Strategic supplier selection:the case of international food trading company

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การคัดเลือกผู้จัดจำหน่ายเชิงกลยุทธ์ในบริษัทส่งออกผลิตภัณฑ์อาหาร

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นาถชนก ปรมาพร : การคัดเลือกผู้จัดจำหน่ายเชิงกลยุทธ์ในบริษัทส่งออกผลิตภัณฑ์อาหาร. (Strategic supplier selection:the case of international food trading company) อ.ที่ปรึกษาหลัก : ศ. ดร.ปารเมศ ชุติมา, อ.ที่ปรึกษาร่วม : ผศ.ชูเวช ชาญสง่าเวช

วัตถุประสงค์ของโครงการวิจัยคือการพัฒนาระบบการเลือกซัพพลายเออร์เชิงกลยุทธ์สำหรับบริษัทเทรดดิ้งอาหารระหว่างประเทศโดยใช้กระบวนการวิเคราะห์เชิงลำดับชั้น (AHP) ผลิตภัณฑ์ที่เกี่ยวข้องในงานวิจัยนี้คืออาหารกระป๋องสำหรับการส่งออก ส่วนผู้มีอำนาจในการตัดสินใจประกอบด้วยประธาน 1 คน และผู้จัดการฝ่ายการตลาด 2 คน เกณฑ์การตัดสินใจที่ได้รับการคัดเลือกมีน้ำหนักความสำคัญดังนี้ 'ความสามารถในการส่งออก' (54%), 'นโยบายการกำหนดราคา' (28%), 'ก้าวทันเทคโนโลยี' (10%), 'การปฏิบัติอย่างมีจริยธรรม' (5%) และ 'การจัดการสิ่งแวดล้อม' (3%) สำหรับเกณฑ์การคัดเลือกย่อยคือ 'จำนวนใบรับรองความปลอดภัยของอาหาร' (54%), 'ราคาขายสุทธิ' (23%), 'ระบบอัตโนมัติในกระบวนการผลิต' (8%), 'เงื่อนไขการชำระเงิน' (5%), 'ความปลอดภัยและสุขภาพของแรงงาน' (4%), 'การควบคุมสภาพอากาศไม่พึงประสงค์' (2%), 'ความหลากหลายของบรรจุภัณฑ์' (2%), 'การหยุดจ้างเด็กและแรงงานที่ถูกบังคับ' (1%) และ 'การปฏิบัติกฎระเบียบด้านสิ่งแวดล้อม' (1%)

ในปัจจุบันบริษัทคัดเลือกซัพพลายเออร์โดยใช้ราคาประมูลต่ำสุดเป็นเกณฑ์ซึ่งเลือกใช้ซัพพลายเออร์ C สำหรับผลิตภัณฑ์สับปะรด, ซัพพพลายเออร์ F สำหรับผลิตภัณฑ์ข้าวโพดหวาน, และซัพพลายเออร์ L สำหรับผลิตภัณฑ์ข้าวโพดอ่อน หลังจากนำระบบการคัดเลือกซัพพลายเออร์เชิงกลยุทธ์ที่พัฒนาขึ้นมานำไปใช้จะพบว่า ซัพพลายเออร์ที่ดีที่สุดของผลิตภัณฑ์สับปะรดคือ ซัพพลายเออร์ B (ด้วยคะแนน 33.6%) และซัพพลายเออร์ D (32.8%) สำหรับผลิตภัณฑ์ข้าวโพดหวานคือซัพพลายเออร์ F (29.35%) และซัพพลายเออร์ E (29.22%) และผลิตภัณฑ์ข้าวโพดอ่อนคือ ซัพพลายเออร์ I และ K ที่มีคะแนน 32.33% และ 26.55%

สามารถสรุปได้จากงานวิจัยวิทยานิพนธ์ได้ว่าเกณฑ์คัดเลือกเชิงกลยุทธ์ที่เกี่ยวข้องกับสภาพแวดล้อมทางธุรกิจในปัจจุบันได้รับน้ำหนักจำนวนมากพอสมควรในความคิดเห็นของผู้เชี่ยวชาญ ด้วยความคิดเห็นเช่นนี้จึงสามารถยืนยันได้ว่าการเลือกซัพพลายเออร์เชิงกลยุทธ์ควรจะได้รับความสนใจมากขึ้นสำหรับภาคธุรกิจ

สาขาวิชา	การจัดการทางวิศวกรรม	ลายมือชื่อนิสิต .....
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Natchanok Paramaporn : Strategic supplier selection:the case of international food trading company. Advisor: Prof. PARAMES CHUTIMA, Ph.D. Co-advisor: Assoc. Prof. Chuvej Chansa-ngavej, Ph.D.

The objective of the research project is to develop strategic supplier selection system for an international food trading company using the Analytic Hierarchy Process (AHP). The products involved are canned food for worldwide export. The decision makers consist of a president and two marketing managers. The chosen decision criteria listed by weight of important are 'Export Capability' (54%), 'Pricing Policy' (28%), 'Technological Catch-up' (10%), 'Ethical Practices' (5%), and 'Environmental Management' (3%). The sub-criteria chosen are 'Number of Food Safety Certificate' (54%), 'Net Selling Price' (23%), 'Automation in Production Process' (8%), 'Payment Terms' (5%), 'Worker's Safety and Health' (4%), 'Adverse Weather Control' (2%), 'Packaging Varieties' (2%), 'Stop Child and forced labor' (1%), and 'Environmental Compliances'(1%).

According to the company existing choice of supplier using cheap price as the criterion for selection that supplier C for pineapple products, supplier F for sweet corn products, and supplier L for baby corn products. After the proposed strategic selection system is applied, the optimal suppliers for pineapple are found to be Supplier B (with a score of 33.6%) and Supplier D (32.8%), for sweet corn product are Supplier F (29.35%) and Supplier E (29.22%), and for baby corn product are Supplier I (32.33%) and Supplier K (26.55%).

It may be concluded from the present thesis research that strategic criteria involved with current business environments obtained substantial weight from expert's opinion. This confirmed that Strategic Supplier Selection should obtain a lot of attention from business sector.

Field of Study:	Engineering Management	Student's Signature .....
Academic Year:	2019	Advisor's Signature .....
		Co-advisor's Signature .....

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I place on record, my sincere gratitude to the experts who were involved in the validation interview for this research thesis: a president and sale and marketing officers of the case study company (food trading company). Without the passionate participation, the validation interview could not have been effectively conducted.

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Natchanok Paramaporn

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1.1 Overview of Thailand food export products

According to Food export-Midwest and Food export-Northeast (n.d.), Thailand is counted as one of the most and fastest developed food processing supplier, compared to other South East Asia nations. Thailand has been trading a wide variety of commodities and goods for ages. The well-known food product categories include cassava, rice, processed vegetables and fruits, poultry meat, seafood, ready-to-eat and frozen food.

The number of food production plant is over 10,000 with small, medium, and large-scale factories. Such small to medium processors serve mostly the domestic market, whereas medium to large producers serve both domestic and international markets. Thailand's food manufacturers heavily rely on exportation with over 50 percent of total agricultural goods sent out to countries around the globe. Food products from Thailand has labeled as high-quality food ingredients and sold in reasonable prices in the eyes of overseas entrepreneurs (Thailand Country Profile, n.d.).

It is reported by Thailand Board of Investment (n.d.) that Thailand has placed itself and has been called as "Kitchen of the world" due to the fact that a majority of Thai population mainly involve with food and agricultural production with 50% of total ground regions used for farming aims. Thailand's landscape is inclusive of abundant natural resources with all year-round growing season. Besides, Thailand gain numerous

competitive advantages against other agricultural countries from leveraging the benefit of relatively low labor cost and highly-skilled workforce.

Agricultural industry is one of significant fragments for driving Thailand's economic as this particular industry contributed approximately 23% of Thailand's Gross Domestic Product (GDP). The value of food trade balance in 2016 accounted for USD 16.7 billion, making Thailand to be acknowledged as one of the world's largest food exporter and second place in Asia. Moreover, agricultural industry received substantial advocation from governments for integrating the industry with Thailand 4.0 economic model and building Food Innopolis (global food innovation hub) in Bangkok.

When it comes to food export ranking, Thailand rank first place compared to countries worldwide for Cassava products, Canned Tuna, and Canned Pineapple, as well as second place for Rice and Sugar (**Figure 1.1**). The top agricultural export values are from rice, natural rubber, fruit products, Fish products, and cassava products (**Figure 1.2**). There are 9,000 of food processing firm hosting in Thailand and the amount of processed food exports contributed roughly 52% of entire food exports.

Figure 1. 1 Thailand's Food Export Ranking in 2016 (Source: Thailand Board of Investment, n.d.)

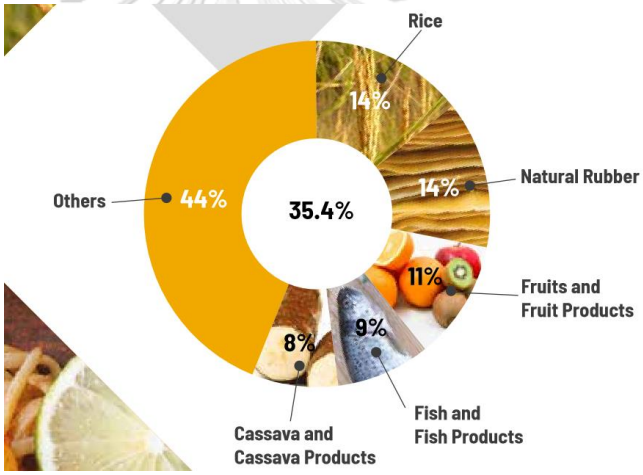


Figure 1. 2 Thailand Agricultural Export Value by Product in 2016 (Source: Thailand Board of Investment, n.d.)

Workman (2019) has claimed that percentage share of the overall exported goods and the fastest-growing exports from Thailand during 2018 illustrate in **Table 1.1** and **Table 1.2**.

Focusing on food products, the meat/seafood preparations held the eighth rank in global shipments, and fruits, nuts and coffee, tea, spices ranked the fourth and sixth in the world's fastest-growing exports between 2014 and 2018. From these ranks, it means food exports from Thailand have high potential in market expansion and contribution to economic growth.

Interestingly, a focal company runs a fruit export business, and this, in turn, is a good sign for these kinds of business with the percentage increase at 110.4%.

Table 1. 1: Top 10 Thai Exports to the world during 2018 (Source: Workman, 2019)

Rank	*Exported poducts*	*Values (USD)*	*Percentage share*
1	Machinery including computers	42.9 billion	17.2%
2	Electrical machinery, equipment	35 billion	14%
3	Vehicles	30.4 billion	12.2%
4	Rubber, rubber articles	15.5 billion	6.2%
5	Plastics, plastic articles	14.5 billion	5.8%
6	Gems, precious metals	11.9 billion	4.8%
7	Mineral fuels including oil	10.6 billion	4.2%
8	Meat/seafood preparations	6.6 billion	2.6%
9	Organic chemicals	6.1 billion	2.5%
10	Cereals	5.7 billion	2.3%

Table 1. 2: Top 10 Thai fastest-growing exports during 2018 (Source: Workman, 2019)

Rank	*Exported products*	*Values (USD)*	*Percentage change from 2014*
1	Fur skins and artificial fur	160.1 million	Up 6,305%
2	Cork	973,000	Up 892.9%
3	Railway, tram, equipment	92 million	Up 123.8%
4	Fruits, Nuts food	2.7 billion	Up 110.4%
5	Live animals	291.4 million	Up 97.2%
6	Coffee, tea, spices food	140.9 million	Up 94.5%
7	Nickel	12.6 million	Up 90%
8	Arms, ammunition	14.5 million	Up 79.4%
9	Tobacco	169.6 million	Up 74.7%
10	Lead	57 million	Up 70.9%

1.2 Strategic Supplier Selection

Supplier selection plays a vital role of being one of the top priorities for driving procurement success. The success or failure of procurement cycle depends on company's buying decision process. Consequently, the selection stage benefits company in terms of minimizing negative risk-taking from trading with undependable

supplier and those group of vendors deserve to be replaced by top-notch performance providers.

The proper way to diminish the possibility of suffering from mistakes in decision-making of supplier assortment is to find the right supplier who provide the reasonable price and greatest performance simultaneously. However, the purchasing authority usually bought the commodities from suppliers who quoted the cheapest bidding price which in turn brought a long list of difficulties and supply chain disruption. Such kinds of problems directly affected to corporate creditability and long-lasting relationship with business partners.

The prevalent content towards supplier selection in recent years from scientific publications focus on the topic “sustainable supplier selection”. The majority of academics has been writing research articles about finding the imperative criteria to enhance the selection process sustainably. However, they overlooked the truth that the sustainable supplier is not always count as best performance supplier.

Strategic supplier selection is then need to be studied further in order to find the eligible potential supplier by integrating efficient supplier qualification, supplier risk management, and sustainable supplier selection as three major qualifications for exploring relevant criteria. Criteria from most studies in the literature are considered under the main theme such as economic and environmental. Whereas the imperious

criteria involved with social theme have been forgotten and seems to be more important in the past few years and near future.

The right of human is becoming the hot topic during this time and future. The United Nations and International Labor Organization concentrate on elimination of unethical practices to legal workers as well as forced labors. Besides, technological innovations began to be an important part for helping suppliers to reduce excessive cost, improve production efficiency, and strengthen positive image. The technological criteria are another interesting element to consider for supplier selection in the digital era.

When it comes to economic, the strategic selection method is more complicated than traditional process. There are numerous economic criteria apart from low price quotation such as quality, warranty, delivery cost, and payment terms which these criteria will be applied to adjust with particular product as appropriate.

1.3 Company Background and Products

1.3.1 Company information

The group of case study companies is a wholesale distributor, established since 1981. At present, the company has operations in two countries; Thailand and Indonesia. The case study company in this thesis focuses on the company in Thailand that sells grocery and other food products to a multiplicity of buyers abroad from different

countries in different continents; America, South America, Europe, Asia, and the Middle East.

Company's responsibility is to procure food products according to foreign customer specifications and strict laws and regulations for a typical country. With such trade barriers, the company needs to be serious in selecting reliable and potential food manufacturers to match such specification complexities.

There are several food products in the focal company that depends on the supplier performance. The number of supplier sources for some kinds of product category is relatively abundant. However, because of recent economic recession in Thailand, the major group of company suppliers have been confronting with financial problems, and bankruptcy in the end. The case study company, consequently, desires to find the right suppliers matching with company's demands and global market.

1.3.2 Company supply chain

The process steps in the trading firm begins with finding local food manufacturers, trade dealing with suppliers through contract agreement, dealing with printing house to print brand labels, checking the progress of the ordered product lots, shipment reservation of maritime facility, manipulating export tariffs, ending with the goods arrival to the port of destination.

The transportation mode that has been used for a long time to the destination country is waterborne transport due to the heavyweight of canned food, long-distance, lower cost compared to other modes and the long shelf life of canned food.

Company's supply chain comprises of four blocks which are local food manufacturer, trading company, distributor, and retailer, as shown in **Figure 1.3**.

Figure 1. 3 A Focal Company's Supply Chain (Source: Derived by the Author)

1.3.3 Company products and sales

The company exports grocery food products to overseas with the company own brand names BALA and with customer brand (**Figure 1.4**). The company sells a variety of food products which are canned food, preserving food in jars and sauce.

Figure 1. 4 Canned products under company's brand (Source: The case study company)

The entire income of the focal company describes in **Figure 1.5** and **Table 1.3**. The regular products that continue trading during 2016 to 2018 were Baby corn, Sweet corn, Pineapple, Coconut milk, Sweet chili sauce, Tuna, Oyster, Fruit Cocktail, and Rice vermicelli.

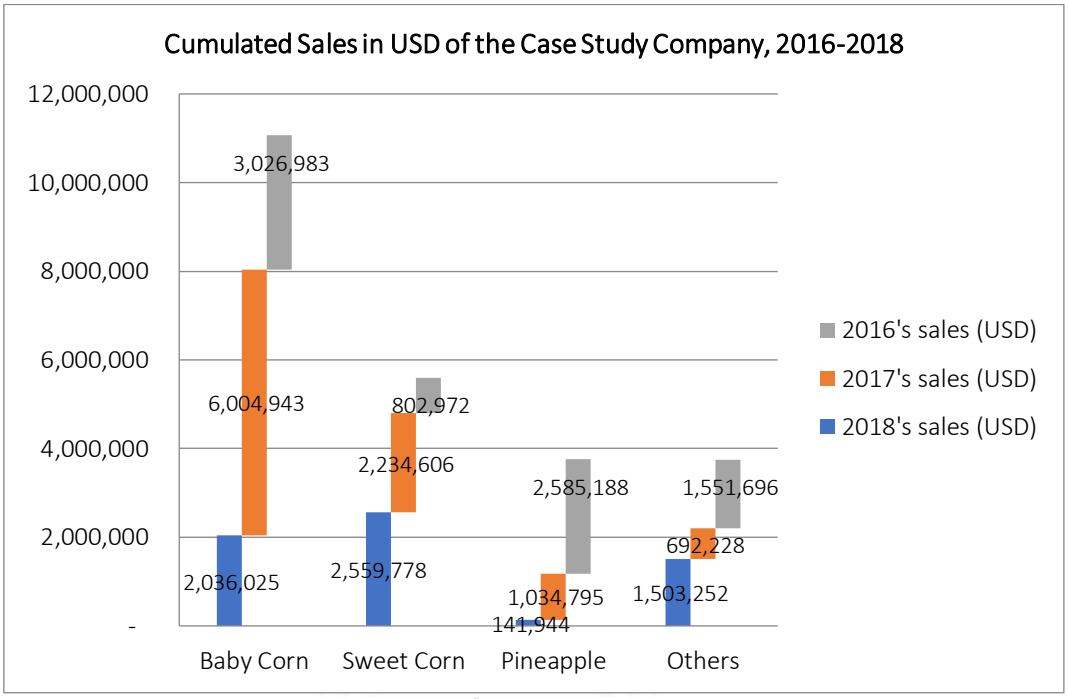


Figure 1. 5 Cumulated Sales in USD of the Case Study Company by Years, 2016-2018

(Source: Derived by the Author)

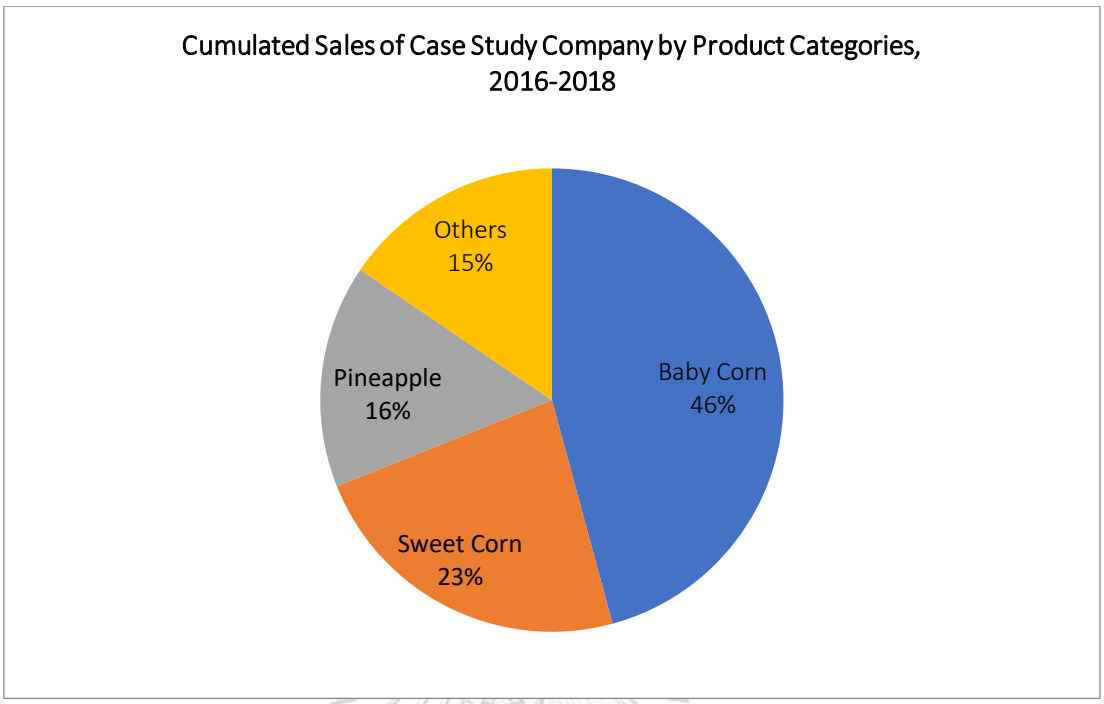


Figure 1. 6 Cumulated Sales in percentage of the Case Study Company by Product Categories, 2016-2018 (Source: Derived by the Author)

According to **Figure 1.6**, the main sources of company earnings were from baby corn, sweet corn, and pineapple (calculated from Y2016 to Y2018). 46% of total sales belong to baby corn products, while that of sweet corn accounted for 23% and that of pineapple are 16%.

On account of agricultural products, each type of plants does not grow properly, or the quality and quantity of them are poor and less in some seasons. This makes the company need to occasionally procure those products from neighboring countries for customer retention, while quality oyster needs to be exported from the port of South Korea directly to that of destination country.

Table 1. 3: Cumulated Income of the Case Study Company by Product Categories, 2016-2018 (Source: Derived by the Author)

Rank	*Products*	*2018 sale (USD)*	*2017 sale (USD)*	*2016 sales (USD)*	*Total*
1	Baby Corn	2,036,025	6,004,943	3,026,983	11,067,951
2	Sweet Corn	2,559,778	2,234,606	802,972	5,597,356
3	Pineapple	141,944	1,034,795	2,585,188	3,761,927
4	Coconut	872,482	144,823	189,335	1,206,640
5	Fruits Cocktail	30,240	139,964	1,008,866	1,179,070
6	Sweet Chili Sauce	403,610	272,080	223,685	899,375
7	Oyster	196,920	135,360	129,810	462,090
8	Tuna	127,887	209,450	-	337,337
9	Mango	-	90,510	103,625	194,135
10	Rice Vermicelli	45,356	101,314	-	146,670
11	Longan	68,900	-	-	68,900
12	Tomato Paste	49,549	-	-	49,549
13	Papaya	-	18,900	8,400	27,300
14	Bean Curd	-	20,955	-	20,955
15	Jackfruit	-	1,090	-	1,090
				Total sales	*25,020,344*

1.4 Problem statement

1.4.1 Internal current situations

In these days, the firm has no structural screening process for supplier selection. The decision-making in product procurement for typical customers are dependent on two marketing managers and a president. Decision-makers consider selecting an appropriate supplier based on food certificates in line with the demands of typical customers as well as the cheapest bidding price.

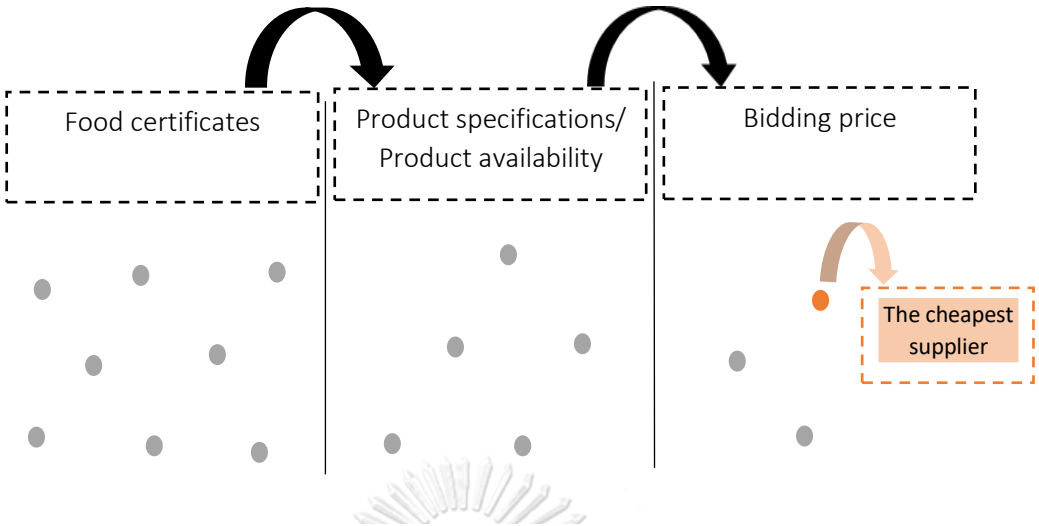


Figure 1. 7 A current process of supplier selection in focal company (Source: Derived by the Author)

Major imperative problems of the case study company from trading with a group of untrustworthy suppliers are 'Shipment Delay', 'Price Appreciation', 'Quality Drop', and 'Others' with different percentages; 37%, 18%, 26%, 19% respectively as depicted in **Figure 1.8** and the example of case study are as shown in **Figures 1.9, 1.10, 1.11 & 1.12.**

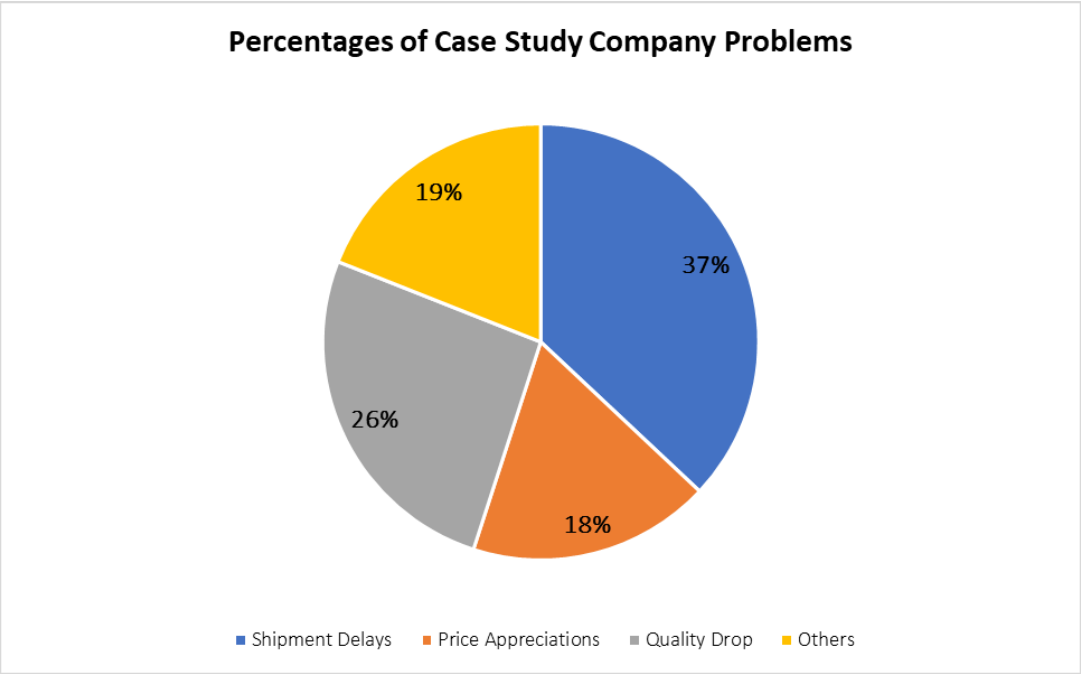


Figure 1. 8 Percentages of Case Study Company Problems

Case study I: Shipment Delay

Hi *Company marketing team**

Our *Product's name** is out of stock due to one-month **shipment delay***.
Per our requirement, PO 10678-1 supposed to ship early February; however, the actual departure date is end of February.
Since we are not able to deliver baby corn to our customer, **the penalty might incur***.
Please explain our situation to printer and ask for Ai file from them.
Thank you.

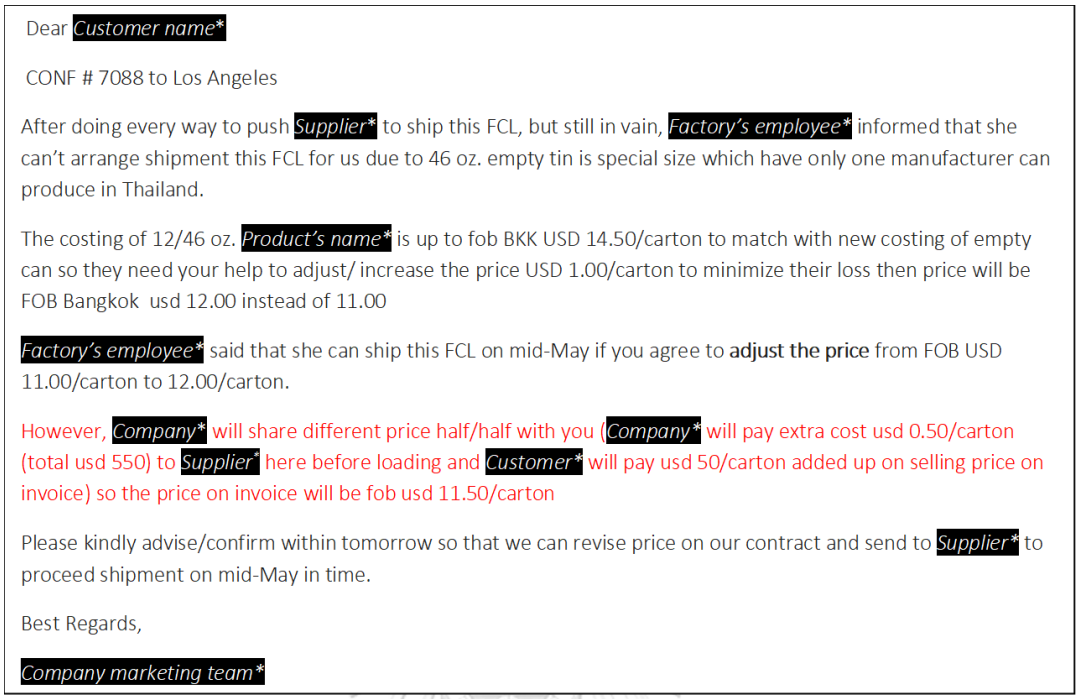
Best Regards,
*Customer name**
*Customer brand**

Figure 1. 9 The case study of shipment delay (Source: Adapted from case study company, emphases by the Author)

According to **Figure 1.9**, it appears that this particular supplier was unable to produce the finished products to serve the customer as promised. In this case, the

customer considered to charge the penalty from in charge parties and decided to buy products from another vendor to fill the goods into supermarket's shelf and asked for label format to use with products. The supplier often keeps making excuses towards raw material shortage from natural disaster, but actually it is possible to maintain stocks for selling directly to overseas markets or mistakes in available stock planning.

Case study II: Price Appreciation



Dear *Customer name**

CONF # 7088 to Los Angeles

After doing every way to push *Supplier** to ship this FCL, but still in vain, *Factory's employee** informed that she can't arrange shipment this FCL for us due to 46 oz. empty tin is special size which have only one manufacturer can produce in Thailand.

The costing of 12/46 oz. *Product's name** is up to fob BKK USD 14.50/carton to match with new costing of empty can so they need your help to adjust/ increase the price USD 1.00/carton to minimize their loss then price will be FOB Bangkok usd 12.00 instead of 11.00

*Factory's employee** said that she can ship this FCL on mid-May if you agree to **adjust the price** from FOB USD 11.00/carton to 12.00/carton.

However, *Company** will share different price half/half with you (*Company** will pay extra cost usd 0.50/carton (total usd 550) to *Supplier** here before loading and *Customer** will pay usd 50/carton added up on selling price on invoice) so the price on invoice will be fob usd 11.50/carton

Please kindly advise/confirm within tomorrow so that we can revise price on our contract and send to *Supplier** to proceed shipment on mid-May in time.

Best Regards,

*Company marketing team**

Figure 1. 10 The case study of price appreciation (Source: Adapted from case study company, emphases by the Author)

According to **Figure 1.10**, it appears that this particular supplier quoted extremely low-priced to entice vendees and distributors. Once the scheduled delivery date comes closer, the unit price is determined to be appreciated with a defence of necessity. In this case, the company needed to share the different price with customers to carry on the shipment.

Case study III: Quality Drop

Dear *Customer name**

I am following up to see when the production records will be sent (as request Jan 29, 2020- see below).
In addition, I am following up as I have received the QIMA report on the *Product's name**.
There are a few issues that I need a respond from the factory on;

53 out of 200 cans inspected had minor dents on the side – see samples of picture in report. Please explain why and what steps can be done in the future to reduce this. This was not seen in previous reports.

ORGANOLEPTIC CHECK/DEFECTS	**For Reference: YB2 KCC 200106 BB/MA: 2023 JA 06** Defects found: Dent mark- 53pcs Product Length below specification- 11pcs Product diameter below specification- 1pc Poor trimming- 4pcs Blemish- 2pcs Foreign material- 1pc Silk- 1pc

I await the product records and a response on the dents.

Best Regards,
*Importer's quality assurance manager**
*Customer brand**

Figure 1. 11 The Case Study of Quality Problem I (Source: Adapted from case study company, emphases by the Author)

Defectives List Pictures

Defect Type	Defective Pictures	
Dent mark		
Product Length below specification		

Figure 1. 12 The case study of quality problem II (Source: The case study company)

According to **Figure 1.11 and 1.12**, it appears that product samples produced by this particular supplier have quite a lot of quality troubles from product itself and packaging which is strictly against the quality standard as promised. In this case, the company needs to find out the cause of such issues to respond to clients before this lot can be sent via vessel to destinations. This problem might affect to departure schedule postponement.

On an account of the unstructured working procedure, the trading company has been confronted with a long list of critical supply problems and disruptions.

- Penalty charges
- Customer dissatisfactions
- Customer complaints
- Late shipments
- Wrong item delivered
- Defective product delivered
- Business defamation
- Loss selling opportunity
- Loss financial budget

In conclusion, company's current situation is encountering with the problem about income reduction due to lower number of customers. The root cause of that issue is from trade partnership with unqualified suppliers.

1.4.2 External current situations

International food safety standards are currently being upgraded to become one of the trade barriers factors. Good Manufacturing Practice (GMP), Hazard Analysis and

Critical Control Point (HACCP) and ISO system are enhanced to have higher standards with nonstop version updated. Besides, typical region has its food safety requirements; British Retail Consortium (BRC) for European countries and the Food and Drug Administration (FDA) for the united states.

With all of such complications, the number of practical alternative suppliers is restricted to be lower and searching for a group of eligible domestic suppliers is much more problematic than before. The updated safety standards for different types of certificates are as in **Figure 1.13** and the symbol of typical certificate are as **Figure 1.14**. Besides, some retailers decided to provide annual third-party audit to check food standards for particular local factory on behalf of the company itself (**Figure 1.15**).

As a result, it is necessary for the buyer to find the eligible suppliers who have ability to catch up the trend of food quality standard.

ISO 22000	ISO 22000:2005 sets out the requirements and maps out what an organisation needs to do to demonstrate its ability to control food safety hazards in order to ensure that food is safe.
FSSC 22000	FSSC 22000 is fully recognised by the Global Food Safety Initiative (GFSI) and is based on existing ISO Standards.
TACCP	Threat Analysis and Critical Control Point (TACCP) is a management system closely aligned to HACCP to simultaneously manage both unintentional (HACCP) and intentional contamination and economically motivated adulteration (TACCP).
HACCP	HACCP is a management system in which governs the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product.
GLOBAL GAP	GLOBAL G.A.P. is an internationally recognised set of farm standards dedicated to Good Agricultural Practices (**GAP**).
British Retail Consortium (BRC)	BRC is GFSI recognised and contains requirements for food processors to follow to build an effective food safety management system. It is suitable for food packaging manufacturers, storage and distribution companies.
Halal certification	Halal certification ensures the features and quality of the products according to the rules established by the Islamic Council that allow the use of the mark Halal.

Figure 1. 13 Definition of Different Types of International Food Safety Standards (Source: PAnlyseis, n.d.)

Figure 1. 14 The symbol of international food safety standard

(Source: Panlyseis, n.d.)

THIRD-PARTY FOOD SAFETY AUDITS

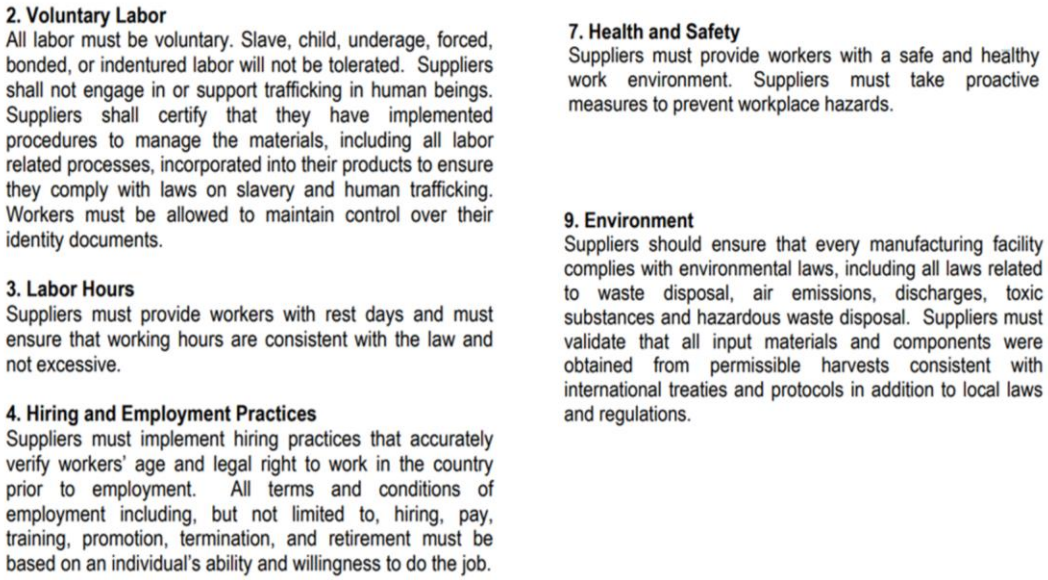
Walmart understands that some fresh produce suppliers have limited food safety resources due to the size of their company. While encouraged to pursue full GFSI certification, these suppliers have the option to obtain a third-party audit instead. Fresh produce suppliers who have a total annual revenue less than $1 million and have been approved by a Food Safety Manager can obtain an annual third-party food safety audit in lieu of GFSI certification. We will only accept third-party audits from accredited certification bodies that have been approved by Walmart. Audits conducted by an approved certification body on behalf of another retailer will not be accepted. Please refer to the Fresh Produce Third-Party Food Safety Audit Information in the Appendix for a list of approved audits for your operation type.

Figure 1. 15 Third-party food safety audit (Source: Walmart, 2017)

Plenty of organizations are paying attention to corporate social responsibility (CSR) topic because high demands of publics currently keep an eye on the culture of ethics and integrity.

One of company overseas distributors has worked with Walmart Central America on food product supply, the company then need to seek for a group of domestic production plants where are able to be compliance with Walmart's CSR initiative covering the elimination of human trafficking and unfair labor practices from the entire food supply chain (Patrick, 2018). The Walmart's standard for suppliers relating to labor,

health and safety, and environment are shown in **Figure 1.16**. Walmart is the first company to set the extraordinary standards for suppliers; other retailers would set such kinds of safety standards involved with social and environment in the near future for promoting company's image and beat competitors.



2. Voluntary Labor
All labor must be voluntary. Slave, child, underage, forced, bonded, or indentured labor will not be tolerated. Suppliers shall not engage in or support trafficking in human beings. Suppliers shall certify that they have implemented procedures to manage the materials, including all labor related processes, incorporated into their products to ensure they comply with laws on slavery and human trafficking. Workers must be allowed to maintain control over their identity documents.

3. Labor Hours
Suppliers must provide workers with rest days and must ensure that working hours are consistent with the law and not excessive.

4. Hiring and Employment Practices
Suppliers must implement hiring practices that accurately verify workers' age and legal right to work in the country prior to employment. All terms and conditions of employment including, but not limited to, hiring, pay, training, promotion, termination, and retirement must be based on an individual's ability and willingness to do the job.

7. Health and Safety
Suppliers must provide workers with a safe and healthy work environment. Suppliers must take proactive measures to prevent workplace hazards.

9. Environment
Suppliers should ensure that every manufacturing facility complies with environmental laws, including all laws related to waste disposal, air emissions, discharges, toxic substances and hazardous waste disposal. Suppliers must validate that all input materials and components were obtained from permissible harvests consistent with international treaties and protocols in addition to local laws and regulations.

Figure 1. 16 Walmart's standard for suppliers relating to labor, health and safety, and environment

From the above reasons, it is necessary for the trading company to create strategic supplier selection to dispel supplier selection problem and achieve more competitiveness.

1.5 Objective of the thesis study

To develop strategic supplier selection system to be appropriate for applying with the trading company through the Analytic Hierarchy Process (AHP).

1.6 Scope of study

Three products (baby corn, sweet corn, and pineapple) will be picked to consider the eligible candidate suppliers in the thesis. Thesis study places important on such product categories because they are listed as the top three best sellers of the focal company, accounting for 85% of total sales, and each category value exceeds 1 million US dollar. Besides, such product categories are from the identical type of supply source.

1.7 Expected benefits

Strategic supplier selection system provides advantages to both parties; trading-company and academic community.

1.7.1 Trading company

To begin with trading company, application of strategic selection is able to improve decision-making to be more accurate and precise as well as getting rid of bias on one dimension over others. In most cases, cheap price is frequently set by unqualified sellers in order to entice the buyers to purchase those products.

The structured process can help corporate find a group of potential suppliers. From this, the firm will have the list of alternative eligible suppliers and able to suddenly switch to auxiliary when the most optimal one has subjective problems, contributing to no disruption in supply chain. Another benefit, trading with reliable suppliers helps the

company use fewer suppliers with supply variety, leading to strengthening the relationship and building a positive image in the eyes of customers.

1.7.2 Researcher and interested party

For academic interest, the strategic supplier selection is a new approach for the supplier selection topic. This thesis aims to develop strategic supplier selection framework based on further study towards three main strategic criteria; efficient supplier qualification, supplier risk management, and sustainable supplier selection with multiple decision-makers. In the thesis, the sustainability and risk criteria are explained to make practitioners and researchers enlighten about such vital criteria that can help the firm gain competitive advantages.

Chapter 2 Literature Review

2.1 Strategic Supplier Selection

Alikhani *et al*. (2019) suggested that finding qualified suppliers is a pivotal task for every organization to improve the efficiency of the supply chain. The candidate selection should be a strategic decision, including consideration of risk and sustainability factors.

The best performing supplier might not be a sustainable supplier, and the risk dimension should be systematically considered to avoid various uncertainties such as natural disasters and supply disruptions.

The author described the area of optimal strategic suppliers as illustrated in **Figure 2.1**, and the eligible suppliers should have all these qualifications; Efficient Supplier Qualification (ESQ), Sustainable Supplier Selection (SSS), and Supplier Risk Management (SRM).

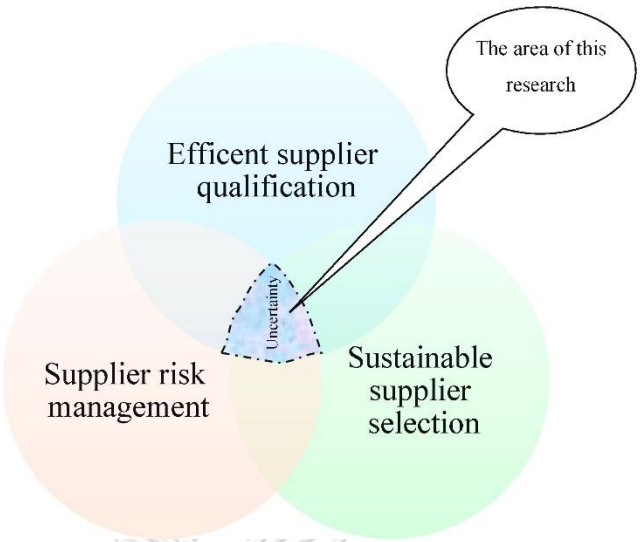


Figure 2. 1 An area of optimal strategic suppliers (Source: Alikhani et al., 2019)

The risk influencing factor comprises of ten elements as follows.

1. Quality
2. Cost
3. Long-term cooperation
4. Bankruptcy
5. On-time delivery
6. Supply constraints
7. Supplier's profile
8. Continuity
9. Second-tier supplier
10. Contractual and opportunism

The sustainable criteria comprise of nine elements as follows.

1. Cost/Price
2. Quality
3. Technology Capabilities
4. Green Design
5. Environmental Management System
6. Environmental Competencies
7. Interests and Rights of Employees
8. Rights of Stakeholders
9. Social Management Commitment

From the factor above, apart from cost and quality which are the fundamental factors for every industry, the continuity is one of the useful factors in food industry (especially vegetable and fruit industry) because the crop growth is dependent on the specific condition for each particular plant and natural disaster can damage the plants. The technology capabilities are another interesting element due to the fact that the innovation is a part of enhancing product quality and increasing product capacity. Environmental management system in this research focused on obtaining ISO 14000 which is the basic certification to illustrate that the supplier complies with environmental regulation.

Memari *et al. (2019)* proposed the developed SSS framework with four major steps as illustrated in **Figure 2.2**.

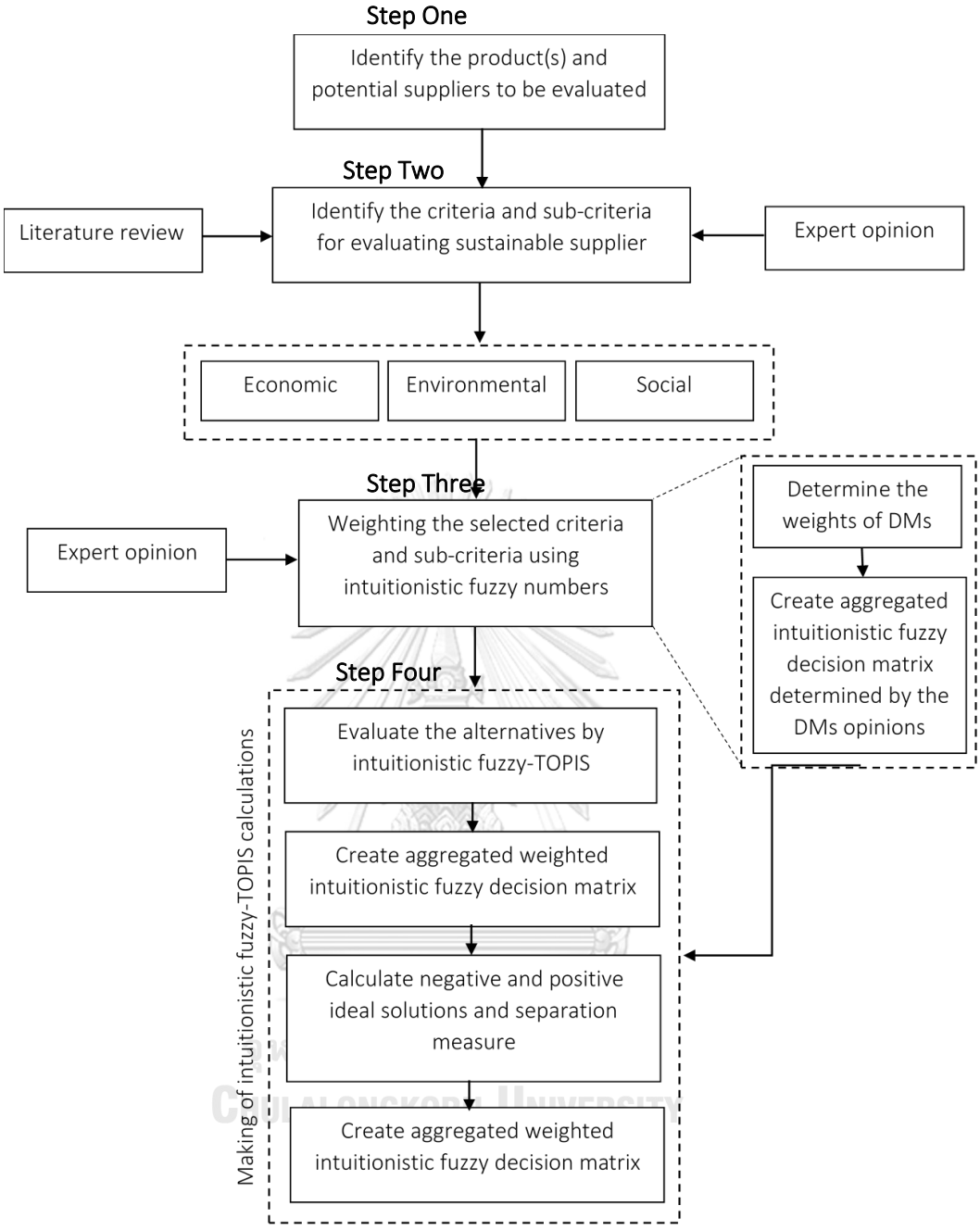


Figure 2. 2 Four steps of sustainable supplier selection framework (Source: adapted from Memari et al., (2019)

1. *Identify product and evaluate potential supplier* – a list of the regular purchase order is initially identified. After that, the potential supplier who can supply the required products is specified.
2. *Determine main criteria and corresponding sub-criteria* – criteria and sub-criteria relating to sustainability dimension are determined by studying literature review and gathering decision-makers' opinions (using nominal group technique for getting rid of individual bias). The sustainability themes comprise of economic, environmental, and social.
3. *Weight the selected criteria and sub-criteria* – the weight score to selected criteria and sub-criteria are given by experts. Afterwards, decision matrix is created for giving the values of each criterion to be used in the following step.
4. *Making a calculation to rank sustainable supplier* – a list of supplier candidates is evaluated by using intuitionistic fuzzy-TOPIS calculations and the output of the sustainable supplier ranking is processed.

Zimmer *et al. (2015)* had conducted a review of models supporting sustainable supplier selection in a structured manner, with crucial analysis of 143 publications. The paper shows the decomposition of hierarchical structure relating to sustainable supplier management into three dimensions which are economic, environmental, and social issues.

The framework in **Figure 2.3** is validated by eleven experts who operate in corporation sustainability in the function of purchasing and product development. Such experts suggested determining the three different levels on a hierarchical structure which are the dimension, main theme, and theme.

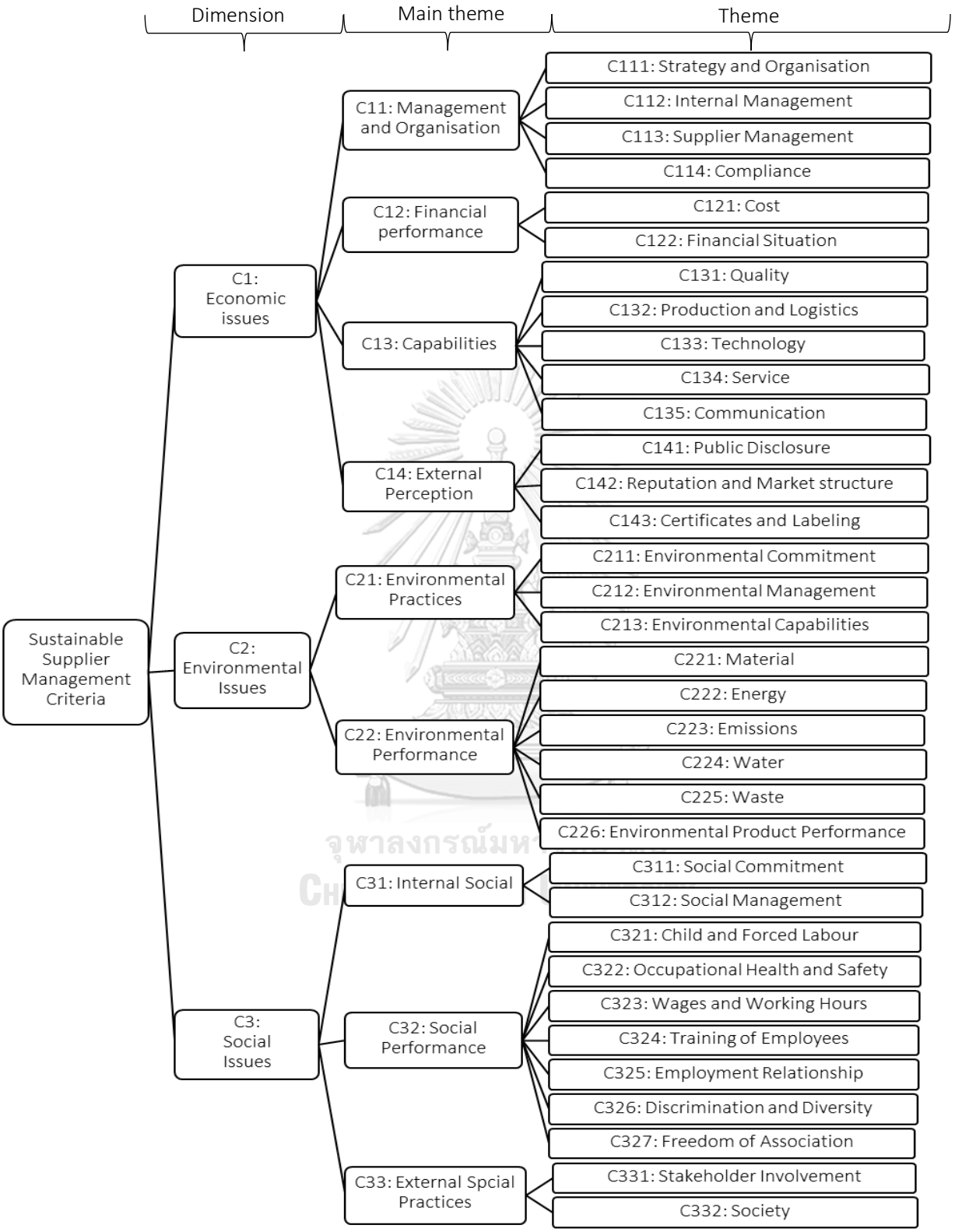


Figure 2. 3 Sustainable Supplier Management Criteria (Source: Zimmer, Fröhling and Schultmann, 2015)

There are 2661 collected criteria from analysed literature sample. With the analysis of the corresponding themes, the most frequently used considered theme is the economic dimension with 52.5%, while that of environmental and social issues is 38.1% and 9.4% in succession.

The rare use of social criteria is because of the particularity of social issues and the difficulty in measuring and quantifying social sustainability. This area needs to be practically integrated with strategic supplier selection as an environmental theme did. The top ten of the used criteria for each theme illustrate in **Table 2.1, 2.2, and 2.3**.

It is surprising that 'water' and 'energy' are less mention amongst environmental criteria despite the fact that it is recommended by the United Nations (UN) and the Global Reporting Initiative (GRI). While, 'Child and forced labour', 'Discrimination', and 'Abuse of human rights' often recommended by UN and International Labour Organization (ILO) are not listed at the top 10 social criteria.

Table 2. 1: Top 10 Economic Criteria (Source: adapted from Zimmer et al ,2015)

Economic criteria	*Number of times*
Quality	48
Flexibility	45
Price	43
Lead time	39
Relationship	37
Cost	36
Technical capability	32
Logistics cost	27
Reverse logistics	25
Rejection ratio (ppm)	23

Table 2. 2: Top 10 Environmental Criteria (Source: adapted from Zimmer et al. ,2015)

Environmental criteria	*Number of times*
Environmental management system	67
Resource consumption	51
Eco-design	47
Recycling	44
Controlling of ecological impacts	35

Wastewater	34
Energy consumption	32
Reuse	28
Air emissions	27
Environmental code of conduct	23

Table 2. 3: Top 10 Social Criteria (Source: adapted from Zimmer et al. ,2015)

Social criteria	*Number of times*
Involvement of stakeholders	22
Staff training	21
Social management commitment	17
Health and safety	14
Stakeholder relations	11
Social code of conduct	10
Donations for sustainable projects	9
The right of stakeholders	8
Safety practices	6
The annual number of accidents	6

2.2 Supplier Selection Relating to Food Industry

According to *Lau et al. (2020)*, the paper reviewed the assessment of organic food suppliers. The information using for evaluation was extensively collected through derived the interesting theme from interview data which required to be in line with the research questions and theoretical framework wrote from reliable sources of publications. The interviews were conducted with collaboration of expert team (researchers and practitioners) and organic food consumers.

Top 5 of primary criteria belong to cost of monitoring, certified organic and safety, quality, delivery, and product respectively, the hierarchical model of superior food supplier performance with primary criteria and its weights is depicted in **Figure 2.4**.

As the fresh and organic food product, laboratory testing and non-organic producer from 'Cost of monitoring' are brought to consider as crucial factors and 'Delivery' criteria is another significant due to the fact that fresh and organic food require lots of mandatory requirements such as refrigerated storage and need fast delivery to maintain freshness and reduce time to be contaminated by ambient environments. On the other hand, 'Quality', 'Certified product and safety', 'Product' are fundamental essential features for entire food product categories.

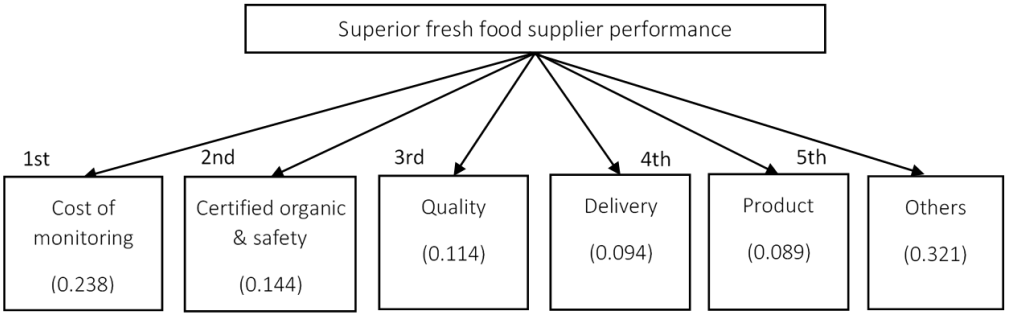


Figure 2. 4 The hierarchical model of superior food supplier performance (Source: Adapted from Lau et al., 2020)

According to Azadnia *et al. (2014)*, the journal article is about applying sustainability criteria for supplier selection in packaging film in food industry with mathematical model (fuzzy AHP) to cut off lot-sizing difficulties and choosing the best group of suppliers. In order to survive in the competitive environment of global market, apart from traditional cost and 'Economic' elements, 'Environmental' and 'Social' should become the factor to consider in sustainable supplier selection. All of the relevant elements are illustrated in **Table 2.4**, derived from expert suggestions, company's current supplier evaluation system, and the literature.

Because this is the packaging firm, then the 'Environment' is the most imperative criteria with the weight accounted at 0.3374, following by 'Economic' and 'Social'. Quality came in the first place for economic criteria weighting. It is remarkably that 'Occupational health and safety management system' obtained overwhelming weight

rating compared to other two sub-criteria from Social criteria. This interesting element will be applied to this research study for being one of the criteria in social theme.

Table 2. 4: The used criteria of packaging film in food industry (Source: Azadnia et al, 2014)

Criteria	*Sub-criteria*	*Influencing factors*
Economic *(0.2182)*	Cost (0.2778)	Purchasing cost
		Holding cost
		Ordering cost
	Quality (0.3374)	Product quality level
	Delivery (0.2778)	On-time delivery reliability level
	Loyalty (0.2183)	Loyalty level to company
	Technical capability (0.1665)	Production facilities and capacities, ability to adopt with company's demand changes
Environmental *(0.3374)*	Environmental management system (0.388)	Level of EMS implementation
		Environmental protection level
	Pollution (0.3356)	Chemical waste (raw material extraction)
		Product waste

	Greenhouse emission (0.2756)	Methane emission to air
		CO_2 emission
		NO_2 emission to air
Social *(0.1665)*	Occupational health and safety management system (0.4488)	Level of implementation for occupational health and safety system
		Percentage of workforce represented in formal joint management work health and safety committee
	Worker safety and labor health (0.2756)	Percent of injury per year
		Mercury (Hg)
		Sulphur dioxide (SO_2)
		Particles (PM10)
	Training education and Community development (0.2756)	Average hours of training per year per employee (Managers)
		Average hours of training per year per employee (Personnel)
		Number of created job opportunity

2.3 Multi-Criteria Decision-Making Approaches

Chai *et al.* (2013) collects 123 international journal articles about decision making (DM) approaches for supplier selection published between 2008 and 2012 and 26 decision-making techniques were discovered which classified into three categories; Multiple Criteria Decision Making (MCDM), Mathematical Programming (MP), and Artificial Intelligence (AI). Comparatively, the most utilized DM model belongs to Analytic Hierarchy Process (AHP) with a percentage at 24.39%, following closely by Analytic Network Process (ANP) which both are the subset of multi-attribute utility method of MCDM paradigm (**Table 2.5**). This is due to its effectiveness in having multi choices of tasks and rankings system.

Table 2. 5: The list and frequency of the DM techniques that were used more than twice (Source: adapted from Chai et al., 2013)

The used DM techniques	*Abbreviation*	*Amount*	*Percentage*
1. MCDM techniques			
• Analytic Hierarchy Process	AHP	30	24.39
• The technique for order performance by similarity to the ideal solution	TOPSIS	18	14.63
• Analytic Network Process	ANP	15	12.20
• Elimination and choice expressing the reality	ELECTRE	4	3.25
	VIKOR	3	2.44
• Multicriteria optimization and a compromise solution	DEMATEL	3	2.44
• Decision-making trial and evaluation laboratory		1	0.81
• Others			
2. MP techniques			
• Linear Programming	LP	19	15.44
• Data Envelopment Analysis	DEA	13	10.57
• Multi-objective programming	MOP	13	10.57

• Goal Programming	GP	7	5.69
• Nonlinear Programming	NLP	6	4.88
• Others		2	1.63
3. AI techniques			
• Generic Algorithm	GA	8	6.50
• Grey system theory	GST	6	4.88
• Neural networks	NN	5	4.07
• Rough set theory	RST	4	3.25
• Others		12	9.76

To understand better, Chai *et al.* (2013) claimed that this theoretical structure provided finite alternatives derived from logical and reasonable recommendations, whereas it can be assessed with multiple criteria or called attributes. The MCDM comprises of several techniques, but the prevalent technique like AHP and ANP is in multi-attribute utility methods. It is about assigned a utility rating to every choice of criteria for indicating the preference degree. The expert judgments will be collected to measure intangible and qualitative attributes via pairwise comparison of the AHP method, while ANP is an extensive studying of measurement of intangible measurement.

According to Ho (2008), the journal article refers to AHP's advantages that the model is considered as a popular approach because it provides simplicity, flexibility,

and ease of use to the academic researchers and practitioners. From 78 papers gathered between 2000 and 2008 of Ho *et al.* (2010) article, AHP is mostly selected to integrate with other decision approaches, while the most popular integrated AHP technique is integrated AHP with GP (Goal programming). The uniqueness of AHP can provide the relative important weightings of alternative suppliers with high consistency because of feedback mechanism that makes it be a good decision- making model, while GP can compensate AHP due to consideration of resource constraints such as buyer's budget. In terms of sustainability decision making, AHP mainly used in the manufacturing industry (Dos Santos *et al.,* 2019).

The approach limitations are time-consuming when finding expert's judgments and consistency ratio over a limit value. This feedback mechanism contributes to review and revise for repeating the pairwise comparisons. Noticeably, there was a steady increase in using multiple-criteria decision-making techniques from 31 to 47 in the period of 2000-2004 and 2005-2008 which means it will be more and more frequently and widely used in the future due to ability to sustain effective supply chain (Ho *et al.,* 2010).

Erdogan *et al.* (2017) suggested software package "Expert Choice" which can apply for determining criteria weights. While, *Labib (2014)* claimed that the supporting software is user-friendly because of including several necessary facilities; priorities and

consistency automatic calculation, intuitive graphical user interfaces, and sensitivity analysis. The main criteria were input to the program in the first place, and the result will be determined. To check the consistency of the expert's judgement, the corresponding consistency (CR) ratio less than 0.1 is acceptable, then the sub-criteria for each criteria group will be inputted to determine the sub-criteria weights. After that, the scoring of each supplier will be counted with the help of Expert Choice.

2.4 Analytical Hierarchy Process

The AHP approach was the first advent and studying further by Saaty (1972, 1977, and 1980) that the concept of this model is to give the relative importance to different criterion and then specify the degree of preference to the criterion.

The process starts from identifying the primary objective or conflict to be resolved as in the top of **Figure 2.5**, and then such conflicts are decomposed into several levels with respect to decision hierarchy. Examples of high-level to lower-level in a hierarchy are the criterion, sub-criterion, and alternative in succession. Afterwards, the element comparison is performed through pair-wise comparison with respect to the main topic of each alternative and criterion, using the one-to-nine ratio scale.

From this, the prioritization of the option at each level in the hierarchy is calculated, and consistencies of the scores are measured to be a validation. Lastly, a sensitivity analysis conducted until discovering the requisite model.

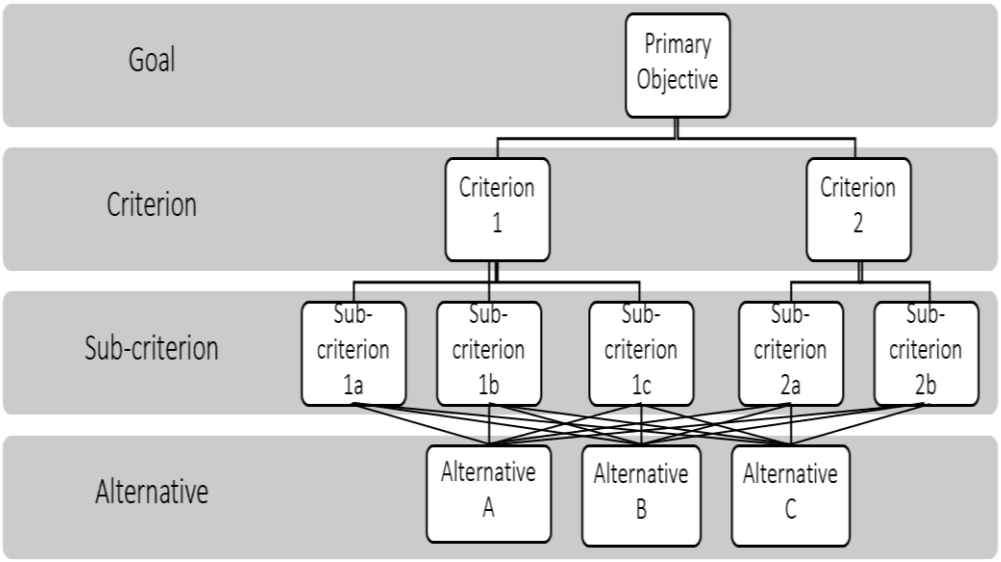


Figure 2. 5 AHP decision hierarchical model (Source: adapted from Saaty, 1980)

There are four simple steps to complete problem-solving, which are problem modelling, weights valuation, weights aggregation, and sensitivity analysis. In terms of pair-wise comparisons, the psychologist claimed that comparison one opinion on two alternatives is easier and more correct method rather than consideration all at once *(Labib, 2014)*.

For priority establishment, the one-to-nine scale has rated for computing pair-wise comparison. The criteria i and j determined for asking decision-maker with the description of Saaty (1980) as shown in **Table 2.6**.

Table 2. 6: Relative importance scales (Source: adapted from Saaty, 1980)

Intensity of importance	*Value Description*	*Explanation*
1	Criterion *i* and *j* are of equal importance	Two activities contribute equally to the objective
3	Criterion *i* is weakly more importance than *j*	Experience and judgments slightly favor one activity over another
5	Criterion *i* is strongly more importance than *j*	Experience and judgments strongly favor one activity over another
7	Criterion *i* is very strongly more importance than *j*	Activity is strongly favored, and its dominance demonstrated in practice
9	Criterion *i* is absolutely more important than *j*	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent values	When a compromise in judgments is needed

Dyer and Forman (1992) suggested that AHP can integrate into a group judgment in many ways to fit variational contexts. They proposed there is a variety of AHP model building which is basic and complex hierarchical models. The fundamental

structure comprises of goal, criteria, and alternatives, while to reach the advance analysis, more elements are added in the hierarchy such as scenarios and actors. The following hierarchical structure patterns are examples of typical hierarchical structures:

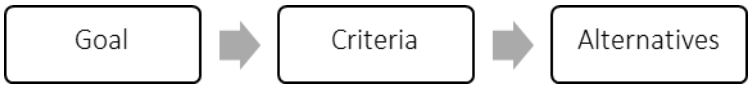


Figure 2. 6 Hierarchical Structure Pattern 1 (Source: adapted from Dyer and Forman, 1992)

Figure 2. 7 Hierarchical Structure Pattern 2 (Source: adapted from Dyer and Forman, 1992)

Figure 2. 8 Hierarchical Structure Pattern 3 (Source: adapted from Dyer and Forman, 1992)

Figure 2. 9 Hierarchical Structure Pattern 4 (Source: adapted from Dyer and Forman, 1992)

There are four ways to apply AHP into a common objective context which are consensus, voting, individual judgement's geometric mean, and separate models or

players. The last one with separate players is an interesting method due to able to make decision separately amongst individual group members.

As noted by Saaty (1980), the player importance should be done through pairwise comparison owing to the differentiation of people's judgement and experience to eliminate controversy among group members. The factors to indicated appropriate relative important of individuals should create according to **Figures 2.6 to 2.9**. Such factors are education, past performance, experience, and responsibility

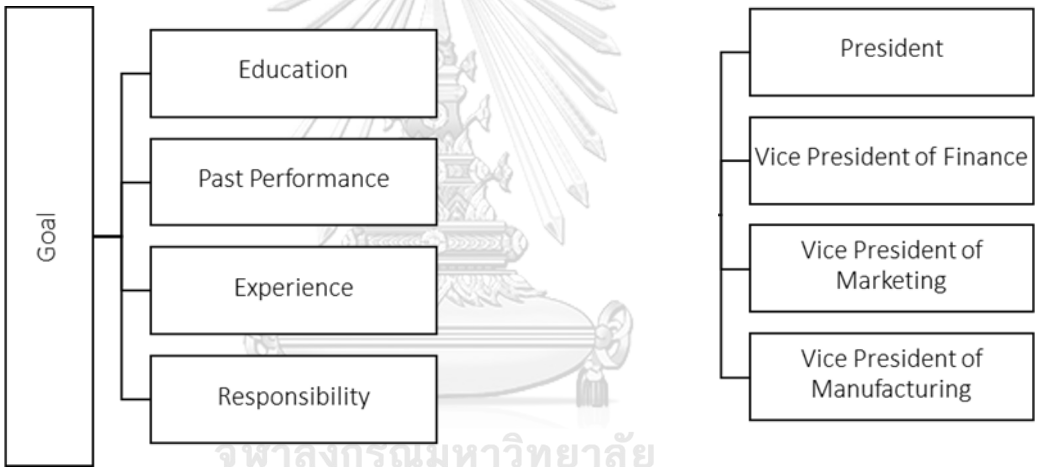


Figure 2. 10 Model for evaluating the relative importance of the decision-makers

2.5 Criteria Selection

It is argued by Chansa-ngavej and Srijuntub (2010) that the principle of criteria selection for using in the research study applying AHP process comprises of five elements. The criteria selection is the significant factor for making a decision and needs to have careful considerations during the process.

1. Completeness – the hierarchical model or layer diagram is a useful instrument to ensure that whole relevant criteria are completely brought to consider in the research.

2. Non-redundancy – All of the replicated or trivial criteria are necessity to be excised at the initial phase.

3. Decomposability – Every criterion must be independent from others and the performance of alternative is able to be determined independently on one particular criterion.

4. Operationality – Every criterion must have the meaningfulness and must able to be judge against others.

5. Minimum number of criteria – the number of criteria must be restricted in order to avoid excessive effort in result analysis stage and it is more difficult to analyze a great deal of criteria. The researcher should perform the final check to ensure that the proper number of necessary criteria is gathered. The minimum number must be less than seven elements for inability of human judgement evasion.

This research will be conducted base on concerning the valuable principal of criteria above to gain the most precise and correct experimental results.

2.6 Research Gap

- Insufficient information of Strategic Supplier Selection researches
- Most innovative researches focused on Sustainable Supplier
- Extend the research work of Alikhani et al. (2019); Consideration of Uncertainty Factors (i.e. Risk & Sustainability)
- No Strategic Supplier Selection for Export & Preserved Food Industry
- Social Criteria is fewer presence for Supplier Selection and can be shown how it could measurable

Chapter 3 Model development

3.1 Classify the strategic supplier dimensions

According to **Section 2.1**, **Figure 5**, the optimal strategic suppliers includes three qualifications; Efficient Supplier Qualification (ESQ), Supplier Risk Management (SSS), and Sustainable Supplier Selection (SRM). All of those is restructured to involve with the thesis criteria in form of **Figure 3.1**.

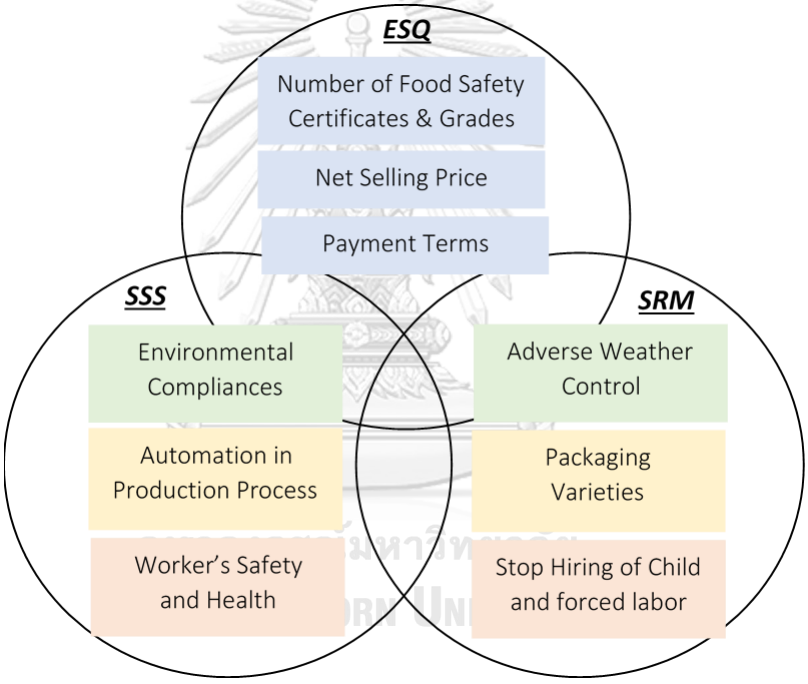


Figure 3. 1 The Classification of Dimensions of Strategic Supplier Selection (Source: Derived by the Author)

As noted by Zimmer *et al*. (2015), the determined dimension for consideration of Strategic Supplier Selection are Economic, Social, and Environmental, while this thesis

aims to study further in order for being in line with this technological advancement era by adding one more significant element which is called 'Technological'.

Cutting-edge technology application is able to help finding more competitively priced suppliers. The majority of food consumers can obviously distinguish the quality of food goods from other product categories in terms of earlier noticing a drop in product standard from using cut-price materials. To be more economical, the supplier needs to leverage automated apparatuses as compatible assistance and utilize such valuable technologies to enhance food processing and its packaging. The innovation technique provides the growth of productivity, precise measurements, and production cost saving. Consumer is now smarter and looking for the reputation of food producers apart from taste, price, and safety. (Fbtechreview, 2019; Fbtechreview, 2020)

To give an instance of importance of technology adoption in Thailand, The Charoen Pokphand Food (CPF), Thailand's largest agro-industrial and food conglomerate, is focusing on automating production process implementation in order to encourage the business to propel forward and play a fundamental role for survival in the digital era. CPF aims to improve product quality and safety such as transition sausage production into completely automation line for reducing contamination from human to products (Susan, 2018; Sangwongwanich, 2019; Pornpatdetudom, n.d.).

3.2 Identify the must criteria for strategic supplier evaluation

The must criteria are a basic screening tool to identify which potential supplier is capable of grocery goods supply to foreign distributors. The operation of international trading company and supplied products need to comply with regulatory requirements relating to food safety of particular destination territory which are Good Manufacturing Practices (GMP) and Hazard Analysis and Critical Control Point (HACCP). Potential suppliers who lacks one of mandatory attributes will be considered as unqualified suppliers and not counted as supplier candidates for evaluating with desire criteria in the next following stage.

3.2.1 GMP

The GMP is a set of basic quality regulation to control the manufacturing of health-related products; food, drugs, cosmetics and medical devices, enforced by World Health Organization (WHO). The guidance covers the operation from processing, packaging, and distribution and all of the operations needs to reach a level of high standard.

3.2.2 HACCP

The HACCP is the trade barrier and international food safety requirements in several countries and is an advanced quality standard rather than the GMP. This food

safety management system is for preventing food safety problems which could be a threat to human health controlled by monitoring critical points across the food chain.

3.2.3 Package Usage

Package type and size used for export to case study company clients are 15 ounces and 108 ounces (or called A10) of canned packaging for sweet corn and baby corn products and 20 ounces and 108 ounces of canned packaging for pineapple products. A cluster of potential factory needs to own both of the size for each product category in order to trading with case study corporate.

3.2 Identify want criteria for strategic supplier evaluation

The key criteria of economic, social, environmental, and technological for strategic supplier evaluation select from a prioritized set of success criteria in Chapter 2 combined with the list of crucial factors of the food industry.

Table 3. 1: Key Criteria of Strategic Supplier Selection Classified by Typical Dimensions (Source: Derived by the Author)

Dimension	*Criteria*	*Sub-criteria*
Economic	Export Capability (C1)	Number of Food Safety Certificates & Grades (C11)
	Pricing Policy (C2)	Net Selling price (C21) Payment Terms (C22)
Social	Ethical Practices (C3)	Stop Hiring of Child & forced labor (C31) Worker's Safety & Health (C32)
Environmental	Environmental Management (C4)	Environmental Compliances (C41) Adverse Weather Control (C42)
Technological	Technological Catch-up (C5)	Packaging Varieties (C51) Automation in Production Process (C52)

3.2.1 Export Capability

Number of Food Safety Certificates & Grades refers to the overall grade written on the food safety certificate, which received when the inspection team audited the plant

according to the food safety standard checklists. The certificates are Halal, Kosher, IFS, FCE and FDA registration number, BRC grade C, BRC grade B, and BRC grade A. The greater number of certificates award the more export competency.

3.2.2 Pricing Policy

Net Selling Price refers to final price charged for food goods, which is the total cost the buyer pays. The final value includes the price of the product itself, all taxes and any fees added. The discount is excluded because of invalid due to ordering small to medium lots (do not obtain discount for ordering less than 5 FCL) for each purchase.

Payment Terms refers to the conditions of payments created by a purchaser who has agreed with seller. The payment method is completely different dependent on negotiation with particular suppliers which are percentage of advance payment; no advanced payment, 30% of advanced payments, 50% of advanced payments, and 100% of advanced payments.

3.2.3 Ethical Practices

Stop Hiring of Child & Forced Labor refers to the exploitation of underage children and people who are forced to work against their will. The factor used for scoring are daily wages, MoU conducts, worker ages, and certificate of ethical trade audit. Daily Wages paid for worker should be accordance with minimum daily wage in Thailand. Memorandum of Understanding (MoU) to express a convergence of will between

employers and employees need to be conducted legally. Ethical trade audit is a mandatory requirement for being able to trading with large ethical retailers or distributors.

Worker's Safety & Health refers to the capability of the manufacturer in hazardous prevention towards work-related illness, injury, and accidents and control risk in the workplace. The criterion is measured through Occupational Health and Safety Management (OHSAS) 18000 implementation that identified the applicable regulation for support worker's safety and health. Another measure is certified supply chain security audits whose initial audit issues cover all type of security in the workplace and being reward the certificate mean being able to trading with giant ethical retailers or distributors.

3.2.4 Environmental management

Environmental Compliances ISO 14000 series are international standards for minimizing the negative effect of company's operation to the environment. ISO 9000 series are international standard for declining redundancy of manufacture which in turn a drop in raw material usage and waste releases. Supplier will be obtained scores when trying to award or award mentioned ISO systems.

Adverse Weather Control can be measured through the capability in the provision of certain raw materials under different weather and climate conditions due to certain

grains and crops are able to cultivate in specific climatic conditions. Supplier candidate who can supply as long as possible are counted to manage the best possible climate management, while full masks will be given to all-year round finished goods supplied suppliers.

3.2.5 Technological Catch-up

Packaging Varieties refers to materials which used for wrapping food products to protect for distribution and storage. The more type of materials used for packages the more packaging varieties supply (apart from 15 and 108 ounces of canned packages for sweet and baby corn products and 20 and 108 ounces for pineapple products that mentioned in must-criteria).

Automation in Production Process maximum amount of productivity (kilogram) that the machine can produce divided by the number of workforces. The higher number of products is produced, the lower labor is hired means the plant pays attention to improvement of machinery for production and supports labor-less automation.

3.3 Determine expert respondents and backgrounds

Table 3. 2: List of Expert Respondents and Their Information Details (Source: Derived by the Author)

Code of Experts	*Participant position*	*Year of experiences*	*Education*	*Responsibility Description*
R1	President	38 years	Master degree	• Company founder since 1981 • Oversee staff performance and control company direction • Maintain healthy relationship with clients through taking customers to visit local plants • Experience in trading with American and European customers
R2	Marketing manager I	28 years	Bachelor degree	• Liaise with American clients • Procure goods from local manufacturers in line with U.S. and Central America requirements • Handle U.S. and Central America export documents

R3	Marketing manager II	31 years	Bachelor degree	• Liaise with European and Asian clients • Procure goods from local manufacturers in line with Asian and European's requirements • Handle Asia and Europe export documents

From the table above, president and marketing managers are selected to weight the relative importance of supplier selection criteria. Others in finance, shipping, and label and document functions exclude from scoring the selection process.

The reason for rejecting is that president and marketing have a trading communication with foreign customers and get insight into foreign grocery markets and specific requirements.

The total respondents comprise of one president and two marketing with the code of participant named 'R1' to 'R3' as shown in **Table 3.2**.

3.4 Design hierarchical model

The hierarchical model of strategic supplier selection based on AHP technique is illustrated in **Figure 3.3**. There are four levels in AHP hierarchical model which are primary objective, criterion, sub-criterion, and alternatives.

The primary goal in first level is strategic supplier selection that is the problem in the thesis.

The criteria in second level is discovered based on four dimensions which are Export Capability and Pricing Policy from Economic dimension, Employment Practices from Social dimension, Environmental Management from Environmental dimension, and the Technological-catch up from Technological dimension.

The third level contains eleven sub-criteria; Number of Food Safety Certificates & Grades, Net Selling price, Payment Terms, Stop Hiring of Child & Forced labor, Worker's Safety & Health, Environmental Compliances, Adverse Weather Control, Packaging varieties, Automation in Production Process

The fourth level is alternatives which are four qualified supplier candidates who are able to pass the must criteria.

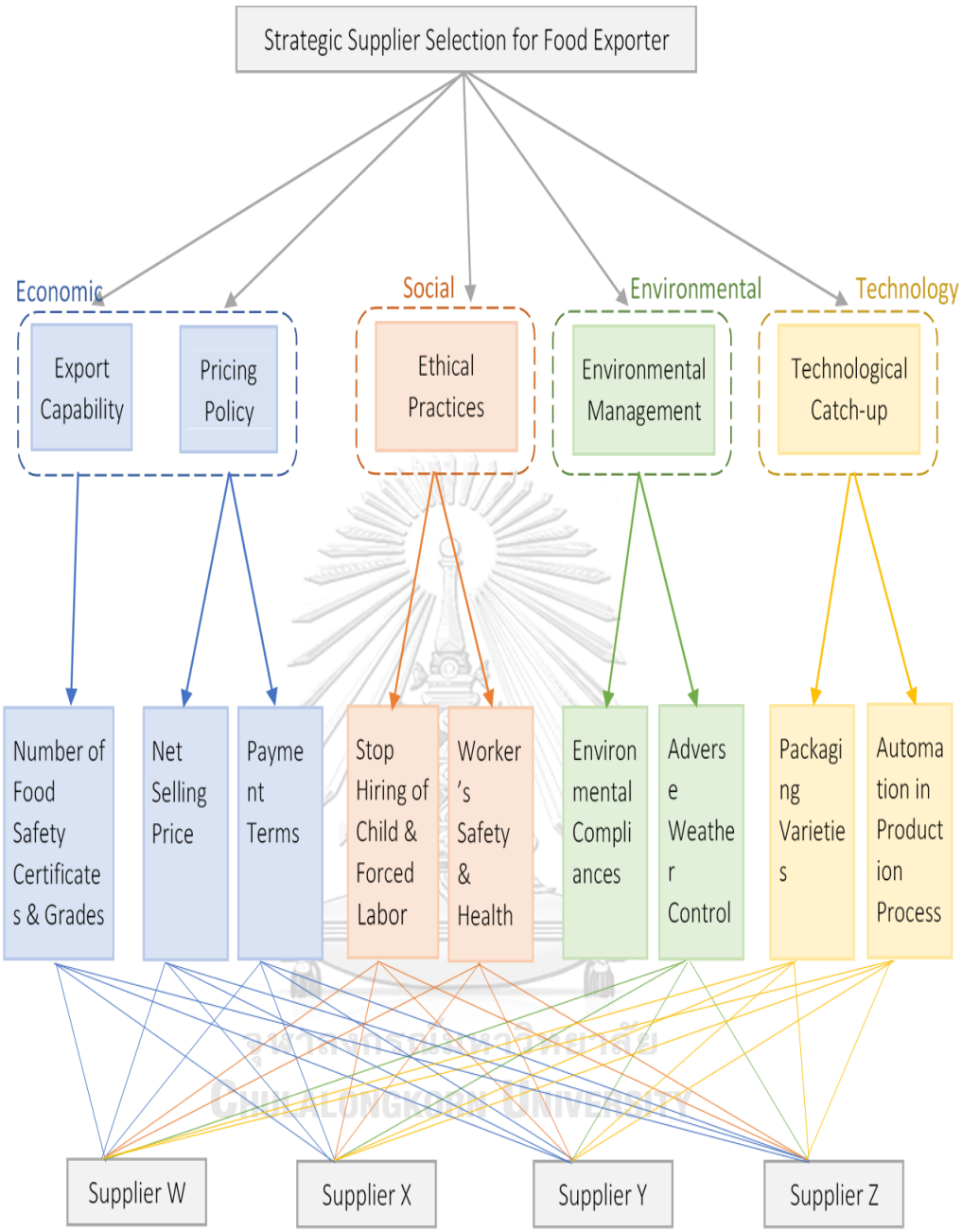


Figure 3. 2 A Hierarchical Model of Strategic Supplier Selection (Source: Derived by the Author)

3.5 Conduct a survey

The survey for priority establishment is conduct through three experts' interview. The respondents are questioned to answer the preference degree against strategic supplier criteria with one-to-nine scale method. The description of each scale is described as mentioned in **Table 2.5** of **Section 2.3**.

Table 2.5: Relative importance scales (Source: Adapted from Saaty, 1980)

Intensity of importance	*Value Description*	*Explanation*
1	*Criterion i and j are of equal importance*	*Two activities contribute equally to the objective*
3	*Criterion i is weakly more importance than j*	*Experience and judgments slightly favor one activity over another*
5	*Criterion i is strongly more importance than j*	*Experience and judgments strongly favor one activity over another*
7	*Criterion i is very strongly more importance than j*	*Activity is strongly favored, and its dominance demonstrated in practice*

9	*Criterion i is absolutely more important than j*	*The evidence favoring one activity over another is of the highest possible order of affirmation*
2,4,6,8	*Intermediate values between the two adjacent values*	*When a compromise in judgments is needed*

To begin with, the respondents are asked to rank the relative important of each main criterion.

For 1, 2, 3; 4, 5; the preference degree is rank

1 ..... 2 ..... 3 ..... 4 ..... 5 .....

To give an assumption, *i* is criterion A on the left side and *j* is criterion B on the right side. Providing that, the participant scores the intensity of important at five, the interviewer will circle at five.

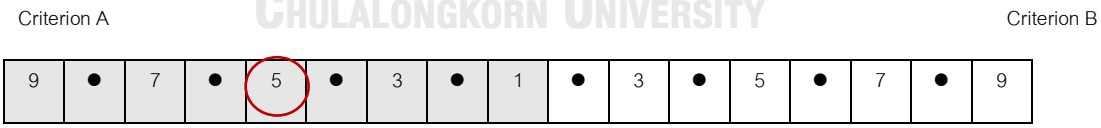


Figure 3. 3 The Explanation of Prioritization Establishment 1 (Source: Derived by the Author)

Give the ☑ correct check into the block that has the higher rank (compared to opposite criterion)

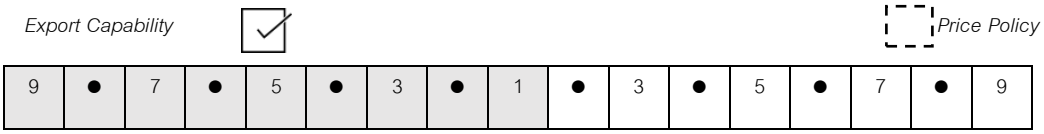


Figure 3. 4 The Explanation of Prioritization Establishment 2 (Source: Derived by the Author)

For instance, if the 'Export Capability' ranks first and 'Pricing Policy' ranks second, the correct check will be written down on the block on 'Export Capability' side.

After that, the respondent is questioned "Which level from 1 to 9 do you think Export Capability is more important for supplier selection than Pricing Policy?" in order to scale the level of preference.

Finally, If the 'Quality' is strongly important over Price with the intensity of importance at 5, the questionnaire will be circled on block number 5 on the left side (superior rank).

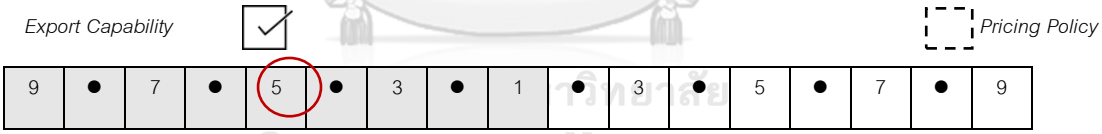


Figure 3. 5 The explanation of prioritization establishment 3 (Source: Derived by the Author)

The pair-wise comparison is continued to conduct until a full set of criteria and its sub-criteria are completely done with identical methodology as above.

Total criteria and its sub-criteria are depicted in questionnaire in ***Appendix Part I***, in order to gather survey results for computing pair-wise comparison in the next following

stage. Afterward, the preference degree will be computed through Geometric mean and AHP process as described in ***Appendix Part II***.

3.6 Create the list of appropriated suppliers

The supplier candidate who passes the must criteria are selected to be listed as qualified suppliers around four candidates. A group of suppliers will be scored individually according to determined criteria. The assigned score of particular criteria will be multiplied with local weight of particular criterion and assigned score of sub-criteria will be multiplied with global weight of particular sub-criterion.

$$\textit{Global weight} = \textit{Local weight of criterion} \times \textit{Local weight of sub-criterion}$$

Figure 3. 6 Global weight formulation (Source: Derived by the Author)

3.7 Research methodology

<u>Phase I: Data Collection</u>

• Find the most efficient and widely used DM techniques from the literature review

• Study the procedure of the selected eligible technique and its constraints

• Study the concept of strategic supplier selection from the literature review

<u>Phase II: Criteria Identification</u>

• Identify the must criteria for screening supplier candidates

• Gather all criteria discovery and select the popular criteria afterwards

• Gather all criteria relating to food export at this moment

• Identify the main theme covering ESQ, SSS, and SRM

• Identify measurable criteria and its sub-criteria and describe the definition of each criterion

• Structure hierarchical model

Phase III: Conduct Survey

• Develop interview questions in questionnaire survey

• Determine the list of eligible decision-makers

• Prepare a questionnaire with a one-to-nine scale for making the pairwise comparison

• Interview the expert respondents to give weight to each criterion

Phase IV: Data Analysis

• Collect the inquiry data and calculate the weight score through AHP technique

• Identify the supplier candidates and collect supplier information

• Score the candidate according to determined criteria and sub-criteria

• Rank the eligible supplier candidate

Phase V: Summary, Recommendation, and Discussion

• Conclude result analysis of three product category through radar graphs

• Give recommendations of purchasing policy, including exception cases

• Discuss towards benefits and improvement of SSS for researchers and case study company

Chapter 4: Analysis of Results

4.1 Criteria and Sub-criteria Weights

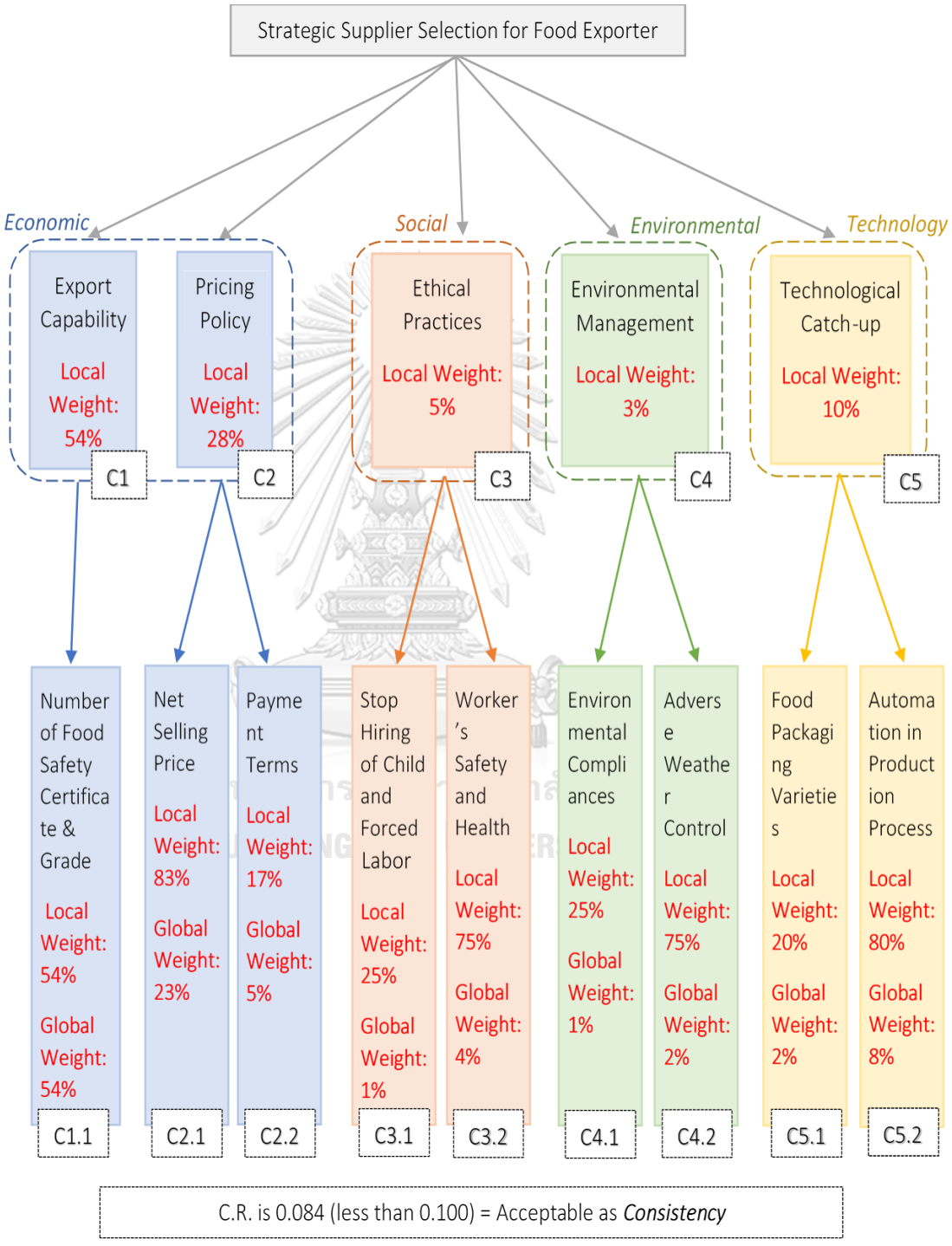


Figure 4. 1 Composite Priority Weights for Criteria of Food Supplier Selection

After interviewing the group of food export professionals, the composite priority weight of criteria and sub-criteria are illustrated in **Figure 4.1** through computing by AHP method. Raw data given by three evaluators through one-to-nine scales and geometric means of all experts are as depicted in ***Appendix Part III***.

4.1.1 Main Criterion Rating

When it comes to criteria, there are five criteria to consider with codes from C1 to C5. Rank of major criteria is C1, C2, C5, C3, and C4 in succession. ***Export Capability (C1)*** is valued as the first priority criterion for supplier selection of food export industry, accounted for over half of entire percentages at 54%. The second largest percentage belong to ***Pricing Policy (C2)*** with 28%, which the number is pretty far away from Export Capability (C1). It is noticeable that these two criteria are from economic theme and capable of making up 82% of the total local weight. Interestingly, the trending criteria, ***Technological Catch-up (C5)***, is able to remain ahead of traditional popular criteria at 10% of total local weight. The least proportion belong to ***Ethical Practices (C4)*** and ***Environmental Management (C3)*** at 5% and 3% respectively. Together, totality of percentage of these two criteria is less than Technological Catch-up alone.

According to **Section 2.3**, it is argued by Saaty (1980) that corresponding consistency (C.R.) ratio needs to be fewer than 0.1 or 10% in order to be consent as acceptable value and the result of pair-wise comparison is reliable. The C.R. of overall

major criteria for supplier selection in the thesis study is 0.0.84 or 8.4% which means acceptable following principle of general journal articles.

4.1.2 Causes behind the weight of Criterion and Sub-criterion

All of sub-criteria are calculated with quantitative analysis based on supplier numerical data.

Speaking of sub-criteria, the proportion of ***Number of Food Safety Certificates & Grades (C1.1)*** comes first rank with no any other sub-criterions in Export Capability category to compare with. The global weigh of C1.1 is accounted for 54%, exactly the identical number as Main theme criteria (C1). The criterion is the top priority because as the company's product is preserved human food, all of the customer worldwide requests the concrete guarantee of what they consume are sanitary and harmless for their health. Fundamental standard of food safety for domestic market is GMP while basic certificate for international markets is HACCP. Each group of customer consent different certification. For example, European assent the goods with BRC and IFS certificate whereas American prefer the product which is registration to FDA and has been received FDA and FCE number. Some group of customers have a special individual eating habit when it involves religion that cannot be disregard any forbidden. For example, the food Kosher is certificate to ensure that imported food to Jewish countries such as middle east countries and U.S. is require proper production in accordance with

Jewish dietary regulations. The food Halal certificate is another for exporting to Muslim countries and any other countries where requesting. Besides, some group of distributors requires the best quality products in order to take the brand image to a whole new level. The certificate is a sensitive assurance in the eyes of worldwide population, then it is considered to be the first priority for supplier selection in international food export environments.

Obviously, ***Net Selling Price (C2.1)*** wins against ***Payment Terms (C2.2)*** by 18% of total global weight. Net Selling Price of product is more important than Payment Terms due to the fact that unit selling price can really attract sale volumes in terms of customer decision in buying products. The number may fluctuate dependent on peak or low season of the product because of food product that normally rely on weather and ability to harvest of plantation. In the case study company, the discount is invalid because the company purchases small to medium quantity, but the discount is offered when ordering over 5 Full-Container-Load (FCL) per one purchase. The normalization of Inverse numbers technique derived from Wedley (1990) is applied to the criterion scoring due to the cheaper price the more desirable.

Calculation example: Supplier A: 39, Supplier B: 40, Supplier C: 31, and Supplier D: 37

$$W1 = (I/39)/ (1/39 + 1/40 + 1/31 + 1/37) = 0.2340$$

$$W2 = (I/40)/ (1/39 + 1/40 + 1/31 + 1/37) = 0.2282$$

W3 = (I/40)/ (1/39 + 1/40 + 1/31 + 1/37) = 0.2944

W4 = (I/40)/ (1/39 + 1/40 + 1/31 + 1/37) = 0.2434

Total = 1.0000

Nevertheless, Payment term is another crucial factor to consider on an account of capable of improving company's cash flow management, but selling price is still the first priority. The extra day or longer payment terms can help company to regulate the outlays of capital without requirement to refinance for doing any other necessary activities or maximize profits from interest or external investment.

Ethical Practices is a hot topic of concern from the eyes of public and several non-profit organizations. In contrast, opinion from preserve food export experts is distinguish from others. This might be because nowadays not every market in the world require the guarantee of ethical treatment of employee in workplace. Only large organizations keep an eye on human workforces in order to surge positive image and repetition to their own company. ***Stop Hiring of Child & Forced labor (C3.1)*** is given 1% of total global weight, while ***Worker's Safety & Health (C3.2)*** receives greater scores at 4% of total global weight. Ethical Trade and Supply Chain Security audits play a key role in judgement of level of illegal workforce employment and security. Once the factory has no such guarantees, it means the goods is unable to export to a group of ethical distributors. The comment from expert is that supplier can leverage the maximum

benefits of healthy employees because wellness of workforces is affirmed to be more productive and it shows the moral responsibility of supplier itself to take care of wage-earners' security.

Environmental protection is fundamental responsibility of a company to protect natural resources and avoid depletion or degradation of natural environment, but the end-buyer rarely asked for environmental compliances prior to making purchasing decision. ***Environmental Compliances (C4.1)*** then obtains just 1% of total global weight. ***Adverse Weather Control (C4.2)*** makes up 2% of total global weight that shows this criterion got popularity rather than another one. This is because the criterion covers the meaning of supplier's capability in finished goods supplies without any disruptions. The continuity of product supply can sustain or ruin the company reputations in terms of creditability to customer as promised which is a direct impact to company. Whereas, ISO series inspection is indirect impact on general natural environment which is basic factory responsibility and there are no distributors asking for this standard right now.

It is notable that Technological Catch-up which is a trending criterion that has begun to apply with this thesis gain a great attention from sophisticated experts who have seen numerous variations in food business society. Technological Catch-up comprises of 10% of total global weight, following behind just two economic theme criteria. On an account of technology is becoming embedded in everything in digital

era. Overall majority vote for ***Automation in Production Process (C5.2)***, accounted for 8% out of 10% of total C5 percentage. The labour-less production means lower contaminations and higher product quality which really impacts on end-customer perception. However, ***Packaging Varieties (C5.1)*** is still the important element to concern because the adoption of suppliers with packaging diversities can help company trade with fewer cluster of suppliers. Once the customer orders the goods, the supplier can provide several product categories filled with full container load (FLC), helping cost-cutting and less complexity for container management.

4.2 Supplier Priority and Selection of Pineapple

4.2.1 Supplier A

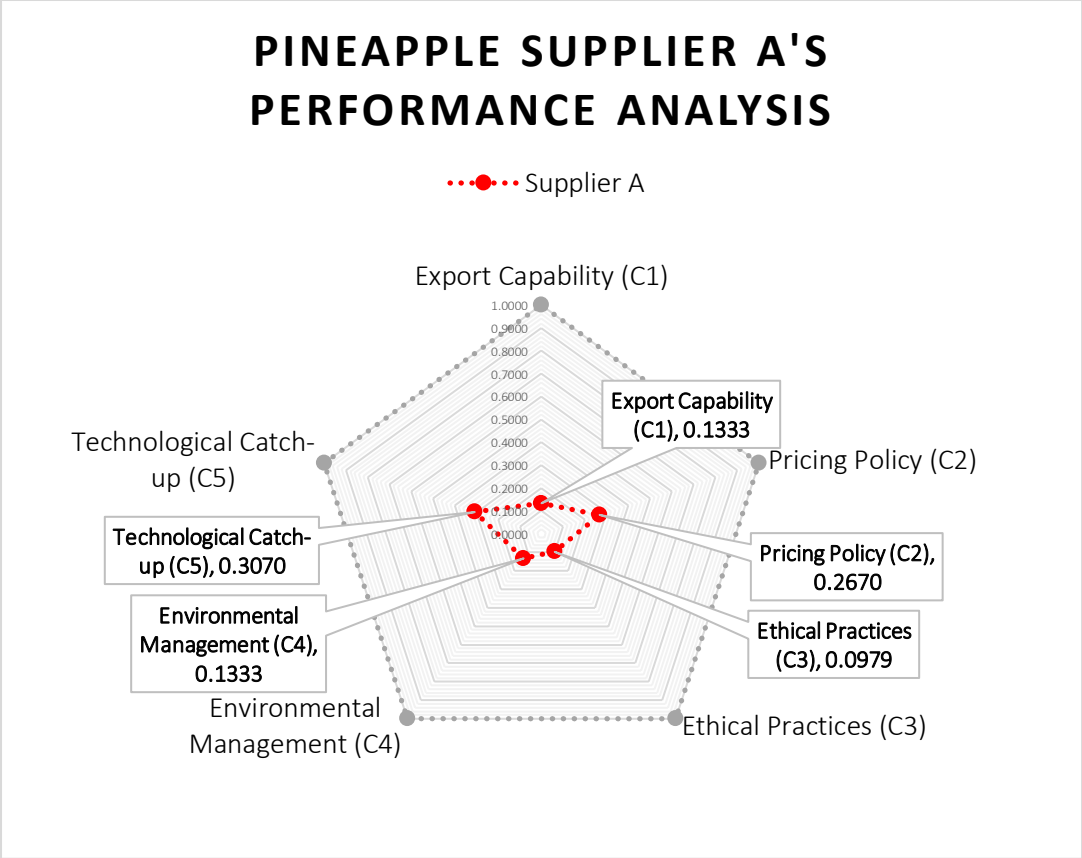


Figure 4. 2 Pineapple Supplier A's Performance Analysis

Supplier A is a original seller operating since 1999 where based in Kanchanaburi province (Western part of Thailand), supplied raw material with its own pineapple plantations. The factory provides tropical fruit and vegetable products, while the largest sale belongs to pineapple related products. The small-sized plant provides two kinds of products; canned and vacuum-sealed products.

Export Capability

Quality issue is one of the weakness of supplier performance on an account of received merely two of food safety acknowledged guarantees; Kosher for Jewish and FCE number and FDA registration number for export to the U.S. market, but the competency is superior to supplier C.

Pricing Policy

The price for best seller product sizes; 17 USD/carton for 20 ounces and 22 USD/carton for 108 ounces. The cost of 20 ounces is relatively expensive, making the high price of pineapple offerings at 39 USD/carton. While payment term offering is considered as in the level of premium packages. Payment in advance is required for just 30% of total product values prior to actual production.

Ethical Practices

Ethical practices in workplace is being taken into consideration within factory. The worker's wage is relatively expensive at 350 baht, higher than any other pineapple plants. Myanmar workers have been conducted the MOU document to be legal workforce in Thailand. However, Ethics in workplace (Ethical Trade audit) has never been inspected by private external organization. Likewise, supplier's plant has never been investigated the supply chain security and OHSAS, but willing to implement for OHSAS if requesting.

Environmental Management

The factory has its own environmental-friendly system to deal with environmental related issues and never received any environmental ISO certificate same as that of pineapple suppliers. The ISO 14000 system has never been set up and not willing to install at this time. The plant can handle adverse weather due to the fact that harvesting and bearing cannot be conducted between July and September, but the finished goods is able to supply a year-round.

Technological Catch-up

Supplier A is capable of abundant packaging provision; 8, 15, 20, 30, 108 ounces and vacuum-sealed products, occupying the highest number of packages for pineapple products. The supplier is a medium to small production plant, then full capacity for producing food goods is around 27 tones and there are approximately 100 workers in production lines.

4.2.2 Supplier B

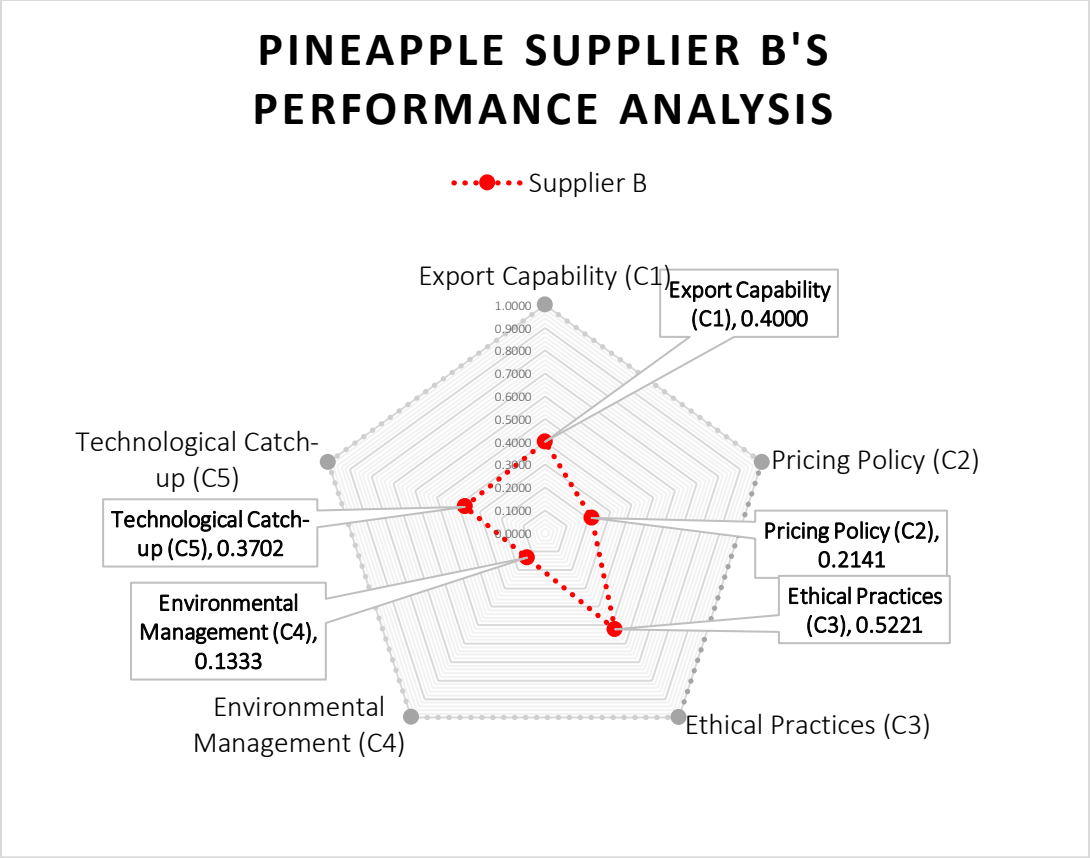


Figure 4. 3 Pineapple Supplier B's Performance Analysis

Supplier B is a high standard seller where based in Prachuap Khiri Khan province (Southern part of Thailand) and is Thailand's largest pineapple growing area. The plant provides several types of fruit that are exported to many places worldwide, while major exported fruit is pineapple related products.

Export Capability

The product quality was given nearly full marks as the factory attained so many food safeties certificates; Halal, Kosher, FCE, FDA, IFS, and especially for BRC that supplier has been grading B. With these quality assurances, the product can be definitely sent out widespread across the globe.

Pricing Policy

Likewise, the goods price head to the same direction with high standard of product and process quality, most expensive net selling price. Price for 20 and 108 ounces stand for 18 and 22 USD, sum of each cost is 40. The payment term is rather reasonable due to enforcing to purchase at 50% of total value of finished goods prior to production.

Ethical Practices

The production plant was found out that there are Thais and Burmese workers with the age range from 18 to 60. The MOU for bringing foreign worker to work with employer in the Kingdom of Thailand has been conducted completely by the factory. Daily wage for production workers is at 300 which is National minimum daily wage. The freedom and right of the employee in workplace have been certified by passing the standard of Ethical Trade audit and worker's safety and health has been approval Supply Chain Security audit.

Environmental Management

Environment is another element that factory concern. The plant has basic environmental management system, but never carried out the ISO inspection. They said they are welcome to implement this system if required. The potential in adverse weather control is considered to be low risk because of lacking of bearing and harvesting seasons happened during for just three months; July, August, and September. However, they can provide finished goods all year round due to excellent stock planning.

Technological Catch-up

Food storage pouch which is additional option of modern packaging that customers is asking for and rare size use, 30 ounces, are available that means the factory cannot provide variety types of packaging. The supplier seems to respond labor-less trend because full capacity of producing goods is at 800 tones despite the fact that the number of production line workers are about 787 persons with 12 production lines.

4.2.3 Supplier C

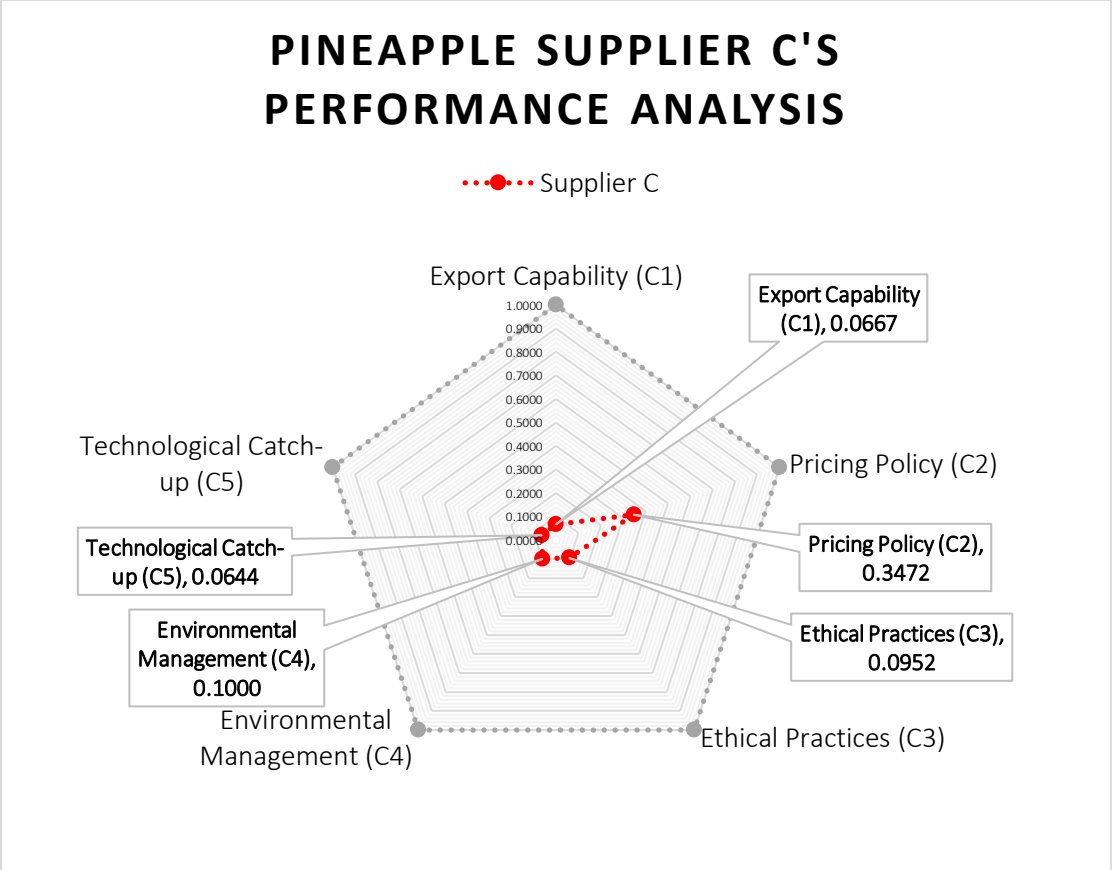


Figure 4. 4 Pineapple Supplier C's Performance Analysis

Supplier C is an extremely small-sized seller located in Rayong province (Eastern coast of Thailand) and is capable of supplying pineapple products to domestic and relative low standard of food safety certificate required countries that required at least Halal certificate.

Export Capability

Factory has certified only Halal food safety certificate, except from GMP and HACCP certificate which is must-criteria. The product is then absolutely able to export to middle east nations and relative low requirement countries.

Pricing Policy

In the same way as product quality, the price offerings are very inexpensive for 20 and 108 ounces at 14 USD/carton and 17 USD/carton respectively, the cheapest for both product sizes of amongst the group of potential suppliers leads to the lowest price of sum of both sizes at 31 baht/carton. Payment condition really draws buyer's attention with unnecessary to pay in advance before production starts due to long great relationship with.

Ethical Practices

Workers in any worksites comprise of Thais and Burmese with aged over 18 and lower 60 years old with 331 baht of daily wage, less than just Supplier A. All of Burmese are legalized by managing MOU document to support employee status in Thailand. The supplier's factory has never been checked neither Ethical Trade nor Supply Chain Security.

Environmental Management

Because of its small-scaled plant and low technology installed machine, the production plant then has no concern about environmental issues. Low capacity of productivity means low wastes released to the environment. The factory believes in its own legal environmental management system and is not willing to be investigated by ISO due to budget restriction. The factory can only supply finished goods in pineapple cropping season (except from July and September).

Technological Catch-up

The supplier can provide rare size using of canned package 15 ounces, low scoring for packaging varieties same as Supplier B. The number of workers in the production lines is 350 persons, whereas finished goods can be manufactured daily for just 10 tones, indicating lowest labor-less supported.

4.2.4 Supplier D

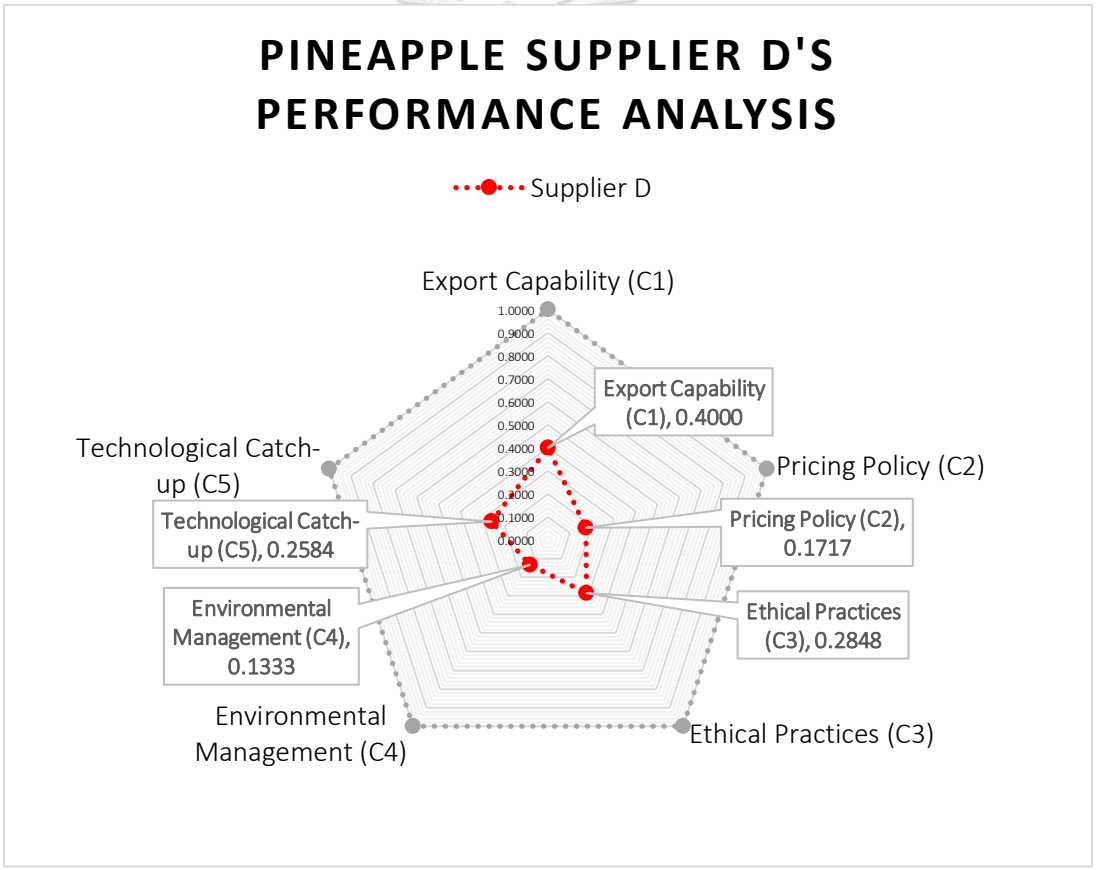


*Figure 4. **5 Pineapple Supplier D's Performance Analysis***

Supplier D is a qualified seller located in Prachuap Khiri Khan province (Southern part of Thailand). The factory supplies tropical fruits and pineapples to many

destinations whom required high standard products with friendly prices offerings to customers.

Export Capability

Supplier D attained so many food safety certificates guarantee same as supplier B; Halal, Kosher, FCE, FDA, IFS, and BRC with B grade. In fact, with such high standard, the plant is able to supply products to many places worldwide, but there is a thoughtful restriction about low yield of productivity compared to formidable rival as supplier B.

Pricing Policy

Product prices for 20 and 108 ounces are 15.5 and 20 baht/carton in succession which making sum of both costs at 35.5. The supplier provides very reasonable price when comparing with high standard offerings. The payment condition is the worst amongst other suppliers; 100% payment in advance.

Ethical Practices

18 to 60 years-old of Burmese working in the production lines, but they have never been managing any MOU documents by the employer. They are then being illegal employees even though supplier claimed they are not permanent workers. The plant used to be audited the Ethical Trade, but inspection result showed not pass. The supplier is now trying to pass the standard by improving factory's ethical systems. In terms of health

and safety, the factory has never been inspected the OHSAS before, but the supply chain security has been done before with the not pass result.

Environmental Management

Supplier has its own environmental management system which is legal, but ready and welcome to implement ISO whether customers require in order to increase the positive image in the eyes of customers. The production plant can supply food goods all year round including not in the cropping season (bearing and harvesting) of pineapple during July to September.

Technological Catch-up

The packages used in the plant are relatively diversity, which are 8 and 30 ounces of canned packages and food pouch which can increase attractions from distributors who need to switch from can to stand up pouch because of easy to store in cabinets and easy to eat. Peak daily capacity of production is approximately 150 tones, larger than supplier A and C. The number of workers in production line is exactly 506 persons, appropriate for production capacity of small to medium factory.

4.2.5 Rank of All Potential Pineapple Suppliers

Table 4. 1: Final Scores of Pineapple Suppliers

Selected Suppliers	*Final Scores*
Supplier A	0.1871
Supplier B	0.3357
Supplier C	0.1389
Supplier D	0.3283

After collecting and computing the score of all potential pineapple suppliers, the first rank belongs to **Supplier B**, followed closely by **Supplier D**. The next place the company should list as a group of backup sellers are **Supplier A** and **Supplier C** respectively.

4.3 Supplier Priority and Selection of Sweet Corn

4.3.1 Supplier E

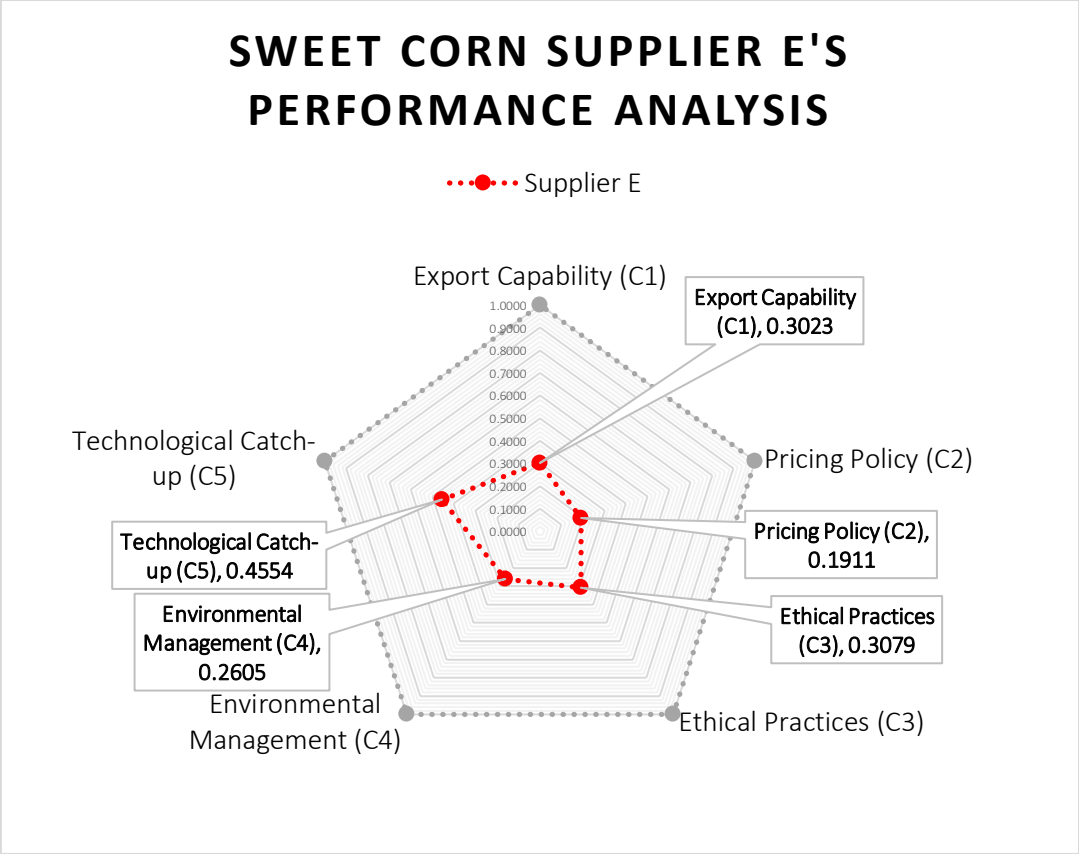


Figure 4. 6 Sweet Corn Supplier E's Performance Analysis

Supplier E is the best quality food operating since 2003 where based in Kanchanaburi province (Western part of Thailand). The factory supplies tropical fruits and pineapples to global markets. The factory provides tropical fruit and vegetable products. The factory also supplies baby corn products and focuses on manufacturing baby corn rather than sweet corn products.

Export Capability

Quality performance is definitely the strongest point of supplier E on an account of received all of the vital food safety acknowledged guarantees; IFS, FCE number and FDA registration number, Halal, Kosher, and BRC with B plus grading.

Pricing Policy

The price for best seller product sizes; 10.5 USD for 20 ounces and 15.5 USD for 108 ounces (sum is at 26 USD/carton) which is the most expensive goods for sweet corn, more costly than supplier F with same types of export capability awards. Payment terms in advance is relatively unattractive with requirement to pay 50% of total product values prior to actual production, highest cost amongst potential competitors. others

Ethical Practices

Worker's wage is the most expensive one, compared to other sweet corn sellers. The supplier recruits Burmese working in sweet corn production lines, but they all have never been documented the MOU. The reason behind is because they are not permanent employees and cannot have rights in obtaining any protection according to Thailand's labor law. Ethics in workplace was ensured by passing the supply chain security and ethical trade audits by private famous organizations. Supplier's plant has never been checked the OHSAS, but welcome to implement OHSAS system.

Environmental Management

Supplier has never received ISO 14000 certificate, but the factory has been registered the ISO 9002. The system could help decrease redundancy of production, contributing to a drop in raw material usage and a drop of waste. Harvesting and bearing cannot be conducted between April and September, accounting for 6 months. In contrast, the plant confirmed that finished goods can be supplied across the year.

Technological Catch-up

Supplier is capable of abundant packaging provision; 8 and 12 ounces of canned packages, 8 and 12 ounces of glass jars, 8 ounces of plastic cup, and 3 kg of food pouch, receiving the most points for sweet corn packages. Supplier E is considered as large production plant, then average full capacity of productivity is approximately 500 tones, with roughly 80 workers in production lines.

4.3.2 Supplier F

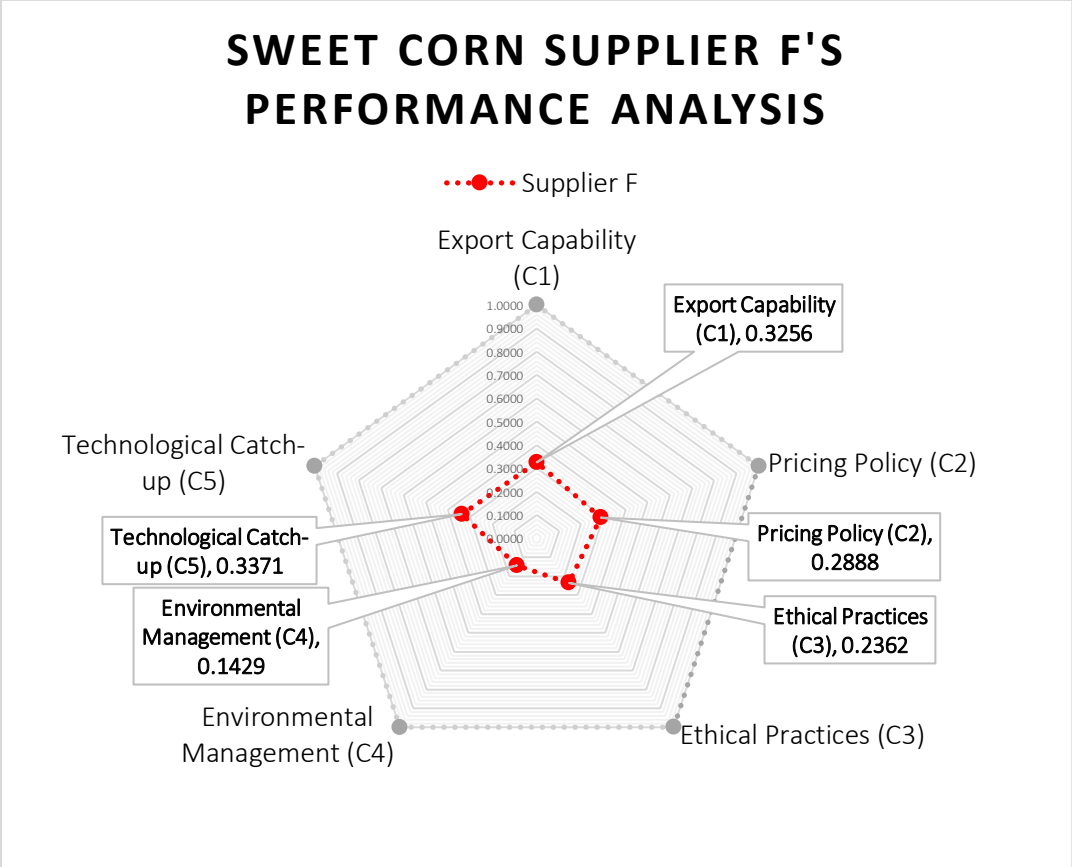


Figure 4. 7 Sweet Corn Supplier F's Performance Analysis

Supplier F is an excellent standard seller where based in Kanchanaburi province (Western part of Thailand), set up since 1986. Dominant products are sweet corn, and minor sale is baby corn. High quality of raw material comes from its affiliate plantations across Thailand.

Export Capability

The product quality was given exactly full marks as the factory has been awarded numerous food safeties certificates; Halal, Kosher, FCE, FDA, IFS, and specifically BRC with grade A, same as Supplier E. The superior point is that the seller has been sophisticated in export widespread across the globe.

Pricing Policy

In contrast, the goods price goes to the opposite direction with high standard of product quality. Price for 15 and 108 ounces stand for 9 and 13 USD/carton (sum of prices is 21 USD/carton). The payment term is very beneficial to the buyer with no enforcement of advance purchase prior to production due to long-term of relationship. It is still worth for investment because of the cheapest cost of products, beating over other potential rivals.

Ethical Practices

The production plant hires Thai, Cambodian, and Burmese workers with the age range from 18 to 60. The MOU contract has been signed completely by both parties to protect foreign rights equal to Thai workforce. Daily wage for production workers is at 315. The freedom and right of workforce in workplace have been certified by passing the standard of supply chain security and ethical trade audits. However, the OHSAS has never been implemented in order to take care of worker's health and safety.

Environmental Management

Environment is the element that factory has less concerns. The plant has just basic environmental management system, but the factory has never conducted the ISO inspection and is not welcome installation of ISO. The potential in adverse weather control is considered to be very low risk because of no non-growing season (including bearing and harvesting) within a year-round. In turn, finished goods can be supply to distributors all year round.

Technological Catch-up

8, 12, and 75 ounces of canned packages are available, but other types of packaging cannot be provided which is one of the supplier weakness points. The supplier has encouraged the labor-less trend because daily full capacity of producing goods is at 450 tones, while the number of production line workers are about 70 persons.

4.3.3 Supplier G

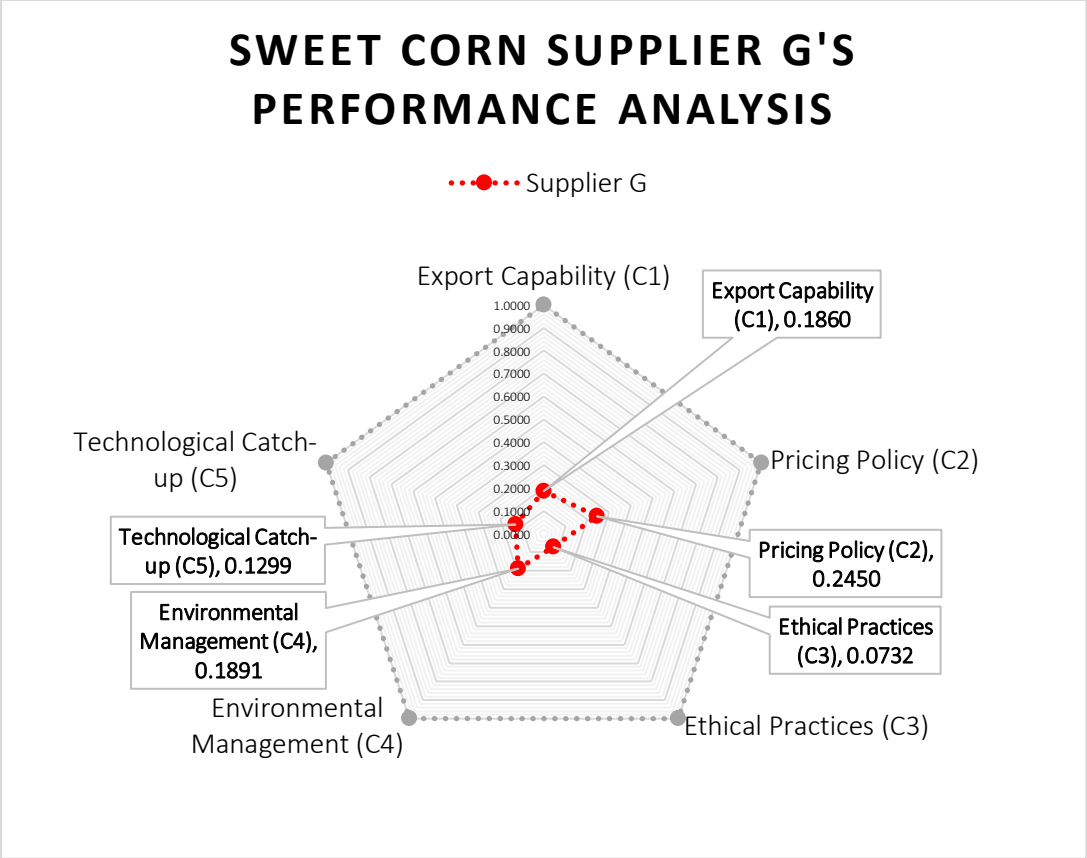


*Figure 4. **8 Sweet Corn Supplier G's Performance Analysis***

Supplier G is a primitive manufacturer located in Nong Khai province (the North East of Thailand), set up in 1988. The factory supplies tomato, sweet corn, aloe vera, nata de coco, mango, sweet corn kernel/cream, jackfruit chip, etc. The agricultural products from supplier G is produced under renowned brand for international markets.

Export Capability

The supplier offers relatively high-quality products, but did not penetrate large broader market. The plant is awarded Halal, FCE and FDA registration number, and BRC with grade B, not being certified Kosher and IFS. With such potential standard the products can market premium target groups of customers.

Pricing Policy

Price of baby corn for both sizes, 15 and 108 ounces, are relatively reasonable compared to quite high-quality products; 9.4 USD/carton and 13.5 USD/carton respectively and sum of each cost is at 22.90 USD/carton. Price for 15 ounces is a bit expensive than supplier F by just 0.4 USD/carton, same as price for 108 ounces is more costly than supplier F by 0.5 USD/carton, still winning against supplier E and H. Buyers are enforced to pay in advance around 30% of product values, better deal than supplier E.

Ethical Practices

This category for supplier G loses against other potential vendors, the reason is because the factory has never been certified any world-class audits from external reliable organizations; ethical trade and supply chain security audits and never implemented (but willing to implement once ready) OHSAS system to ensure workers

safety and health in the workplace. All of the workers came from countryside of Thailand, earning daily wages 325 baht.

Environmental Management

Supplier's production process is in compliance with specific environmental requirements. The ISO 9100:2000 has been implemented at the working sites, the plant can leverage benefit from more systematic process of ISO in order to decrease raw material usage and waste releasing from production process. The supplier is deficiency of adverse weather control during January to March and October to December, accounting for 6 months of unavailability of finished goods. Despite the fact that sweet corn from affiliated plantation can be produce fruit all year-round.

Technological Catch-up

Packages that supplier currently uses is diversity for canned food packaging; 8, 12, 75 ounces, whereas other packaging apart from UHT is not available. One of the strong points of supplier G is the only one sweet corn supplier who have UHT packages. The level of automation in production process is the lowest one with 36 tons of productivity yield with 280 workers.

4.3.4 Supplier H

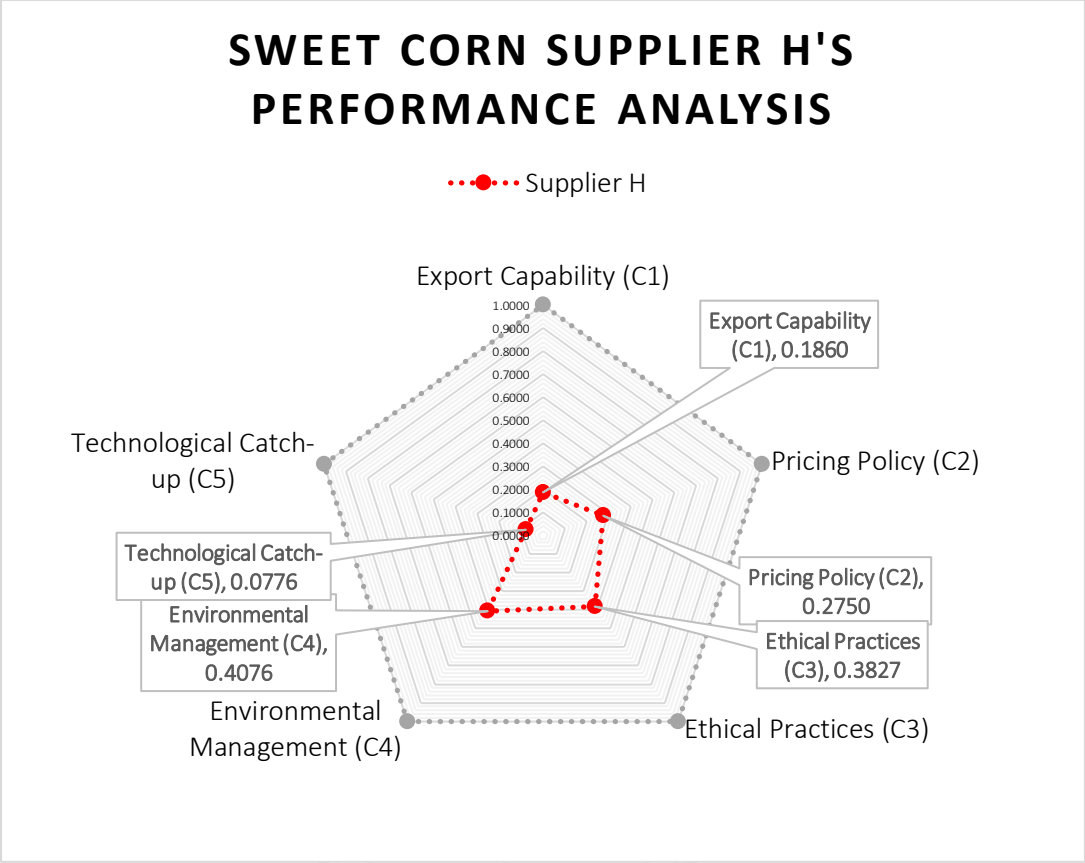


Figure 4. 9 Sweet Corn Supplier H's Performance Analysis

Supplier H is a primitive producer located in Lampang province (Northern part of Thailand), set up since 1969. The size of the plant areas is considered to be giant with approximately 126,000 square meters. The factory provides fruits, vegetables, and juices in can, pouch, and glass jar. Supplier L sells its notable product brand to both domestic and international markets. The supplier produces agricultural products under its brand and customer brand.

Export Capability

Supplier H's factory is sophisticated in export to international markets as the plant has been awarded the BRC audits with same scores as supplier G, received grade B of BRC certificate. Other guarantees attained are FCE and FDA registered, and IFS, but no Halal and Kosher.

Pricing Policy

Payment condition is very attractive same as supplier F with no advance payments enforced. In contrast, price is a bit expensive compared to moderate to high quality of products, 10 USD/carton and 14.5 USD/carton for 15 and 108 ounces respectively, more costly than supplier F, and G. Sum of each product sizes is 24.50 USD/carton.

Ethical Practices

Supplier H hires production workers from Myanmar and Thailand. The international workers have been already managed a legal employment contract (MOU). 315 baht pays as daily wage for production workers. The supplier relatively focuses on ethical practices through being certified supply chain security and ethical trade audits and OHSAS certificate which could help attract a group of customers who claimed itself as ethical company.

Environmental Management

Supplier's production process is in compliance with international environmental management standards, guides, and technical reports, ISO 14000, wining against any other potential rivals. In addition, the supplier has full potential to control adverse weather. Over a year, affiliated plantations are able to bearing and harvesting the fruit, contributing to able to produce finished goods during that period of time.

Technological Catch-up

The production efficiency of sweet corn products is not that high as supplier E and F. The average yield of production for sweet corn is about 100 tones, with 250 manpower to produce the goods. The level of automation in production process is small to moderate. The package used are the canned size in must-criteria (15 and 108 ounces) and 8 and 12 ounces of glass jars.

4.3.5 Rank of Sweet Corn Supplier

Table 4. 2: Final Scores of Sweet Corn Supplier

Selected Suppliers	*Final Scores*
Supplier E	0.2922
Supplier F	0.2935
Supplier G	0.1985
Supplier H	0.2159

From the result above towards all potential sweet corn supplier's performance, the first place belongs to **Supplier F**, followed by **Supplier E**. The next rank the company could list as a group of reserved vendors are **Supplier H** and **Supplier G** in succession, with no different of scores.

4.4 Supplier Priority and Selection of Baby Corn

4.4.1 Supplier I

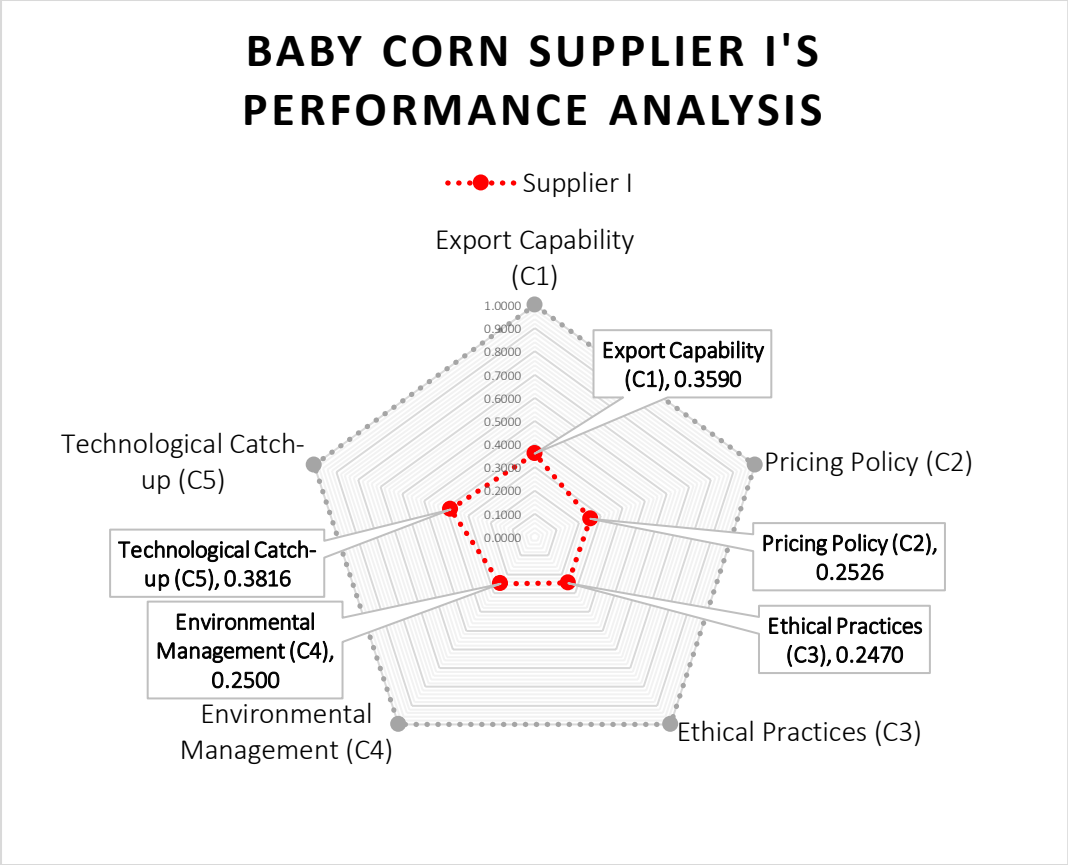


Figure 4. 10 Baby Corn Supplier I's Performance Analysis

Supplier I is the best quality food processor located in Kanchanaburi province (Western part of Thailand), established in 2003. The factory supplies tropical fruits and pineapples to global markets. The supplier is positioned as Thailand's largest exporter of corn kernels and baby corn and produces products under various renowned global brand names.

Export Capability

Supplier has a strong commitment to be the best quality food manufacturer, then always taking care of its quality system, attained all of the important certification; Halal, Kosher, FCE and FDA registration number, IFS, and especially for BRC that supplier has been grading A. The plant has a great potential to export baby corn products worldwide.

Pricing Policy

Price for 15 ounces from supplier I is the most reasonable, accounted for 10.5 USD/carton. In contrast, price for 108 ounces is at 16.5 USD/carton, above the baby corn cost average, making average high price offerings at 27 USD/carton. The price for 15 ounces is really attractive the buyers who often buys the small-sized canned vegetables. The supplier allows the buyer to not pay any money in advance before production, same as supplier K and L.

Ethical Practices

The supplier has never manipulated any MOU documents for Burmese labors because of temporary employees which means the status of workers is illegal. The daily wage is high cost around 400 baht. The plant has been awarded supply chain security and ethical trade certificate by external notable audit teams. However, the OHSAS has never been inspected because the factory is not ready for inspection now, but welcome to inspect once the plant will have adjusted the safety and health system.

Environmental Management

The supplier's factory has never been implemented the ISO 14000, but being awarded ISO 9002 certification which is the great starting point for ISO 14000 implementation. The production plant cannot supply baby corn products all year round due to the unable to fruitage and harvesting during July to September. The supplier is then able to supply finished goods to a group of distributors for just 9 months out of 12 months.

Technological Catch-up

Packages used in the factory is relatively diversity, the most variety packaging amongst potential suppliers. There is availability of 8 ounces of canned size, 8 and 12 ounces of glass jar, 8 and 12 ounces of plastic cup, and 3 kg of food pouch. Full capacity the factory can produce finished goods is 20 tons with having 70 workers in production lines. The supplier supports automation process in factory, have less manpower but having high yield of productivity.

4.4.2 Supplier J

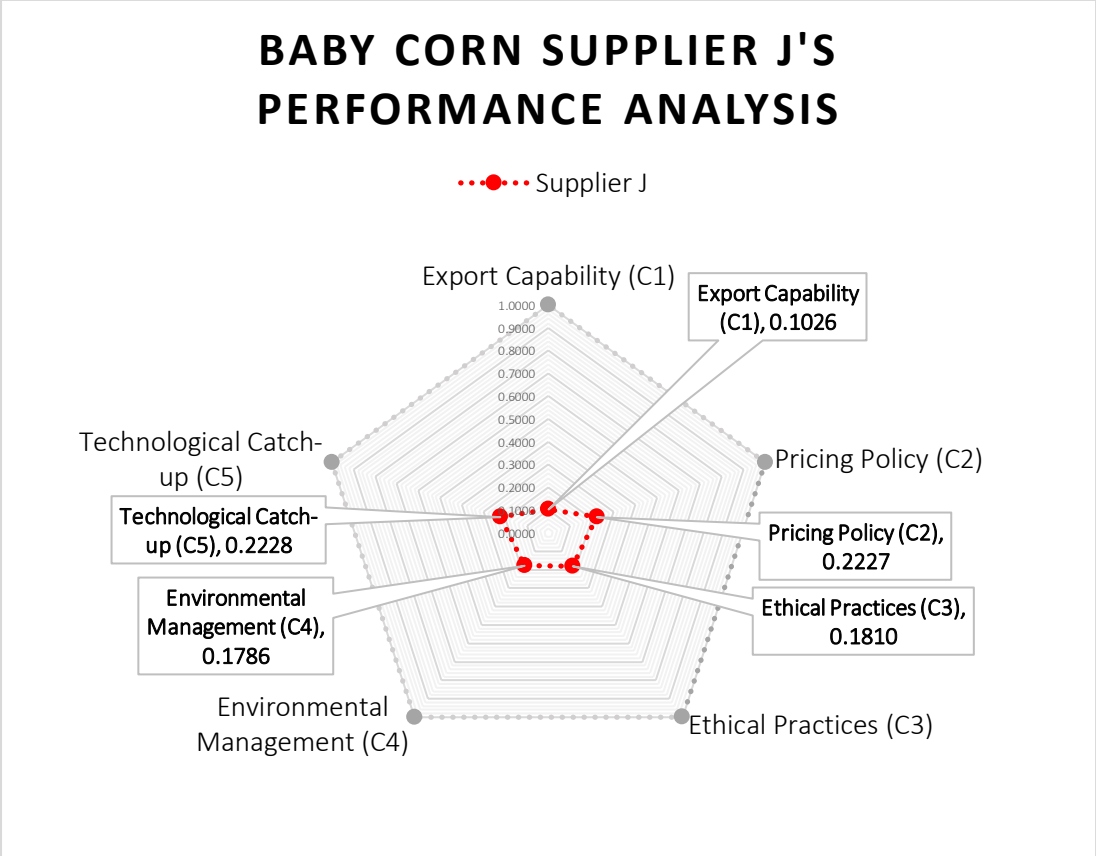


Figure 4. 11 Baby Corn Supplier J's Performance Analysis

Supplier J is a small to medium food processor (5,210 square meter areas) located in Kanchanaburi province (Western part of Thailand), set up since 2012. Main product of the plant is baby corn, and minor focus on bamboo shoot and coconut, rice and herbal drink in can and glass jar. The producer produces orders for only international markets, with major sale belongs to USA (98% of total productivity) and produces under customer brands (OEM products).

Export Capability

Supplier has been certified just two of food safety certificates named Halal and FCE and FDA registration number. The factory used to be certified BRC, but it was expired in August 2018. The supplier pays attention to a group of believers, but it is difficult to send out products to complex markets whom requires several advanced certificates.

Pricing Policy

Price 108 ounces is 13.25 USD/carton which is relatively low price, a bit more expensive cost than supplier L whom is the cheapest. In contrast, price for 15 ounces is the most expensive baby corn products offerings, 13 USD/carton. 30% of advance payment is the final negotiation that supplier offers. Supplier I and L is considered as more attractive sellers with best price and product quality including payment term than supplier J.

Ethical Practices

Employees in supplier J's factory are hired legally and ethically by the employer. All of Burmese workers is hired permanently and have been hiring legally through MOU agreement for both parties. Daily wage for production line worker is 320 baht. The plant has been awarded supply chain security audits, but not being verified for ethical trade audits. Supplier L is welcome to implement OHSAS when the system about health and safety of the plant is ready for inspection.

Environmental Management

Supplier's production plant has never been installed any ISO system before. The supplier open mind to welcome ISO 14000 system when the system of the factory is getting better standard. It is interesting that there are no non-growing seasons (covering bearing and harvesting) within a year, indicating that supplier J is one of two potential suppliers who is able to supply all year-round (same as supplier K).

Technological Catch-up

Supplier's small to medium sized plant can produce just 4 tons of baby corn raw materials which is the least yield of results compared to other competitors while hiring just 25 production workers. The technology in the plant of supplier J is unable to compare to supplier I and L, but beyond supplier K. Packaging uses in the factory is 15 mandatory sizes of canned packages and plastic bottle which is the outstanding point of supplier J.

4.4.3 Supplier K

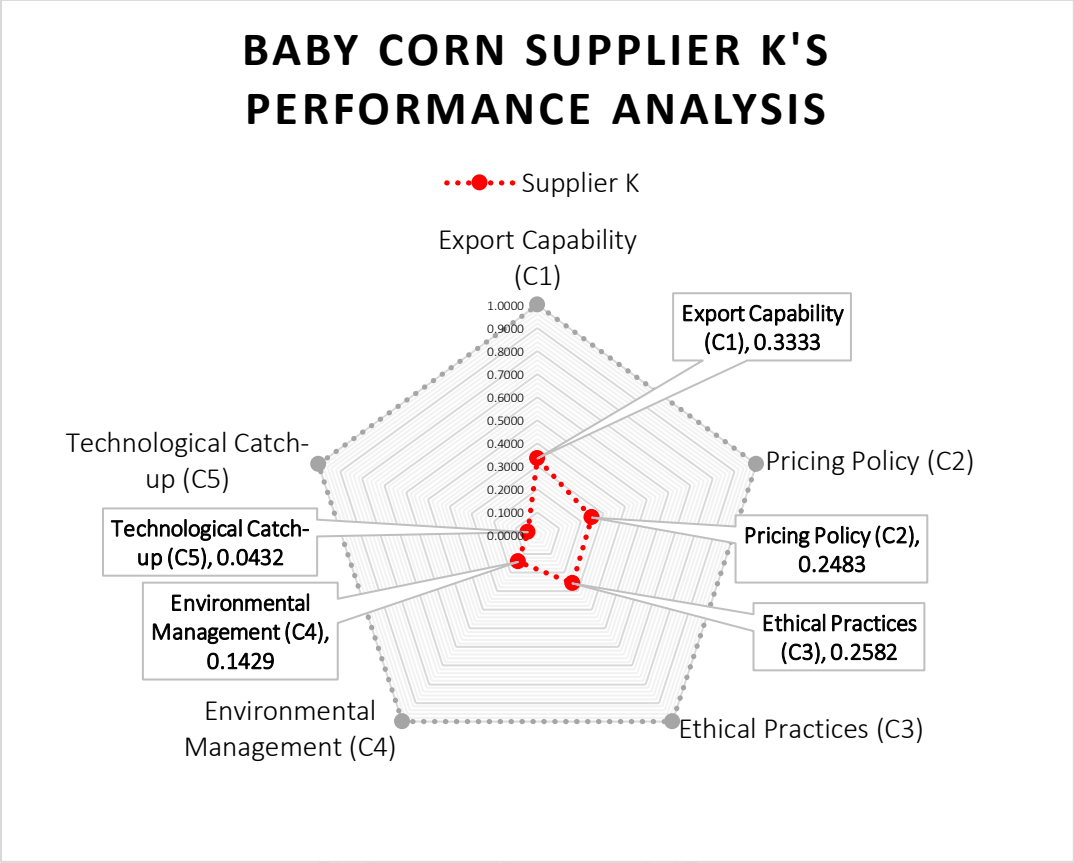


Figure 4. 12 Baby Corn Supplier K's Performance Analysis

Supplier K is excellent quality and primitive food producer located in Kanchanaburi province (Western part of Thailand), established in 1986. The factory has a main concentrate on sweet corn products, and minor focus on baby corn products. The supplier highlights on value added product. High quality of raw material comes from its affiliates across Thailand; Chiang Rai, Chiang Mai, Sokhothai, Nakhonsawan, Kanchanaburi, and Nakonratchasima provinces.

Export Capability

Supplier K's factory is the most sophisticated baby corn seller due to export to many places worldwide than any other suppliers, but supplier K has been awarded a little less food safety certificate than supplier I. The differentiation is that supplier I obtains BRC with grade A, while supplier K attains BRC with grade B+. Other guarantees are the same; Halal, Kosher, FCE, FDA, and IFS. Full marks for capability of exportation belong to only supplier K, the destination regions cover Europe, USA, Canada, Japan, China, Africa, Middle East, Middle and South America, Russia, and Australia and New Zealand.

Pricing Policy

Supplier K refuses to give any promotion to a group of buyers even though purchasing a big lot of orders at once. However, the payment is very attractive same as supplier I and L with no advance payments enforced. Price for 15 and 108 ounces are relatively high but the price is compatible with high product quality, 12 and 16 USD/carton respectively, more expensive than supplier I for 15 ounces but a little bit cheaper than supplier I for 108 ounces. Sum of both sizes is at 28 USD/carton.

Ethical Practices

Supplier K hires production workers from Cambodia, Burmese, and Thailand. The international workers have a legal employment contract with the plant by signing in the MOU agreement. Daily wage is at 315 baht/day for workers. The supplier focuses on

ethical practices through passing supply chain security and ethical trade audits which could help attract the organization that claimed itself as ethical company. Nevertheless, the company has never implemented OHSAS system for taking care of worker's health and safety.

Environmental Management

The company has set its own system to sustain environment around the plant, but the ISO system has never been set up at the factory and not welcome to implement the environmental system process. The supplier has a great potential on control adverse weather conditions. The baby corn plantation can supply raw materials to factory all year round due to capability to bear and harvest all year round. The production plant is then able to produce finished goods without a gap month.

Technological Catch-up

The company focuses on manufacturing sweet corn products due to original product of a factory; the production efficiency of baby corn products is then the lowest one compared to other baby corn plants. The average yield of production for baby corn is about 8 tones, with 100 manpower to produce the goods. The factory seems to rely on human workforce rather than manufacturing technology. The plant provides just mandatory canned package sizes.

4.4.4 Supplier L

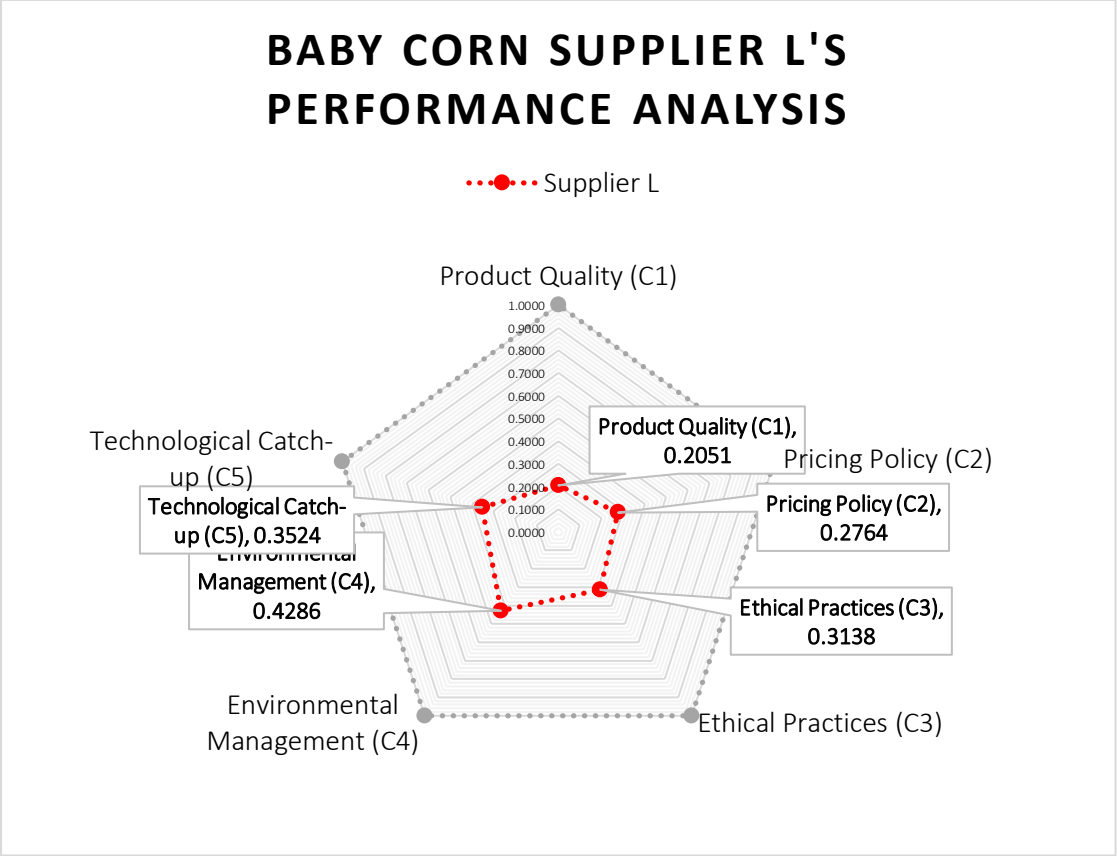


Figure 4. 13 Baby Corn Supplier L's Performance Analysis

Supplier L is a leading and primitive manufacturer located in Lampang province (Northern part of Thailand), established since 1969. The factory supplies fruits, vegetables, and juices in can, glass jar, and pouch. The agricultural products from supplier L is a notable brand for both domestic and international markets. The supplier utterly paid attention to worker's ethics, contributing to peaceful and happy workplace.

Export Capability

Supplier offers pretty high-quality products, but not give any attention to a group of believers. The plant is certified IFS, FCE and FDA registration number, and BRC with grade B, not being certified Kosher and Halal for Muslim and Jewish. If the products have certified just one of them, it is able to help compensate another group of believers to buy the goods.

Pricing Policy

Price of baby corn for both sizes, 15 and 108 ounces, are very reasonable compared to medium to high quality of products; 11 USD/carton and 11.5 USD/carton respectively. Price for 15 ounces is a bit expensive than supplier I by just 0.5 USD/carton, whereas price for 108 ounces is the cheapest amongst those potential suppliers, lower than supplier J by 1.75 USD/carton. Sum of each type is at 22.5 USD/carton, the lowest price suppliers with no advance payment enforcement.

Ethical Practices

This category for supplier L wins against any other vendors, major factor is because the factory has been certified world-class audits from external approval organizations; ethical trade and supply chain security audits. All of the workers came from Myanmar and countryside of Thailand, earning daily wages of 315 baht. Interestingly, the supplier

is only one supplier who attains OHSAS certification for approval worker's health and safety.

Environmental Management

Supplier's production process is in compliance with ISO environmental requirements. The ISO 14000 has been implemented at the production plant which is the strongest point of supplier L performance. This approval helps the company to have positive image in terms of environmental concerns. On the other hand, the supplier is lack of ability to control adverse weather during January to March, covering bearing, harvesting, and producing finished goods.

Technological Catch-up

Packaging that supplier currently uses is quite variety, including can, glass jar, and pouch, whereas there are only two mandatories canned sizes used in the production plant. The glass jar sizes are 7 and 8 ounces and 1 size of pouch. The level of automation in production process is the highest one with 100 tons of production yield and 250 workers working in baby corn production lines, going together with large plant size.

4.4.5 Rank of All Potential Baby Corn Suppliers

Table 4. 3: Final Scores of Baby Corn Suppliers

Selected Suppliers	*Final Scores*
Supplier I	0.3233
Supplier J	0.1638
Supplier K	0.2655
Supplier L	0.2474

Table above illustrates all potential baby corn supplier's performance, the first place belongs to **Supplier I**, followed closely by **Supplier K**. The next rank the company could list as a group of reserved vendors are **Supplier L** and **Supplier J** in succession, with big different of points.

4.5 Discussion of Criteria and Weights

The optimal strategic supplier framework (as illustrated in **Figure 2.1**) from Alikhani *et al*. (2019) covers three dimensions; Efficient Supplier Qualification (ESQ), Sustainable Supplier Selection (SSS), and Supplier Risk Management (SRM).

Figure 2.1: An Area of Optimal Strategic Suppliers (Source: Alikhani et al., 2019)

The thesis attempts to extend the research work by considering risk (to prevent uncertainty) and sustainability (to support certainty) factors and develop such criteria to get along with preserved food export industry. Combined with the concept from Zimmer *et al*. (2015) that decomposes a hierarchical structure into 3 parts; dimension, criteria, and sub-criteria criteria, the author in turn proposed 4 dimensions for strategic supplier selection of food export industry.

Supplier Risk Management (SRM) comprises of three risk factors; Adverse Weather Control (adjusted from 'Continuity'), Packaging Varieties (derived by author), Stop Hiring of Child and Forced Labor (derived by author).

Sustainable Supplier Selection (SSS) encompasses three risk factors; Environmental Compliances (adjusted from 'Environmental Management System'),

Automation in Production Process (adjusted from 'Technology Capability'), Worker's Safety and Health (adjusted from 'Interests and Rights of Employees') as depicted in **Figure 3.1.**

Efficient Supplier Qualification (ESQ) in the thesis has been adjusted into the form of Economic theme whose criteria (Export Capability and Pricing Policy) covers Number of Food Safety Certificates & Grades, Net Selling Price, and Payment Terms. Export Capability is a result form 'Quality' development, the Export Capability is designed to cover measurement of quality product and process because food products are sensitive ingredients to human health, financial status, and most importantly religions that food process chain need to be strictly control and management. When it comes to Cost, Net Selling Price is adjusted from 'Cost' and Payment Terms is additional element to concern due to the request from supplier towards less made-to-stock production.

The figure below is reproduced from **Figure 3.1** which illustrates author attempt to apply the framework to the food export industry. (Blue blocks stand for Economic dimension, Green blocks stand for Environmental dimension, Yellow blocks stand for Technological dimension, and Orange blocks stand for Social dimension)

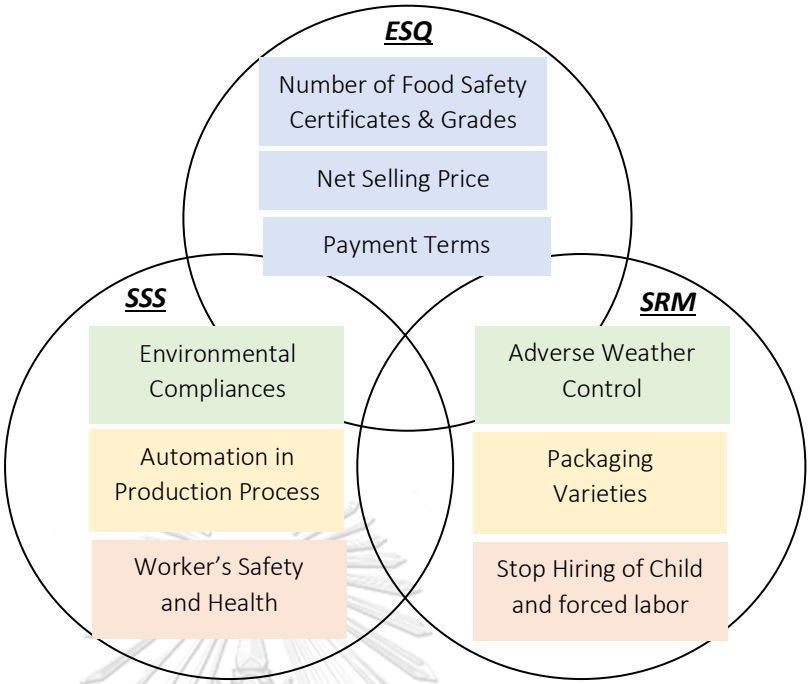


Figure 3.1: The Classification of Dimensions of Strategic Supplier Selection (Source: Derived by the Author)

Applying strategic supplier selection will be beneficial to an organization as it could promote procurement success. The first stage of a business chain is procurement which could lead the direction of the rest of company process. Compared to former times, structural supplier selection is to determine traditional criteria which are Quality, Cost, and Delivery. In recent years, considering such traditional criteria is not sufficient because there are so many specification and complexation in particular business to concern.

However, cost and quality are still vital for food export industry as a group of experts given top two highest weight scores. For years to comes, red ocean, where

competing mainly on price, will disappeared and the advent of blue ocean, where creating new market space, will replace the old style of competition. The traditional criteria will have less concern and modern strategic criteria will gain more shares instead of conservative one. As nowadays a lot of specific goal of organizations take place every day to obtain particular demands from end-consumer such as premium, religious, ethical distributors and retailers (as described in recommendations in chapter 5: summary and conclusion).

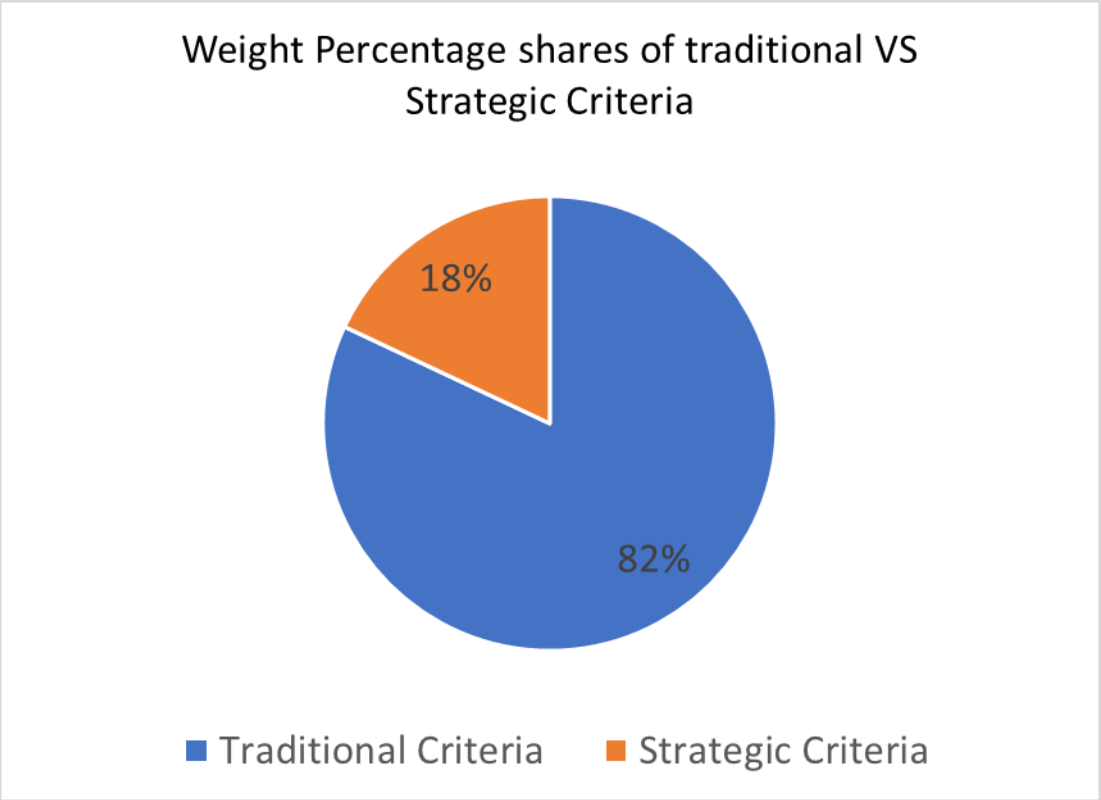


Figure 4. 14 Expected Tendency of Future Weight Propotions of Traditional vs Strategic Selection

On account of relative low weight scores of SRM and SSS criteria, there are still tendency to change the expert's mindset to give more rates to those criteria due to several reasons that could bring a long list of problems happened every day as shown in **Figure 4.14**.

Following the recent news report by Setboonsarng (2020), British supermarkets ban Thai coconut products because of accusations from People for Ethical Treatment of Animals (PETA) alleged that Thai coconut harvested by abused monkeys. In contrast, Thai governments confirmed that most of export coconut harvested by human with poles and machines. This can reflect that current and near future the ethics must be the important topic to concern. The weight of ethical practices must be augmented in the opinion of food export businesses. Besides, PETA responded that Thailand still keeps monkey in coconut chains with nonsensical solution of counting the number of monkeys and farms. With this kind of ethical arguments, ethical certificate to ensure non-abusive labors in food process inspected by approval organizations must be essential stamps soon after and the important of certificate to acknowledge ethical trades must be augmented as well.

In these days, consumers are aware of sustainable products selection prior to making purchases. The greener lifestyle of consumers can indirectly affect to business sectors more than before. Green products are the product that have less of

environmental impacts which can be informed consumers through certification labeling. There are numerous certificates to ensure green products, but for agricultural products USDA organic is the certificate to ensure that all biological and mechanical processes is conducted to conserve natural resources and biodiversity. ISO 14000 is the beginner step to help decrease environmental impacts from production process on the surrounding environments such as toxic compounds and chemicals releases which is earlier step before certified green products. Currently, environmental-related topic is a big concern among end-consumers, but the business-to-business sectors will follow such environmental-friendly concerns in future, contributing to increase the important weight of environmental factors.

Thailand's economic heavily relies on agricultural product exportation as one of the world largest food exporter. Approximately 50% of agricultural products produced in Thailand is sent out to worldwide countries, the production competency should be another vital factor to focus on in order to surge the yield of productivity respond to high consumption demands. The food export experts rate a moderate important weight to technological dimension (but still far away from traditional dimension) due to the fact that supply disruptions commonly take place in some seasons of the year which affect directly company sales. Providing that more advanced technology is adopted and applied to the plant's affiliate plantation and production machines, the trading company

can supply food products to foreign distributors without a gap month. Another point is that the more machine installs the less workforce hire which means less ethical problems. The supplier pays for the machine just once and occasionally for maintenance or when the machine is broken. Unlike the taking great care of employees that are much more delicate and difficult.

Chapter 5: Summary and Conclusion

5.1 Comparison of Alternative Potential Suppliers

5.1.1 Pineapple

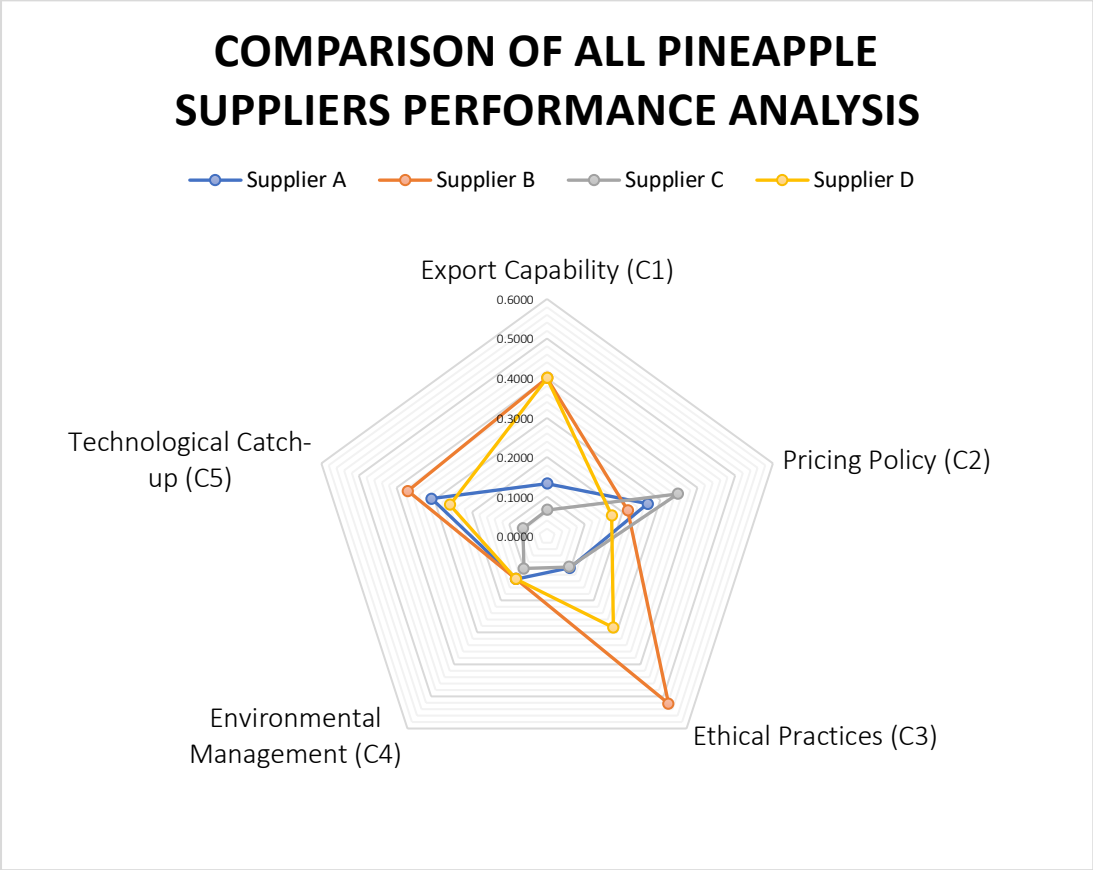


Figure 5. 1 Comparison of All Pineapple Supplier's Performance Analysis

Performance Dimensions: the rank of pineapple supplier are as follows;

Export Capability: Supplier B = Supplier D > Supplier A > Supplier C

Pricing Policy: Supplier C > Supplier A > Supplier B > Supplier D

Ethical Practices: Supplier B > Supplier D > Supplier A > Supplier C

Environmental Management: Supplier D = Supplier B = Supplier A > Supplier C

Technological Catch-up: Supplier B > Supplier A > Supplier D > Supplier C

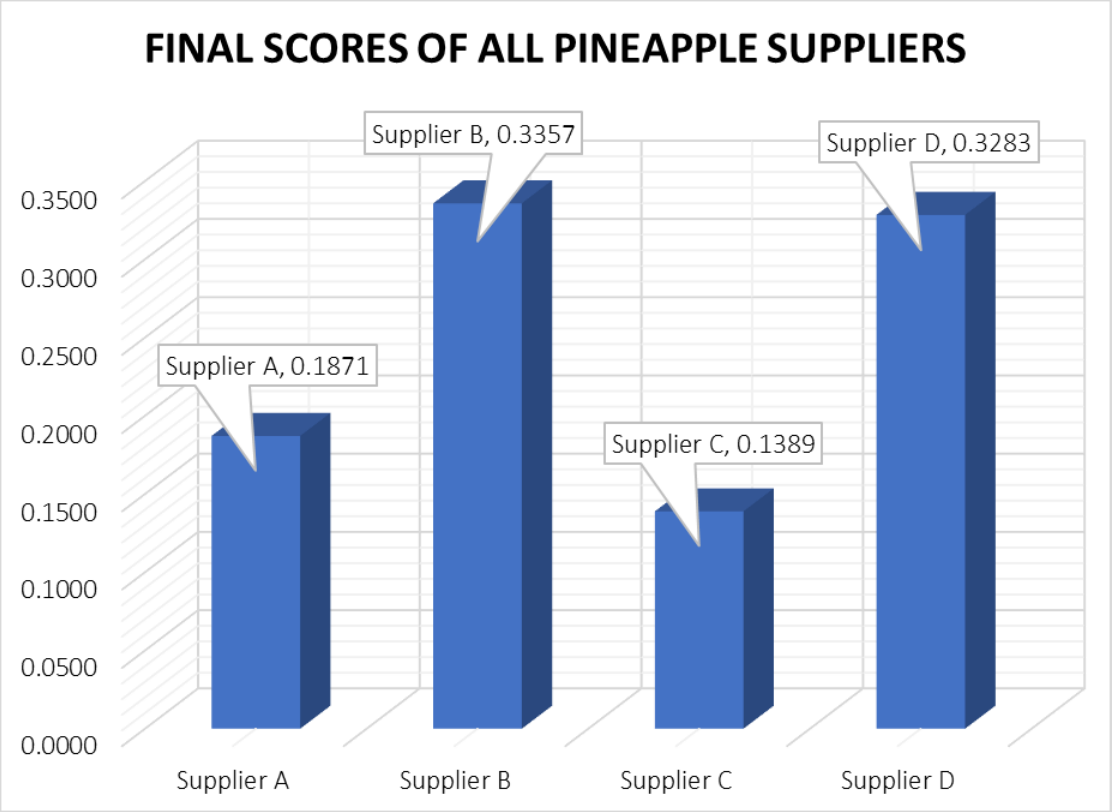


Figure 5. 2 Final Scores of Pineapple Suppliers

When comparing all of the radar graphs from different supplier and weighting scores from AHP, it found out that the weight of product quality comes the number one with very high proportion, then great quality suppliers, Supplier B and D obtained equal high scores from this category. Supplier B ranks number one due to wining against Supplier D in the category of pricing policy despite Supplier D offers lower price by 2.5 USD/carton. But supplier D requires purchaser to pay in advance 100% which is relatively unacceptable. The final scores for technological involvement of Supplier B is

extremely high, while two potential supplier, A and D, are brutally close to that of Supplier B, left Supplier C far behind. This is because Supplier C is an undersized factory with lower yield of daily productivity. Supplier B received high scores for ethical practices, a major reason is that it was certified Ethical Trade and Supply Chain Security audits which are vital certifications for trading with giant international retailers. However, Supplier D received some scores from endeavor in hiring external audit team to inspect the plant, even though the result shows not pass. Supplier A and C do not have any notable guarantees that makes they obtains relatively low scores. All of the potential supplier of pineapple supply has never been certified ISO 14000 that making the score for this category is not that different and three of supplier (Supplier A, B, and D) is able to control adverse weather with the same level, but this category obtains the least weight of AHP. The radar graph of Supplier C is very outstanding that Supplier C is appropriate for export the product to low requirements of distributors on an account of low score in every category, except from pricing policy.

Overall: the rank of pineapple supplier is as follows;

1. Supplier B
2. Supplier D
3. Supplier A
4. Supplier C

5.1.2 Sweet Corn

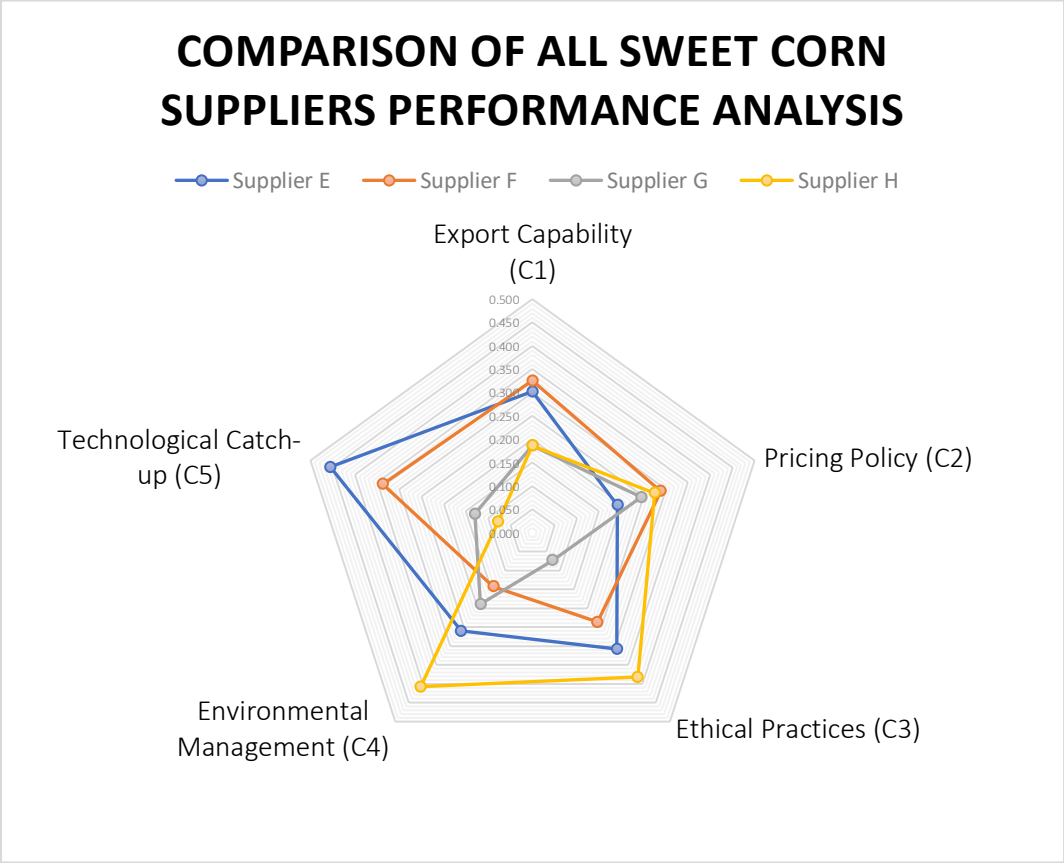


Figure 5. 3 Comparison of All Sweet Corn Supplier's Performance Analysis

Performance Dimensions: the rank of sweet corn supplier are as follows;

Export Capability: Supplier F > Supplier E > Supplier H = Supplier G

Pricing Policy: Supplier F > Supplier H > Supplier G > Supplier E

Ethical Practices: Supplier H > Supplier E > Supplier F > Supplier G

Environmental Management: Supplier H > Supplier E > Supplier G > Supplier F

Technological Catch-up: Supplier E > Supplier F > Supplier G > Supplier H

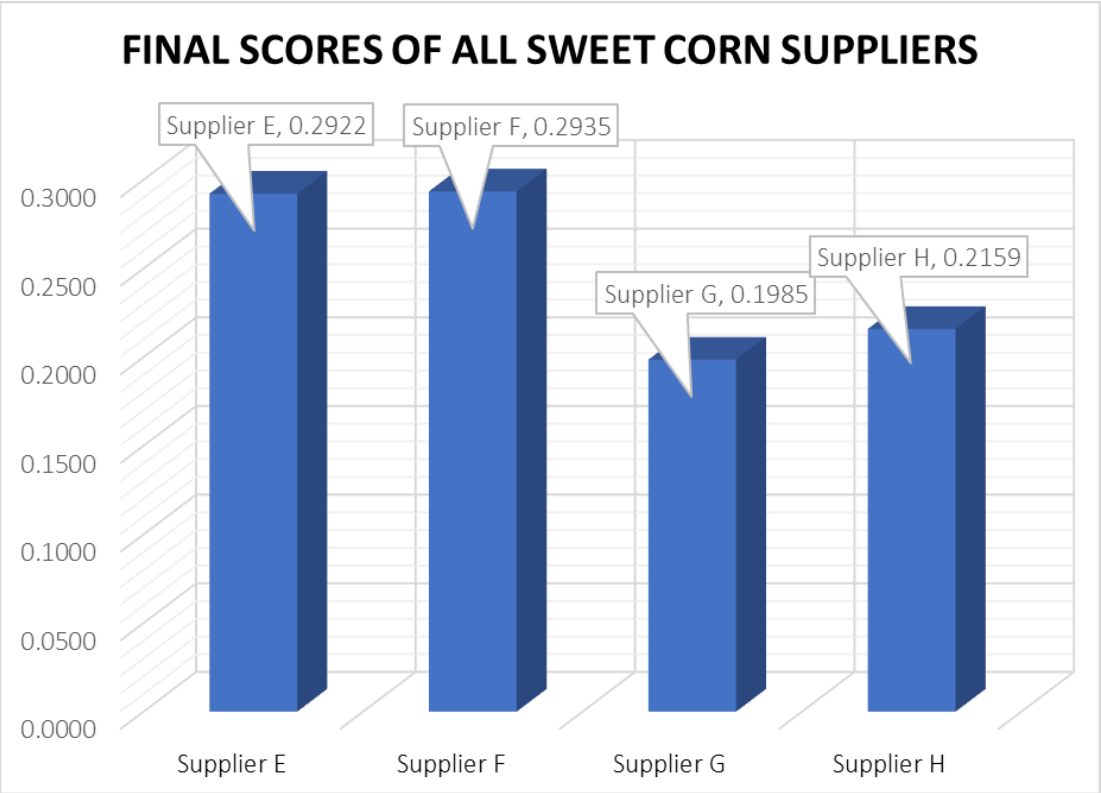


Figure 5. 4 Final Scores of Sweet Corn Suppliers

The radar graphs show different supplier performances in different dimensions and the bar chart depicts the final scores after sum of the AHP weight (**Figures 5.3 & 5.4**). Due to overabundant of product quality weights, it makes Supplier E and F who is premium quality processors obtains ground player positions for sweet corn product agents. However, supplier F obtains a little of victory over Supplier E in terms of export capability which is BRC grade A award and in terms of pricing policy that the seller offers very great deal of the lowest price and no advance payment enforcement. The score of Supplier F is then outstanding rather than other potential rivals, maybe the buyer accepts great deal because of being a customer of baby corn products as well.

The moderate quality supplier, Supplier G and H, with expensive cost of products is in turn classified as backup sellers. Supplier H has a strong point in terms of ethical practices and environmental management due to ISO 14000 and OHSAS implementation and Ethical Trade, Supply Chain Security certification, but the ratio of weight is less, contributing to less meaningful for overall. By comparison, Supplier G did not obtain any certification or system implementation, making it receives the last prize for ethical practices category. Supplier E and F have a high potential in Automation in Production Process, leading to high scores for Technological Catch-up category. The radar graph of Supplier G and Supplier H is very remarkable that Supplier G is not a good performance supplier on an account of low score in every category without exceptions and supplier H receives low scores the important high weight category as export capability and technological catch-up.

Overall: the rank of sweet corn supplier is as follows;

1. Supplier F
2. Supplier E
3. Supplier H
4. Supplier G

5.1.3 Baby Corn

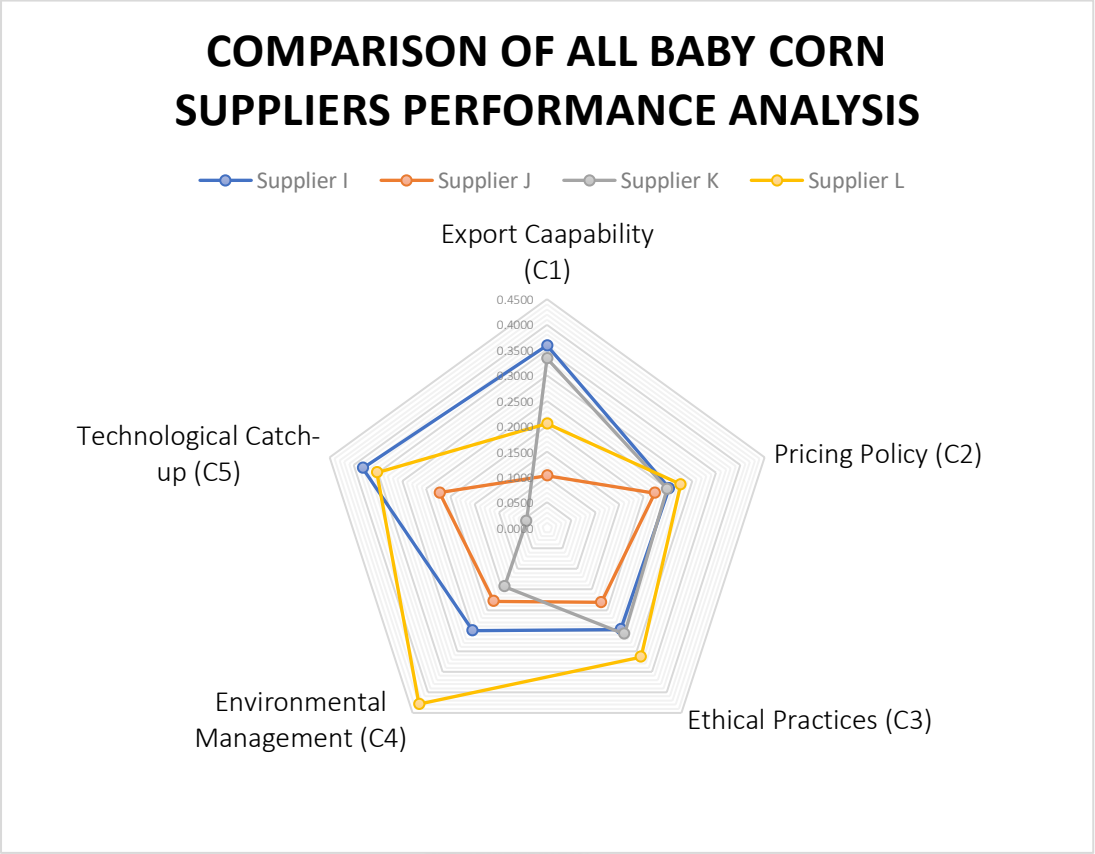


Figure 5. 5 Comparison of All Baby Corn Supplier's Performance Analysis

Performance Dimensions: the rank of baby corn supplier are as follows;

Export Capability: Supplier I > Supplier K > Supplier L > Supplier J

Pricing Policy: Supplier L > Supplier I > Supplier K > Supplier J

Ethical Practices: Supplier L > Supplier K > Supplier I > Supplier J

Environmental Management: Supplier L > Supplier I > Supplier J > Supplier K

Technological Catch-up: Supplier I > Supplier L > Supplier J > Supplier K

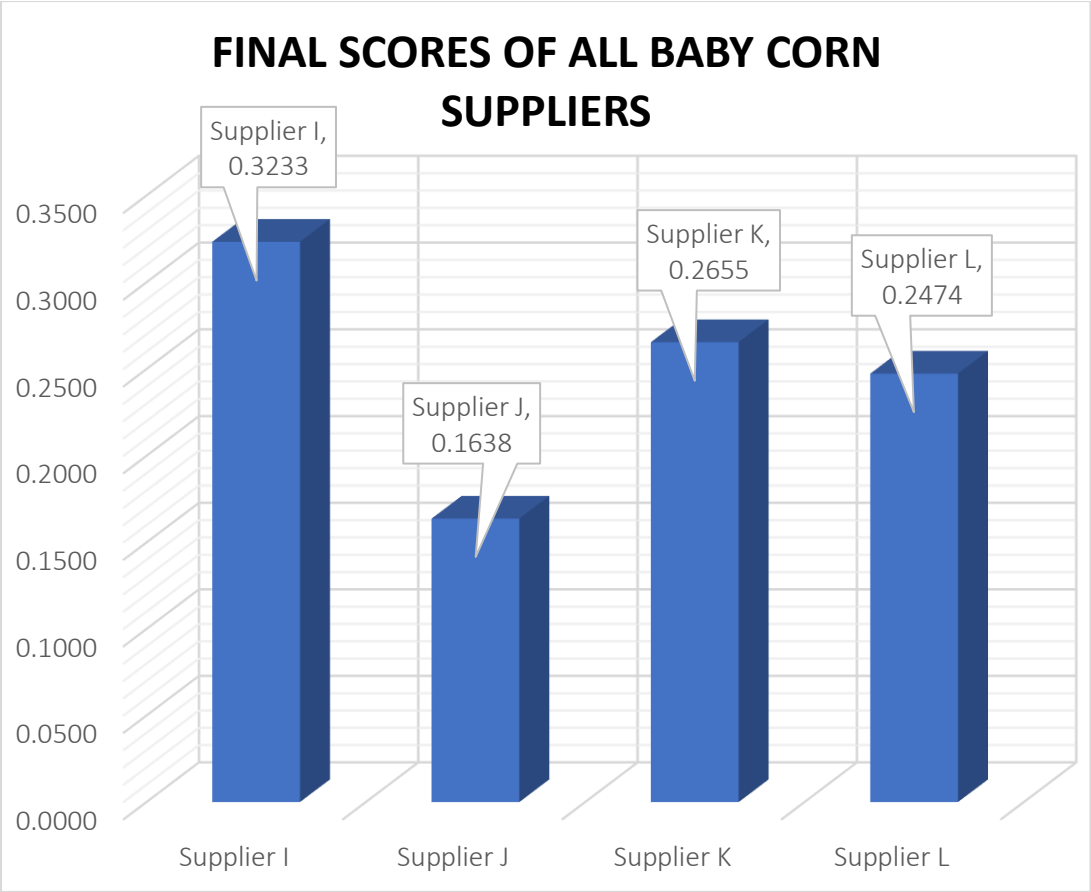


Figure 5. 6 Final Scores of Baby Corn Suppliers

According to bar chart above, there is a tight race for three of potential supplier; Supplier I, Supplier K, and Supplier L, despite the fact that the level of export capability for I and K sellers is not that different from each other, except supplier L that receives moderate scores. From radar charts, there is a reverse variation of both export capability and price for Supplier I, Supplier K, and Supplier L. The rank of the export capability is Supplier K, supplier I, and supplier L respectively, but the rank of price is Supplier L, Supplier I, and Supplier K respectively. Supplier K obtains less scores than supplier I due to a lower class of BRC grading. Meanwhile, the performance of Supplier J is

inferior for all dimensions, except from environmental and technological catch-up themes which are the weakness point of Supplier K. Supplier J can supply product all year round. However, the final score is less than Supplier L who implemented ISO 14000, but the AHP weight of environmental theme is the least proportion. Supplier L has better performance than any other competitors when it comes to export capability and pricing policy where gains top two weight of AHP that makes the final scores of Supplier L is superior to the last rank; Supplier J. Compared to other products, all of the potential baby corn sellers is more focus on ethical practices due to passing Supply Chain Security audit and passing Ethical Trade audit (except from Supplier J).

Overall: the rank of baby corn supplier is as follows;

1. Supplier I
2. Supplier K
3. Supplier L
4. Supplier J

5.2 Hierarchical Models of Different Product Category Suppliers

5.2.1 Hierarchical Models of Pineapple Products Hierarchical Models of Pineapple Suppliers

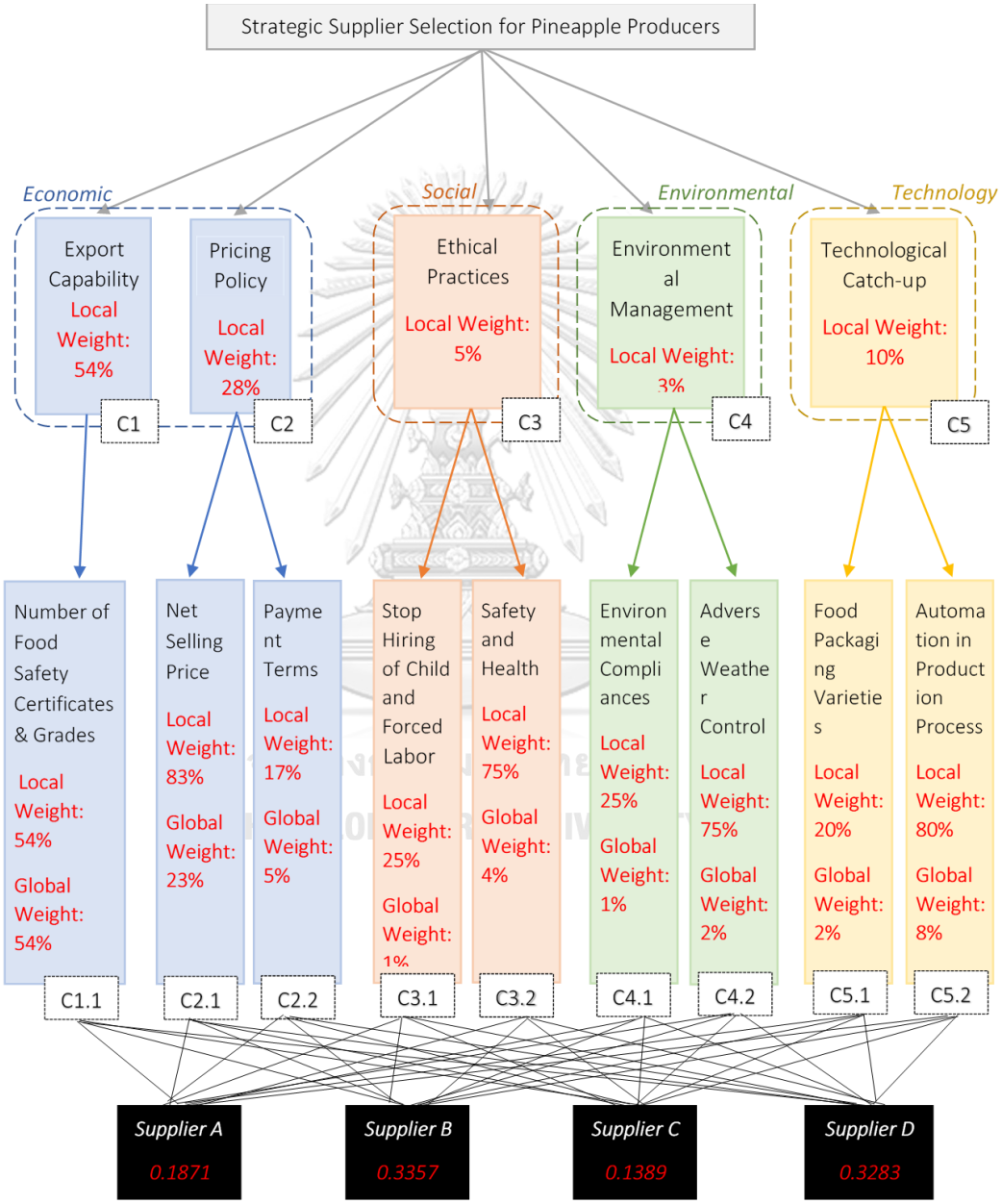


Figure 5. 7 Hierarchical Model of Pineapple Suppliers

5.2.2 Hierarchical Models of Sweet Corn Products

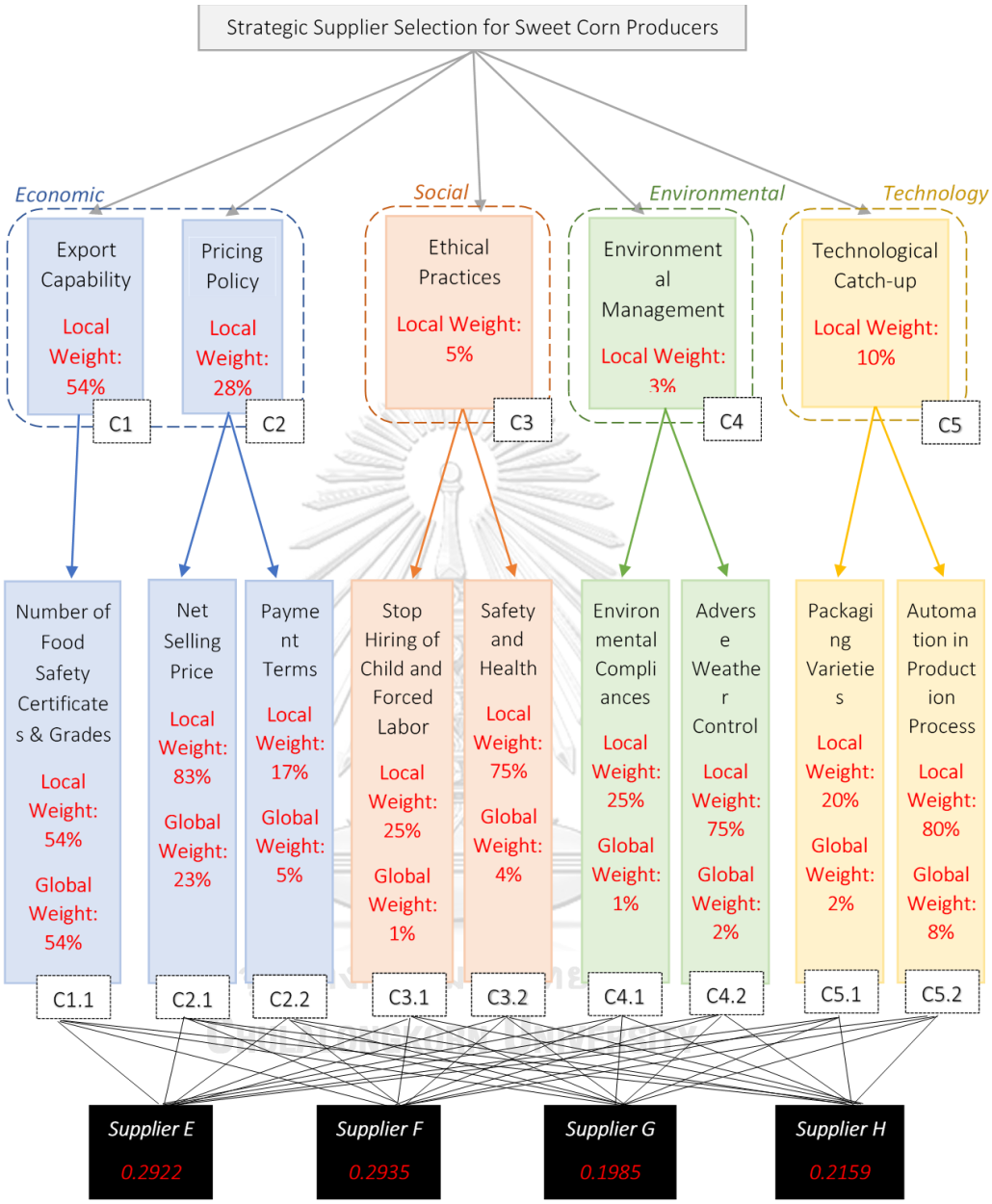


Figure 5. 8 Hierarchical Model of Sweet Corn Supplier

5.2.3 Hierarchical Models of Baby Corn Products

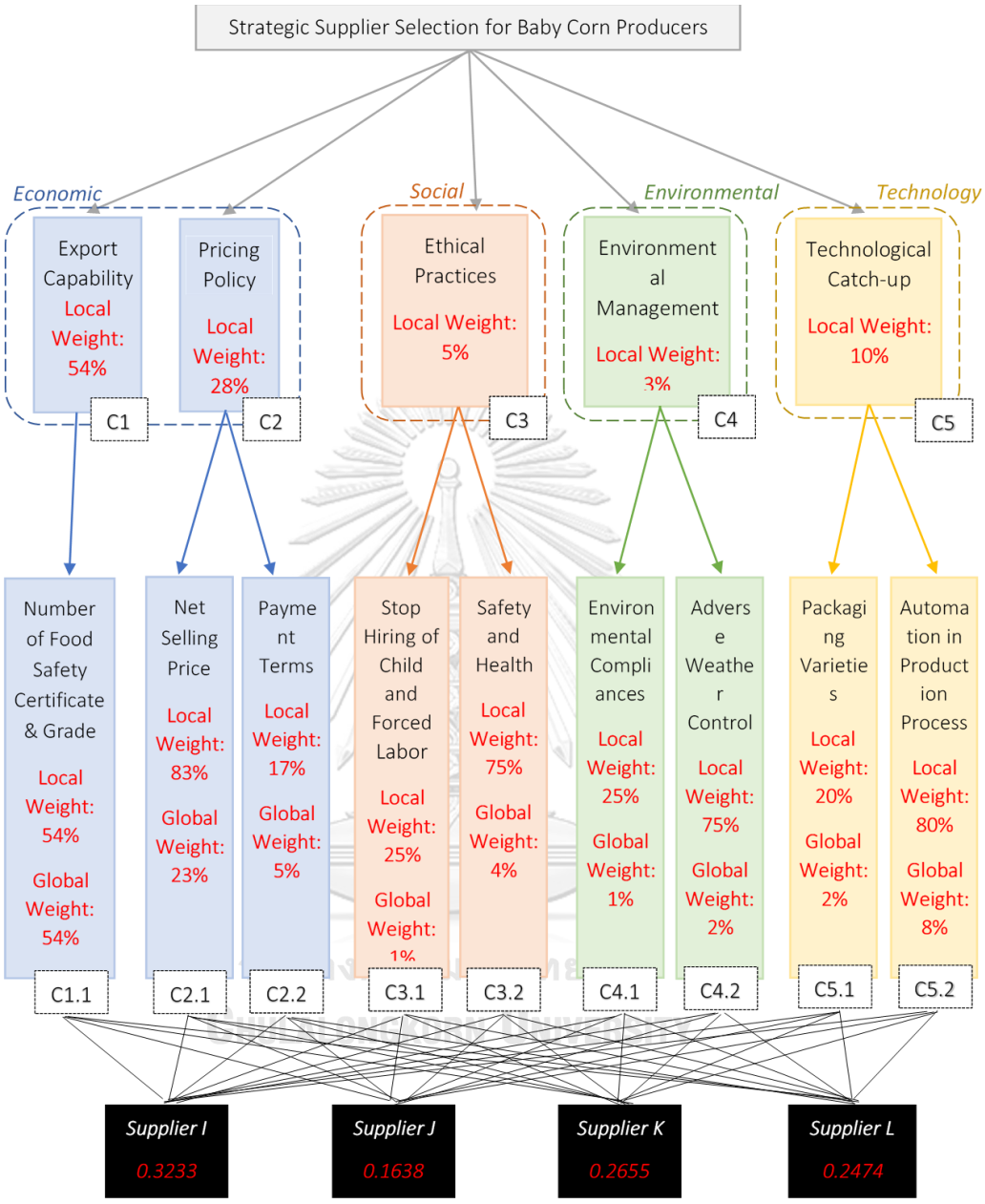


Figure 5. 9 Hierarchical Model of Sweet Corn Suppliers

5.3 Customer Matching

5.3.1 Customer AA

The customer is the subsidiary company under an American multinational retail corporation, operating in South America. The case study company sells the product to this retailer whose export products continue distributing to Costa Rica, Honduras, and Guatemala.

Requirements; Export Capability: BRC grade B up & Kosher, Environmental Compliances: Preferred

Ethical Practices: Ethical Trade & Supply Chain Security Audits

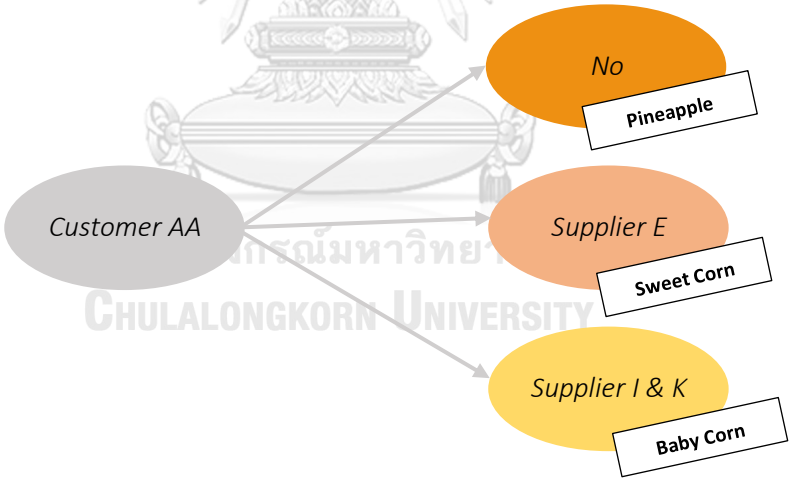


Figure 5. 10 Customer AA Matching

Result: Appropriate supplier for Customer AA are as depicted in **Figure 5.10**; No appropriate one for Pineapple Products, Supplier E for Sweet Corn products, and Supplier I and K for Baby Corn products.

5.3.2 Customer BB

The customer is the moderate company operating in Curaçao which is a constituent country in the Kingdom of the Netherlands. There is no special regulatory requirement and customer BB generally orders in bulk due to long distance for transportation.

Requirements; Pricing Policy: the cheapest cost

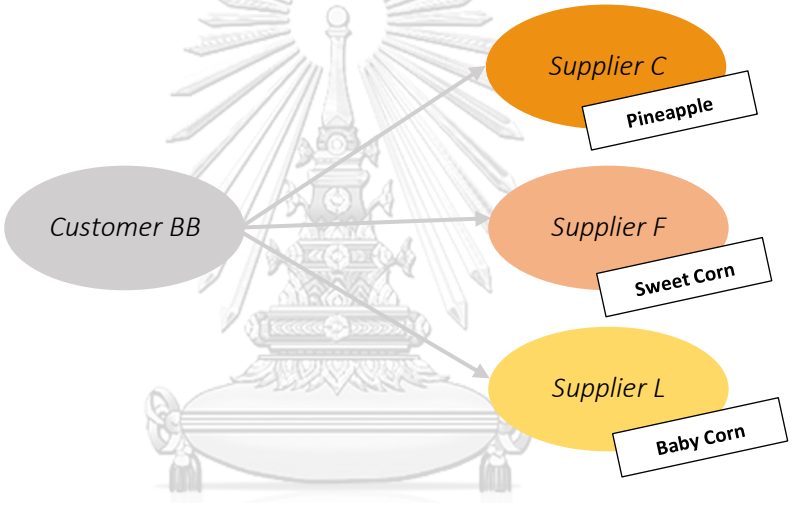


Figure 5. 11 Customer BB Mactching

Result: Appropriate supplier for Customer BB are as depicted in **Figure 5.11**; Supplier C for Pineapple Products, Supplier F for Sweet Corn products, and Supplier L for Baby Corn products.

5.3.3 Customer CC

The customer is one of the large distributors in Canada focusing on international food trading market by bringing in unique products and packaging concepts.

Requirements;

Export Capability: BRC without grading determined, Ethical Practices: Ethical Trade Audit & Supply Chain Security

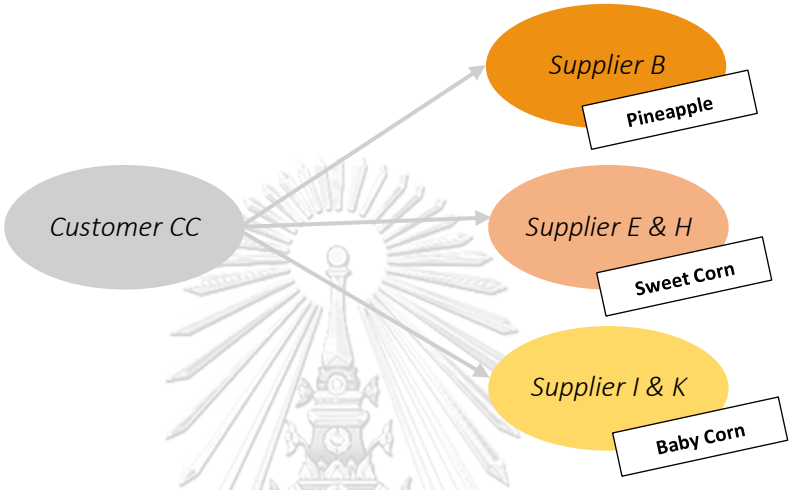


Figure 5. 12 Customer CC Matching

Result: Appropriate supplier for Customer CC are as depicted in **Figure 5.12**; Supplier B for Pineapple Products, Supplier E and H for Sweet Corn products, and Supplier I and K for Baby Corn products.

5.3.4 Customer DD

The customer is one of the large distributors with its famous brand operating in United States of America. A group of religious and terrorist inhibition are top priority in the region because of cultural diversity supports and protecting the food supply from Intentional adulteration.

Requirements; Export Capability: BRC without grading determined, FDA & FCE registration, Kosher, Ethical Practices: Ethical Trade Audit

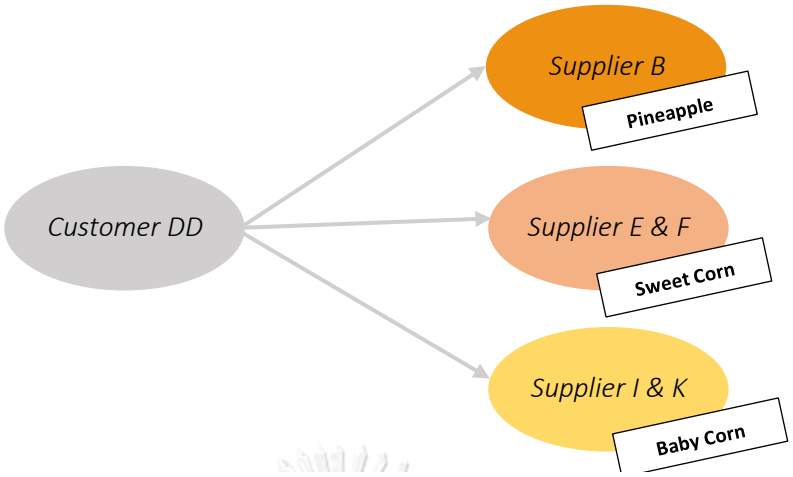


Figure 5. 13 Customer DD Matching

Result: Appropriate supplier for Customer DD are as depicted in **Figure 5.13**; Supplier B for Pineapple Products, Supplier E & F for Sweet Corn products, and Supplier I & K for Baby Corn products.

5.3.5 Customer EE

The customer is a small distributor in the middle east region. The company has no special requirement, except from Halal that is dietary regulatory restriction for Muslims and lowest price.

Requirements; Export Capability: Halal, Pricing Policy: the cheapest cost

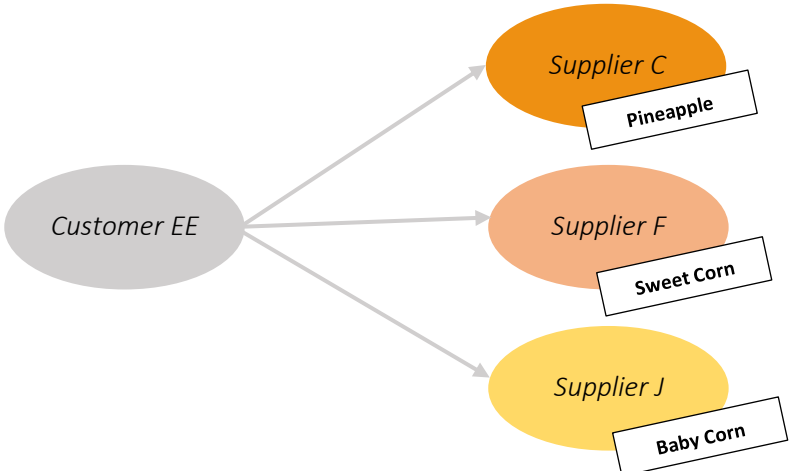


Figure 5. 14 Customer EE Matching

Result: Appropriate supplier for Customer EE are as depicted in **Figure 5.14**; Supplier C for Pineapple Products, Supplier F for Sweet Corn products, and Supplier J for Baby Corn products.

5.4 Recommendations

5..4.1 Purchasing Policy

According to *Lu, D., 2014*, the supply management comprises of two types of producers; mass and lean producers. The positive outputs of lean management are to possess smaller group of suppliers or supply base in order for building closer relationship and have single or dual sourcing in order to get rid of wasting time for linking with multiple suppliers. It is stated by *Sharp (2018)* that the risk of supply chain disruption such as product shortages, inconsistent supply, pricing comparison and benchmarking could be mitigated by using dual sourcing system for a particular category of product.

The prioritization of supplier candidate is sequenced from the highest to lowest scores. Top two qualified supplier candidates of particular product category will be listed as company's potential suppliers with the suggestion to purchase food products at different percentage. The purchasing policy in **Table 5.1** is created to prevent supply chain disruption in case the most appropriated qualified supplier (Supplier W) is suddenly unable to supply the goods to company, the company still has 'Supplier X' who has the healthy relationship to supply goods instead of 'Supplier W' as well as starting to purchase the product from 'Supplier Y' instead of 'buying from Supplier X' who is newly placed to become the first rank on the list.

Table 5. 1: Example of Purchasing Policy (Source: Derived by the Author)

Rank	*Appropriate qualified supplier*	*Purchasing Decision*
1	Supplier W	YES
2	Supplier X	YES
3	Supplier Y	NO
4	Supplier Z	NO

In the dissertation, the tables below (**Table 5.2, 5.3, and 5.4**) illustrate proper purchasing policy for pineapple, sweet corn, and baby corn products that the focal company should attempt to follow the purchasing scheme in order to leverage more

benefits to company itself and eliminate a long list of issues which is mentioned in problem statement before.

Table 5. 2: Recommended Purchasing Policy for Pineapple Products (Source: Derived by the Author)

Rank	*Appropriate Pineapple Supplier*	*Purchasing Decision*
1	Supplier B	YES
2	Supplier D	YES
3	Supplier A	NO
4	Supplier C	NO

Table 5. 3: Recommended Purchasing Policy for Sweet Corn Products (Source: Derived by the Author)

Rank	*Appropriate Sweet Corn Supplier*	*Purchasing Decision*
1	Supplier F	YES
2	Supplier E	YES
3	Supplier H	NO
4	Supplier G	NO

Table 5. 4: Recommended Purchasing Policy for Baby Corn Products (Source: Derived by the Author)

Rank	*Appropriate Baby Corn Supplier*	*Purchasing Decision*
1	Supplier I	*YES*
2	Supplier K	*YES*
3	Supplier L	0%
4	Supplier J	0%

5.4.2 Exceptions for Special Cases

On an account of human food, there are rigorous restrictions for some group of suppliers that need to acquire products from specific potential suppliers which are ethical, high-quality, pious organization, including competency in product supply for some underprovided seasons.

Food export company should source products from the list below first, then follows the policy above as much as possible. Some suppliers who cannot comply with specific distributor's requirements are cut-off from the **Table 5.5** and the proper supplier is prioritized as seen in the table.

Ethical Organizations

Large conglomerates who has claimed itself as ethical distributors or retailers has a commitment to source legal products from all around the world, with the regulatory approval resources. The Ethical Trade and Supply Chain Security audits need to be ensured by global assurance providers before sending out the goods to these kinds of distributors.

Table 5. 5: Purchasing Policy for Ethical Organizations (Source: Derived by the Author)

Products	*Ranks*	*Suppliers*	*Certified*	*Scores*
Pineapple	1	B	Ethical Trade & Supply Chain Security	0.3357
Sweet Corn	1	E	Ethical Trade & Supply Chain Security	0.2922
	2	H	Ethical Trade & Supply Chain Security	0.2159
	3	F	Ethical Trade	0.2935
Baby Corn	1	I	Ethical Trade & Supply Chain Security	0.3233
	2	L	Ethical Trade & Supply Chain Security	0.2474
	3	K	Ethical Trade & Supply Chain Security	0.2655
	4	J	Supply Chain Security	3.805

Religious Organizations

Muslims live around the world, and religious company must source food products from the supplier that uses Halal practices in production process. The food

certificate called Kosher is another food assurance that is proper for eating as the food is produced in accordance with Jewish dietary law. Occasionally, two of such certificates are able to compensate each other when having either one will be sufficient.

Table 5. 6: Purchasing Policy for Religious Organizations (Source: Derived by the Author)

Products	*Ranks*	*Suppliers*	*Certified*	*Scores*
Pineapple	1	B	Halal & Kosher	0.3357
	2	D	Halal & Kosher	0.3283
	3	C	Halal	0.1389
	4	A	Kosher	0.1871
Sweet Corn	1	F	Halal & Kosher	0.2935
	2	E	Halal & Kosher	0.2922
	3	G	Kosher	0.1985
Baby Corn	1	I	Halal & Kosher	0.3233
	2	K	Halal & Kosher	0.2655
	3	J	Halal	0.1638

Premium Organizations

Some group of countries has strict regulations for food exportation that need to be awarded the certification before commercial sales in such regions. The BRC certified

and FCE and FDA registered are the signal of high standard of food quality that in compliance with specific country requirements.

Table 5. 7: Purchasing Policy for Premium Quality Organizations (Source: Derived by the Author)

Products	*Ranks*	*Suppliers*	*Certified*	*Scores*
Pineapple	1	B	BRC (grade B) & FCE, FDA	0.3357
	2	D	BRC (grade B) & FCE, FDA	0.3283
	3	A	Certified FCE, FDA	0.1871
Sweet Corn	1	F	BRC (grade B) & FCE, FDA	0.2935
	2	E	BRC (grade B) & FCE, FDA	0.2922
	3	G	BRC (grade C) & FCE, FDA	0.1985
	4	H	BRC (grade C) & FCE, FDA	0.2159
Baby Corn	1	I	BRC (grade A) & FCE, FDA	0.3233
	2	K	BRC (grade B+) & FCE, FDA	0.2655
	3	L	BRC (grade B) & FCE, FDA	0.2474
	3	J	FCE, FDA	0.1638

Continuity of Supplies

Within a year, cropping season of particular fruit, capability of control of adverse weather, including deal making with affiliate plantations is different, leading to supply

disruptions in some months. A list of proper suppliers for specific period of time is as follows.

Table 5. 8: Purchasing Policy for Supporting Continuity of Supplies (Source: Derived by the Author)

Month	*Products*	*Suppliers*
January - March	Pineapple	B, D, C, A
	Sweet Corn	F, E, H
	Baby Corn	I, K, J
April -June	Pineapple	B, D, C, A
	Sweet Corn	F, E, G, H
	Baby Corn	I, K, L, J
July - September	Pineapple	B, D, A
	Sweet Corn	F, E, G, H
	Baby Corn	K, L, J
October - December	Pineapple	B, D, C, A
	Sweet Corn	F, E, H
	Baby Corn	I, K, L, J

5.5 Executive Level Interview

After completing research project, the author has presented all of the data gathering, research outcomes, covering discussion for giving helpful advices to the case study company. According to the feedback from management team's opinion, strategic supplier selection is interested topic and could help build more awareness toward current business environments relating to food exports that would be beneficial for case study company in near future. The proposed framework including relevant criteria and sub-criteria are valuable contributions for food export industry as such model could be applied to the company operation in procurement process. Besides, the research project has created the supplier matching for giving more concrete examples of strategic supplier selecting to specially apply with case study company. In turn, the executive team expected that the proposed model could help company leverage more competitive advantages over other food trading competitors and generate greater returns from responding to international customer's demands. The executive is extremely grateful for the attempt in helping company give alternatives for overcoming the big crisis of problematic suppliers. In the end, the proposed method is accepted the agreement by consensus to be implemented in the case study company in order to fulfill the gap of current procurement process.

5.6 Managerial Implications

According to **Figure 4.14** that illustrated the current important proportion of traditional vs strategic supplier selections, it indicated the experts gave substantial weight to strategic criteria as attained almost one-fifth of total relative important criteria. This is a better sign to support strategic decisions towards procurement process. In other word, the research project has paved the way for experts to get more insight in various fields rather than low bidding price. Supplier's backgrounds and performances should be prudently considered prior to making any purchases. From now on, every food chain process is vital and need to be transparent due to the fact that everyone in the society worldwide begins to request investigation to a whole food chain and especially the source of products. People now have a question toward where is the food comes from? how the food is produced? who involved with the production? How to source raw materials? How sustainable the factory is? How much does manufacturing process affect the environment? etc. A lot of questions will be inquired from end-customers to distributors, retailers, and importers which these kinds of question will be turned back to trading company to reply simple and clear. In turn, strategic criteria will be an indispensable for reaching procurement success which means executive should find the right potential suppliers to be your partners.

5.7 Future Research

This research project had created the criteria for canned vegetable and fruit export community, but this one is also able to bring some of criteria to apply with other food industries for supplier selection. The similar preserved food is such as frozen food, dehydrated food, and sun-dried food. Some of the criteria can be applied to preserved meat products as well. the production plant, trading company, including people involved with food industry need to take the strategic decision into account in order to prevent supply disruption from several trade barrier measurements in the future.

The mathematics technique applied in the research project is Analytic Hierarchical Process (AHP). The method is well-selected from reliable source of Chai *et al*. (2013) who gathering data from 123 journal articles towards decision making of supplier selection between 2008 and 2012. Two most widely used approaches are TOPSIS and Linear programing which is interesting and can be implemented to future research. However, the experts in this thesis research insisted that the AHP is practical technique enough for consideration of the potential supplier. Providing that more complicated techniques are used, it will be too complicated and likely lead to application problems.

The proposed four dimensions which are economic, social, environment that adapted from previous paper, and technology that are created and obtained really good

respond from experts could develop and enrich the strategic supplier selection. However, it would be better whether there is a deeper study towards risk and sustainability of 'supplier's profiles' (apart from risk and sustainability of business environments for responding international consumer demands in this dissertation). Due to the fact that it could become another practical tool to minimize risk and maximize sustainability such as studying of supplier's financial background for perceiving plant's sustainability and the cost of product to understand supplier's problems. Another interesting dimension is 'nature of customer', it could help understand the actual requirement of particular customer for preventing choosing overqualified supplier that leads to waste of extra unreasonable expenditures

As the conjecture linkage by the author shown in **Figure 5.15**, entire proposed criteria in the project are designed fulfill the gap of current procurement process and solving both internal and external problems as shown in problem statements. There could be confirmed or rejected the relationship of this connections by further research. However, the conjecture framework is conducted based on intuitive listening and discussion during interview.

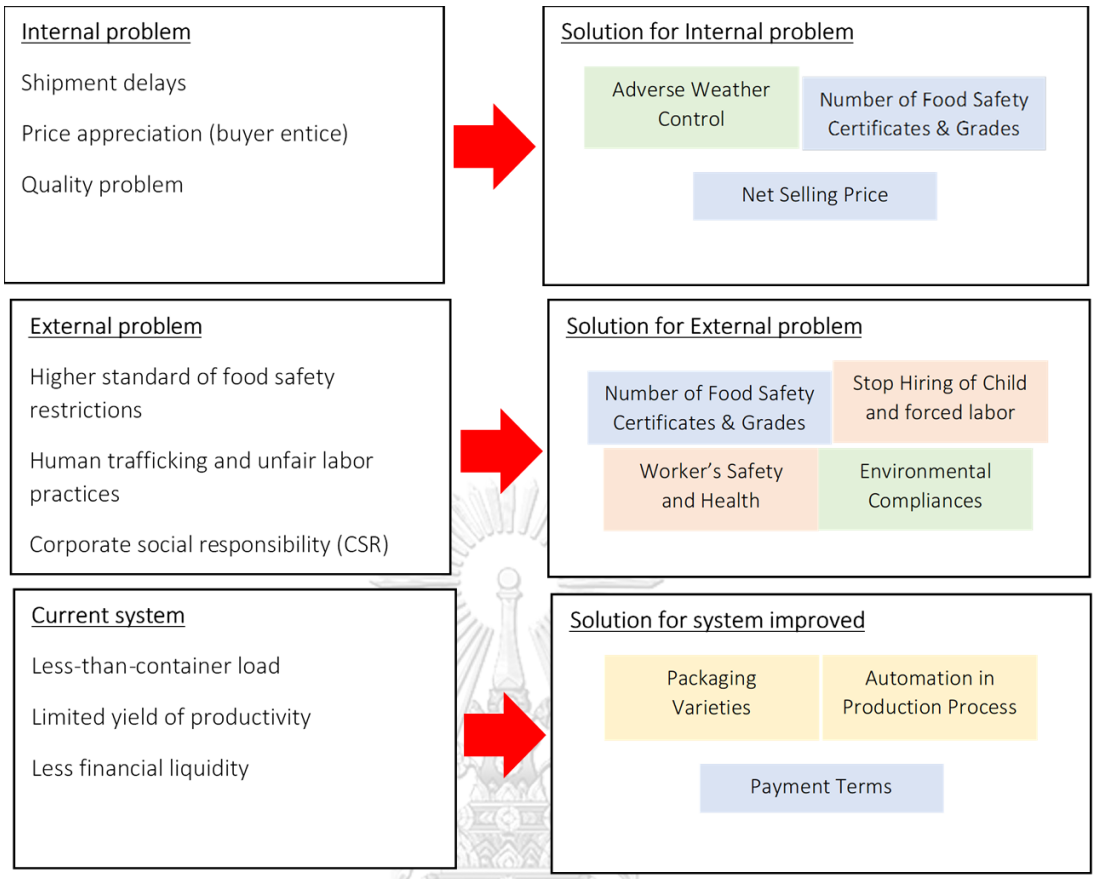


Figure 5. 15 Conjecture of Resolution for Further Research

Internal problems which are shipment delays, price appreciation, and quality problem can be addressed through addressed through 'Adverse Weather Control', 'Net Selling Price', and 'Number of Food Safety Certificates & Grades'. Shipment delay is a problem caused by natural disasters and poor stock planning. Providing that supplier has great potential in handling affiliate plantations and stock management, the supplier is capable of supplying products all year round, contributing to stopping shipment delays. The canned products can be produced and kept in the warehouse due to long

shelf lives foods. Price appreciation to entice buyers will have eliminated because net selling price of each product has been determined by a group of potential producers. Quality problem can be addressed through selecting potential suppliers based on certificate which have been certified the quality of product and process by famous assurance agents.

External problems which are higher standard of food safety restrictions, human trafficking and unfair labor practices, corporate social responsibility (CSR) can be addressed through 'Food Safety Certificates & Grades', 'Stop Hiring of Child and Forced Labor', 'Worker's Safety and Health', and 'Environmental Compliances'. Due to higher food safety standard requirements, domestic supplier selection is much more difficult, but can be found out through seeking from the award they have certified. Humans trafficking is able to be eliminated from the food chain by checking the ethical system of the production plant and ethical approval certifications, same as unfair labor practices. To respond the demand of greener product, CSR towards environmental concern could begin from ISO installation to minimize impacts to environment surrounding.

Current system which are less-than-container load, limited yield of productivity, less financial liquidity can be improved through 'Packaging Varieties', 'Automation in Production Process' and 'Payment terms. Loose container load is because occasionally customer requires to buy varieties type of packaging of products to fully fill the shipping

container. Providing that supplier is able to provide variety types of packaging, customer can leverage economic of scale by full container load. Thai product supply now is not sufficient to respond the demand of customer in the international market. The technology could help the supplier to faster and effectively manufacture the product, while still not drop in product quality.

Appendix

Part i: Questionnaire

Key criteria for strategic supplier evaluation are as follows;

Dimension	*Criteria*	*Sub-criteria*
Economic	Export Capability (C1)	Number of Food Safety Certificates & Grades (1.1)
	Pricing Policy (C2)	Net Selling Price (2.1), Payment Term (2.2)
Social	Ethical Practices (C3)	Stop Hiring of Child and forced labor (3.1), Worker's Safety and Health (3.2)
Environmental	Environmental Management (C4)	Environmental Compliances (4.1), Adverse Weather Control (4.2)
Technological	Technological Catch-up (C5)	Packaging Varieties (5.1), Automation in Production Process (5.2)

Definitions of each criterion are as follows;

Criteria	*Sub-criteria*
Export Capability	***Number of Food Safety Certificates & Grades***: refers to the overall grade written on the food safety certificate, which received when the inspection team audited the plant according to the food safety standard checklists. The certificates are Halal, Kosher, IFS, FCE and FDA registration number, BRC grade C, BRC grade B, and BRC grade A. The greater number of certificates award the more export competency.
Pricing Policy	***Net Selling Price***: final price charged for food goods, which is the total cost the buyer pays. The final value includes the price of the product itself, all taxes and any fees added. The discount is excluded because of invalid due to ordering small to medium lots (do not obtain discount for ordering less than 5 FCL) for each purchase.
	Payment Terms: refers to the conditions of payments created by a purchaser who has agreed with seller. The payment method is completely different dependent on negotiation with

	particular suppliers which are percentage of advance payment; no advanced payment, 30% of advanced payments, 50% of advanced payments, and 100% of advanced payments.
Ethical Practices	***Stop Hiring of Child & Forced Labor:*** refers to the exploitation of underage children and people who are forced to work against their will. The factor used for scoring are daily wages, MoU conducts, worker ages, and certificate of ethical trade audit. Daily Wages paid for worker should be accordance with minimum daily wage in Thailand. Memorandum of Understanding (MoU) to express a convergence of will between employers and employees need to be conducted legally. Ethical trade audit is a mandatory requirement for being able to trading with giant ethical retailers or distributors.
	Worker's Safety and Health: refers to the capability of the manufacturer in hazardous prevention towards work-related illness, injury, and accidents and control risk in the workplace. The criterion is measured through Occupational Health and Safety Management (OHSAS) 18000 implementation that

	identified the applicable regulation for support worker's safety and health. Another measure is certified supply chain security audits whose initial audit issues cover all type of security in the workplace and being reward the certificate mean being able to trading with giant ethical retailers or distributors.
Environmental management	*Environmental Compliances*: ISO 14000 series are international standards for minimizing the negative effect of company's operation to the environment. ISO 9000 series are international standard for declining redundancy of manufacture which in turn a drop in raw material usage and waste releases. Supplier will be obtained scores when trying to award or award mentioned ISO systems.
	Adverse Weather Control: can be measured through the capability in the provision of certain raw materials under different weather and climate conditions due to certain grains and crops are able to cultivate in specific climatic conditions. Supplier candidate who can supply as long as possible are counted to manage the best possible climate management,

	while full masks will be given to all-year round finished goods supplied suppliers.
Technological Catch-up	***Packaging varieties***: materials which used for wrapping food products to protect for distribution and storage. The more type of materials used for packages the more packaging varieties supply (apart from 15 and 108 ounces of canned packages for sweet and baby corn products and 20 and 108 ounces for pineapple products that mentioned in must-criteria).
	Automation in Production Process: maximum amount of productivity (kilogram) that the machine can produce divided by the number of workforces. The higher number of products is produced, the lower labour is hired means the plant pays attention to improvement of machinery for production and supports labour-less automation.

The respondents will be questioned to answer the preference degree against strategic supplier criteria with one-to-nine scale method. The description of each scale is described in **table below**.

Table 8: relative importance scale

Intensity of importance	*Value Description*	*Explanation*
1	Criterion *i* and *j* are of equal importance	Two activities contribute equally to the objective
3	Criterion *i* is weakly more importance than *j*	Experience and judgments slightly favor one activity over another
5	Criterion *i* is strongly more importance than *j*	Experience and judgments strongly favor one activity over another
7	Criterion *i* is very strongly more importance than *j*	Activity is strongly favored, and its dominance demonstrated in practice
9	Criterion *i* is absolutely more important than *j*	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent values	When a compromise in judgments is needed

A sample of prioritization establishment number

***Assumption**: i is criterion on left side and j is criterion on right side*

Criterion A Criterion B

9	●	7	●	5	●	3	●	1	●	3	●	5	●	7	●	9

***Suggestion**: If participants score the intensity of important at five, the interviewer will circle at five.*

Start the questionnaire

Participant position: ..... ***Code of participant***:

.....

1. Criteria

For 1, 2, 3; 4, 5; the preference degree is rank

1 ..... 2 ..... 3 ..... 4 5

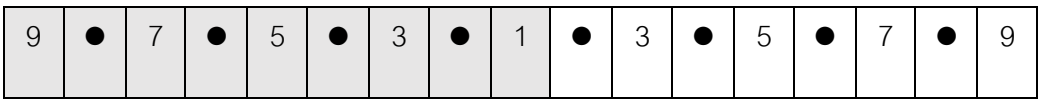
.....

Give the ☑ correct check into the block that has the higher rank (compared to opposite criterion)

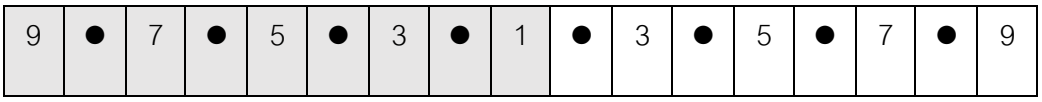
1 Product Quality ☐ ☐ *2 Pricing Policy*

9	●	7	●	5	●	3	●	1	●	3	●	5	●	7	●	9

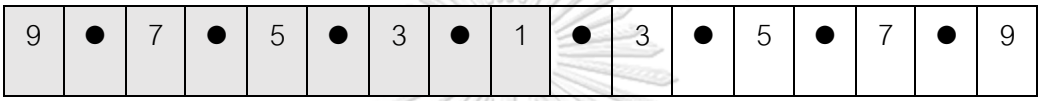
1 Product Quality ☐ ☐ *3 Ethical Practices*



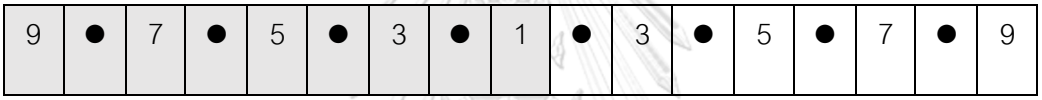
1 Product Quality ☐ ☐ *4 Environmental Management*



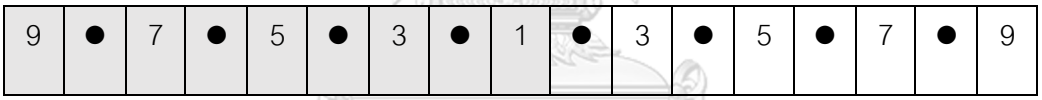
1 Product Quality ☐ ☐ *5 Technological Catch-up*



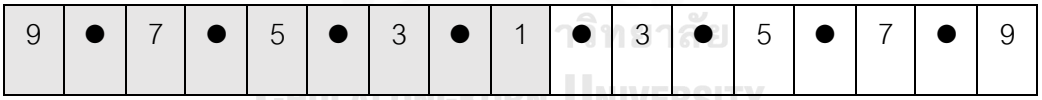
2 Pricing Policy ☐ ☐ *3 Ethical Practices*



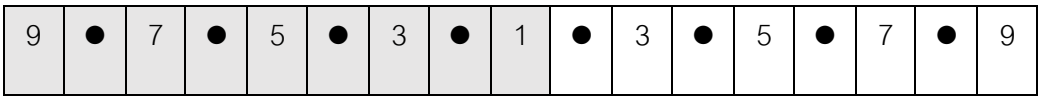
2 Pricing Policy ☐ ☐ *4 Environmental Management*



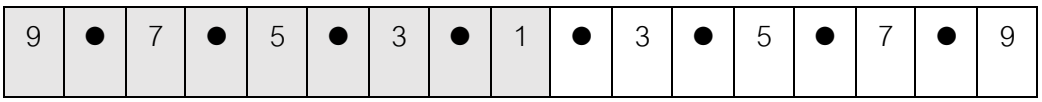
2 Pricing Policy ☐ ☐ *5 Technological Catch-up*



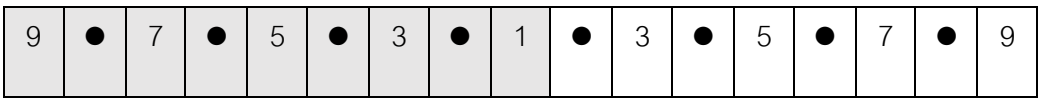
3 Ethical Practices ☐ ☐ *4 Environmental Management*



3 Ethical Practice ☐ *5* ☐ *chnological Catch-up*



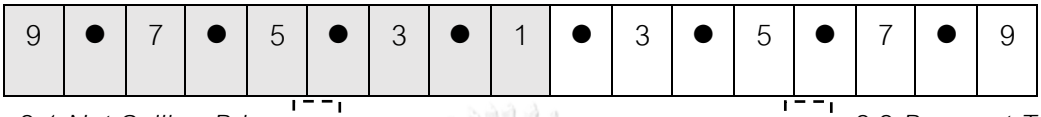
4 Environmental Management ☐ *5* ☐ *chnological Catch-up*



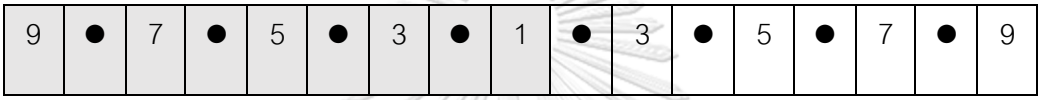
2. Sub-criteria

For 2.1, 2.2, 2.3; the preference degree is rank 1. ..... 2. ..... 3. .....

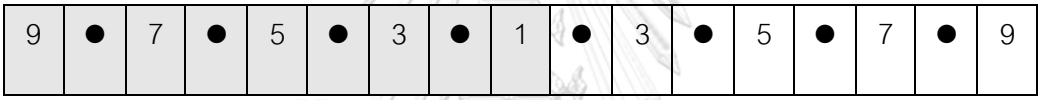
1.1 Food Safety Certificate & Grade [ ] [ ] *1.2 Best Warranty Conditions*



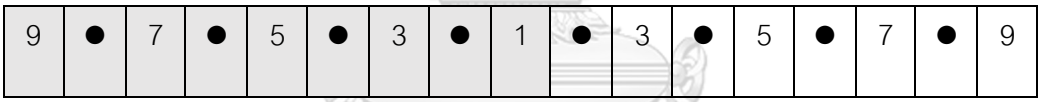
2.1 Net Selling Price [ ] [ ] *2.2 Payment Terms*



2.1 Net Selling Price [ ] [ ] *2.3 Delivery Cost*

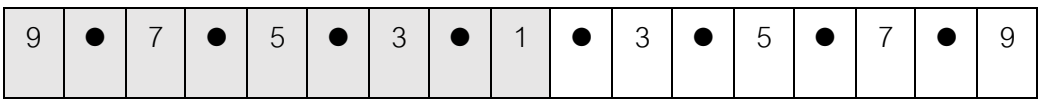


2.2 Payment Terms [ ] [ ] *2.3 Freight Cost*

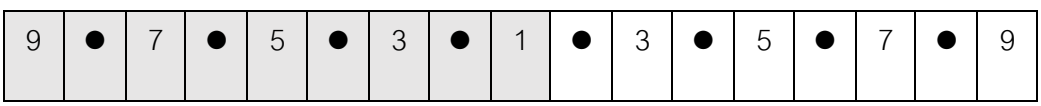


3.1 Safety and Health [ ] [ ] *3.2 Child & Forced Labor*

4.1 Environmental Compliances [ ] [ ] *4.2 Adverse Weather Control*



5.1 Food Packaging Varieties [ ] [ ] *5.2 Automation* in Production Process



Part ii: Preference Degree Ranking

1. Perform geometric means

The group of relative importance given by individuals is calculated to find average mean values of three expert respondents through "Geometric Mean" method as numerical formulation below.

$$\left(\prod_{i=1}^{n} x_i\right)^{\frac{1}{n}} = \sqrt[n]{x_1 x_2 \cdots x_n}$$

When; n: the number of values in the root

x: the relative importance given by individual

In the thesis study; three experts in food export industry are selected to attend preference degree scoring, then n is 3 and x_i are x_1, x_2 and x_3 for particular criterion and sub-criterion.

2. Perform AHP process

The AHP process begins with inputting the product derived from Geometric mean into comparison matrix. The numerical rating input in step 1 is shown in the pattern of numerical ratings and reciprocal values.

Step 1: presuming that C_1 dominates over C_2 at 2 to 1 ratio, therefore the importance of C_2 to C_1 is shown at 1 to 2 ratios.

Criteria	C_1	C_2	C_3
C_1	1	2	3
C_2	1/2	1	3
C_3	1/3	1/3	1

Step 2: calculate the sum of each column and normalize the previous comparison table by dividing each value by the vertical sum.

Criteria	C_1	C_2	C_3
C_1	1.00	2.00	3.00
C_2	0.50	1.00	3.00
C_3	0.33	0.33	1.00
Vertical sum	***1.83***	***3.33***	***7***

Step 3: calculate the total of each row into horizontal sum column and divided horizontal sum by the total of horizontal sum, and then the result is eigenvector (weight).

Criteria	C_1	C_2	C_3	*Horizontal sum*	*Eigenvector (weight)*
C_1	0.55	0.60	0.43	*1.58*	*0.53*
C_2	0.27	0.30	0.43	*1.00*	*0.33*
C_3	0.18	0.10	0.14	*0.42*	*0.14*
Vertical sum	*1.00*	*1.00*	*1.00*	*3.00*	*1.00*

Multiplication products of each decision criteria

Criteria	*Consistency vector*
C1	3.04
C2	3.08
C3	3.03
Vertical sum	9.15

Step 4: Multiple the value in step 2 with Eigenvector (weight) in step 3 in order to find consistency vector for particular criterion.

• Consistency Vector of C_1

$$\frac{[(1.00\times0.53)+(2.00\times0.33)+(3.00\times0.14)]}{0.53} = 3.04$$

Equation 3.1

• Consistency Vector of C_2

$$\frac{[(0.50\times0.53)+(1.00\times0.33)+(3.00\times0.14)]}{0.33} = 3.08$$ Equation 3.2

• Consistency Vector of C_3

$$\frac{[(0.33\times0.53)+(0.33\times0.33)+(1.00\times0.14)]}{0.14} = 3.03$$ Equation 3.3

• Maximum Eigenvector (Lambda max)

$$\lambda_{max} = \frac{\Sigma\, Eigenvalue}{Number\ of\ criteria}$$ Equation 3.4

$$= \frac{9.15}{3}$$

$$= 3.05$$

• Consistency Index (C.I.)

Equation 3.5

$$C.I. = \frac{\lambda\,max - n}{n-1}$$

$$= 3.05\text{-}3.00$$

$$= 0.05$$

• Random Inconsistency (R.I.)

Equation 3.6

$$n = 3$$

$$R.I. = 0.58$$

• Random inconsistency (R.I.)

n	*1*	*2*	*3*	*4*	*5*	*6*	*7*
R.I.	0	0	0.58	0.9	1.12	1.24	1.32

• Consistency Ratio (C.R.)

Equation 3.7

$$\text{C.R.} = \frac{C.I.}{R.I.}$$

$$= \frac{0.05}{0.58}$$

$$= 0.086$$

The eigenvector (weight) is considered to be consistency when C.R. is less than 10% which means relative importance derived from evaluation is able to continue computing in the next stage.

In this case, C.R. is 0.086 less than 0.100. It means the weight is considered to be consistency. The relative importance is as table below.

Criterion	*Percentage*
C_1	53
C_2	33
C_3	14

Part iii: Raw data of Decision-making

1. Raw data of Criteria

Table A: The result of scoring from evaluators relating to criteria

Criteria		R1	R2	R3	Multiple	Geometric Means
Pair1	C 1 > C 2	4	5	4	80	4
Pair2	C 2 > C 5	6	6	5	180	6
Pair3	C 1 > C 3	7	8	7	392	7
Pair4	C 1 > C 4	8	9	9	648	9
Pair5	C 2 > C 5	4	6	5	120	5
Pair6	C 2 > C 3	6	8	7	336	7
Pair7	C 2 > C4	8	9	8	576	8
Pair8	C 5 > C 3	4	3	3	36	3
Pair9	C 5 > C 4	5	4	4	80	4
Pair10	C 3 > C 4	2	2	3	12	2

2. Raw data of Sub-criteria

Table B: The result of scoring from evaluators relating to sub-criteria

Sub-criteria		*R1*	*R2*	*R3*	*Multiple*	*Geometric Means*
Pair1	*C 1.1*	No comparison with another criterion				
Pair2	*C 2.1 > C 2.2*	4	6	5	120	5
Pair3	*C 3.2 > C 3.1*	4	3	2	24	3
Pair4	*C 4.2 > C 4.1*	2	3	4	24	3
Pair5	*C 5.2 > C 5.1*	4	4	5	80	4

Part iv: Raw Data of All Pineapple Supplier Scores

Table C: Raw Data of pineapple scoring

Code of Criterion	*Criterion Choices*	*Full Masks*	*Supplier A*	*Supplier B*	*Supplier C*	*Supplier D*
C1.1	*Number of Food Certificates and Grades*					
	Halal	1		1	1	1
	Kosher	1	1	1		1
	FCE, FDA	1	1	1		1
	IFS	1		1		1
	BRC (C)	1		1		1
	BRC (B)	1		1		1
	BRC (A)	1				
	SUM (Actual)	*7.0000*	*2.0000*	*6.0000*	*1.0000*	*6.0000*
	SUM (1)	*1.0000*	*0.133*	*0.400*	*0.067*	*0.400*
C2.1	*Net Selling Price*					
	20 ounces		17	18	14	15.5
	108 ounces		22	22	17	22
	SUM (Actual)		*39*	*40*	*31*	*37.5*
	SUM (1)	*1.0000*	*0.234*	*0.228*	*0.294*	*0.243*

C2.2	*Payment Terms*					
	No advanced payments	1			1	
	30% of advanced payments	1	1		1	
	50% of advanced payments	1	1	1	1	
	100% of advanced payments	1	1	1	1	1
	SUM (Actual)	*4.0000*	*3.0000*	*2.0000*	*4.0000*	*1.0000*
	SUM (1)	*1.0000*	*0.3000*	*0.2000*	*0.4000*	*0.1000*
C3.1	*Hiring of Child & Forced Labor*					
	Age 18 up	1	1	1	1	1
	MOU	1	1	1	1	
	Wage	2	2	1.714	1.891	1.829
	BSCI or SMETA (Audit)	4		4		2
	SUM (Actual)	*8.0000*	*4.0000*	*7.7143*	*3.8914*	*4.8286*
	SUM (1)	*1.0000*	*0.1957*	*0.3775*	*0.1904*	*0.2363*
C3.2	*Worker's Safety and Health*					
	OHSAS (Law)	1				

	Supply Chain Security (Audit)	2		2		1
	SUM (Actual)	*3.0000*	*0.0000*	*2.0000*	*0.0000*	*1.0000*
	SUM (1)	*1.0000*	*0.0000*	*0.6667*	*0.0000*	*0.3333*
C4.1	*Environmental Compliances*					
	Welcome to implement	1				
	Own ISO 9000	3				
	Own ISO 14000	5				
	SUM (Actual)	*9.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*
	SUM (1)	*1.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*
C4.2	*Adverse Weather Control*					
	Jan-March	1	1	1	1	1
	April-June	1	1	1	1	1
	July-Sep	1	1	1		1
	Oct-Dec	1	1	1	1	1
	SUM (Actual)	*4.0000*	*4.0000*	*4.0000*	*3.0000*	*4.0000*
	SUM (1)	*1.0000*	*0.2667*	*0.2667*	*0.2000*	*0.2667*
C5.1	*Packaging Varieties*					
	8 ounces	1	1			1
	12 ounces	1				

	15 ounces	1	1		1	
	30 ounces	1	1	1		1
	75 ounces	1				
	Jar 8 ounces	1				
	Jar 12 ounces	1				
	Cup	1				
	Pouch or Vacuum-sealed	1	1			1
	UHT	1				
	Bottle	1				
	SUM (Actual)	*11.0000*	*4.0000*	*1.0000*	*1.0000*	*3.0000*
	SUM (1)	*1.0000*	*0.4444*	*0.1111*	*0.1111*	*0.3333*
C5.2	*Automation in Production Process*					
	Capacity		27400	800000	10000	150000
	Number of persons		100	787	350	506
	Capacity/Number of persons		*274.00*	*1,016.52*	*28.57*	*296.44*
	SUM (1)	*1.0000*	*0.1696*	*0.6292*	*0.0177*	*0.1835*

Table D: Criteria Scores Calculated for Showing in Radar Graph for Pineapple Suppliers

Criterion	*Product Quality (C1)*	*Pricing Policy (C2)*	*Ethical Practices (C3)*	*Environmental Management (C4)*	*Technological Catch-up (C5)*
Supplier A	0.1333	0.2670	0.0979	0.1333	0.3070
Supplier B	0.4000	0.2141	0.5221	0.1333	0.3702
Supplier C	0.0667	0.3472	0.0952	0.1000	0.0644
Supplier D	0.4000	0.1717	0.2848	0.1333	0.2584

** Numerical rate of each criterion = the sum of Score of sub-criteria (in **Table J**) from identical category*

Part v: Final Scores of Each Pineapple Supplier

Table E: Pineapple Supplier A's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.1333	0.5400	0.0720
C2.1	Net Selling Price	0.2340	0.2300	0.0538
C2.2	Payment Terms	0.3000	0.0500	0.0150
C3.1	Hiring of Child and forced labor	0.1957	0.0100	0.0020
C3.2	Worker's Safety and Health	0.0000	0.0400	0.0000
C4.1	Environmental Compliances	0.000	0.0100	0.0000
C4.2	Adverse Weather Control	0.2667	0.0200	0.0053
C5.1	Food Packaging Varieties	0.4444	0.0800	0.0356
C5.2	Automation in Production Process	0.1696	0.0200	0.0034
			1.0000	0.1871

* *Final score = Score × Weight*

Table F: Pineapple Supplier B's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.4000	0.5400	0.2160
C2.1	Net Selling Price	0.2282	0.2300	0.0525
C2.2	Payment Terms	0.2000	0.0500	0.0100
C3.1	Hiring of Child and forced labor	0.3775	0.0100	0.0038
C3.2	Worker's Safety and Health	0.6667	0.0400	0.0267
C4.1	Environmental Compliances	0.0000	0.0100	0.0000
C4.2	Adverse Weather Control	0.2667	0.0200	0.0053
C5.1	Food Packaging Varieties	0.1111	0.0800	0.0089
C5.2	Automation in Production Process	0.6292	0.0200	0.0126
			1.0000	0.3357

* Final score = Score × Weight

Table G: Pineapple Supplier C's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.0667	0.5400	0.0360
C2.1	Net Selling Price	0.2944	0.2300	0.0677
C2.2	Payment Terms	0.4000	0.0500	0.0200
C3.1	Hiring of Child and forced labor	0.1904	0.0100	0.0019
C3.2	Worker's Safety and Health	0.0000	0.0400	0.0000
C4.1	Environmental Compliances	0.0000	0.0100	0.0000
C4.2	Adverse Weather Control	0.2000	0.0200	0.0040
C5.1	Food Packaging Varieties	0.1111	0.0800	0.0089
C5.2	Automation in Production Process	0.0177	0.0200	0.0004
			1.0000	0.1389

* *Final score = Score × Weight*

Table H: Pineapple Supplier D's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.4000	0.5400	0.2160
C2.1	Net Selling Price	0.2434	0.2300	0.0560
C2.2	Payment Terms	0.1000	0.0500	0.0050
C3.1	Hiring of Child and forced labor	0.2363	0.0100	0.0024
C3.2	Worker's Safety and Health	0.3333	0.0400	0.0133
C4.1	Environmental Compliances	0.0000	0.0100	0.0000
C4.2	Adverse Weather Control	0.2667	0.0200	0.0053
C5.1	Food Packaging Varieties	0.3333	0.0800	0.0267
C5.2	Automation in Production Process	0.1835	0.0200	0.0037
			1.0000	0.3283

* *Final score = Score × Weight*

Part vi: Raw Data of All Sweet Corn Supplier Scores

Table I: Raw Data of sweet corn scoring

Code of Criterion	*Criterion Choices*	*Full Masks*	*Supplier E*	*Supplier F*	*Supplier G*	*Supplier H*
C1.1	*Number of Food Certificates and Grades*					
	Halal	1	1	1	1	
	Kosher	1	1	1		
	FCE, FDA	1	1	1	1	1
	IFS	1	1	1		1
	BRC (C)	1	1	1	1	1
	BRC (B)	1	1	1	1	1
	BRC (A)	1	0.5	1		
	SUM (Actual)	*7*	*6.5000*	*7.0000*	*4.0000*	*4.0000*
	SUM (1)	*1*	*0.3023*	*0.3256*	*0.1860*	*0.1860*
C2.1	*Net Selling Price*					
	20 ounces		10.5	9	9.4	10
	108 ounces		15.5	13	13.5	14.5
	SUM (Actual)		*26.0000*	*22.0000*	*22.9000*	*24.5000*
	SUM (1)	*1.0000*	*0.2284*	*0.2699*	*0.2593*	*0.2424*

C2.2	*Payment Terms*					
	No advanced payments	1		1		1
	30% of advanced payments	1		1	1	1
	50% of advanced payments	1	1	1	1	1
	100% of advanced payments	1	1	1	1	1
	SUM (Actual)	*4.0000*	*2.0000*	*4.0000*	*3.0000*	*4.0000*
	SUM (1)	*1.0000*	*0.1538*	*0.3077*	*0.2308*	*0.3077*
C3.1	*Hiring of Child & Forced Labor*					
	Age 18 up	1	1	1	1	1
	MOU	1		1	1	
	Wage	2	2	1.575	1.625	1.575
	BSCI or SMETA (Audit)	4	4	4		4
	SUM (Actual)	*8.0000*	*7.0000*	*7.5750*	*3.6250*	*6.5750*
	SUM (1)	*1.0000*	*0.2825*	*0.3058*	*0.1463*	*0.2654*
C3.2	*Worker's Safety and Health*					
	OHSAS (Law)	1	0	1	0	1

	Supply Chain Security (Audit)	2	2	0	0	2
	SUM (Actual)	*3.0000*	*2.0000*	*1.0000*	*0.0000*	*3.0000*
	SUM (1)	*1.0000*	*0.333*	*0.167*	*0.000*	*0.500*
C4.1	*Environmental Compliances*					
	Welcome to implement	1	1		1	1
	Own ISO 9000	3	3		3	3
	Own ISO 14000	5				5
	SUM (Actual)	*9.0000*	*4.0000*	*0.0000*	*4.0000*	*9.0000*
	SUM (1)	*1.0000*	*0.235*	*0.000*	*0.235*	*0.529*
C4.2	*Adverse weather control*					
	Jan-March	1	1	1		1
	April-June	1	1	1	1	1
	July-Sep	1	1	1	1	1
	Oct-Dec	1	1	1		1
	SUM (Actual)	*4.0000*	*4.0000*	*4.0000*	*2.0000*	*4.0000*
	SUM (1)	*1.0000*	*0.2857*	*0.2857*	*0.1429*	*0.2857*
C5.1	*Packaging*					
	8 ounces	1	1	1	1	
	12 ounces	1	1	1	1	

	20 ounces	1				
	30 ounces	1				
	75 ounces	1	1	1	1	
	Jar 8 ounces	1	1			1
	Jar 12 ounces	1	1			1
	Cup	1	1			
	Pouch or Vacuum-sealed	1	1			
	UHT	1			1	
	Bottle	1				
	SUM (Actual)	*11.0000*	*7.0000*	*3.0000*	*4.0000*	*2.0000*
	SUM (1)	*1.0000*	*0.4375*	*0.1875*	*0.2500*	*0.1250*
C5.2	*Automation in Production Process*					
	Capacity		500000	450000	36000	100000
	Number of persons		80.00	70.00	280.00	250.00
	Capacity/Number of persons		*6,250.00*	*6,428.57*	*128.57*	*400.00*
	SUM (1)	*1.0000*	*0.473*	*0.487*	*0.010*	*0.030*

Table J: Criteria Scores Calculated for Showing in Radar Graph for Sweet Corn Suppliers

Criterion	*Product Quality (C1)*	*Pricing Policy (C2)*	*Ethical Practices (C3)*	*Environmental Management (C4)*	*Technological Catch-up (C5)*
Supplier E	0.3023	0.1911	0.3079	0.2605	0.4554
Supplier F	0.3256	0.2888	0.2362	0.1429	0.3371
Supplier G	0.1860	0.2450	0.0732	0.1891	0.1299
Supplier H	0.1860	0.2750	0.3827	0.4076	0.0776

Part vii: Final Scores of Each Sweet Corn Supplier

Table K: Sweet Corn Supplier E's All Criteria Final Scores

Criterion		*Score (1)*	*Weight (AHP)*	*Final Score*
C1.1	*Food Safety Certificate & Grade*	0.3023	0.5400	0.1633
C2.1	*Net Selling Price*	0.2284	0.2300	0.0525
C2.2	*Payment Terms*	0.1538	0.0500	0.0077
C3.1	*Hiring of Child and forced labor*	0.2825	0.0100	0.0028

C3.2	*Worker's Safety and Health*	0.3333	0.0400	0.0133
C4.1	*Environmental Compliances*	0.2353	0.0100	0.0024
C4.2	*Adverse Weather Control*	0.2857	0.0200	0.0057
C5.1	*Food Packaging Varieties*	0.4375	0.0800	0.0350
C5.2	*Automation in Production Process*	0.4732	0.0200	0.0095
			1.0000	0.2922

Table L: Sweet Corn Supplier F's All Criteria Final Scores

Criterion		*Score (1)*	*Weight (AHP)*	*Final Score*
C1.1	*Food Safety Certificate & Grade*	0.3256	0.5400	0.1758
C2.1	*Net Selling Price*	0.2699	0.2300	0.0621
C2.2	*Payment Terms*	0.3077	0.0500	0.0154
C3.1	*Hiring of Child and forced labor*	0.3058	0.0100	0.0031
C3.2	*Worker's Safety and Health*	0.1667	0.0400	0.0067
C4.1	*Environmental Compliances*	0.0000	0.0100	0.0000
C4.2	*Adverse Weather Control*	0.2857	0.0200	0.0057
C5.1	*Food Packaging Varieties*	0.1875	0.0800	0.0150
C5.2	*Automation in Production Process*	0.4867	0.0200	0.0097
			1.0000	0.2935

Table M: Sweet Corn Supplier G's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.1860	0.5400	0.1005
C2.1	Net Selling Price	0.2593	0.2300	0.0596
C2.2	Payment Terms	0.2308	0.0500	0.0115
C3.1	Hiring of Child and forced labor	0.1463	0.0100	0.0015
C3.2	Worker's Safety and Health	0.0000	0.0400	0.0000
C4.1	Environmental Compliances	0.2353	0.0100	0.0024
C4.2	Adverse Weather Control	0.1429	0.0200	0.0029
C5.1	Food Packaging Varieties	0.2500	0.0800	0.0200
C5.2	Automation in Production Process	0.0097	0.0200	0.0002
			1.0000	0.1985

Table N: Sweet Corn Supplier H's All Criteria Final Scores

Criterion		*Score (1)*	*Weight (AHP)*	*Final Score*
C1.1	*Food Safety Certificate & Grade*	0.1860	0.5400	0.1005
C2.1	*Net Selling Price*	0.2424	0.2300	0.0557
C2.2	*Payment Terms*	0.3077	0.0500	0.0154
C3.1	*Hiring of Child and forced labor*	0.2654	0.0100	0.0027
C3.2	*Worker's Safety and Health*	0.5000	0.0400	0.0200
C4.1	*Environmental Compliances*	0.5294	0.0100	0.0053
C4.2	*Adverse Weather Control*	0.2857	0.0200	0.0057
C5.1	*Food Packaging Varieties*	0.1250	0.0800	0.0100
C5.2	*Automation in Production Process*	0.0303	0.0200	0.0006
			1.0000	0.2159

Part viii: Raw Data of All Sweet Corn Supplier Scores

Table O: Raw Data of Baby Corn Scoring

Code of Criterions	*Criterion Choices*	*Full Masks*	*Supplier I*	*Supplier J*	*Supplier K*	*Supplier L*
C1.1	*Number of Food Certificates and Grades*					
	Halal	1	1	1	1	
	Kosher	1	1		1	
	FCE, FDA	1	1	1	1	1
	IFS	1	1		1	1
	BRC (C)	1	1		1	1
	BRC (B)	1	1		1	1
	BRC (A)	1	1		0.5	
	SUM (Actual)	*7.0000*	*7.0000*	*2.0000*	*6.5000*	*4.0000*
	SUM (1)	*1.0000*	*0.3590*	*0.1026*	*0.3333*	*0.2051*
C2.1	*Net Selling Price*					
	15 ounces		10.5	13	12	11
	108 ounces		16.5	13.25	16	11.5
	SUM (Actual)		*27.0000*	*26.2500*	*28.0000*	*22.5000*
	SUM (1)	*1.0000*	*0.2385*	*0.2453*	*0.2300*	*0.2862*

C2.2	*Payment Terms*					
	No advanced payments	1	1		1	1
	30% of advanced payments	1	1	1	1	1
	50% of advanced payments	1	1	1	1	1
	100% of advanced payments	1	1	1	1	1
	SUM (Actual)	*4.0000*	*4.0000*	*3.0000*	*4.0000*	*4.0000*
	SUM (1)	*1.0000*	*0.2667*	*0.2000*	*0.2667*	*0.2667*
C3.1	*Hiring of Child & Forced Labor*					
	Age 18 up	1	1	1	1	1
	MOU	1		1	1	1
	Wage	2	2	1.6	1.575	1.575
	BSCI or SMETA (Audit)	4	4		4	4
	SUM (Actual)	*8.0000*	*7.0000*	*3.6000*	*7.5750*	*7.5750*
	SUM (1)	*1.0000*	*0.2718*	*0.1398*	*0.2942*	*0.2942*
C3.2	*Worker's Safety and Health*					
	OHSAS (Law)	1				1

	Supply Chain Security (Audit)	2	2	2	2	2
	SUM (Actual)	*3.0000*	*2.0000*	*2.0000*	*2.0000*	*3.0000*
	SUM (1)	*1.0000*	*0.2222*	*0.2222*	*0.2222*	*0.3333*
C4.1	*Environmental Compliances*					
	Welcome to implement	1	1	1		1
	Own ISO 9000	3	3			3
	Own ISO 14000	5				5
	SUM (Actual)	*9.0000*	*4.0000*	*1.0000*	*0.0000*	*9.0000*
	SUM (1)	*1.0000*	*0.2857*	*0.0714*	*0.0000*	*0.6429*
C4.2	*Adverse weather control*					
	Jan-March (Finished Goods)	1	1	1	1	
	April-June (Finished Goods)	1	1	1	1	1
	July-Sep (Finished Goods)	1		1	1	1
	Oct-Dec (Finished Goods)	1	1	1	1	1
	SUM (Actual)	*4.0000*	*3.0000*	*4.0000*	*4.0000*	*3.0000*

	SUM (1)	*1.0000*	*0.2143*	*0.2857*	*0.2857*	*0.2143*
C5.1	*Packaging Varieties*					
	8 ounces	1	1			
	12 ounces	1				
	20 ounces	1				
	30 ounces	1				
	75 ounces	1				
	Jar 8 ounces	1	1	1		1
	Jar 12 ounces	1	1	1		1
	Cup	1	1			
	Pouch or Vacuum-sealed	1	1			1
	UHT	1				
	Bottle	1		1		
	SUM (Actual)	*11.0000*	*5.0000*	*3.0000*	*0.0000*	*3.0000*
	SUM (1)	*1.0000*	*0.4545*	*0.2727*	*0.0000*	*0.2727*
C5.2	*Automation in Production Process*					
	Capacity		20000	4000	8000	100000
	Number of persons		70	25	100	250

	Capacity/Number of persons		*285.71*	*160.00*	*80.00*	*400.00*
	SUM (1)	*1.0000*	*0.3086*	*0.1728*	*0.0864*	*0.4321*

Table P: Criteria Scores Calculated for Showing in Radar Graph for Baby Corn Suppliers

Criterion	Product Quality (C1)	Pricing Policy (C2)	Ethical Practices (C3)	Environmental Management (C4)	Technological Catch-up (C5)
Supplier I	0.3590	0.2526	0.2470	0.2500	0.3816
Supplier J	0.1026	0.2227	0.1810	0.1786	0.2228
Supplier K	0.3333	0.2483	0.2582	0.1429	0.0432
Supplier L	0.2051	0.2764	0.3138	0.4286	0.3524

Part ix: Final Scores of Each Sweet Corn Supplier

Table Q: Baby Corn Supplier I's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.3590	0.5400	0.1938
C2.1	Net Selling Price	0.2385	0.2300	0.0549
C2.2	Payment Terms	0.2667	0.0500	0.0133
C3.1	Hiring of Child and forced labor	0.2718	0.0100	0.0027
C3.2	Worker's Safety and Health	0.2222	0.0400	0.0089
C4.1	Environmental Compliances	0.2857	0.0100	0.0029
C4.2	Adverse Weather Control	0.2143	0.0200	0.0043
C5.1	Food Packaging Varieties	0.4545	0.0800	0.0364
C5.2	Automation in Production Process	0.3086	0.0200	0.0062
			1.0000	0.3233

Table R: Baby Corn Supplier J's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.1026	0.5400	0.0554
C2.1	Net Selling Price	0.2453	0.2300	0.0564
C2.2	Payment Terms	0.2000	0.0500	0.0100
C3.1	Hiring of Child and forced labor	0.1398	0.0100	0.0014
C3.2	Worker's Safety and Health	0.2222	0.0400	0.0089
C4.1	Environmental Compliances	0.0714	0.0100	0.0007
C4.2	Adverse Weather Control	0.2857	0.0200	0.0057
C5.1	Food Packaging Varieties	0.2727	0.0800	0.0218
C5.2	Automation in Production Process	0.1728	0.0200	0.0035
			1.0000	0.1638

Table S: Baby Corn Supplier K's All Criteria Final Scores

Criterion		Score (1)	Weight (AHP)	Final Score
C1.1	Food Safety Certificate & Grade	0.3333	0.5400	0.1800
C2.1	Net Selling Price	0.2300	0.2300	0.0529
C2.2	Payment Terms	0.2667	0.0500	0.0133
C3.1	Hiring of Child and forced labor	0.2942	0.0100	0.0029
C3.2	Worker's Safety and Health	0.2222	0.0400	0.0089
C4.1	Environmental Compliances	0.0000	0.0100	0.0000
C4.2	Adverse Weather Control	0.2857	0.0200	0.0057
C5.1	Food Packaging Varieties	0.0000	0.0800	0.0000
C5.2	Automation in Production Process	0.0864	0.0200	0.0017
			1.0000	0.2655

Table T: Baby Corn Supplier L's All Criteria Final Scores

Criterion		*Score (1)*	*Weight (AHP)*	*Final Score*
C1.1	*Food Safety Certificate & Grade*	0.2051	0.5400	0.1108
C2.1	*Net Selling Price*	0.2862	0.2300	0.0658
C2.2	*Payment Terms*	0.2667	0.0500	0.0133
C3.1	*Hiring of Child and forced labor*	0.2942	0.0100	0.0029
C3.2	*Worker's Safety and Health*	0.3333	0.0400	0.0133
C4.1	*Environmental Compliances*	0.6429	0.0100	0.0064
C4.2	*Adverse Weather Control*	0.2143	0.0200	0.0043
C5.1	*Food Packaging Varieties*	0.2727	0.0800	0.0218
C5.2	*Automation in Production Process*	0.4321	0.0200	0.0086
			1.0000	0.2474

REFERENCES

REFERENCES

1. Alikhani, R., Torabi, S. and Altay, N., 2019. Strategic supplier selection under sustainability and risk criteria. *International Journal of Production Economics*, 208, pp.69-82.

2. Azadnia, A., Saman, M. and Wong, K., 2014. Sustainable supplier selection and order lot-sizing: an integrated multi-objective decision-making process. *International Journal of Production Research*, 53(2), pp.383-408.

3. Chai, J., Liu, J. and Ngai, E. (2013). Application of decision-making techniques in supplier selection: A systematic review of the literature. *Expert Systems with Applications*, 40(10), pp.3872-3885.

4. Chansa-ngavej, C. and Srijuntub, A., 2010. Using Analytic Hierarchy Process for innovative technology selection: a case study. *International Journal of Innovation and Learning*, 8(3), p.279.

5. Dos Santos, P., Neves, S., Sant'Anna, D., Oliveira, C. and Carvalho, H. (2019). The analytic hierarchy process supporting decision making for sustainable development: An overview of applications. *Journal of Cleaner Production*, 212, pp.119-138.

6. Dyer, R. and Forman, E. (1992). Group decision support with the Analytic Hierarchy Process. Decision Support Systems, 8(2), pp.99-124.

7. Erdogan, S., Šaparauskas, J. and Turskis, Z. (2017). Decision Making in Construction Management: AHP and Expert Choice Approach. *Procedia Engineering*, 172, pp.270-276.

8. Fbtechreview, 2019. *Food And Beverage Industry Embraces Automation*. [online] Fbtechreview.com. Available at: <https://www.fbtechreview.com/news/food-and-beverage-industry-embraces-automation-nwid-171.html> [Accessed 20 March 2020].

9. Fbtechreview, 2020. *How Food Automation And Management Technologies Help The Industry?*. [online] Fbtechreview.com. Available at: <https://www.fbtechreview.com/news/how-food-automation-and-management-technologies-help-the-industry-nwid-539.html> [Accessed 20 March 2020].

10. Food export. n.d. *Thailand Country Profile*. [online] Available at: <https://www.foodexport.org/import-us-products/get-started/country-market-profiles/southeast-asia/thailand-country-profile> [Accessed 21 April 2020].

11. Ho, W. (2008). Integrated analytic hierarchy process and its applications – A literature review. *European Journal of Operational Research*, 186(1), pp.211-228.

12. Ho, W., Xu, X. and Dey, P. (2010). Multi-criteria decision making approaches for supplier evaluation and selection: A literature review. *European Journal of Operational Research*, 202(1), pp.16-24.

13. Labib, A. (2014). *Learning from failures*. Amsterdam: Elsevier Butterworth-Heinemann, pp.33-44.

14. Lau, H., Shum, P., Nakandala, D., Fan, Y. and Lee, C. (2020). A game theoretic decision model for organic food supplier evaluation in the global supply chains. Journal of Cleaner Production, 242, p.118536.

15. Lu, D. (2014). *Fundamentals of Supply Chain Management*. 1st ed. United Kingdom: Bookboon, pp.50-60.

16. Memari, A., Dargi, A., Akbari Jokar, M., Ahmad, R. and Abdul Rahim, A. (2019). Sustainable supplier selection: A multi-criteria intuitionistic fuzzy TOPSIS method. Journal of Manufacturing Systems, [online] 50, pp.9-24.

17. Panlyseis. (n.d.). *Panlyseis Food Safety Services - Panlyseis*. [online] Available at: http://panlyseis.com/panlyseis-food-safety-service/ [Accessed 28 Feb. 2020].

18. Patrick, K. (2018). *Walmart's improved social responsibility efforts begin with supply chain*. [online] Supply Chain Dive. Available at: https://www.supplychaindive.com/news/walmart-corporate-social-responsibility-efforts/521961/ [Accessed 28 Aug. 2019].

19. Pornpatdetudom, E., n.d. *Sausage Production Made Easy With Automation Line*. [online] Cpfworldwide.com. Available at: <https://www.cpfworldwide.com/en/media-center/939-939> [Accessed 19 March 2020].

20. Saaty, T., 1980. *The Analytic Hierarchy Process*. New York: McGraw-Hill.

21. Sangwongwanich, P., 2019. *CP Chief Discusses Automation*. [online] https://www.bangkokpost.com. Available at: <https://www.bangkokpost.com/business/1729275/cp-chief-discusses-automation> [Accessed 19 March 2020].

22. Setboonsarng, C., 2020. *Thai Monkey Trainer Rejects PETA Claims On Coconut Harvesting*. [online] https://www.reuters.com. Available at: <https://www.reuters.com/article/us-britain-retail-monkey-labour-thailand/thai-monkey-trainer-rejects-peta-claims-on-coconut-harvesting-idUSKCN24C0C9> [Accessed 14 July 2020].

23. Sharp, N., 2018. *Is Dual Sourcing The Answer To The Supply Chain Management Challenge?*. [online] Jjsmanufacturing.com. Available at: <https://www.jjsmanufacturing.com/blog/is-dual-sourcing-the-answer-to-the-supply-chain-management-challengethe> [Accessed 19 March 2020].

24. Susan, 2018. *In The World Of Digital Transformation, DR John Jiang Opens Up About CP Group's Business Transformation*. [online] Techsauce. Available at: <https://techsauce.co/tech-and-biz/in-the-world-of-digital-transformation-dr-john-jiang-opens-up-about-cp-groups-business-transformation> [Accessed 19 March 2020].

25. Thailand Board of Investment. n.d. *Thailand: Food Industry*. [online] Available at: <http://www.boi.go.th/upload/content/Food%20industry_5aa7b40bd758b.pdf> [Accessed 23 April 2020].

26. Walmart. (2012). *Standards for Suppliers*. [online] Available at: http://cdn.corporate.walmart.com/67/fd/5c9b7b964883b792bce97dd00edf/standards-for-suppliers-poster_129884072278822736.pdf [Accessed 28 Feb. 2020].

27. Walmart. (2017). *Audits & Certifications*. [online] Available at: https://cdn.corporate.walmart.com/3d/b3/f30fc5f44fc58ea06cec84102c26/supplier-food-safety-requirements-2017-v2.pdf [Accessed 28 Feb. 2020].

28. Wedley, W., 1990. Combining qualitative and quantitative factors—an analytic hierarchy approach. *Socio-Economic Planning Sciences*, 24(1), pp.57-64.

29. Workman, D. (2019). Top Thailand Exports. [online] Worldsrichestcountries.com. Available at: http://www.worldsrichestcountries.com/top_thailand_exports.html [Accessed 4 Sep. 2019].

30. Zimmer, K., Fröhling, M. and Schultmann, F. (2015). Sustainable supplier management – a review of models supporting sustainable supplier selection, monitoring and development. International Journal of Production Research, [online] 54(5), pp.1412-1442.

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