quality of raw material is essential; nevertheless the raw material's price is also important (0.75.), especially when buying in a big volume. Since soy protein is one of the main spices in producing sausages and balls, a good sourcing of the main raw material can considerably help reduce the unit cost which is accounted of about 80% of the cost of goods sold and increase company's profit with the same selling price. Besides casings, soy protein is another raw material that has to be supplied from aboard since there is no soy protein producer who can supply mass volume for industrial production of soy protein in Thailand. Consequently, a little difference of currency exchange rate can cost a considerable amount of money. Thereby, the cost of raw material come the second considered criteria. According to the modified starch supplier selection, although it can be seen that the number of used

modified starch (2,000 tons) and the number of used soy protein (300 tons) are significantly different, cost of these two materials are considerably close, just 10 million Baht different. Thereby, it is an interesting raw material to be studied. As soy protein is an agricultural crop likes modified starch, thereby the purchasing strategies of these two spices are similar. The company collects the whole-year volume to negotiate the price in the harvest time and fix it with the potential supplier who wins the auction for a whole year. However, there is a risk when the trend of world's weather seem to be bad which will not be suitable for growing crops this way the company will decide early from the beginning of the year to have at least 2 suppliers in order to reduce the risk of raw material shortage. For the credit term, ideally the company would prefer a longer period of time to pay invoices because the company can have an opportunity to use this amount of money for purchasing raw materials or investing on something that have to pay by cash. This way the company will have a healthy cash flow (0.25).

Delivery and management and organization are weighted equally. According to the specification, the ABC Company specifies the way of how soy protein has to be delivered as the same as delivering modified starch. The company asks the supplier to deliver soy protein that is packed with red HDPE bag and carried by sealed and dried vehicle. In terms of delivery, the lead time of delivering raw material is the criteria that the company value as the first place (0.50) because soy protein is procured aboard. Sourcing raw material from other countries not only increase the lead time of delivering

goods but also increase the cost of transportation. Moreover, delivering the order at the right time is also considered (0.25) equally important to the location of the supplier's plant. Late delivery can cause a big issue and bad consequences for instance raw material shortage, stopped production line and missed customer orders. Nevertheless, in case of late delivery and raw material shortage, the production department always keeps some safety stocks, just enough to run productions while waiting for the raw material to be delivered. Besides, the location of the supplier's plant is also essential which can significantly make a difference. Ideally, the company would like to trade with suppliers whose plant is located as near as possible to the company's factory. Sourcing from near locations provides many advantages such as shorter lead time, lower transportation cost and may lead to low percentage of late delivery. Furthermore, near suppliers tend to be more responsive to changes than far suppliers.

In terms of management, the company emphasizes the responsiveness of suppliers (0.66667) because the material is purchased aboard thereby, the company expects its supplier to provide a good service and efficient coordination and communication on daily basis. In addition, the company would like its supplier to provide some level of flexibility in order to cope with demand uncertainty and market changes such as changing in agreed delivery quantity and delivery date as well as provide supports where necessary and a long-term commitment. For the supplier's capacity (0.33333), the company would like to trade with the supplier who has a fit-for-

purpose capacity not too many and not too small capacity because the company want to be a special customer to their suppliers where the suppliers give a good care and service, not just an ignored small customer. Moreover, unlike modified starch, there is no soy protein dealer in Thailand who sources soy protein from several soy protein manufacturers selection or the representative which is owned separately by the mother company like the casing supplier selection; the soy protein representative companies in Thailand are more like a company who sells several kinds of chemical substances for food industry; thereby the purchasing context will be different.

4.3.4 Identify soy protein supplier priority and selection

Table 21 the AHP final result of soy protein supplier selection

Potential supplier	weight
Q	0.43493
R	0.31776
S	0.24731

From the Table 21, according to the AHP result, the first supplier that the ABC Company should trade with is Q. Q is an international soy ingredient supplier which was formed as a joint venture between DuPont and Bunge Limited in 1985. About 27 years later, Q has fully owned by DuPont and merged into Danisco. Q sells mainly foods, feeds and industrial ingredients focusing on soy for example soy protein isolates soy flours and soy polymers. Q has invested considerable amount of money on their innovation in order to improve their product quality. Thereby, Q's soy protein has a very

good quality and never causes any production's problem. Obviously, they provide a product warranty in case of misspecification nevertheless the company has never claimed due to a high product quality. In terms of price, Q is the supplier who offers a premium product quality. As a result, they sell their product in a high price and highest among the other suppliers. For the credit term, Q provides a 90-day credit term with 2.5% of interest rate. Because The Q's plant is located in St. Louis, Missouri, USA which is considered the farthest supplier thereby purchasing soy protein from Q will take the longest lead time compared to the others. Besides, the longest lead time, the transportation cost is also very high as well. Nevertheless, they never delivery purchased orders late. In addition, Q had demonstrated a very high commitment in a long term relationship with supportive and responsive services. Although the plant is very far, Q has their own office in Thailand in order to provide a good service for their customers. The customer service and sales team are responsive, they are willing to look after and provide service support as soon as possible. Furthermore, Q had sent their food specialists to the ABC's plant in Thailand to develop and improve recipes and find the most effective way of applying their soy protein with the R&D department of the company. Moreover, Q sometimes provides a resilience of the payment. They are occasionally willing to extend their credit term period from 90 days to 120 days if the ABC Company asks. Finally, the ABC Company doesn't have a visibility of The Q Company's capacity yet the company believes it is quite high due to the fact that Q has

manufacturing operations in many countries such as the USA, Brazil, Mexico, Denmark, France, Italy, Belgium, and China.

The next supplier that the company should trade with is a company called Shandong R. R is a Chinese soy protein manufacturer who produces an acceptable soy protein quality yet not as good as Q's. Soy protein which has purchased from R never has a quality problem and is guaranteed for its quality as the same as the other suppliers. Since R doesn't produce a premium product quality thereby they can sell their soy protein in a lower price and lowest than the other 2 companies. For a credit term, R also provides a 90-days credit term with a 2.5% of interest rate as well. In terms of delivery service, buying soy protein from R gives a significant shorter lead time than buying from Q as R's plant is located in China which is considerable nearer to Thailand than Unite States of America. Besides, a greater shorter lead time buying from R also reduces much of a transportation cost. Furthermore, R has never delivered orders late. In addition, the ABC Company doesn't buy soy protein directly with R but buy from R's Thai dealer named Chaipattana Solution Company Limited which is located in Bangkok. As a result, it's convenient to cooperate and communicate in a daily basis. R treats the ABC Company in a usual appropriate manner as a good customer. For its capacity, R is able to produce soy protein at 834 tons per month which is considered to be the smallest supplier among the others.

Finally, the third place is the company named S. S is also a Chinese soy protein manufacturer from the same county of R, Shandong County. S's soy protein passes the R&D test with all needed specification and never has quality issue. S also provides a product warranty as the same as the other companies. Soy protein from R and S are both at the same level of quality, but S sells its product at a higher price but still lower than Q's. These three companies offer the same credit term at 90 days with 2.5% of interest rate. In terms of delivery, since S is located at the same county of R therefore the lead time is the same and considerably shorter than Q. As a result, the transportation cost equal to R's and cheaper than Q's as well. In addition, S has never delivered their soy protein late. S also has a Thai dealer named Ultimate Wide Chemical co., ltd. Which is located in Bangkok as the same as the buying context of R. The thing which is slightly different is that S's dealer is more responsive and supportive than R's dealer. They treat the ABC Company in a more special way as a premium customer. For their capacity, S is able to manufacture soy protein at 3400 tons per month.

Chapter 5 Discussion and conclusion

5.1 Discussion

Studies of supplier selection criteria has been continuously mentioned and improved from the first famous study of [8] who proposed a set of important 23 supplier selection criteria by conducting questionnaires to understand which criteria buyers value the

most. At that time, the most important criteria were product quality, on-time delivery, suppliers' performance history and product warranty which are mostly still significant for the ABC Company. However, the company didn't focus on performance history since they believe that the main criteria together with the sub-criteria are enough to show how suppliers perform. In addition, the four main criteria which selected by the ABC Company are all in the list of 23 Dickson's important criteria as well. According to [32], who studied the criteria and the procedures for the supplier selection process used in different business environments, found that different business environments for example a pharmaceutical company and a molding injection company shared the same key performance measures but the relative importance or weight assigned to each criterion is vary depending on the nature of industry. This evidence accords with the AHP results of this dissertation that all of the supplier selections (chicken, casing and spice) shared the same key performance measurements but the weight of each criteria are vary depending on the business contexts and the purchasing strategy. Furthermore, his study also indicated that manufacturing companies shares the product quality as the first priority as the same as the ABC Company.

The AHP method has been widely used to solve supplier selection problems which required making a trade-off between quantitative and qualitative factors for example the study of [1], [4], [22] and [7]. [5], [17], [24], [6], [2] and [29]. However, some studies have their own context exclusive of rating suppliers for example besides using AHP to

overcome tangible and intangible aspects [1] also applied a linear programing to determine how to allocate an amount of orders to qualified suppliers. But for this study's context and scope the linear programing isn't necessary since the company knows exactly how many should the company make orders to its suppliers and the linear programming is also not needed in casing and spices supplier selection since the company purchasing these items via bidding for the whole-year quantity. According to [32], in order to embrace the supplier chain development, companies should implement some supply chain software to improve supplier decision making process thereby the study of [22] who developed the website for AHP supplier evaluation is an interesting study for a simple future development of this thesis since the company is able to review and revise its decision easily which helps increase effectiveness of supplier selection process. The later work from 1990 to 2001 had suggested that besides the traditional criteria, suppliers' flexibility and organization and management were one of critical success factor of supplier selection which is considered as one of criteria for the supplier selection of the ABC Company. Another study which is applicable to this dissertation is the study of [23] who let personnel from both from functional and cross functional areas such as quality control unit and warehouse officers to participate in supplier selection process which is a good idea and this idea is also implemented in supplier selection of the ABC Company as the company believes opinions from both areas will significantly help increase the precision while making a supplier selection

decision. It likes an alignment of supply chain within the organization. And in the same year, there was a new supply chain trend emerged: a green supply chain. Hanfield proposed an environmental performance of suppliers as one of selection criteria [17]. Nevertheless, the ABC Company doesn't highlight this issue as a result it wasn't included in the selection criteria. [6] proposed that besides quality, cost and delivery trust should be included in supplier selection and together with using of AHP and linear program can solve supplier selection where tangible and intangible criteria are involved. However, trust wasn't selected as supplier selection criteria in this paper since the ABC Company values supplier's responsiveness which trust is included with this criterion.

According to [32], experts agree that there is no certain best way to evaluate and select suppliers for example the categorical methods, the weighted point model, the cost ratio method, total cost of ownership (TCO) models, the principal component analysis method, the analytical hierarchy process and the neural network model. Some approaches are used for pre-qualification of suitable suppliers and some approaches are used for the final choice-phrase. Therefore organizations use several different approaches which fit for their purpose with the same ultimate goal: to reduce supply risks and maximize overall values. To summarize, the categorical model is the simplest, quickest and easiest method with the smallest cost of implementation, but it indicates a high level of subjectivity and is imprecision. The weighted point model is also easy and flexible to implement since it provides an optimization of supplier selection decision, yet

it's more costly than the categorical model and still quite subjective as it's difficult to consider qualitative criteria. The cost ratio method is less subjective than the previous ones however it's a complex approach which requires a developed and strong cost accounting system and mainly considers only about cost aspect. The total cost model is a precise method nevertheless; it's expensive to implement as it requires a very high complexity and time consuming. The principal component analysis method is a good method when facing multiple conflicting factors but it requires knowledge of advanced statistical method. The analytical hierarchy process is relatively simple and easy to understand, allows both qualitative and quantitative criteria. The neural network model is a model that helps save money and times of system development but it demands a software and qualified expert on this field for implementation.

For the ABC Company's context, AHP is a suitable approach since AHP provides reliable results as it uses the comparative couple of decisions before answer questions and normally a supplier selection problem is a complicated problem. From this reason, AHP model allows users to structure the complicated problems as a hierarchy chart , which mimics human cognitive processes, making it easy to use and understand compared to other precise approaches which mostly require specialists to structure the model, costly and time consuming. Furthermore, because of final numeric outcome, it's easy to be prioritized, compared or used as a benchmark with other departments. In addition, supplier selection process usually involves with both

qualitative and quantitative aspects and a group discussion. This way AHP is an appropriate tool as it can cover all required aspects. Moreover, this approach can eliminate bias of decision making and provide a consistency of decision making.

Thought this study hasn't implemented in a real case yet, there are some comments from the participants as follow. The inventory manager commented that suppliers giving outstanding conveyance capacity give values to a firm by lessening its problem of raw material shortage, saving money on transportation costs, decreasing the requirement for capacity and diminishing the expenses associated with inventory. The production manager also added that suppliers offering request adaptability give values to firms by giving them the capacity to seize opportunities or turn away emergencies because of last minute changes. Very late changes are unavoidable and adaptability is the way to surviving such changes. In addition, selecting suppliers that give outstanding quality and unwavering quality will give raw materials that fit in with the company's requirements on the primary conveyance, as well as on each conveyance the length of the relationship endures. This conformance saves the time and money of checking things at the accepting dock and assessing things for quality, commented by the quality control manager. Furthermore, suppliers offering a reasonable cost give the advantage of cost reduction to the purchasing firm, while additionally furnishing themselves with a reasonable benefit. A commonly gainful cost permits suppliers to stay productive and proceed with business. Firms that win to a great degree low net revenues in respect to

their rivals are prone to either compromise on quality or to leave the relationship, commented by the chief purchasing executive. Finally, the chief financial executive mentioned that the expenses and advantages of supplier selection and evaluation are extremely hard to weigh. Numerous are subjective in nature, for example, upgraded consumer loyalty, expanded intensity, less guarantee issues and enhanced responsiveness. Few firms can measure these. Nevertheless, the supplier assessment will eventually provide positively affects to both financial and non-financial firm performance.

Originally, the company choose and prioritize suppliers based on the purchasing officers' experiences and the price quoted by suppliers. Even though the procurement team obtains the whole year manufacturing plan from the factory department, the team still buys raw materials month by month. As a result, although the company has considerable bargaining power due to large volume order, the company didn't take full advantage from its strength. Furthermore, the company has never shared its information with the suppliers such as the production schedule and capacity. In addition, there is no clear step or purchasing strategy to be followed. The officers can decide the purchasing volume freely to buy with any suppliers. This study suggests a new way of supplier selection and evaluation for chicken, casing and spices which includes the wider aspects besides cost and recommend some purchasing strategy for each raw materials.

The purchasing strategy that the company should obtain for these 3 types of raw materials are quite similar. First, the company has to utilize the production schedule obtained from the production department by accumulate the total amount of raw material used in a whole year of each type and used these combined volume to negotiate the price. As a result, the company can gain the full advantage from increased bargaining power such as a lower unit cost. In addition, for the agricultural products, negotiating during the harvest time helps enhance the bargaining power since in the harvest season there will be many products and surplus. As a result, the company can get the raw material in an even better price. Second, if possible, the company should encourage the potential suppliers to involve in the auction for price quotation. The auction provides benefits for both buyer and suppliers since the suppliers have a full right to quote the price they would like to sell their products and the buyer also has a right to choose the best supplier who fit for the purpose. The suppliers who would like to involve in the auction have to be informed in advance that if they win the auction the price they quoted will be fixed for a certain period of time depending on the agreement such as 6 months or a year. Some suppliers may not want to take a risk by fixing their price thereby the condition has to be informed before they involve the auction. By fixing the price, the company's raw material cost is fixed and will not varied with the business environment such as demand and supply dynamic and currency exchange rate. This is good especially for the raw materials that have to source aboard because the supply is

ensured and the exchange rate is secured from fluctuations. Third, the company should share some relevant information with the suppliers in order to smoothen the supply chain such as the production schedule. At first, it seems hard to do because the company may perceive this information as a commercial secret but it is a way to have a sustainable supply chain. If the suppliers have a visibility of how many the buyer want to be supplied in each month in a whole year, they can then manage their resources more efficiently and effectively and in turns the buyer has a health supply chain which reduces costs associated with inventory, raw material shortage and better delivery system. Fourth, the company should source raw materials directly from manufacturers rather than dealers because buying from the manufacturers is cheaper than buying from the dealers. Nevertheless, the company needs to consider its purchasing volume regards the capacity of the manufacturers. If the volume is big enough compared with the capacity of the manufacturers, the company should buy from the manufacturers. However, if the compared volume isn't that big buying from dealer may be a better choice. Because the dealers collects small batches from its customers and then the whole order gets bigger and it's big enough to negotiate with the producer in order to get a much lower price. The manufactures is likely to welcome high-volume customers thereby a company with a small volume may purchase a material in a high price. On the other hand, a dealer tends to have more small-batch customers than the manufactures. A group of small-batch customers can make a very high volume and even higher than

high-volume customers of the manufactures. The dealer then gathers the total volume of its customers to negotiate and buy a material from the manufactures. This way buying the material from the dealer gives a better price compared to buying from the manufactures. Finally, the company should revise the supplier selection and evaluation regularly in order to gain the full advantage from other coming potential suppliers.

Originally, the company buys chicken from many suppliers, approximately 9 potential suppliers as mentioned before. Nevertheless, within these 9 suppliers there are only 2 main suppliers which is F (6^{th} place from the result) and G (7^{th} place from the result). The suggestion is that the company should narrow its supply base from 9 suppliers to 2 to 3 suppliers in order to increase the bargaining power. According to the result, GFS (1^{st} place from the result) is the best supplier that the company should trade with since they have a very good performance in every aspect. Another interesting supplier is D though their product quality is not that good but they're improving and already announced that within this year their product will reach the export standards. Furthermore, the price is the lowest and they are the only one supplier who provides a credit term. H is also interesting since the only aspect that H should be improved is their pricing which is negotiable if the company offers them a bulk volume not a few volumes as before.

For casing, originally the company primarily source both cellulose casing and collagen casing from L (3^{rd} place in cellulose and 2^{nd} place in collagen) since L quoted

the lowest price. Nevertheless, the quality of L casing of both types was very variable and didn't responsible for their mistake as it should be. This study's result suggests that the company should source the cellulose casing from J (1st place) and should source the collagen casing from M. If the company buys the cellulose casing from J, the company will get the better product quality so there will be less or no problem during the production which helps save cost from non-conformances. Furthermore, this year J quoted the lowest price among the others and they established the new plant in Philippines. As a result, buying from J helps reduce the raw material cost, taxes and transportation cost as well as the lead time. Buying the collagen casing from M (1st place) also provides advantages to the company since the product quality of M is very good thereby, the company won't have problem and waste money from non-conformances during and after the production. M also takes good care its customers and they have stocks in Thailand thereby the company will get the advantage and flexibility when demand fluctuated.

For modified starch, the study's result suggests that the company should source the modified starch from N, O and P respectively which is what the company does originally. Things that the company should do are narrow the supply base from 3 suppliers to 2 suppliers in order to get higher bargaining power. In order to reduce risks of having a single source, 2 suppliers is recommended. Since N quoted the lowest price thereby N should get the higher purchasing volume than O. Finally, for soy protein,

originally the company source soy protein from S (3rd place) as they quoted the lowest price. Nevertheless, for long term benefits the company should source soy protein from Q (1st place) though it's more expensive but the quality of product is the most important thing for food manufacturers. Moreover, Q sends their specialist to improve the way of using their soy protein in order to find the most efficient and effective way, for a sustainable value chain Q is interesting supplier.

Overall, the expected benefit which can be anticipated from implementing this study is that the company will have a stronger and narrower supply base and lower raw material costs due to an increasing of bargaining power. Furthermore, the sourced raw materials have a good quality which conforms to the company's requirements. Thereby, the cost of non-conformance will be reduced. Finally the company will have a healthier supply chain as there will be improvements on the delivery and management aspects.

5.2 Conclusion

The supplier selection problem has been attracted by interested researchers since the 1960s and studies in this field have been evolved. Supplier selection issue is about trading off between qualitative and quantitative aspects of suppliers in order to find the best supplier who mostly matches with a company's requirement which depending on each nature of business. As a result, there is no best way of supplier selection.

The main contribution of this study is to improve procurement efficiency through sourcing and purchasing raw materials using supplier selection through AHP technique

by first identifying the main important criteria and sub-criteria for the supplier selection process. Then the development of the multi-criteria decision model for selecting and evaluating supplier is conducted using the AHP approach which helps assess decision makers to indicate and evaluate the supplier selection.

Finally, the model is tested with three main supplier selections: chicken, casing and spices supplier selection problem. The outcome of the test demonstrates that the model is able to support decision makers to examine the advantages and disadvantages of each supplier by comparing and trading-off between the main criteria and sub-criteria. The developed model hasn't been implemented in the real case, nevertheless the result of these 3 supplier selections imply that the quality criterion is always weighted highest among the other criteria since the ABC Company is a food manufacturing company, and thereby the quality of raw materials used in productions is the primary concern. In addition, because most of raw materials can be sourced in Thailand therefore besides the quality of material suppliers are competing mainly on price including raw material cost and transportation cost which are accounted of 80% of the unit cost. For the raw material that is procured aboard like sausage casing and soy protein the major consideration shifts to delivery and management criteria since the price quoted by suppliers weren't much different. As a result, the company should focus on potential costs which may be increased from a longer lead time, late deliveries and a higher transportation due to far distances of suppliers' plant. Furthermore, purchasing materials

aboard requires a close coordination and clear effective communication as well as responsive service support between a supplier and a buyer to smoothen the business relationship and success of business. However, the cost criterion is weighted higher than delivery and management criterion in the soy protein supplier selection since the transportation cost is essentially impact the net price due to the extreme different location of the existing suppliers. In addition, according to the result, the criteria that share the same characteristic are warranty and percentage of late delivery as every supplier all provides product warranty and they have never delivered orders late, thereby these two criteria cannot distinguish the suppliers. Since the suppliers are reliable as they've never delivered materials late, the main consideration shifts to the location of the suppliers because the location is the criterion that can indicate how long the lead time and how much the transportation cost as well as the possibility of late delivery which may impact the productions. Another criterion that every supplier is similar is a credit term. Most of suppliers in the same industry are likely to offer duration of the credit term as nearly the same as the others or just a few days differ from the others which make the criterion less considerable. Lastly, the capacity criterion is almost ranked at the bottom because it isn't that important to be focus. If the supplier is able to produce at the agreed amount according to company's requirement, then it's fine for the supplier capacity.

This study provides advantages to the ABC Company since the purchasing department always sources raw materials from the supplier who quotes the lowest price regardless of other aspects. This study provides a wider area of supplier selection process for the ABC Company by introducing hidden essential aspects besides price of raw material to be considered for more precise decision making. Thereby, the company can trade with the right supplier who provides the right quantity of material at the right time and cost as well as a more integrated and sustainable supply chain. The study also demonstrates strengths and weaknesses of suppliers in industries which the company has to trade off and identify the best supplier who matches exactly to the ABC's business context and environment. Furthermore, the supplier selection together with a well-planned schedule and purchasing strategy helps the company to produce more profits by optimizing its sourcing part of the supply chain. For example combining volume for a whole year to negotiate with suppliers not only enhances buyer bargaining power but also reduces supply risks, bullwhip effect and raw material costs. Nevertheless, there are also some disadvantages that the company may have to be considered as well. Moreover, this study helps the company to narrow down its supply based by indicating the potential best suppliers so that the company will have more bargaining power with its suppliers due to a higher volume for negotiation. In addition, this study also indicates a risk of having a single supplier for a material and encourages the company to gather several potential suppliers for price quotation and implement an

auction in order to gain the highest advantages. Though the study has included essential criteria for evaluating and selection suppliers, there might be other criteria and sub-criteria that should be included in order to be more precisely and establish a strong and sustainable relationship between buyers and suppliers within the supply chain for example environmental and trust criteria. Furthermore, the company should focus more on the existing criteria which may help increase company's benefits like the capacity criterion. Thought the result shows that the capacity of suppliers is less significant and nearly disregarded, being a premium customer to its supplier provides considerable advantages. For example, if the company buys small amount of raw material from a big supplier, the company is not only buying in a higher price but also tend to receive poor to ordinary service and commitment from the big supplier compared to buying from a supplier who has a capacity that fits for company's purpose. In addition, due to the fact that the business context is always changed and very dynamic thus besides using this static model the company has to consider the business environment and revise the selection and evaluation decision regularly. As a result, the company should aware that the existing suppliers are not always the best source of supply, there will be new potential suppliers which the company has to consider and revise its supply based in order to stay competitive and maximize its benefits by improving supplier selection and evaluation process.

Appendices

Appendix A

No.	Material List	Amount	Cumulative	% total	group
1	Carcass without tail	131,788,341.80	131,788,341.80	11.08757612	
2	Boneless Breast meat (yield 3%)	79,926,244.27	211,714,586.07	17.81190624	
3	Breast meat (yield 3%)	75,852,900.00	287,567,486.07	24.19353902	
4	Casing no.22 yellow collagen	75,624,435.00	363,191,921.07	30.55595066	
5	Casing no.22 yellow	65,800,673.40	428,992,594.47	36.09187261	
6	Breast meat	55,286,233.55	484,278,828.02	40.74319696	
7	Modified Starch	52,249,500.00	536,528,328.02	45.13903577	
8	Breast skin	44,852,132.75	581,380,460.77	48.91252157	
9	Soy protein	39,135,000.00	620,515,460.77	52.20501531	
10	Fillet (yield 3%)	35,447,827.97	655,963,288.74	55.18730104	
11	Skin leg (yield 3%)	32,315,583.52	688,278,872.26	57.90606574	A
12	Casing no. 29	26,900,523.94	715,179,396.20	60.16925232	
13	Carcass	25,386,963.14	740,566,359.34	62.30510048	
14	Potato starch	24,579,000.00	765,145,359.34	64.37297332	
15	Wheat flour	23,945,134.50	789,090,493.84	66.38751799	
16	SBB Shoulder off (yield 3%)	20,414,957.50	809,505,451.34	68.1050629	

17	Casing no.21 cellulose	19,513,161.16	829,018,612.50	69.74673815	
18	Casing no.19	15,418,784.12	844,437,396.62	71.04394654	
19	Casing no.26	14,168,857.50	858,606,254.12	72.23599649	
20	Casing no.16	13,611,483.59	872,217,737.71	73.38115363	
21	Granulated sugar	13,398,720.00	885,616,457.71	74.5084106	
22	Casing no. 22	12,319,098.20	897,935,555.91	75.54483717	
23	Fillet	12,195,426.63	910,130,982.54	76.57085904	
24	Boneless Breast meat	11,571,790.39	921,702,772.93	77.54441334	
25	Casing no.20	10,911,009.84	932,613,782.77	78.46237506	
26	Casing no.28	9,828,756.00	942,442,538.77	79.28928492	
27	Casing Amiflex Tp#37	8,445,105.00	950,887,643.77	79.99978589	
28	Sausage package HF/SF 1000กรัม	8,398,166.57	959,285,810.34	80.70633785	
29	Casing no.22 collagen	8,113,770.00	967,399,580.34	81.38896305	
30	Peeled Breast	8,103,428.00	975,503,008.34	82.07071815	
31	Ice	7,655,127.55	983,158,135.89	82.71475698	
32	Casing no. 21 yellow collagen	7,563,909.60	990,722,045.49	83.35112149	
33	DAIRY SPREAD CHEESE	7,019,800.00	997,741,845.49	83.94170914	
34	BOTTOM FILM304MM*200MC (transparent)	6,439,600.00	1,004,181,445.49	84.48348358	
35	VEGE 860 VEGETABLE EXTRACT	5,517,441.63	1,009,698,887.12	84.94767527	

36	Skim milk powder	5,186,200.00	1,014,885,087.12	85.38399905	
37	Casing Amipak "LST"19A Clear	4,929,957.90	1,019,815,045.02	85.79876475	
38	16x20 HD transparent Bag 0.07m.	4,803,350.00	1,024,618,395.02	86.20287871	
39	BOTTOM FILM239MM*200MC transparent	4,720,000.00	1,029,338,395.02	86.59998029	
40	Trimmed carcass	4,619,416.00	1,033,957,811.02	86.98861958	
41	Casing Collagen No.21/70	4,592,328.00	1,038,550,139.02	87.3749799	
42	Spices for chicken sausages	4,130,700.00	1,042,680,839.02	87.72250268	
43	Pepper powder	3,825,000.00	1,046,505,839.02	88.0443064	
44	Hampro	3,687,500.00	1,050,193,339.02	88.35454201	
45	Peeled garlic	3,565,542.12	1,053,758,881.14	88.6545171	
46	Garlic powder	3,425,850.00	1,057,184,731.14	88.94273965	
47	Casing no.22 collagen cartoon	3,196,665.00	1,060,381,396.14	89.21168049	
48	Pink color	3,105,000.00	1,063,486,396.14	89.47290939	
49	Mashed ice	3,039,739.55	1,066,526,135.69	89.72864782	
50	Boneless leg meat	2,990,044.00	1,069,516,179.69	89.98020528	
51	SMOKE SAUSAGE	2,872,750.00	1,072,388,929.69	90.2218946	B
52	PE4.5*12*0.10 Bag (logo)	2,657,140.00	1,075,046,069.69	90.44544428	
53	Sauce powder	2,652,888.00	1,077,698,957.69	90.66863623	
54	VACCOUM Bag for sausage & ball 500G.	2,648,717.80	1,080,347,675.49	90.89147734	

55	PE 8.5"x12"x0.18 CT Bag 1kg	2,602,480.00	1,082,950,155.49	91.11042839	
56	STPP	2,494,060.00	1,085,444,215.49	91.32025787	
57	Sodium Acritate	2,418,000.00	1,087,862,215.49	91.5236883	
58	Smoke water scent P50	2,334,920.00	1,090,197,135.49	91.72012907	
59	TSPP.	2,304,105.00	1,092,501,240.49	91.91397732	
60	SHMP.	2,304,080.00	1,094,805,320.49	92.10782347	
61	Paprika Oil	2,293,200.00	1,097,098,520.49	92.30075427	
62	Neck	2,285,971.00	1,099,384,491.49	92.49307687	
63	PURE LINE	2,193,670.00	1,101,578,161.49	92.67763404	
64	Casinf Amiflex Tp cal 60mm.	2,156,000.00	1,103,734,161.49	92.85902197	
65	PE 9*13 Bag New printed for water print	2,155,537.00	1,105,889,698.49	93.04037094	
66	Red chilli	2,058,588.62	1,107,948,287.11	93.21356348	
67	Vacuum chicken film 28(286X600X75MM)	2,000,600.00	1,109,948,887.11	93.38187735	
68	Barcode sticker 4*4	1,986,960.00	1,111,935,847.11	93.54904365	
69	Casing no.25	1,969,150.00	1,113,904,997.11	93.71471157	
70	Smoke scent	1,953,400.00	1,115,858,397.11	93.87905442	
71	Vacuum bag (new)	1,920,020.00	1,117,778,417.11	94.04058895	
72	Fresh garlic	1,868,193.40	1,119,646,610.51	94.19776322	
73	Casing no. 22 football	1,823,770.20	1,121,470,380.71	94.35120009	

74	Chicken film 222*600*75 MM	1,818,600.00	1,123,288,980.71	94.50420199	
75	Chicken powder scent	1,724,400.00	1,125,013,380.71	94.64927867	
76	Printed bag B 1kg.	1,717,749.00	1,126,731,129.71	94.7937958	
77	Casing no.22 Collagen (cartoon)	1,666,494.00	1,128,397,623.71	94.93400076	
78	Casing NIPPI Collagen Y230A	1,652,670.00	1,130,050,293.71	95.07304268	
79	GDL	1,605,000.00	1,131,655,293.71	95.20807405	
80	SAUSAGE POWDER	1,569,120.00	1,133,224,413.71	95.34008677	
81	CCM	1,540,000.00	1,134,764,413.71	95.46964957	
82	HD+PE 16*20*0.07 mm. white & green Bag	1,526,747.00	1,136,291,160.71	95.59809738	
83	Casing no.21 CALLAGEN(CUTISIN)	1,389,582.00	1,137,680,742.71	95.71500527	
84	PE 9*13*.16 Ching Tong Bag 1000ก.(children)	1,260,324.00	1,138,941,066.71	95.82103846	
85	Jasmine rice	1,165,250.00	1,140,106,316.71	95.91907291	
86	LIPPON barcode (RESIN IN)	1,107,135.00	1,141,213,451.71	96.01221805	
87	Skin leg	1,065,315.92	1,142,278,767.63	96.10184488	C
88	Green Chilli	1,052,354.27	1,143,331,121.90	96.19038122	
89	Vacuum chicken film 22(222X600X75MM)	993,800.00	1,144,324,921.90	96.2739913	
90	Salt powder	989,520.00	1,145,314,441.90	96.35724129	
91	Red rice flour	963,400.00	1,146,277,841.90	96.43829376	
92	PE 4.5*12*0.10mm Bag HF 5 fold	930,645.00	1,147,208,486.90	96.5165905	

93	Monosodium glutamate	864,800.00	1,148,073,286.90	96.58934759	
94	SF/HF Yellow Orange 500 g Bag	837,804.15	1,148,911,091.05	96.65983347	
95	500 g. 4 colors screened bag (new)	837,700.00	1,149,748,791.05	96.73031059	
96	Gypsum	832,462.51	1,150,581,253.56	96.80034706	
97	Frankfurter scent	830,893.92	1,151,412,147.48	96.87025158	
98	KNACK WURST	809,000.00	1,152,221,147.48	96.93831411	
99	SMOKE OIL	780,500.00	1,153,001,647.48	97.0039789	
100	Large cloves garlic	780,000.00	1,153,781,647.48	97.06960162	
101	Casing no. 27	760,725.00	1,154,542,372.48	97.1336027	
102	PE 7*9*.16 500 g Ching Tong Bag (children)	720,300.00	1,155,262,672.48	97.19420276	
103	PE 4.5*12*0.10 mm Bag 5 colors fold	718,871.00	1,155,981,543.48	97.25468259	
104	Casinf ICEL+40 Brown	714,420.00	1,156,695,963.48	97.31478795	
105	Staple 713	678,375.00	1,157,374,338.48	97.37186079	
106	R335C45MMX460M	678,000.00	1,158,052,338.48	97.42890208	
107	Cheese scent	676,000.00	1,158,728,338.48	97.4857751	
108	WOOD BEACH	674,458.00	1,159,402,796.48	97.54251839	
109	Collagen CasingNDX 28/70 CE	663,552.00	1,160,066,348.48	97.59834414	
110	Glutinous Flour	658,021.50	1,160,724,369.98	97.65370461	
111	CALGONIT NF 5401	649,800.00	1,161,374,169.98	97.70837338	

112	Chicken film 5 colors 286*600MM*75	637,568.00	1,162,011,737.98	97.76201305	
113	Sausage bag (new) 500 g	629,057.00	1,162,640,794.98	97.81493668	
114	CALGONIT NF 489	585,000.00	1,163,225,794.98	97.86415372	
115	Casing no.28 CALLAGEN YELLOW	573,804.00	1,163,799,598.98	97.91242882	
116	Sodium erythorbate	549,300.00	1,164,348,898.98	97.95864236	
117	Casing Amiflex Tp cal 40mm.	532,522.20	1,164,881,421.18	98.00344436	
118	Casing 27CALLAGEN(CUTISIN)	524,880.00	1,165,406,301.18	98.0476034	
119	CLIP#27010T	518,700.00	1,165,925,001.18	98.09124251	
120	Casing no. 21 CALLAGEN (arch)	514,404.66	1,166,439,405.84	98.13452024	
121	135 MM*235MM*80(CHIC CHEF) bag	509,760.00	1,166,949,165.84	98.17740721	
122	VACCOUM bag 225*335 mm.	505,463.00	1,167,454,628.84	98.21993267	
123	Tarpee 27	498,750.00	1,167,953,378.84	98.26189335	
124	LABEL40MMX40MM	498,000.00	1,168,451,378.84	98.30379093	
125	Chicken water scent	479,130.00	1,168,930,508.84	98.34410095	
126	Chlorine	472,500.00	1,169,403,008.84	98.38385317	
127	Casing no. 23	468,388.27	1,169,871,397.11	98.42325947	
128	HD transparent 18*28 bag	465,000.00	1,170,336,397.11	98.46238071	
129	smokez classic 5100	426,300.00	1,170,762,697.11	98.49824605	
130	Salt (Vacuum)	407,167.00	1,171,169,864.11	98.5325017	

131	Rohu	380,850.00	1,171,550,714.11	98.56454325	
132	PE 5*23 chicken york Bag (new)	377,940.00	1,171,928,654.11	98.59633998	
133	500 g Golden Farmsook bag	358,920.00	1,172,287,574.11	98.62653653	
134	Long cut knee ligament	340,952.00	1,172,628,526.11	98.6552214	
135	CCM (F)	340,170.00	1,172,968,696.11	98.68384047	
136	Casing Amipak(LST) Cal.25	339,822.00	1,173,308,518.11	98.71243027	
137	Blue rubber gloves	335,200.00	1,173,643,718.11	98.74063122	
138	Casing no.26/28 collagen	330,450.00	1,173,974,168.11	98.76843253	
139	Breast meat with bone (yield 3%)	330,399.13	1,174,304,567.24	98.79622957	
140	CHIC CHEF PREMIUM 3 sides sealed pack	320,000.00	1,174,624,567.24	98.82315171	
141	3 layers 2*18*7.5 brown box	312,570.00	1,174,937,137.24	98.84944876	
142	Casing R260A(18m.) collagen	306,180.00	1,175,243,317.24	98.8752082	
143	Chicken ham	301,000.00	1,175,544,317.24	98.90053184	
144	B 1kg. Green Bag	298,421.00	1,175,842,738.24	98.9256385	
145	HD3*15*0.04mm transparent plastic plate	295,396.00	1,176,138,134.24	98.95049067	
146	PE 5*23 chicken York bag (pink)	290,671.00	1,176,428,805.24	98.97494531	
147	Casing Amipak(LST)Cal.24	273,136.50	1,176,701,941.74	98.99792474	
148	Casing Amipak (LST)Cal.20 type R	272,160.00	1,176,974,101.74	99.02082203	
149	Loaf sugar	259,110.00	1,177,233,211.74	99.04262139	

150	Sticker PP.4*1.5	250,000.00	1,177,483,211.74	99.06365431	
151	Tari K 8	241,200.00	1,177,724,411.74	99.08394688	
152	POAM PLUS	236,000.00	1,177,960,411.74	99.10380195	
153	Nitro glove without flour TOP GLOVE (purple)	233,200.00	1,178,193,611.74	99.12342146	
154	Sodium Lactate powder	227,200.00	1,178,420,811.74	99.14253619	
155	B Grade PE 7x9 500g Bag	220,108.00	1,178,640,919.74	99.16105424	
156	PE 9.5*14*0.07mm Bag	218,510.00	1,178,859,429.74	99.17943786	
157	Cone paper	218,450.00	1,179,077,879.74	99.19781643	
158	HIALK NN465	214,000.00	1,179,291,879.74	99.21582061	
159	Cornflour	212,700.00	1,179,504,579.74	99.23371542	
160	Large rolls of toilet paper	204,450.00	1,179,709,029.74	99.25091614	
161	Yam	189,129.10	1,179,898,158.84	99.2668279	
162	LIQUID TA 109	187,200.00	1,180,085,358.84	99.28257735	
163	PP 7*12*0.07mm Bag	187,100.00	1,180,272,458.84	99.29831839	
164	Yellow color	171,875.00	1,180,444,333.84	99.31277852	
165	Onion	169,348.07	1,180,613,681.91	99.32702606	
166	PE 4.5*12*.11HF 1000G. Bag (new)	169,116.00	1,180,782,797.91	99.34125408	
167	Mesh sponge 3M	167,092.00	1,180,949,889.91	99.35531181	
168	Light Blue plastic gloves	166,500.00	1,181,116,389.91	99.36931974	

169	Bolognese scent	164,000.00	1,181,280,389.91	99.38311733	
170	Plastic Pallet 1200*1000*160mm.	160,000.00	1,181,440,389.91	99.3965784	
171	Meat scent	158,000.00	1,181,598,389.91	99.40987121	
172	XYIOSE	157,500.00	1,181,755,889.91	99.42312195	
173	Pruned carcass	150,000.00	1,181,905,889.91	99.43574171	
174	MAKE-UP 43S	144,400.00	1,182,050,289.91	99.44789032	
175	Soy sauce formula 5	142,859.25	1,182,193,149.16	99.45990931	
176	Milk & Butter scent	139,200.00	1,182,332,349.16	99.47162044	
177	Casing no.22/24 (sheep)	135,000.00	1,182,467,349.16	99.48297822	
178	Vermicelli	124,400.00	1,182,591,749.16	99.49344421	
179	Halved fillet	120,939.40	1,182,712,688.56	99.50361904	
180	Corn in brine	119,900.00	1,182,832,588.56	99.51370643	
181	WOOD CHIP(15kgs/Bag)	117,000.00	1,182,949,588.56	99.52354984	
182	Sugar in bag	110,800.00	1,183,060,388.56	99.53287163	
183	3"x6"x12" Sponge	109,200.00	1,183,169,588.56	99.54205881	
184	Fresh carrot	106,861.47	1,183,276,450.03	99.55104925	
185	Vinegar	106,331.20	1,183,382,781.23	99.55999507	
186	Nitro	104,000.00	1,183,486,781.23	99.56874477	
187	Upper wing	102,600.00	1,183,589,381.23	99.57737668	

188	LIQUID SMOKE D MAX	102,500.00	1,183,691,881.23	99.58600018	
189	Dried mushroom	100,000.00	1,183,791,881.23	99.59441335	
190	SPICE MIXED	97,788.00	1,183,889,669.23	99.60264042	
191	Zohar lab	96,800.00	1,183,986,469.23	99.61078436	
192	Chicken jock sticker (piece)	96,000.00	1,184,082,469.23	99.61886101	
193	Long fed pepper	93,179.00	1,184,175,648.23	99.62670031	
194	Sauce sticker (piece)	93,040.00	1,184,268,688.23	99.63452793	
195	Dextrose	92,000.00	1,184,360,688.23	99.64226804	
196	Old chicken carcass	90,861.63	1,184,451,549.86	99.64991238	
197	Alum powder	90,720.00	1,184,542,269.86	99.65754481	
198	PE 9“ 13.5x0.18 Bag	89,208.00	1,184,631,477.86	99.66505003	
199	Casing Collagen Casing NDX 21/50 CE Yelow	87,784.40	1,184,719,262.26	99.67243548	
200	Pruned chicken	87,610.00	1,184,806,872.26	99.67980626	
201	Carrot powder	87,500.00	1,184,894,372.26	99.68716778	
202	TAPFIL-8 Modified starch	86,635.50	1,184,981,007.76	99.69445657	
203	Vegetable oil	84,065.40	1,185,065,073.16	99.70152914	
204	Green Bigon 600 mm.	83,076.00	1,185,148,149.16	99.70851846	
205	B1 kg bag	80,575.00	1,185,228,724.16	99.71529737	
206	Fermented garlic	73,920.00	1,185,302,644.16	99.72151639	

207	Coriander	71,616.81	1,185,374,260.97	99.72754163	
208	Manufac. Date sticker (white)	71,200.00	1,185,445,460.97	99.73353181	
209	Sopical	70,000.00	1,185,515,460.97	99.73942103	
210	PE 4*6 Bag	69,000.00	1,185,584,460.97	99.74522611	
211	NUREMBERG BRATWURST ECONOMY	67,000.00	1,185,651,460.97	99.75086294	
212	HD 16*20 Blue bag	66,600.00	1,185,718,060.97	99.75646611	
213	Barbeque spices TO 294-01	64,000.00	1,185,782,060.97	99.76185053	
214	Form factory with long sleeves, white cap	63,000.00	1,185,845,060.97	99.76715083	
215	Celery	61,524.36	1,185,906,585.33	99.77232698	
216	IPA	60,696.00	1,185,967,281.33	99.77743344	
217	Alkaline supplements	57,600.00	1,186,024,881.33	99.78227942	
218	CLEANING 43S	56,400.00	1,186,081,281.33	99.78702445	
219	Laundry Products	55,440.00	1,186,136,721.33	99.79168871	
220	Chemical K70	54,600.00	1,186,191,321.33	99.7962823	
221	Black garbage bags	54,432.00	1,186,245,753.33	99.80086176	
222	CHICKEN VF 92002	53,500.00	1,186,299,253.33	99.8053628	
223	PP 7*12*0.07 mm Bag	53,115.00	1,186,352,368.33	99.80983146	
224	Pepper	52,000.00	1,186,404,368.33	99.81420631	
225	Tentacles	51,777.50	1,186,456,145.83	99.81856243	

226	HD 18x28 Blue Bag	49,581.00	1,186,505,726.83	99.82273377	
227	Nitro glove without flour TOP GLOVE white	49,250.00	1,186,554,976.83	99.82687725	
228	Grease remover	49,140.00	1,186,604,116.83	99.83101148	
229	Fongso 4 R	49,000.00	1,186,653,116.83	99.83513394	
230	N 70	47,022.00	1,186,700,138.83	99.83908998	
231	5 kg Sauce gallon	47,000.00	1,186,747,138.83	99.84304417	
232	3-side sealed 155MM.*200MM. pack	46,956.00	1,186,794,094.83	99.84699465	
233	HD 3"*15"*0.04MM Blue plate	43,803.00	1,186,837,897.83	99.85067988	
234	PP 7*12*0.07 mm Bag	43,553.00	1,186,881,450.83	99.85434406	
235	Floor Squeegee	43,500.00	1,186,924,950.83	99.85800379	
236	VITA CEL L600	42,000.00	1,186,966,950.83	99.86153732	
237	Breach	41,400.00	1,187,008,350.83	99.86502037	
238	Goa Carbon	40,000.00	1,187,048,350.83	99.86838564	
239	Onion (big)	39,775.00	1,187,088,125.83	99.87173198	
240	AL-STAIN	38,880.00	1,187,127,005.83	99.87500302	
241	Moldex mask	36,090.00	1,187,163,095.83	99.87803933	
242	Mac Burger sticker (piece)	36,000.00	1,187,199,095.83	99.88106807	
243	INK-BLACK 43S	36,000.00	1,187,235,095.83	99.88409681	
244	VACCOUM Bag for sausage and ball 250G.	35,490.00	1,187,270,585.83	99.88708265	

245	Sauce bottle	35,048.00	1,187,305,633.83	99.8900313	
246	Lime scent	34,871.00	1,187,340,504.83	99.89296505	
247	PP 2.3*22*0.14mm Bag	34,500.00	1,187,375,004.83	99.8958676	
248	Form factory with long sleeve purple cap	31,500.00	1,187,406,504.83	99.89851774	
249	Carcass (yield 3%)	30,000.50	1,187,436,505.33	99.90104174	
250	Head flavoring	30,000.00	1,187,466,505.33	99.90356569	
251	CALGONIT DS 418	30,000.00	1,187,496,505.33	99.90608964	
252	HD 3*24*0.04 mm. Blue plate	27,186.00	1,187,523,691.33	99.90837684	
253	Residues cleaner	26,730.00	1,187,550,421.33	99.91062568	
254	PP 5x18 bag	26,572.00	1,187,576,993.33	99.91286123	
255	Dried big chilli	25,365.00	1,187,602,358.33	99.91499523	
256	HD. red 16*20 Bag	25,200.00	1,187,627,558.33	99.91711535	
257	PVC green sleeve	25,000.00	1,187,652,558.33	99.91921864	
258	Basil	24,008.45	1,187,676,566.78	99.92123851	
259	Floor boards	23,000.00	1,187,699,566.78	99.92317354	
260	Cotton glove	22,050.00	1,187,721,616.78	99.92502865	
261	Tissue paper for hand	21,000.00	1,187,742,616.78	99.92679541	
262	Middle wing	20,400.00	1,187,763,016.78	99.9285117	
263	Chemical KD	19,800.00	1,187,782,816.78	99.9301775	

264	1.5” Elastic waist	19,440.00	1,187,802,256.78	99.93181302	
265	Adhesive insect trap	19,360.00	1,187,821,616.78	99.93344181	
266	Red onion powder	18,450.00	1,187,840,066.78	99.93499404	
267	PP 5*9*0.07mm chicken York A bag	18,000.00	1,187,858,066.78	99.93650841	
268	PP 5*9*0.07mm chicken York B bag	18,000.00	1,187,876,066.78	99.93802279	
269	4 color sauce bag	17,381.00	1,187,893,447.78	99.93948508	
270	Black rubber glove	17,280.00	1,187,910,727.78	99.94093887	
271	Long knee ligament	17,050.00	1,187,927,777.78	99.94237332	
272	Fabric mop	16,560.00	1,187,944,337.78	99.94376654	
273	HD3X15 yellow plastic plate	16,422.00	1,187,960,759.78	99.94514815	
274	Brown tape	16,000.00	1,187,976,759.78	99.94649426	
275	VEP	15,439.20	1,187,992,198.98	99.94779318	
276	Lactose	15,100.00	1,188,007,298.98	99.94906357	
277	PE 3.5x18*0.07mm Bag	13,464.00	1,188,020,762.98	99.95019632	
278	Sausage rope	12,750.00	1,188,033,512.98	99.951269	
279	HD 18*28 red bag	12,600.00	1,188,046,112.98	99.95232906	
280	Form plant with long green cap	12,600.00	1,188,058,712.98	99.95338912	
281	Green Boots B4250(A)#11.5	12,320.24	1,188,071,033.22	99.95442564	
282	Chicken jock sticker 500g.(piece)	12,000.00	1,188,083,033.22	99.95543522	

283	Stainless steel capillary	11,040.00	1,188,094,073.22	99.95636404	
284	Green Boots B4250(A)#11	10,780.24	1,188,104,853.46	99.957271	
285	Blue Boots 11"	10,780.24	1,188,115,633.70	99.95817796	
286	Option Toilet Cleaner@5kg	10,560.00	1,188,126,193.70	99.95906639	
287	Sauce bottle cap	10,400.00	1,188,136,593.70	99.95994136	
288	HD3X15 pink plastic plate	10,350.00	1,188,146,943.70	99.96081212	
289	Adhesive trap lizards	10,331.68	1,188,157,275.38	99.96168134	
290	A 4 paper	10,320.00	1,188,167,595.38	99.96254958	
291	Back Safety belt	9,780.00	1,188,177,375.38	99.96337239	
292	Black sauce formula 5	9,747.69	1,188,187,123.07	99.96419248	
293	HD 18x28 pink bag	9,591.00	1,188,196,714.07	99.96499938	
294	Scott Bright	9,480.00	1,188,206,194.07	99.96579695	
295	Cleaning Roller	9,480.00	1,188,215,674.07	99.96659452	
296	Green plastic glove	9,450.00	1,188,225,124.07	99.96738957	
297	Form factory with long sleeve green hat	9,450.00	1,188,234,574.07	99.96818461	
298	Apron	9,300.00	1,188,243,874.07	99.96896703	
299	Red Boots 11"	9,240.00	1,188,253,114.07	99.96974441	
300	PP 5*8*0.07mm chicken York A bag	8,730.00	1,188,261,844.07	99.97047888	
301	Book corner boards	8,729.00	1,188,270,573.07	99.97121327	

302	Iron brush	8,220.00	1,188,278,793.07	99.97190483	
303	Tapioca flour	8,200.00	1,188,286,993.07	99.97259471	
304	PP 5*8*0.07 chicken York B bag	8,010.00	1,188,295,003.07	99.9732686	
305	Male Velcro	7,980.00	1,188,302,983.07	99.97393997	
306	Female Velcro	7,980.00	1,188,310,963.07	99.97461135	
307	Tape	6,971.00	1,188,317,934.07	99.97519783	
308	0.5” Elastic waist	6,480.00	1,188,324,414.07	99.975743	
309	Blue pen	6,365.00	1,188,330,779.07	99.9762785	
310	Minced ginger	6,309.35	1,188,337,088.42	99.97680932	
311	Blue Boot 11.5"	6,160.24	1,188,343,248.66	99.97732759	
312	Green Boot B4250(A)#10.5	6,160.08	1,188,349,408.74	99.97784584	
313	Blue Boot 10.5"	6,160.08	1,188,355,568.82	99.9783641	
314	Red Boot 11.5"	6,160.00	1,188,361,728.82	99.97888235	
315	Box of glue mousetrap	6,000.00	1,188,367,728.82	99.97938714	
316	Camo color	5,900.00	1,188,373,628.82	99.97988352	
317	BL (yield 3%)	5,800.00	1,188,379,428.82	99.98037148	
318	L-Clean70 (alcohol)	5,600.00	1,188,385,028.82	99.98084262	
319	HH-OP LAVENDER 252448	5,159.00	1,188,390,187.82	99.98127666	
320	Concentrated pure sour	5,000.00	1,188,395,187.82	99.98169732	

321	Green Boot 10"	4,620.08	1,188,399,807.90	99.98208601	
322	Green Boot B4250(A)#12	4,620.08	1,188,404,427.98	99.98247471	
323	Mashed breast	4,600.00	1,188,409,027.98	99.98286171	
324	2AA Battery	4,524.00	1,188,413,551.98	99.98324232	
325	CHICKEN SOUP	4,500.00	1,188,418,051.98	99.98362092	
326	TONER LASER CE278A NO.78,P1566 J CA	4,133.34	1,188,422,185.32	99.98396866	
327	Calculator	3,950.00	1,188,426,135.32	99.98430098	
328	Water sprayer	3,947.52	1,188,430,082.84	99.98463309	
329	Big purple light sewing thread	3,900.00	1,188,433,982.84	99.98496121	
330	Stiff broom	3,870.00	1,188,437,852.84	99.9852868	
331	Notebook	3,864.00	1,188,441,716.84	99.98561188	
332	Paprika	3,750.00	1,188,445,466.84	99.98592738	
333	EPSON TO73190/T105190	3,730.00	1,188,449,196.84	99.98624119	
334	TONER LASER CB542A CP1215 J YELLOW	3,700.00	1,188,452,896.84	99.98655247	
335	Big battery	3,693.00	1,188,456,589.84	99.98686317	
336	Perfume	3,685.00	1,188,460,274.84	99.9871732	
337	Rice	3,500.00	1,188,463,774.84	99.98746766	
338	Dustpan	3,355.00	1,188,467,129.84	99.98774992	
339	Coriander seed powder	3,350.00	1,188,470,479.84	99.98803176	

340	3AA battery	3,316.00	1,188,473,795.84	99.98831074	
341	Preservative	3,315.00	1,188,477,110.84	99.98858964	
342	Form factory with long sleeves, a pink cap	3,250.00	1,188,480,360.84	99.98886307	
343	Liver	3,200.00	1,188,483,560.84	99.98913229	
344	Double-sided adhesive tape	3,186.00	1,188,486,746.84	99.98940033	
345	Tentacle	3,100.00	1,188,489,846.84	99.98966114	
346	Blue Boot 12"	3,080.08	1,188,492,926.92	99.98992027	
347	White Boot 11"	3,080.00	1,188,496,006.92	99.9901794	
348	Red Boot 10.5"	3,080.00	1,188,499,086.92	99.99043852	
349	Plastic rope	3,000.00	1,188,502,086.92	99.99069092	
350	Ink for pen	2,814.00	1,188,504,900.92	99.99092766	
351	Roach trap	2,800.00	1,188,507,700.92	99.99116323	
352	Sauce	2,769.38	1,188,510,470.30	99.99139623	
353	20 liter plastic tank	2,700.00	1,188,513,170.30	99.99162338	
354	9.5x11 1 layer continuous paper	2,625.00	1,188,515,795.30	99.99184423	
355	Rice flour	2,340.00	1,188,518,135.30	99.9920411	
356	Maltodextrin	2,268.00	1,188,520,403.30	99.99223191	
357	EPSON ink	2,238.00	1,188,522,641.30	99.99242019	
358	18” nylon brush	2,160.00	1,188,524,801.30	99.99260192	

359	uniform short-sleeved orange	2,150.00	1,188,526,951.30	99.9927828	
360	uniform short-sleeved yellow	2,150.00	1,188,529,101.30	99.99296368	
361	Pine Oil 65%@0.40kg.	2,100.00	1,188,531,201.30	99.99314036	
362	Bird's Eye Chilli	2,082.85	1,188,533,284.15	99.99331559	
363	Baking powder	2,060.76	1,188,535,344.91	99.99348897	
364	Nylon brush with hand hold	2,040.00	1,188,537,384.91	99.9936606	
365	Red pen	2,010.00	1,188,539,394.91	99.9938297	
366	INKJET HP NO.21 BLACK	1,973.34	1,188,541,368.25	99.99399572	
367	Blue carbon paper	1,960.00	1,188,543,328.25	99.99416062	
368	9.5x11 3 layers continuous paper	1,880.00	1,188,545,208.25	99.99431879	
369	TONER LASER BLACK	1,866.67	1,188,547,074.92	99.99447583	
370	Yellow boot 11"	1,850.00	1,188,548,924.92	99.99463148	
371	Yellow boot 11.5"	1,850.00	1,188,550,774.92	99.99478712	
372	TONER LASER CB540A CP1215 J BLACK	1,850.00	1,188,552,624.92	99.99494277	
373	TONER LASER CB540A CP1215 J MAGENNTA	1,850.00	1,188,554,474.92	99.99509841	
374	Epson Cart.For Lq2170/2180(REAL)#SO155	1,800.00	1,188,556,274.92	99.99524985	
375	24INK CANON BLACK 250 ML	1,800.00	1,188,558,074.92	99.99540128	
376	24INK CANON MAGENTA 250 ML	1,800.00	1,188,559,874.92	99.99555272	
377	24INK CANON CYAN 250 ML	1,800.00	1,188,561,674.92	99.99570416	

378	24INK CANON YELLO 250 ML	1,800.00	1,188,563,474.92	99.99585559	
379	Sewing needles	1,785.00	1,188,565,259.92	99.99600577	
380	TONER LASER CE320A CP1525NW BLACK	1,750.00	1,188,567,009.92	99.996153	
381	TONER LASER CE321A CP1525NW GYAN	1,750.00	1,188,568,759.92	99.99630023	
382	TONER LASER CE323A CP1525NW MAGENTA	1,750.00	1,188,570,509.92	99.99644746	
383	INKJET GM NO.678 BLACK	1,700.00	1,188,572,209.92	99.99659048	
384	9.5x5.5 3 layers continuous paper	1,700.00	1,188,573,909.92	99.99673351	
385	Slit glass	1,680.00	1,188,575,589.92	99.99687485	
386	Dried coriander	1,560.00	1,188,577,149.92	99.9970061	
387	Blue boot 10"	1,540.08	1,188,578,690.00	99.99713567	
388	White boot11.5"	1,540.00	1,188,580,230.00	99.99726523	
389	Red boot 10"	1,540.00	1,188,581,770.00	99.99739479	
390	Red boot 12"	1,540.00	1,188,583,310.00	99.99752435	
391	Copy paper	1,396.00	1,188,584,706.00	99.9976418	
392	INKJET GM NO.901 BLACK	1,395.00	1,188,586,101.00	99.99775917	
393	Wing's meat (yield 3%)	1,325.00	1,188,587,426.00	99.99787064	
394	Tooth brush	1,320.00	1,188,588,746.00	99.99798169	
395	Lentils	1,267.05	1,188,590,013.05	99.99808829	
396	Ink for red pen	1,210.00	1,188,591,223.05	99.99819009	

397	Iron Brush	1,190.00	1,188,592,413.05	99.99829021	
398	Grilled fillet	1,141.40	1,188,593,554.45	99.99838624	
399	Bottle Brush	1,050.00	1,188,594,604.45	99.99847457	
400	INKJET GM NO.678 COLOR	1,020.00	1,188,595,624.45	99.99856039	
401	INKJET GM HP NO.18 COLOR	1,013.31	1,188,596,637.76	99.99864564	
402	Laminating Pouch Films	984.00	1,188,597,621.76	99.99872843	
403	SUNSET YELLOW	980.00	1,188,598,601.76	99.99881088	
404	Citric Acid Monohydrate@1kg	880.00	1,188,599,481.76	99.99888491	
405	Scissors	830.00	1,188,600,311.76	99.99895474	
406	EPSON TO73290/T105290	746.00	1,188,601,057.76	99.9990175	
407	EPSON TO73390/T105390	746.00	1,188,601,803.76	99.99908026	
408	EPSON TO73490/T105490	746.00	1,188,602,549.76	99.99914303	
409	Glue	720.00	1,188,603,269.76	99.9992036	
410	Blue Whiteboard	702.00	1,188,603,971.76	99.99926266	
411	INKJET GM HP NO.18 BLACK	676.67	1,188,604,648.43	99.99931959	
412	Soft broom	660.00	1,188,605,308.43	99.99937512	
413	Stapler	620.00	1,188,605,928.43	99.99942728	
414	INKJET HP NO.22 COLOR	601.67	1,188,606,530.10	99.9994779	
415	Red Slippers	600.00	1,188,607,130.10	99.99952838	

416	Blue Slippers	600.00	1,188,607,730.10	99.99957886	
417	Toilet brush	600.00	1,188,608,330.10	99.99962934	
418	9V Battery	564.00	1,188,608,894.10	99.99967679	
419	HP INK CN692 COLOR NO.704	558.00	1,188,609,452.10	99.99972373	
420	Toilet brush	550.00	1,188,610,002.10	99.99977	
421	Cutter blade	390.00	1,188,610,392.10	99.99980282	
422	Squids	355.25	1,188,610,747.35	99.9998327	
423	Computer mouse	290.00	1,188,611,037.35	99.9998571	
424	HP INK CN692 BLACK NO.704	279.00	1,188,611,316.35	99.99988058	
425	21g UHU	225.00	1,188,611,541.35	99.9998995	
426	Staple No.35	204.00	1,188,611,745.35	99.99991667	
427	Plastic clipboard	184.50	1,188,611,929.85	99.99993219	
428	Plastic brush to scrub floors	180.00	1,188,612,109.85	99.99994733	
429	Staple No.10	120.00	1,188,612,229.85	99.99995743	
430	Tape cutter plate	120.00	1,188,612,349.85	99.99996753	
431	Red whiteboard pen	117.00	1,188,612,466.85	99.99997737	
432	Rubber stamp	103.00	1,188,612,569.85	99.99998603	
433	Signing book	98.00	1,188,612,667.85	99.99999428	
434	Platforms imprint	48.00	1,188,612,715.85	99.99999832	

435	Cutter	20.00	1,188,612,735.85	100	
436	Fat	-	1,188,612,735.85	100	
437	PE 4.5*12*.10mm calcium 5 fold	-	1,188,612,735.85	100	
438	Casing no.285 (net)	-	1,188,612,735.85	100	

Appendix B: Table of CR value for the alternatives of each supplier selections

CR value	Chicken suppliers	Cellulose casing suppliers	Collagen casing suppliers	Modified starch suppliers	Soy protein suppliers
Food standards	0.01	0.00	0.00	0.01	0.00
Warranty	0.01	0.00	0.00	0.00	0.00
Net price	0.03	0.01	0.00	0.00	0.01
Credit term	0.01	0.00	0.00	0.00	0.00
Lead time	0.01	0.00	0.00	0.00	0.00
Percentage of late delivery	0.01	0.00	0.00	0.00	0.00
Location	0.01	0.05	0.00	0.01	0.00
Responsiveness	0.01	0.05	0.00	0.00	0.00
Capacity	0.01	0.00	0.00	0.00	0.00

REFERENCES

APPENDIX

VITA

Miss Puncharas Nanthiyanuragsa was born on 16th April, 1992 in Bangkok, Thailand. After completing her high school from Satriwitthaya 2 School in 2010, she pursued her bachelor degree in Biomedical Engineering at Faculty of Engineering, Srinakharinwirot University, in 2010. She completed her bachelor in 2014. After that she pursued her post-graduate dual degree programme in Engineering Management offered by Regional Centre for Manufacturing System Engineering (RCMSE), Chulalongkorn University and Engineering Business Management, jointly Warwick Manufacturing Group (WMG), University of Warwick.