THAI DURIAN SUPPLY CHAIN CHARACTERISTICS, PERFORMANCE INDICATORS, AND ANALYTIC HIERARCHY PROCESS

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A Dissertation Submitted in Partial
Fulfillment of the Requirements for the Degree of
Doctor of Philosophy (Management)
International College,
National Institute of Development Administration
2020

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ABSTRACT

Title of Dissertation	THAI DURIAN SUPPLY CHAIN CHARACTERISTICS, PERFORMANCE INDICATORS, AND ANALYTIC HIERARCHY PROCESS
Author	Asdawut Siriprasertchok
Degree	Doctor of Philosophy (Management)
Year	2020

In managing agri-food supply chains, performance measurement is one of the strategic issues of a firm to achieve business success since it helps in determining courses of action through evaluation of earlier practices and benchmarking, addressing performance gaps, as well as redesigning a firm strategy and management system. In spite of its business vitality, little attention has been paid to this area of study. As Thailand is the top durian exporter in the global market, this paper aims to explore the characteristics of the Thai durian supply chain and identify the key performance indicators (PIs) of the chain. To fulfill such aims, focused interviews and face-to-face surveys were adopted to draw out the information embedded in the proficiencies of twenty-one durian specialists recruited by adopting purposive sampling, snowball sampling, and convenience sampling. Constant comparison method was used in analyzing the data in relation to supply chain characteristics and Analytic Hierarchy Process (AHP) analysis was done on the predefined list of performance indicators derived from the conceptual framework of agri-food supply chain performance indicators to determine the weight of importance of each indicator. It is found that the chain characteristics have changed from the previous study. Moreover, online trade and agro-tourism have emerged, horizontal and backward integration are revealed with the withdrawal of district collectors and collectors from other provinces in the industry. Regarding the PIs, only eight of eighteen indicators are found to be critically meaningful to the case of the Thai durian supply chain. However, further experimental and quantitative research is suggested for empirical validation and to resolve any idiosyncrasy in the research.

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my deep gratitude to Assoc. Prof. Dr Aweewan Panyagometh who has always provided supportive advices, and constructive feedbacks from the beginning, and Dr Kullapa Soratana for the guidance in completing this paper. In addition, I would like to extend my sincere thanks to Asst. Prof. Dr Sid Suntrayuth who had guided me through the darkness during the very beginning of the project until it reached the way out. Additionally, I am deeply impressed with the cooperation obtained from all informants. My deepest gratitude finally goes to my family for always taking care of everything for me over the project period.

Asdawut Siriprasertchok

September 2020

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Durian is grown in Southeast Asian and perceived by most Asian people as "The King of Fruits" due to its unique and well-known overwhelming aroma and taste (Aziz & Jalil, 2019; MK Durian Harvests Sdn. Bhd., 2018). In the global durian trade, Thailand is the largest durian exporter, accounting for more than 90 percent of global durian market share of which export value is more than 20 billion Thai Baht or 650 million USD (Global Trade Atlas, 2020; Office of Agricultural Economics, 2016).

On the one hand, durian has been considered by food scientists to be a source of rich nutrition to humans such as natural folates (Striegel et al., 2018), polyphenols, which is the main contributor of antioxidant capacity in durian, (Arancibia et al., 2008), vitamin B complex, potassium, iron, anti-aging and antidepressant properties (Grand View Research, 2019), as well as properties to reduce blood glucose and cholesterol in human (Aziz & Jalil, 2019). Awareness of the benefits of durian consumption has expanded during recent years until the demand for durian, including durian products, across the world has been rising in not just the existing markets, like Asian countries, but new markets, as such U.S., U.K. and Germany, as well (Grand View Research, 2019).

On the other hand, even as the durian market seems to enjoy a favorable trend with its distinctive healthy functions, there are still a number of trade-related issues of durian that need to be dealt with. Bank of Thailand (2019) conducted a study and found that Thailand has been the leader of durian exports among its rivals with rapid growth of demand from other countries. Yet, Thailand's exports of durian still depend on a few markets only, which are China and Hong Kong, and lack market diversification. Moreover, Thailand still lacks support in research and development in the relevant field. Accordingly, the durian industry of Thailand has been underdeveloped or has

developed slower than its potential. Apart from that, durian quality management throughout the entire supply chain has been observed so little that the destination country needs to issue an import control scheme to check the quality of durian imported from Thailand (Bank of Thailand, 2019; Prachachatdhurakij, 2019; Utt Pisarnwanich, 2019).

Meanwhile, Thailand's competitors have been trying to develop their own durian industry by means of breeding, production, cultivation, supply chain management etc. in a serious manner with the support of their own government in an effort to take away market share from Thailand. In contrast, Thailand has still maintained its status quo without significant improvement. If this situation remains unchanged, Thailand seems to face certain market failure in the foreseeable future (Utt Pisarnwanich, 2019).

Therefore, to maintain its market share while competing against other competitors, the food supply chain and operations should be effectively managed so that durian of good quality is consistently supplied to the market at a reasonable price while maximizing customer satisfaction (Tsolakis, Keramydas, Toka, Aidonis, & Lakovou, 2012). Also, the food supply chain has been deemed by the European Union (EU) to be one of the important industries to be regulated and protected since it plays a role as a tool for fulfilling human needs, a source of employment, a driver of economic growth, and a pathway to reach new markets (Humphrey & Memedovic, 2006).

In order for a supply chain to be effectively managed, comprehensive supply chain performance measurement needs to be carried out. In general, performance measurement can reflect not only the customers' point of view but individual firms, supply chain actors and overall networks as well. Specifically, performance measurement can assist a firm in managing the chain; in doing that, it helps to set an organizational strategic plan, evaluate the overall operational and strategic performance, and determine future courses of action to achieve desirable outcomes (Bijman, 2002; Bijman, Omta, Trienekens, Wijnands, & Wubben, 2006; Gunasekaran, Patel, & McGaughey, 2004; Neely, 2007; Wijnands & Ondersteijn, 2006). In brief, the effectiveness of supply chain management (SCM) can be assessed through performance measurement.

However, performance measurement is quite challenging to business managers because of the difficulty of reflecting the performance results that each different entity existing in the chain puts an emphasis on, especially the chains with various suppliers, trading firms and end consumers, whether regional, national or global (Bijman et al., 2006). Therefore, performance measurement of SCM is classified as a multi-criteria decision-making problem since numerous relevant factors need to be taken into consideration before making any management decisions. Consequently, the success and competitiveness of firms rely on making the right choice of performance measurement factors, especially in this era of globalization (Bhagwat & Sharma, 2007).

Even though performance measurement is critical for business firms to achieve successful SCM, there are still few studies in the field of performance measurement in the food industry, especially in fresh fruit (Gunasekaran et al., 2004; Wijnands & Ondersteijn, 2006). The establishment of a "Performance Measurement System" (PMS) for each different "Food Supply Chain" (FSC) should be done individually by taking the firm's strategy and chain characteristics into account (Van der Vorst, 2006). Additionally, in order to design an effective supply chain PMS, performance indicators (PIs) have to be identified mindfully so that its performance can be measured, meaningfully interpreted and effectively managed (Aramyan, Ondersteijn, Kooten, & Lansink, 2006).

Accordingly, this study attempts to understand the performance measurement system of the durian supply chain. Giving the fact that durian is perishable, its lifetime is short. Therefore, logistics and supply chain management for such goods is incredibly important to ensure that quality products are properly sent from the hands of producers to the hands of customers. To fulfil this aim, it is essential to explore the supply chain structure so as to update it, as well as to understand the current relation/partnership between two or more business players whose complementary strengths create more value for them and their customers than independent execution would.

Consequently, performance indicators will be recognized. Empirical tests of the specified models will be included in this study to examine the significance level of each indicator to achieve core competitiveness. The implications of findings will then contribute to guidelines for durian business competitiveness enhancement.

1.2 Objectives of the Study

The aim of this study is to determine an improved performance measurement system for the Thai durian supply chain considering all players including farmers, producers, relevant trading firms, chains, and networks. Performance indicators which reflect the level of overall performance, chain efficiency and effectiveness, and business profitability are to be identified as a result. The research questions are as follows:

RQ1: What is the structure of Thai durian supply chain and its relations?

RQ2: What are the suitable performance indicators which can reflect the supply chain performance of Thai durian?

RQ3: What is the level of significance of each indicator?

From the above questions, the objectives of this study can be specified as follows:

1) To illustrate the structures of Thai durian supply chain processes and their relations in Thailand

2) To identify suitable performance indicators which can reflect the performance of the Thai durian supply chain

3) To determine the significance level of each indicator which can be utilized in setting relevant strategy, evaluating performance and determining future courses of action

4) To provide recommendations for public policy in relation to Thai durian or management guidelines to the stakeholders in the Thai durian industry

1.3 Scope of the Study

This study aims to analyze the existing trade system in the durian business and its business ecosystem including players, product flow, and chain collaboration as a generality, with specific interests in durian produced in the specific area of study, Chantaburi province of Thailand, which is the main area of Thai durian production.

From this analysis, potential supply chain sectors are listed together with the definition of their functions, role, and relationships in the business chain. The performance indicators of the existing supply chain are determined and significant indicators are identified and measured, and a theoretic connection is sought within the supply chain system.

In the world fruit industry, more than 100 varieties of fruits are cultivated not only for local consumption but also for export. Yet, tropical fruits are mostly for domestic consumption purposes with only 5% being exported. Tropical fruit cultivation in Thailand is so successful that the production areas have been expanding gradually every year (Phavaphutanon, 2008). Thailand thus enjoys a wide selection of unique tropical fruit yields. From the international trade database 'Global Trade Atlas' it can be seen that in the world market, Thailand is the largest exporter of processed pineapple (canned pineapple and pineapple juice concentrate), processed longan (dried and canned longan), fresh durian, fresh mangosteen, and fresh lychee, as illustrated in Figure 1.1. Due to its unique characteristics, nutritional qualities, taste, and texture, Thai fresh durian, called the King of Fruits, commands the highest share in the world market. Moreover, fresh durian possessed the highest ratio of export volume per production volume in 2016 and tends to increase annually along with its export value as shown in Figure 1.2 and Figure 1.3, respectively. Though the export value per tonnage of durian is lower than rambutan and pineapple, the export volume of durian is much higher than rambutan and the ratio of export volume to production of durian (81%) is higher than the other two (4% for rambutan and 33% for pineapple). Therefore, this study intentionally focuses on Thai fresh durian which is one of the most valuable fruit exports of Thailand.

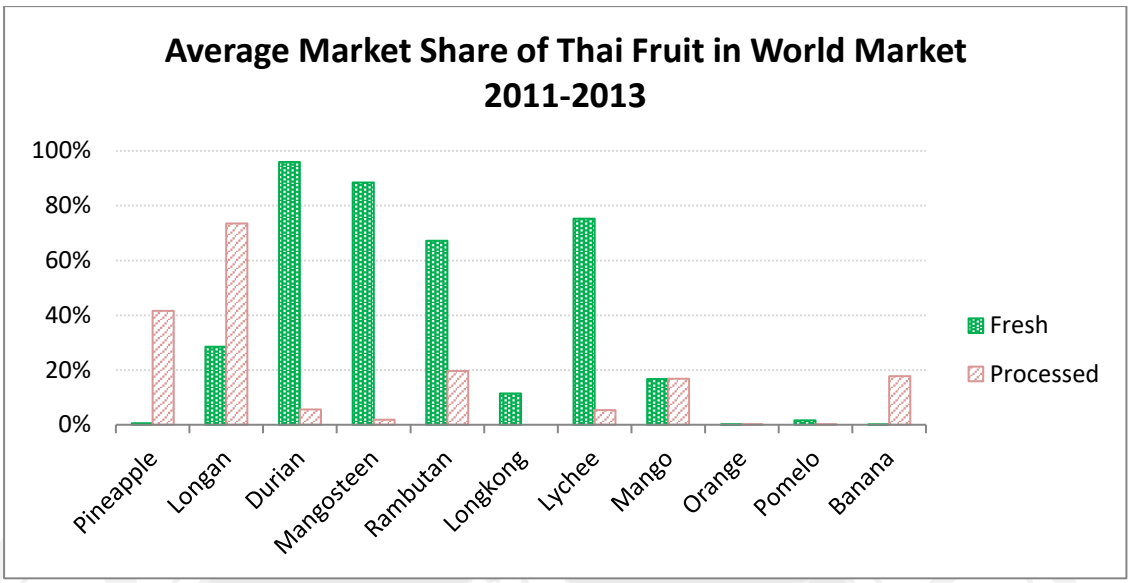

Figure 1.1 Average Market Share of Thai Fruit in World Market 2011-2013

Source: Calculated from Global Trade Atlas (2018a)

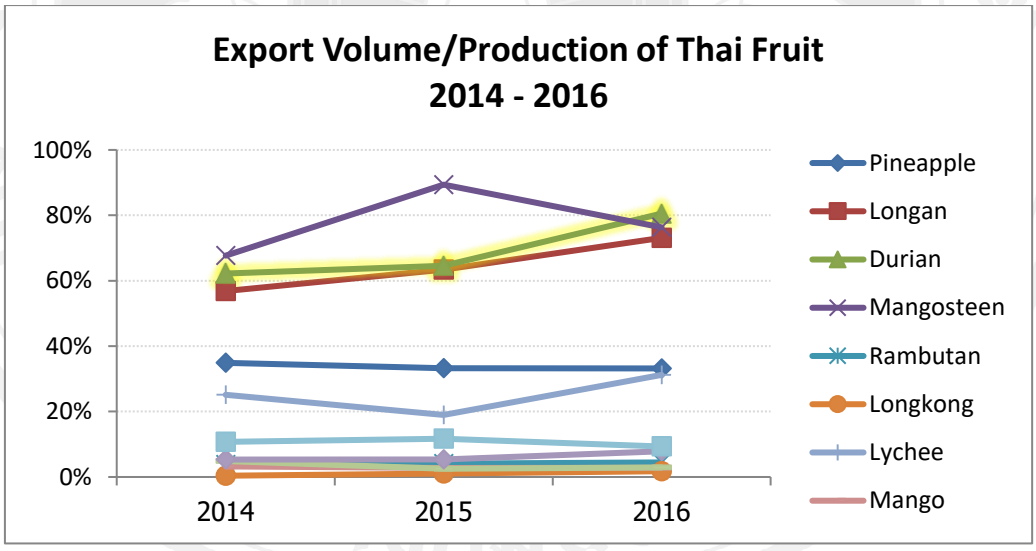

Figure 1.2 Export Volume per Production of Thai Fruit 2014-2016

Source: Calculated from Global Trade Atlas (2018e) and Office of the Agricultural Economics (2016)

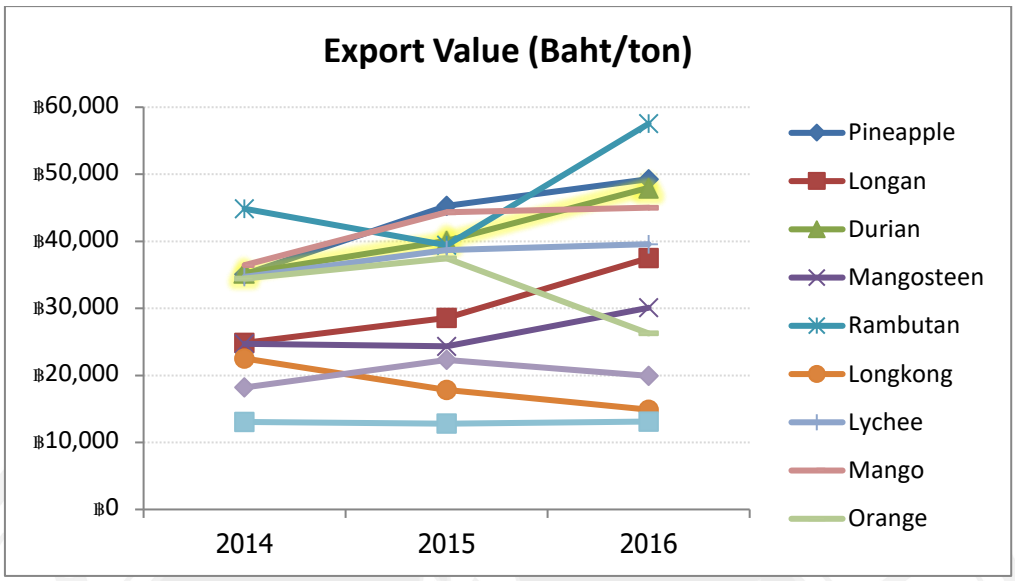

Figure 1.3 Export Value of Thai Fruit 2014-2016

Source: Global Trade Atlas (2018c)

In 2016, Chantaburi province claimed the highest production and planted area of durian in Thailand (Department of Agricultural Extension, 2016). Among 199,983 rai (319.97 million sq.m.) of planted area in this province, the harvested area accounted for 166,675 rai (266.68 sq.m.) which was approximately 28 percent of the whole province. In terms of production, there were 31,366 durian farmers in Chantaburi producing 230,715 tons of durian in 2016. The yield rate of this province was the highest rate among durian producing provinces in Thailand at 1,384 kg/rai or 0.865 kg/sq.m.

1.4 Expected Results

The study aims to reveal the durian supply chain structure. It expects to comprehend durian distribution from producers through consumers to gain an overall understanding of the flow of products along the supply chain and related activities. The response to dynamic changes in today's Thai context relevant to durian trade is also sought. Furthermore, this study carries an expectation to provide a better understanding

of the durian supply chain performance management system in order to be used in supply chain development of Thai durian products which may also be applied to durian cultivation in other countries. It aims, firstly, to be beneficial to players along the durian supply chain which includes farmers managing their farming process, local traders who consolidate and gather the products which are of finest quality, and wholesalers and retailers attempting to maximize the supply chain efficiency and effectiveness. Apart from that, the supply chain actors will be able to optimize the supply chain performance as a whole in an integrative approach while minimizing potential conflicts among groups; a so-called win-win situation. The public agency will then be able to utilize the research findings in strategic management of the durian supply chain. Finally, this study can benefit academia and researchers in conducting future research in the field of agricultural supply chain performance management.

1.5 Dissertation Outline

This dissertation is organized into five chapters as illustrated in Figure 1.4. The second chapter reviews the relevant literatures on current fruit and durian businesses, existing market channels, supply chain management performance measurement system, analysis tools and conceptual framework. The third chapter presents the research design and methodology. The forth chapter contains data analysis and results. The final chapter summarizes the overall research efforts, suggestions and recommendations, and addresses research contributions and suggestions for future research.

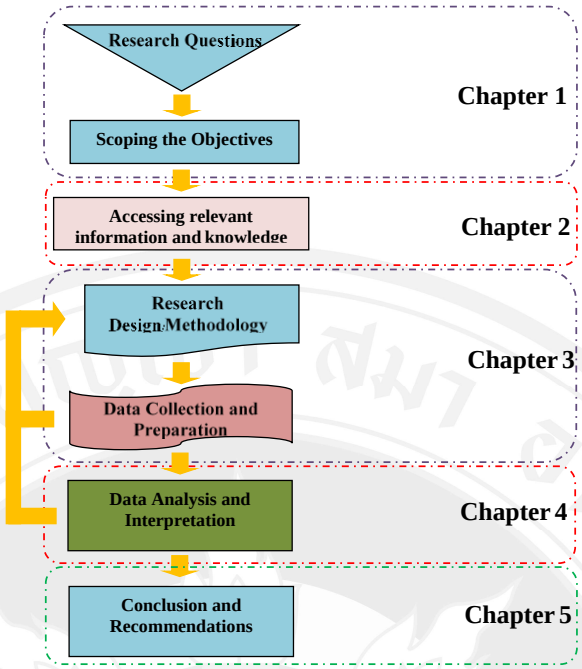

Figure 1.4 Dissertation Outline

CHAPTER 2

LITERATURE REVIEW

This chapter aims to review various literatures including theories, knowledge and previous researches which can be useful in supply chain management in fruit business. The overviews of Thailand fruit business are described. Conceptual views of the supply chain management, market channel, and previous agricultural supply chain management studies, performance measurement system, and analysis tools are also summarized in this chapter.

2.1 Overview of Thai Fruit Business

Developing countries contribute to about 98% of total fruit production, while 80% of world fruit imports are possessed by developed countries. Recently, most of the increase in fruit production derives from the expansion of plantation areas to serve the export markets. The major producing continent is Asia, in which accounts for more than 70% from tropical fruit production, followed by Latin America and the Caribbean, of which production account for 15% of world fruit production, and Africa for 9% of total fruit production. Oceania, the United States and Europe make up the balance (Food and Agriculture Organization, 2002). The world largest fruit import market is the European Community, followed by the United States. The import demand of both regions account for 70% of world fruit demand. Nonetheless, Europe is still expected to remain the major market since France is the major fruit importer (Food and Agriculture Organization, 2002).

Generally, the fruit demand can be from 3 sources which are (1) demand in producing countries, from both local citizen and foreign tourists, (2) import demand from foreign countries, and (3) demand from domestic processing industries. A producing country can be well served in one or more of the above markets. For example, India works good in serving the first source of demand as it is the largest producer of

tropical fruit yet consumes almost all of its production; while less than 0.5% of fruit products are exported. Costa Rica and Mexico are considered as major fresh fruit exporters, while Philippines is keen in being major processors of tropical fruits. Nonetheless, Thailand has been classified as good in fulfilling demands from the second and third groups from its capacities in exporting major proportion of fresh tropical fruits; i.e. durian, longan, mangosteen, lychee, rambutan, and processed tropical fruit; i.e. pineapple concentrate, canned pineapple, dried longan, and canned rambutan (Food and Agriculture Organization, 2002; Office of Agricultural Economics, 2017b).

The total area of Thailand is 0.5136 million square kilometer with the population of 65.9 million people (Narong Chomchalow, Songpol Somsri, & Prempree Na Songkhla, 2008). Thailand is located in South East Asia region at 98-108 °E, 25-30 °N, with 1,200-1,600 mm. of annual rainfall, average temperature of 25-30 °C and relative humidity of 72 - 78%. This tropical climate facilitated Thailand in producing various types of tropical fruits (Narong Chomchalow et al., 2008). Tropical fruits can be another source of food nutrition to human as such carbohydrate, vitamins, minerals and fibers. They are generally grown in tropical and subtropical countries where there are well drained soils.

Thailand is one of the major tropical fruit exporters of the world because of its considerably high capacities in planting diverse tropical fruit species. In particular, more than 70% of total productions of durian, longan and mangosteen have been exported (Office of Agricultural Economics, 2016). Thai fruits are of so high quality that they are well-known and demanded by various importing countries. Even though a wide range of fruits are produced in Thailand, only some kinds of them, like durian, longan, mangosteen, and pineapple, can give a significant economic contribution to the national economy (Narong Chomchalow et al., 2008).

Thai tropical fruits can be categorized into two groups which are major economic tropical fruits and miscellaneous tropical fruits. The former is the category of fruits which are significant to the national economy in terms of sources of national income, employment in agricultural sector, and potential in serving domestic and export demand. There are eleven fruits which belong to the former group and they consist of pineapple, longan, durian, mangosteen, rambutan, longkong, lychee, mango, orange, pomelo, and banana. The latter is the groups of fruits which can provide comparatively

less economic impact to the national economy. They can meet only domestic demand with lacking capability to be exported due to their limitations such as limited production capacity, logistic constraints, and quality problems. This group comprises santol, rose apple, java apple, sugar apple, etc. (Somsri & Vichitrananda, 2007).

According to Thailand's fruit statistical data, volume per production of Thai fruits in the market and their export value are shown in Table 2.1. As witnessed in Table 2.1 and Figure 2.1, durian, mangosteen and longan possessed high ratio of export volume per production, approximately greater than 70%, and grew up annually as well as its export value during 2014-2016. This information shall imply that those fruits are economically valuable fruits of Thailand.

Table 2.1 Volume per Production and Export Value of Thai Fruits in the Market

Fruit	Export Volume/Production				Export Value (Baht/ton)			
	2014	2015	2016	CAGR	2014	2015	2016	CAGR
Pineapple	35%	33%	33%	-2.52%	35,077	45,280	49,266	16.42%
Longan	57%	63%	73%	12.62%	24,846	28,581	37,506	20.88%
Durian	62%	65%	81%	13.26%	35,223	40,057	47,981	15.53%
Mangosteen	68%	89%	76%	5.53%	24,694	24,344	30,085	10.22%
Rambutan	4%	4%	4%	8.45%	44,833	39,410	57,536	13.44%
Longkong	0%	1%	2%	64.33%	22,518	17,820	14,889	-20.72%
Lychee	25%	19%	31%	12.16%	34,699	38,686	39,574	6.47%
Mango	3%	3%	3%	-7.65%	36,441	44,319	45,015	10.22%
Orange	5%	3%	3%	-27.90%	34,435	37,460	26,257	-12.50%
Pomelo	5%	5%	8%	20.40%	18,197	22,301	19,908	4.25%
Banana	11%	12%	9%	-6.67%	13,072	12,794	13,114	0.16%

Source: Office of Agricultural Economics (2017b)

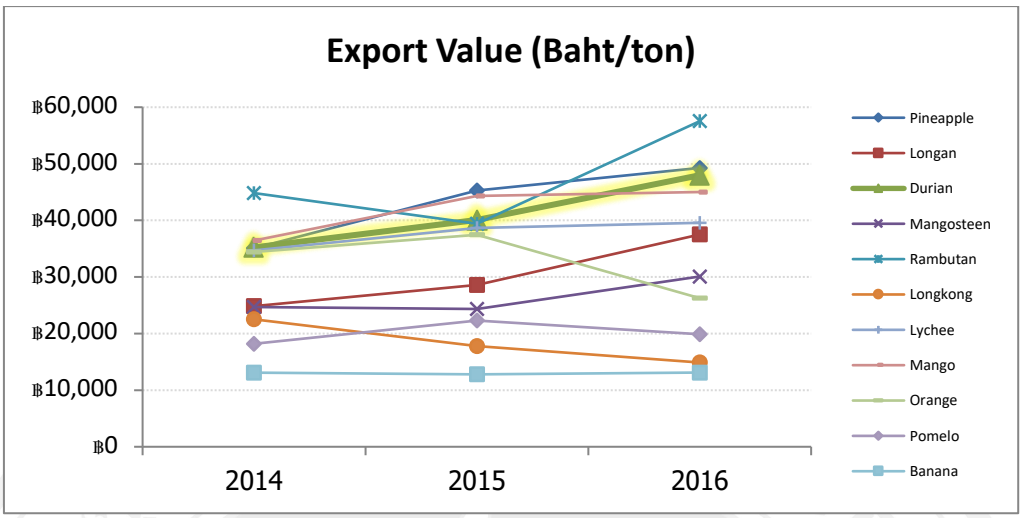

Figure 2.1 Export Value of Thai Fruit 2014-2016

Source: Office of Agricultural Economics (2017b)

2.1.1 Seasonality

With a large diversity of fruit species being cultivated in Thailand, fruits are very common commodities in local markets throughout the year. Tropical and subtropical fruits in Thailand can be classified into two arbitrary groups based on their availability over time (Somsri & Vichitrananda, 2007). There are: (a) seasonal type and (b) non-seasonal or ever-bearing type as shown Figure 2.2.

(a) Seasonal-type fruits can be found during certain months of the year. They comprise: santol, jack fruit, rambutan, durian, sugar apple, jujube, marian plum, mango, mangosteen, sapodilla, longan, pomelo, tangerine, etc.

(b) Non-seasonal or ever-bearing types: At any time of the year these fruits are available in the local markets. They consist of banana, guava, young coconut, papaya and pineapple.

Fruit	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1 TANGERINE												
2 SWEET TAMARIND												
3 STRAWBERRY												
4 GRAPE												
5 MANGO												
6 JACKFRUIT												
7 LYCHEE												

Fruit	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
8 DURIAN												
9 MANGOSTEEN												
10 RAMBUTAN												
11 LONGKONG												
12 LIME												
13 LONGAN												
14 PUMMELO												
15 SUGAR APPLE												
16 BANANA												
17 GUAVA												
18 PAPAYA												
19 YOUNG COCONUT												

None In-Season Off-Season

Figure 2.2 Fruit Season in Thailand

Source: Posomboon (2005)

2.1.2 Marketing Issues: Domestic and Export Markets

2.1.2.1 Domestic markets

In general, supply and demand are the mechanisms that reflect the movement of commodities from production source to market. The product flow also incurs transactional cost to the supply chain actors which varies upon the efficiency of marketing practices. The efficient marketing management is then critical to business; especially the tropical fruit one which needs to deal with the perishability and seasonal variation. In managing each different fruit products that carry different characteristics, each operator along their supply chains need to perform various activities in the marketing system; for example, consolidation, grading, packing, labelling, transshipment, transportation, documentation, and etc. The most critical activity that incurs highest marketing cost is transportation; particularly road transportation. Therefore, any location located in poor transport link and facilities tend to be disadvantageous in terms of market competitiveness comparing with other locations with convenient accessible routes. In another word, even the fruit processing industry or plant is highly developed and fully-equipped with high technological machines, it may be unable to source raw materials with sufficiently good quality, run production at full capacity, and transport to the seaport due to the limitations from the poor location.

In Thailand, the price determination of fruits is done by local intermediaries, based on market prices quoted in the previous days unless, for some areas in the central part of Thailand, the fruit farmers make a direct contact with the major wholesalers since they have a sufficiently strong business tie.

Due to the road improvement throughout Thailand, it makes logistics and transportation from production plant to destination so convenient that the number of truck merchants has dramatically increased and individual farmers have changed to not just farming but trading as well. This phenomenon has altered the patterns of marketing channels away from the traditional approach, in that farmers directly contact and sell their products to the wholesalers and retailers in Bangkok and other cities without the involvement of intermediaries at all. The wholesale prices are normally quoted by the traders based on the quantity demanded and supplied in the market at each single time. Therefore, the prices of fruit in the market quite fluctuates rapidly the whole time, depending on the market situations on each particular day. Unfortunately, in Thailand, the auction system has not been yet adopted in fruit industry. The fruit merchants still play the role as sales agent in the market which can be considered as intermediaries who deliver the goods from the farm to market. The wholesale markets in Bangkok are located in the internal city zone called Pak Klong Market Bangkok. This market is wholesale markets of agricultural produces like flowers, vegetables and fruits. At present, wholesale agricultural market have been developed in various locations in not just Bangkok but also surrounding provincial areas such as Simummuang market in Pathumthani province, Talaad Thai Market in Pathumthani province, Bangkae market in the North of Bangkok, Nonthaburi Fruit and Vegetable Central Market in Nonthaburi province (Somsri & Vichitrananda, 2007).

Currently, to facilitate the fruit trade system to achieve more efficient and effective logistics services, Thai government has put an attempt to develop one-stop service trade office. This office embraces an aim to shorten and minimize the operational lead time along the supply chain which occurs from a number of activities as such product handling, grading, sorting, packing, quality check, certification, documentation, customs clearances, and etc., by gathering all of these services in one location. Additionally, to accomplish such goal, it is necessary to develop a new

physical venue which contains fruit auction system and offers various public and private services on integrative basis (Somsri & Vichitrananda, 2007).

The domestic marketing channel of fresh and processed fruits was illustrated in Figure 2.3. It presents the main channels of fruit trade from farm through various tiers of middlemen to consumers. In overview, the majority (75%) of Thai tropical fruit products are traded locally in the domestic market whereas the remaining are exported to the oversea markets (Office of Agricultural Economics, 2016; Somsri & Vichitrananda, 2007).

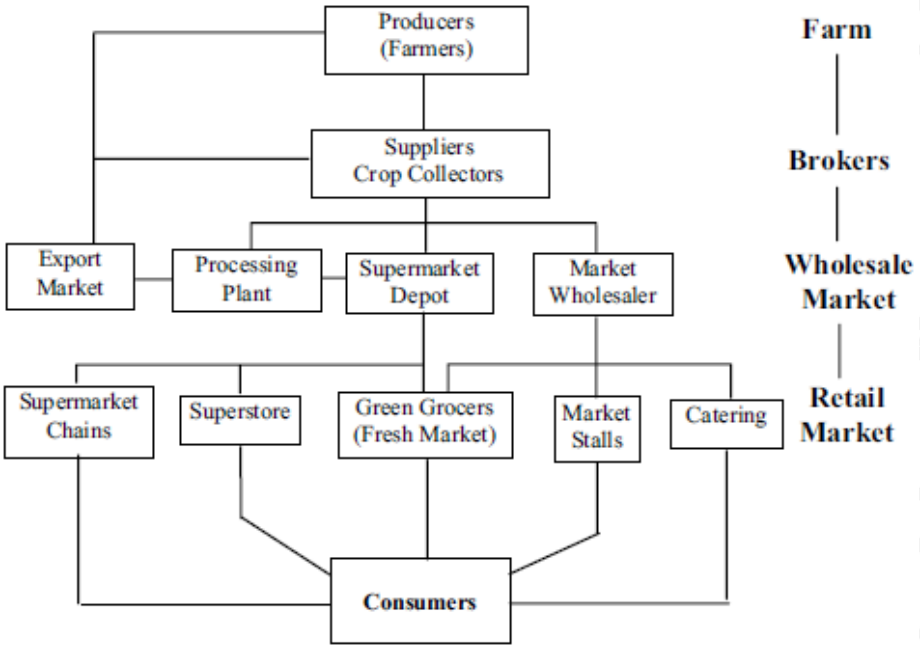

Figure 2.3 Marketing Channels of Fresh and Processed Fruits in Thailand

Source: Narong Chomchalow et al. (2008)

2.1.2.2 Export markets

Diverse kinds of tropical fruits are planted throughout Thailand such as banana, durian, guava, longan, mangosteen, orange, pineapple, rambutan, and so on, since they contain considerably high nutrition and delicious flavors. Because of advanced agri-technology, the tropical fruits can be harvested all year round. Thailand is, consequently, considered as one of the world's largest suppliers of various kinds of

tropical fruits, particularly, durian, longan, mangosteen and pineapple juice concentrate. In 2010, the total area of tropical fruit cultivation in Thailand covered approximately 17,000 square kilometers, with approximate production of 23 million tons, while 256,172 tons were exported of which value were equivalent to roughly 120 million US$ (Somsri, 2014).

The average of total export volume of Thai fruit, which are fresh fruit and products, is approximately 2.2 million tons and the average export value is around 72,500 million baht annually (Office of Agricultural Economics, 2017b). Table 2.2 shows trends in the volume and value of Thailand's total fruit exports for the period 2012 to 2017.

Table 2.2 Volume and Value of Thailand's Fresh Fruit and Products Exports: 2012 – 2017

Year	Quantity (ton)	Value (million baht)
2012	2,117,380	53,618.88
2013	2,132,599	54,994.83
2014	2,094,455	64,813.75
2015	2,022,419	72,501.50
2016	2,051,365	85,745.87
2017	2,703,244	103,565.84
Average	**2,186,910**	**72,540.11**

Source: Office of Agricultural Economics (2017b)

Major export markets of Thai fruits are Canada, Hong Kong, Indonesia, Japan, Malaysia, Singapore, Taiwan, the Netherlands, the United Kingdom, and the United States. In those countries, Thai fruit products are retailed in the upper market. In the same time, Australia, Sweden, Germany, and France are considered as potential markets of Thai fruits because of their upward trend in Thai fruit importation. However, Thailand needs to face the competition from other fruit exporting countries as well; for instances, the Philippines, Indonesia, Malaysia, Vietnam, and China.

There were 11 fruits which were exported to international market. Among those fruits, 5 of them that are pineapple, longan, durian, mangosteen and mango are produced large quantities as well as their export values (DOAE, 2017). One of the important Thailand's exported tropical fruits is durian. The major durian export destinations are China and Taiwan accounting for around 90% of total production (Praiwan, 2017). From the international trade database, the export value of durian accounted for 22,021 million baht in 2017 (Global Trade Atlas, 2018b).

2.1.3 Durian

There is a belief that the origin of durian is Borneo in which politically belongs to Malaysia, Brunei, and Indonesia. Nowadays, even though it is originated in the mentioned 3 countries, it is also grown in other ASEAN countries and Australia. It is well-known not only from its uniquely delicious taste but also from its attractive aroma. Nonetheless, among the durian producing countries, Thailand has been ranked as the world's largest exporter of durian because of its export capacity, followed by Malaysia and Indonesia (MK Durian Harvests Sdn. Bhd., 2018; Nanthachai, 1994). The export volume of durian was 488,716 metric tons with approximate value of 22,021 million baht in 2017 (Global Trade Atlas, 2018b, 2018d).

Referring to the report of Thai Ministry of Agriculture and Cooperatives (2012) and Department of Agricultural Extension (2017), from 2010 to 2015, the production yield tended to increase by 4.39% annually while the production area is likely to reduce by 1.44% as demonstrated in Table 2.3.

Table 2.3 Crop Area, Production Unit, and Production Unit per Area of Durian

Year	Crop Area (Rai*)	Quantity unit (Metric Tons)	Quantity unit per Rai (Kilograms/Rai)
2007	683,044	750,683	1,099
2008	667,437	637,790	956
2009	628,244	661,661	1,053
2010	611,206	568,067	929
2011	604,477	509,424	843
2012	581,684	524,469	902
2013	577,235	569,313	986

2014	570,602	631,775	1,107
2015	573,293	603,332	1,052

*6.25 Rai = 1 hectare or 1 Rai = 1,600 sq.m.

Source: Adapted from Ministry of Agriculture and Cooperatives (2012) and Department of Agricultural Extension (2017)

In the aspect of international trade in fruit, China is the main export destination of Thai durian (Bank of Thailand, 2019; Kanit Likhitwittayawoot, 2011; Utt Pisarnwanich, 2019). As seen in Tables 2.4 and 2.5, in 2012 – 2017, fresh durian accounts for more than 90% of total exports of durian products (Office of Agricultural Economics, 2017b, 2018). During this period, fresh durian export has expanded by 5.83% per annum in terms of quantity with the average increase in export value by 24.10% per year (Office of Agricultural Economics, 2018).

Table 2.4 Durian Export Volume 2012 – 2017

Product	**Export Volume (Tons)**					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
Fresh Durian	351,124	367,056	369,602	358,192	403,634	490,489
Freeze Durian	13,895	13,662	17,143	22,201	20,365	13,303
Preserved Durian	501	230	455	690	720	1,089
Dried durian	392	465	356	401	341	545
Total	**367,924**	**383,427**	**389,570**	**383,498**	**427,075**	**507,443**

Source: Office of Agricultural Economics (2017b, 2018)

Table 2.5 Durian Export Value 2012 – 2017

Product	Export Value (Million baht)					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
Fresh Durian	6,195	7,344	12,436	13,246	17,506	22,098
Freeze Durian	734	877	1,131	1,946	2,171	2,276
Preserved Durian	44	29	58	82	90	138
Dried durian	194	279	218	290	283	431
Total	**9,179**	**10,542**	**15,857**	**17,579**	**22,066**	**26,960**

Source: Office of Agricultural Economics (2017b, 2018)

The area of plantation of durian in Thailand in 2017 is about 804,856 rai (1,287.77 million sq.m.) and the area of production is about 621,686 rai (994.70 million sq.m.) with annual total yield 649,171 tons (Office of Agricultural Economics, 2018). The eastern and the southern parts of Thailand are the main production sites of durian production, which account for around 42% and 51%, respectively. In Thailand, there are almost 200 cultivars of durian having been planted. Among these, only four cultivars are very commonly grown and traded in the market which are “Chani”, “Kra Dum”, “Mon Thong”, and “Kan Yao”. Among these 4 cultivars, 'Mon Thong' occupies the largest production area at about 89.59% of the total durian cultivated area, followed by “Chani” (6.56%), “Kradum” (1.31%) “Kan Yao” (0.89%), and others (1.59%) in 2016 (DOAE, 2017).

In Thailand, as shown in Table 2.6, the central part of Thailand is the area with highest durian production which accounts for 65.92% of total production. Meanwhile, at the provincial level, the top five durian producing provinces, in terms of quantity, consist of Chantaburi (43.88%), Chumporn (17.60%), Rayong (14.33%), Trat (6.85%), and Uttaraditt (4.45%).

Table 2.6 Durian: Area of Plantation, Area of Production, Quantity, Yield B.E. 2560 (2017)

Province	Area of Plantation (Rai)	Area of Production (Rai)	Quantity (Ton)	Yield (Kg/Rai)
Whole country	**804,856**	**621,686**	**649,171**	**1,044**
Northern part	**49,047**	**37,752**	**32,195**	**853**
North-eastern part	**4,360**	**2,636**	**2,783**	**1,056**
Central part	**328,281**	**262,543**	**427,909**	**1,630**
Southern part	**423,168**	**318,755**	**186,284**	**584**
Sukhothai	7,526	5,286	2,784	527
Prae	734	494	172	348
Uttaraditt	40,010	31,316	28,912	923
Phitsanulok	777	656	327	498
Srisaket	3,536	2,349	2,655	1,130
Nakhonratchasima	824	287	128	447
Nonthaburi	3,899	26	1	38
Nakhonnayok	720	262	277	1,057
Prachinburi	2,219	1,229	1,304	1,061
Chantaburi	207,483	173,672	284,874	1,640
Trat	34,911	24,766	44,483	1,796
Rayong	69,187	57,648	93,008	1,613
Chonburi	232	127	148	1,165
Kanchanaburi	1,773	778	502	645
Petchburi	1,173	589	240	407
Prachuabkirikhan	6,684	3,446	3,072	891
Chumporn	180,761	130,911	114,252	876
Ranong	14,154	9,114	5,550	609
Suratthani	51,361	26,866	20,900	778
Pang-Nga	7,458	7,184	1,997	278
Phuket	2,389	2,242	196	87

Province	Area of Plantation (Rai)	Area of Production (Rai)	Quantity (Ton)	Yield (Kg/Rai)
Krabi	2,347	2,013	560	278
Trang	2,282	1,855	440	237
Nakhon Si-Thammarat	49,283	38,390	23,648	616
Pattalung	4,149	3,475	255	73
Songkhla	14,606	14,280	3,150	221
Satul	2,756	2,001	838	338
Pattanee	9,576	6,963	2,553	367
Yala	51,717	44,877	11,797	263
Narathiwas	30,329	28,584	148	5

Remark: *6.25 Rai = 1 hectare or 1 Rai = 1,600 sq.m.

Source: Office of Agricultural Economics (2017a)

2.1.4 Durian in Chantaburi

Chantaburi is the largest province of the eastern part of Thailand in terms of area. It has a total area of 3.96 million rai with population of 534,459 persons in 231,087 households. The land area for agricultural purpose is approximately 2.29 million rai with 45,689 agriculture households (81,200 farmers) in 2018 (Office of Agricultural Economics,2018). Among the area of agriculture, permanent crops take around 74%. The largest cultivated area is Para Rubber (733,051 rai or 1,172.88 square kilometers) and the second is Durian (199,983 rai or 319.97 square kilometers) as shown in Table 2.7.

Table 2.7 Agricultural Land Use in Chantaburi Province in 2018

Agriculture type	Area (rai)	Ratio
Rice field	32,140	1.41%
Farm product	362,515	15.86%
Permanent Crop	1,689,278	73.93%
Vegetable and Flower	7,236	0.32%
others	193,845	8.48%
Total	**2,285,014**	**100%**

Source: Office of Agricultural Economics (2018)

As witnessed above, Chantaburi province owns the largest production area and quantity of durian in Thailand. The statistical data obtained from Chantaburi Provincial Agricultural Extension Office in 2018 illustrates that the cultivated area reduced during 2004 – 2009 and started increasing since 2010 as shown in Table 2.8.

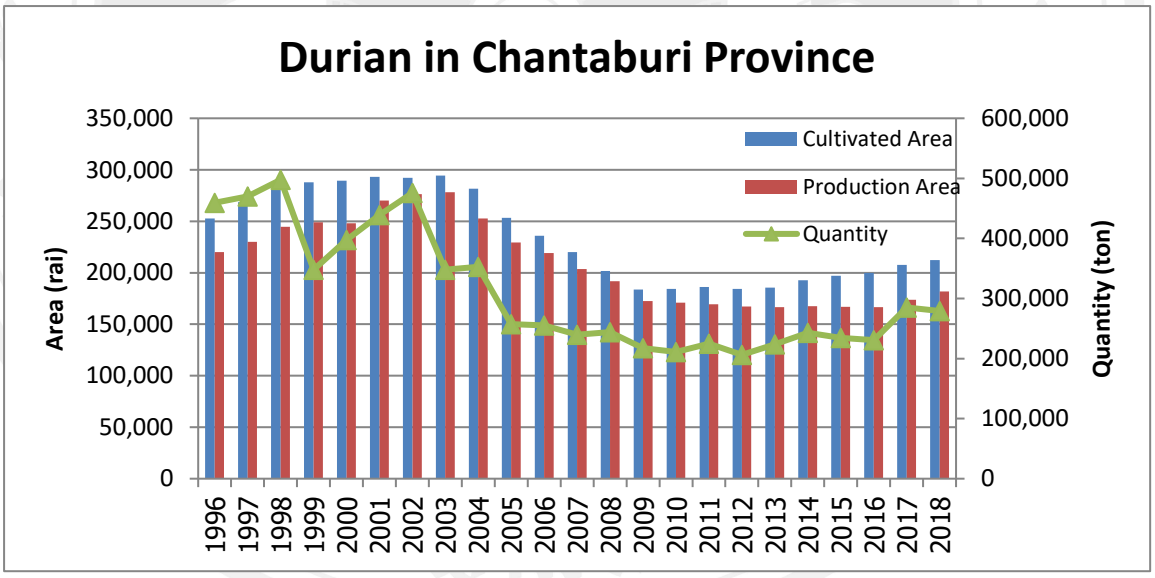

Figure 2.4 Durian Statistical Data of Chantaburi Province

Source: Chantaburi Provincial Agricultural Extension Office (2018)

Table 2.8 Durian Statistical Data of Chantaburi Province 1996-2018

Year	Cultivated Area (sq.m.)	Production Area (sq.m.)	Quantity (ton)	Yield (kg/sq.m.)
1996	404,169,600	351,880,000	459,483	1.306
1997	429,558,400	367,905,600	470,083	1.278
1998	451,646,400	391,478,400	497,651	1.271
1999	460,644,800	398,152,000	347,841	0.874
2000	463,065,600	396,787,200	397,569	1.002
2001	468,857,600	431,956,800	438,954	1.016
2002	467,600,000	441,934,400	476,060	1.077
2003	471,025,600	444,985,600	347,872	0.782
2004	450,377,600	404,124,800	352,599	0.873
2005	405,339,200	367,099,200	257,428	0.701
2006	377,534,400	350,657,600	255,103	0.727
2007	351,934,400	325,838,400	239,606	0.735
2008	322,924,800	306,676,800	243,808	0.795
2009	293,681,600	275,801,600	217,194	0.788
2010	295,059,200	273,740,800	210,890	0.770
2011	297,966,400	270,788,800	224,754	0.830
2012	294,718,400	267,760,000	206,175	0.770
2013	297,091,200	266,534,400	223,889	0.840
2014	308,145,600	268,006,400	242,686	0.906
2015	315,428,800	267,206,400	234,514	0.878
2016	319,972,800	266,680,000	230,715	0.865
2017	331,972,800	277,875,200	284,874	1.025
2018	339,540,800	291,136,000	279,075	0.959

Source: Chantaburi Provincial Agricultural Extension Office (2018)

In Chantaburi, there are 3 main cultivars, “Mon Thong”, “Chani” and “Kradum”, which take higher share for production. Mon Thong takes more than 80%

of production during 2015-2018 (Chantaburi Provincial Agricultural Extension Office, 2018). This might be the results of increasing in export price of durian and reduction of para rubber.

Table 2.9 Chantaburi Durian Production by Cultivar

Durian	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Mon Thong	171,751	164,056	175,889	191,384	188,923	177,316	229,108	228,841
Chani	38,718	31,428	35,380	37,298	32,438	28,009	35,613	33,914
Kradum	9,227	9,219	8,650	9,368	9,028	8,665	10,568	10,190
Others	5,059	4,819	3,970	4,636	5,002	4,799	6,104	6,130
Total	**224,755**	**209,522**	**223,889**	**242,686**	**235,391**	**218,789**	**281,393**	**279,075**

Source: Chantaburi Provincial Agricultural Extension Office (2018)

2.2 Supply Chain Management

As previously mentioned, supply chain can be called in other names, as such marketing channel, distribution channel so that all possible documents mentioning terms are represented in this section.

2.2.1 Definition of Supply Chain Management

SCM is the "Integration of key business processes (customer relationship management, customer service, demand management, order fulfillment, manufacturing flow management, procurement, product development and commercialization and returns) from original supplier through to the end user that provides products, services and information that add value for customers and other stakeholders" (Stock & Lambert, 2001). Supply chain is a simplified map of supply linkage among suppliers, manufacturers, traders, and the other relevant actors (Sheffi, 2005).

While Christopher (1998) explained that a supply chain is a linkage of a number of players that are involved, from upstream to downstream, in different steps and performing value added activities so as to make the product or service offerings

valuable for the final consumers. Thus, SCM is the management of the relationships among suppliers along those linkages to deliver values to the end customers at possible least cost.

Simchi-Levi, Kaminsky, and Simchi-Levi (2000) Chang and Makatsoris (2001) defined SCM as: a set of approaches used in integrating suppliers, producers, warehouses and traders to gain efficiency, so that goods is produced and delivered to the destinations, at the time, and in the quantities without mistakes or errors, with the purpose of minimizing overall costs and fulfilling customers' requirements.

Whereas Tan, Kannan, and Handfield (1998) stated that supply chain management involves product management in transforming ordinary raw materials into final products, which sometimes covers reverse logistics activities (product recycle and reuse). SCM generally emphasizes on the utilization methods that firms adopt in managing their partners, technology and other relevant capabilities to gain technical competitive advantages. It is also counted as management philosophy that forms up a collaboration between the firm and partners along the supply chain in management execution to achieve operational optimization and efficiency.

The term definition can be interpreted into a number of management dimensions. Firstly, SCM covers the consideration on integrative cost-related facilities and the product conformity to customer requirements. Secondly, SCM embraces the aims to enhance efficiency and cost-effectiveness in all areas of business chain operations, ranging from supply management, production, logistics operations, product delivery, to product disposition. Finally, SCM concerns with the firm's activities from the business strategy through management methods to the on-field operations (Kaufman, 2000).

The concept of SCM can; thus, be concluded as the process integration, whether backward or forward approach, with an aim to fulfilling end customer requirements as much as possible at the possible lowest costs. The process integration can be executed by information sharing among the supply chain players to gain mutual benefits. To be specific, the main benefits gained, at least, include minimization of costs in operation, procurement, marketing and distribution (Kaufman, 2000).

With the evolution of SCM concept, the traditional oriented thinking of companies is changed from the proficiency in terms of organizational unique capabilities and resources, and the notion of competition between individual companies to the competition between the supply chain integration of each companies. Wilson (1996) also mentioned that a number of manufacturers, operators and traders attempt to seek for business strategies that can enhance the chain efficiency with an aim to increase the profit margin. Therefore, partnerships and joint ventures, with shared information, have been considered as a new approach to gain competitive advantage against the rivals.

As shown in Figure 2.5, the series of a number of companies that deliver products and services from the supply site to the hands of consumers, including all of the business functions from production, product handling, delivery and recycling, is called a supply chain. When individual firms in supply chain make any business decisions without taking the interests of other supply chain members into account of, this will cause additional costs and time along the supply chain, which finally leads to higher selling prices, poorer quality of supply chain service, and consequently descending customer demand (Wisner, Leong, & Tan, 2005).

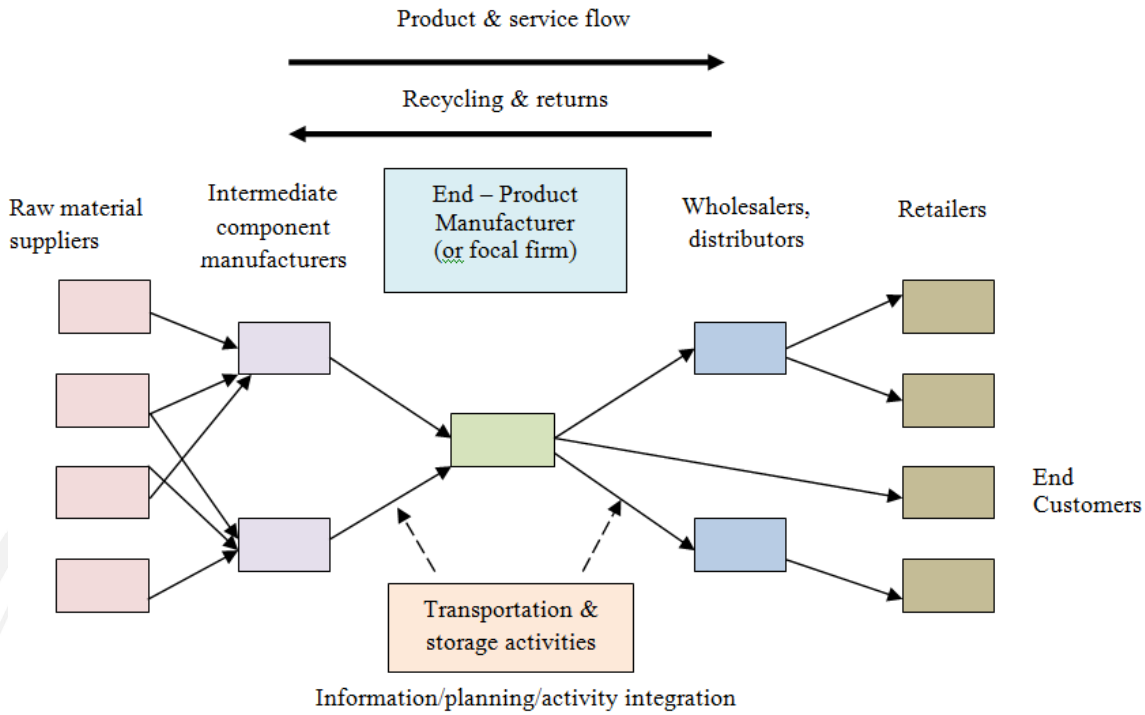

Figure 2.5 A Generic Supply Chain

Source: Wisner et al. (2005)

2.2.2 Principles of Supply Chain Management

The principle consists of the following (Anderson, Britt, & Favre, 1997);

1) Segmentation of customers based on service requirements: Generally, companies have classified customers based on industry type, product type or distribution channel and then offered the same service to every type of customers. In contrast, to make supply chain management effective, customers will be categorized based on different service requirements and the services will be tailored to match the needs of those segments.

2) Customization of the logistics networks: Logistics companies need to take the service requirements and utilities gained of each different customer segments into careful consideration so that the logistics networks have been well-designed to match their customers' objectives.

3) Keep an eye on the signals of the market and plan accordingly: Sales and operation planning must be formulated holistically by considering the demands of each

actors along the supply chain so that the signals of changing demands have been detected as soon as possible. This will be beneficial in enhancing the adaptability of the supply chain services to match the dynamic demands of supply chain players.

4) Product differentiation postponement to customer. To deal with personalized customer demands, companies no longer need to stockpile a huge amount of inventories or safety stock to prevent stockouts which burdens the companies in terms of warehousing cost, holding cost and opportunity loss. Instead, they postpone product differentiation closer to their customers by allowing the customers to design their own products as their preferences before production which will make the goods produced match to the demands of each customers as much as possible. This leads to mutual benefits of all parties along the chain.

5) Supply sourcing in strategic way: By sharing and exchanging relevant information with their suppliers to reduce the overall cost of handling product materials, it will enhance the profit margins of not only the firms but their suppliers as well.

6) Utilization of supply-chain-wide technology: Currently, information technology is an important tool to support the success of supply chain in enhancing the chain efficiency and effectiveness.

2.2.3 Supply Chain Management and Its Benefits

To manage a supply chain, it requires the approach which allows the chain members to participate into planning and controlling the flow of goods, information sharing, technology, capital, tools and equipment from farm to table, or from the suppliers of raw materials to the ultimate consumers (Roekel, Willems, & Boselie, 2002).

In order to effectively and quickly respond to dynamic consumer's demand, supply chain management needs to adopt the concept of consumer-orientation or consumer-centric, which carries an aim to promote consumer participation or at least coordination in the production processes (Handfield & Nichols, 1999; Lambert & Cooper, 2000). Accordingly, for the chain members, it results in the decrease in transaction costs and higher profit margins. With the involvement of various activities

and aspects along the chain, multidisciplinary approach and trade relation management are required. The business relationship in the supply chain relies on inter-firm interdependence, business trust, open communication and mutual benefits (Roekel et al., 2002). There are numerous advantages of the supply chain management which are as follows:

1) Reduction of product losses in logistics operation.
2) Increasing of sales.
3) Dissemination of technology, advanced operation techniques and knowledge among the chain members.
4) Enhanced efficiency of information management regarding the flow of products, markets and operations.
5) Transparency of the supply chain or product traceability and tracking.
6) Better product safety and quality control.
7) Shared investments and risks among the chain members.

2.2.4 Perspectives on International Food Chains

Innovation is promoted and developed by the marketing concept application in a number of ways through international food supply chains. In Figure 2.6**,** it shows that innovation is developed through the food supply chain by taking the consumer's requirements into consideration and feedback reversely from downstream to upstream (Trienekens, Hagen, Beulens, & Omta, 2003).

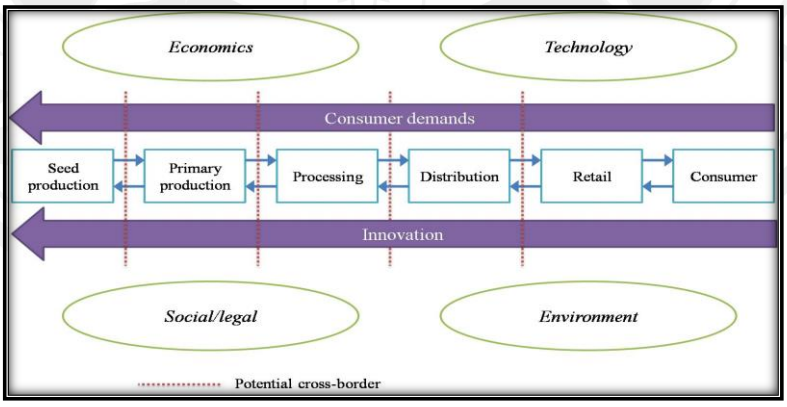

Figure 2.6 Dimensions of Innovation through (International) Food Supply Chains

Source: Trienekens et al. (2003).

The international food supply chain is generally influenced by innovation in four dimensions (Trienekens & Willems, 2002) which can be seen in Figure 2.6. The explanation to those influences is following:

1) *The economic dimension* means to efficiency (in cost-benefit perspective) and to consumer orientation. Due to the change in life-style and behavior patterns of consumers, the demand for convenient food such as cold meals, semi-cooked meals and ready-to-eat meals is significantly increasing. Furthermore, consumers tend to concern more about animal welfare, environmental issues and social aspects, such as working conditions, human trafficking, etc., when they consume any products. The fair-trade practice, organic production, and many proofs of business ethical practice are required as a result. In contrast, the international standards for product and process quality, and other relevant ethical trade practices may depreciate the firm competitiveness in terms of cost and operations.
2) *The environment dimension* is related to the way that food production, trade and distribution are performed in exchange of the depreciation of ecology or environment. The integration of a country into international food chains may cause burdens on the environment in the particular country, for instance natural resource depletion, soil degradation and eruption, the increase of pesticides and chemicals usage. Sustainable supply chain development can be achieved by collaboration of chain members through reverse logistics activities; for example, recycling of waste, packaging materials throughout the chain from consumer to producer, and so on.
3) *The technological dimension* is related to the application of relevant technology in supply chain management to improve production and distribution of food products with of high quality and safety. A range of new technologies has been developed over the decades to improve the quality of logistics operation and supply chain management. In managing international food supply chain, new forms of production, technologies, logistics operations, processes and organizational networks are to be introduced. In particular, technological standards and systems to guide and control processes and flows of goods and information (such as HACCP, tracking and tracing) are increasingly internationalized.
4) *The social and legal dimension* (in terms of norms and values) relates to societal constraints to food production, distribution and trade concerning with the issues like human trafficking, labor treatment, animal treatment and other social issues. Asymmetric power in the chain, or unequal power distribution, and trade barriers impact not only the formulation of the cross-border supply chain but also the cost and benefit sharing among chain members. In particular small-scale food producers in developing countries are disadvantageous

because they have less capital to invest, less access to new production and operation techniques, lack of opportunity to access to new technology and have limited access to international market. As a result of increased competition, they appear to lose since the first point.

These four areas of influence are likely to have a great impact on every single stage of food supply chains (Trienekens et al., 2003).

2.3 Agri-Food Supply Chain Management

In setting the global food security and hunger combatting strategies, agricultural products have been concerned as an essential factor in fulfilling food demands and in response to the dynamic lifestyle changes of consumers in their diets. However, a number of factors which are unpredictable weather conditions, alternative agricultural production methods, impulsive global food demand and commodity price instability lead to a fragile agricultural supply; that is, the production system frequently causes the oversupply incidents (Tsolakis et al., 2012). Agri-food supply (AFS) has then become a critical issue for the global community. Nonetheless, there has been an expectation that developed countries will increase their agricultural productivity in the agri-food supply chain (AFSC) operations to deal with the continuously growing food demand of the world (Food and Agriculture Organization, 2006, 2009; Nelson et al., 2010).

The complexity and cost-efficiency of the logistics operations have been considered as one of the most difficulties in managing agri-food business. In global agri-food network management, multi-level SCM is necessary owing to the increased flows of goods and information from upstream to downstream and vice versa. These requirements lead to the evolution of food retail outlets such as fast food and catering service providers, etc., the need for vertical and horizontal integration, effective market segmentation, product and service offerings differentiation, the diversification of needs, and the new dimension of marketing practices (Chen, Chen, & Shi, 2003; Roekel et al., 2002).

SCM then carries an aim to develop and deploy efficient management policies which is consistent with the specifications of the modern, uncertain business ecosystem

and the constraints of local and cross-border conditions concerning logistics infrastructure, land and water access, production location, application of innovative and good practice concepts, regulatory context, and rapid change of market characteristics.

Particularly, to establish a competitive AFSCs, a number of critical issues need to be managed in order that value addition has been created throughout the chain which consist of:

1) The unique characteristics of AFSCs which are different from traditional supply chains.
2) The decisions in each different level from strategic, operational to tactical levels.
3) The policies which promote sustainable agri-food systems.
4) The innovations needed for agri-food supply chain adaptation to dynamic context.

In general, the operations in an Agri-Food Supply Chain are performed in sequential manner from production site to consumers' hands (Jaffee, Siegel, & Andrews, 2010). These operations embrace the aims to provide logistics, financial, and technical services in appropriate manner, and to support at least three types of flow which are flow of physical goods and services, flow of capital, and flow of information. In addition, they need to cover all activities performed by every single tiers of SC actors, which are suppliers, farmers, traders, processors, wholesalers, retailers, exporters and ultimate consumers (Jaffee et al., 2010; Matopoulos, Vlachopoulou, Manthou, & Manos, 2007; Van der Vorst, 2006). This can be understood that the concept of supply chain integration is vital to global supply chain management to adapt to the continuous evolution of FSCs, and the complexity of the agri-food context in global market. In such structure, strategic relationships and collaborations among chain members are critical, while each members still maintain their identities and autonomy in managing their own businesses (Van der Vorst, Da Silve, & Trienekens, 2007).

As mentioned above, different actors are interconnected from upstream to downstream to achieve a more efficient, effective and consumer centric flow of products. Figure 2.7 illustrates traditional agri-supply chains in which actors from developing and developed countries are incorporated. Such supply chains may include

plant growers, fruit pickers, product packers, consolidators, fruit processors, inbound and outbound logistics service providers, fruit marketers, exporters, importers, wholesalers, and retailers. Each partners or players involving along the chain are interrelated. Consumer, in the chain, needs to input the information about market needs and customer satisfaction through the chain down to food industry entrepreneur. The food industry entrepreneur then informs the agri-industry and farmer to produce market-oriented products, used as raw materials in the manufacturing system in the food industry. Finally, to produce required raw materials, the farmer needs to acquire for appropriate factors of production to plant crops that match the requirements, in terms of type, quality, and quantity.

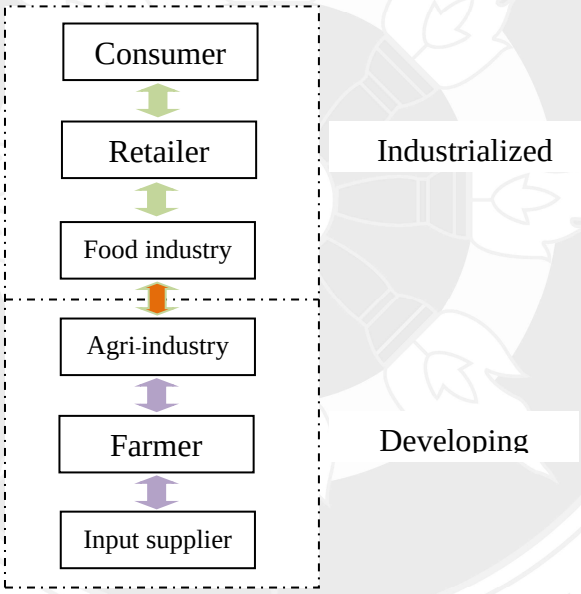

Figure 2.7 Cross-Border Supply Chains

Source: Roekel et al. (2002)

However, three main important market driving forces, which are market segmentation, consumers' demand and low-cost strategy, require supply chain members to make a collaboration among members (Figure 2.8). Especially for chain partners in developing countries who wish to participate into the global market system, supply chain collaboration is one of the most important activities which link each chain actors

together so as to manage the market demands, the flow of attributes, like production factors, goods, services, information, and technology, and to minimize transaction costs (Roekel et al., 2002).

The changing lifestyles and value perception of consumers are driving demand for products with specific characteristics such as organic, exotic, fair trade, semi-cooked food products, ready-to-eat products, etc. This market development challenges chain partners to differentiate their chains to offer products and services with value addition to those particular market segments.

Consumer choices are consequently determined by food safety and health requirements. Issues regarding environment, social fairness and animal welfare are also more concerned. Sustainable development issue is one of the new societal concerns as well. All companies along the chain should cooperate together in order to create consumer trust in the chain process while consumption. In this regards, integrative chain management and quality assurances are fundamental. With the increasing worldwide competition, such collaboration in performing activities will optimize chain performance in terms of cost minimization while maximizing customer satisfaction.

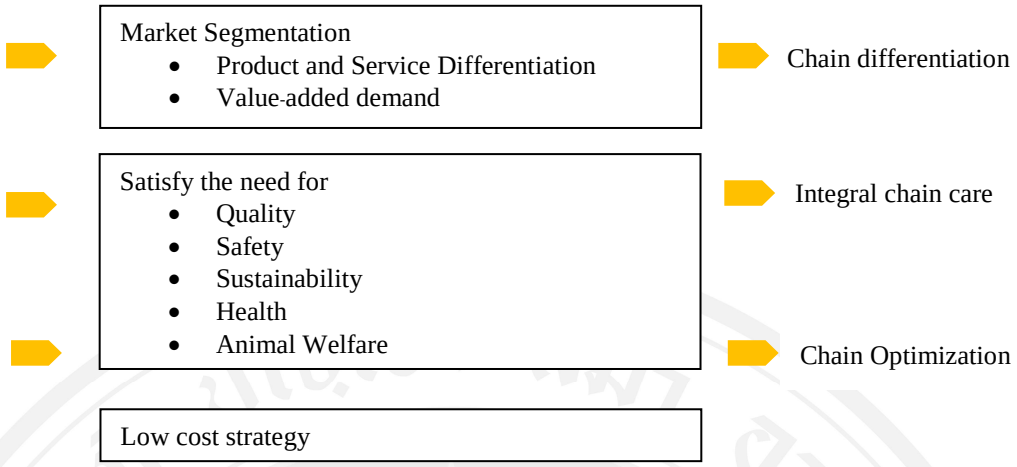

Figure 2.8 Current Market Driving Forces

Source: Roekel et al. (2002)

AFSCs contain a set of unique characteristics of agricultural product that distinguishes them from common supply chain and requires specific management approach (Tsolakis et al., 2012). Van der Vorst (2000, 2006) highlights these particular features concerning with each SC members, as follows;.

1) *Overall*: (1) shelf-life constraints perishability of the products, and product quality alteration across the SC, (2) recycling requirements.
2) *Growers/Farmers/Producers*: (1) time-consuming production, (2) seasonality of production/plantation.
3) *Traders/ Wholesalers/ Retailers*: (1) instability of supply in terms of quality and quantity, (2) global sourcing requirements due to product seasonality which limits the supply, and (3) special treatment and requirements in the transportation and storage process.
4) *Food Industry*: (1) inconstant supply in terms of quality and quantity, (2) low product variety with excess supply, (3) specialized and high technology machinery and intensive capacity requirements, in terms of storage area and labor specialization, (4) process yield variability owing to uncontrollable factors, e.g. biology, season, weather, etc., (5) quarantine issue, (6), storage-buffer capacity restrictions and special storage condition requirements, (7) specialized regulations and legislation regarding environmental protection and consumer rights issues, (8) complementarity of agricultural inputs, (9) physical (e.g. taste, size, shape, appearance, etc.) and specialized additional (convenience of consumption) product features, (10) product safety and traceability and customers' quality perception.

2.4 Design and Management of Agri-Food Supply Chains (AFSCs)

Supply chains are organizational networks that a number of organizations are linked with each other with the aim of producing, processing, selling, and delivering product offerings with or without service offerings to final consumers. The actors along the supply chain include suppliers, producers, processors, traders, customers, and end-consumers, also, transporters, warehouses, and retailers, which can be varied based on the specific supply chain structure (Tavella & Hjorts, 2011). In particular, agri-food supply chains are defined as organizational networks that the network members perform production and sell activities of fresh or processed food products from farm produce or animals (Van der Vorst et al., 2007). In order to ensure the flows of materials, goods, information, finance, technology and knowledge among supply chain partners, supply chains must be dynamic and flexible, established based on coordination, cooperation, control, and trust (Naspetti, Lampkin, Nicolas, Stolze, & Zanoli, 2009; Van der Vorst et al., 2007; Verdouw, Beulens, Trienekens, & Wolfert, 2010).

Supply chain design (SCD) is the process to formulate supply chains in which taking alternatives of supply chain members; customer segmentation; location of production and distribution facilities; and identified facility capacity and transportation modes into account of (Stadtler, 2005). Moreover, Stadtler (2005) presents that SCD is the basic discipline for managing supply chain by performing organizational integration along a supply chain and flows coordination of goods, information, knowledge, finance, technology, and others so that customer demands are satisfied with the purpose of overall chain performance enhancement.

The decision-making in AFSCs design, operation, and management needs to be performed in a complex and integrative manner. This is even more complicated for fresh, perishable and seasonal products which are of high volatility of demand and supply. The AFSCs planning ought to take various issues such as crops planning, harvesting, processing operations, marketing channels, logistics operation, vertical and horizontal integration, risk management, food safety, health concerns and sustainable development into consideration, accordingly.

Tsolakis et al. (2012) have identified key issues in managing modern AFSCs needed to be concerned and classified into 3 different levels. The particular levels consist of strategic, tactical and operational levels which are used in categorizing the key management issues as presented in Table 2.10.

Table 2.10 Key Issues for the Design and Management of AFSCs Mapped in the Hierarchical Decision-Making Process

Decisions	S	T	O
1. Selection of Farming Technologies	✔		
2. Financial Planning& Investments	✔		
3. Supply Chain Partners' Relationships	✔		
4. Supply Chain Network Configuration	✔		
5. Performance Measurement	✔		
6. Risk Management	✔		
7. Sustainability	✔	✔	✔
8. Quality Management	✔	✔	✔
9. Transparency, Food Safety& Traceability	✔		✔
10. Harvest Planning		✔	
11. Logistics Operations		✔	
12. Waste Management & Reverse Logistics	✔	✔	✔
13. Fleet Management, Vehicle Planning & Scheduling		✔	✔

Remark: S for Strategic, T for Tactical, and O for Operational

As shown in Table 2.10, performance measurement on the agri-supply chain is strategically crucial since it determines the decision making of future courses of action through the evaluation of earlier practices and benchmarking. Manager will be able to identify the gap between actual performance of a firm and customer's expectation, and use such information to identify the weakness and design a performance improvement program or even redesign a firm strategy and management system (Reese, 2001). This

is consequently main inspiration and motivation of this dissertation which carries an expectation that the decision makers can have useful information to support their decisions, to ensure work efficiently and minimize supply-chain-wide cost.

2.5 Supply Chain Performance Measurement

In the real practice, it can be seen that operation managers should insightfully measure the Supply Chain (SC) performance in order that long-term organizational success is ensured (Caplice & Sheffi, 1994; Neely, Gregory, & Platts, 2005; Tsolakis et al., 2012). A performance measurement system (PMS) involves overall SC efficiency control and evaluation, while providing updated information to support relevant information comparison, benchmarking, decision making and revision processes. Generally, supply chain performance measurement is a challenging process that becomes even more complicated in the case of modern AFSCs as they contain specific characteristics that require sophisticated and comprehensive managerial capabilities (Aramyan et al., 2006).

2.5.1 Existing Supply Chain Performance Measurement Methods

There are a variety of performance measurement methods, combining multidimensional performance indicators into one measurement system, available for managers or decision-makers to apply with their operation management (Aramyan et al., 2006). Some of well-known measurement methods, such as Activity-Based Costing, Balanced Scorecard (BSC), Data-Envelopment Analysis, Multi-Criteria Analysis, Life-Cycle Analysis, Supply Chain Operations Reference (SCOR®) model, and etc., are presented and analyzed in Aramyan et al.'s work (2006).These measurement methods are explained in the following sections.

Start with the SCOR® model, this method has been developed by Supply Chain Council and it is a standard supply chain process reference model designed for general business without special requirements or characteristics (Supply-Chain Council, 2008). This model provides guidance which can be used to develop a balanced supply chain performance measurement system. The SCOR® model presents a set of supply-chain

performance indicators as a combination of different aspects which are: 1) chain reliability measures; 2) chain cost measures; 3) chain responsiveness measures; and 4) efficiency and effectiveness of asset utilization measures. It is also suggested that the mentioned 4 dimensions must be used wisely so that the performance of a supply chain is reflected in all aspects.

The Balanced Scorecard is a fashionable performance measurement method originally developed by Kaplan and Norton (1992) and utilized in many organizations worldwide. This method employs multidimensional performance metrics from financial management (e.g., manufacturing cost and inventory cost), customer requirements (e.g., timely delivery and order fill rate), business efficacy (e.g., manufacturing adherence-to-plan), innovation and technology utilization (e.g. new product development, product cycle time). With the combination of these different measurement perspectives, the balanced scorecard can support a manager in understanding the interrelationships and trade-offs among each performance indicators which leads to improvement of decision making. Normally, this method is not designed for supply chain management but it could be applied with adjustment according to specific characteristics of supply chain management. Whereas, Multi-Criteria Analysis (MCA) is the method that perform measurement based on the objectives listed by the decision maker, and the measurement is done by measuring the degree of goal achievement in each measurable criterion that the decision maker identifies. This method is designed to support decision makers to deal with the problems which require sophisticated and holistic analysis (Romero & Rehman, 2003). In specific, the MCA can be performed by first start with goal identification, criteria setting, and weight allocation on each criterion that reflect each dimensions of management performance.

On the contrary, Data Envelopment Analysis (DEA) presents the idea of efficiency measurement of a firm or chain by benchmarking with the efficiency of its competitors. The problem in identifying the firm efficiency in supply chain is that a firm not only produces its own direct outputs to be delivered directly to the market but also produces output that is used as input materials for a firm in the next tier. With the contributions of Zhu (2014) in this field various dimensions should be included in chain

efficiency measurement, as such economic and environmental aspects. However, the limitations of DEA model is that it requires massive amount of data for analysis, while data collection in supply-chain context is quite complicated and difficult to clearly identify.

Next, Life-Cycle Analysis (LCA) is the measurement method which proposes a measurement on input material utilization and environmental waste occurred in the production process, from the sourcing of raw materials to consumption and disposal at the final stage. It also takes the possibility of product reuse or recycling into consideration. LCA is then seen heavily concerns with the environmental aspect of the production chain. However, it can be extended to cover economic performance evaluation by integrating economic and environmental cost into the LCA framework which is the underlying concept of life-cycle cost assessment method (Azapagic & Clift, 1999; Carlsson-Kanyama, Ekstrom, & Shanahan, 2003; Hagelaar & Van der Vorst, 2002).

The last one is the Activity-Based Costing (ABC) method which holds accounting fields of management as underlying concept by breaking down firm activities into single tasks or cost drivers, while performing resource estimation (i.e., time, labor, and costs) of each step. This approach offers better assessment on the productivity and costs derived from a supply-chain process. The ABC method offers companies the accurate measurement; for example, the customized services for specially-required customer or the marketing costs for niche products. Moreover, managers can comprehend about what factors that drive each business activities in terms of costs and the contribution of each activities to outputs. ABC analysis is not the method which replaces traditional financial analysis or accounting methods, but it provides a better understanding of performance by taking a look at the same factors in a different angle (Lapide, 2000).

In summary, the SCOR® model is the only method having been developed for supply chain performance management and used globally while the others are not specifically designed for managing supply chain. Yet, they contain potential to be adapted to particular management requirements (Aramyan et al., 2006). However, each

method contains their own advantages and limitations in practices as summarized in Table 2.11.

Furthermore, Wang (2003) has combined the factors regarding product characteristics into supply chain strategic management with an aim to analyze the selection of supply chain based on product natures. SCOR® model level-1 performance metrics has also been adopted and applied as decision criteria in selecting supplier of the supply chain. By using the SCOR® model as theoretical base, a comprehensive analytic hierarchy process (AHP) has been developed to optimize supplier efficiency. An integrative multi-criteria decision-making methodology has been developed to which it contains both qualitative and quantitative measurement attributes.

Table 2.11 Advantages and Disadvantages of Supply Chain Performance Measurement Methods

Methods	Advantages	Disadvantages
Activity-Based Costing (ABC)	❖ Provide more than just financial information ❖ Recognizes the changing cost behaviour of different activities	❖ Costly data collection ❖ Difficulties to collect initially required data ❖ Difficulties to determine appropriate and acceptable costs drivers
Balanced Scorecard (BSC)	❖ Balanced view about the performance ❖ Contain financial and non-financial factors ❖ Top-level strategy and middle-management-level actions are clearly connected and appropriately focused	❖ Not a quick fix ❖ Complete implementation should be staged
Economic Value-Added (EVA)	❖ Consider the cost of capital ❖ Allows projects to be viewed separately	❖ Computation difficulties ❖ Difficult to allocate EVA among divisions
Multi-Criteria Analysis (MCA)	❖ A participatory approach to decision-making ❖ Enables decision-maker to learn about the problems in details ❖ Suitable for problems where monetary values of the effects are not readily available	❖ Information requirements to derive the weights can be considerable ❖ Possibility to introduce implicit weights leading to results that cannot be explained
Life-Cycle Analysis (LCA)	❖ Allows to establish comprehensive baselines of information on a product's or processor's resource requirement ❖ Allows to identify areas where the greatest reduction of environmental burdens can be achieved ❖ Possibility to assess the cost and environmental effects associated with the life cycle of a product or process	❖ Data-intensive methodology ❖ Lack of confidence in the LCA methodology
Data-Envelopment Analysis (DEA)	❖ All inputs and outputs are included ❖ Generates detailed information about the efficient firms within a sample ❖ Does not require a parametric specification of a functional form	❖ Deterministic approach ❖ Data-intensive
Supply-Chain Council's SCOR® Model	❖ Takes into account the performance of the overall supply chain ❖ Balanced approach ❖ Performance of the supply chain in multiple dimensions	❖ Does not attempt to describe every business process or activity ❖ Does not explicitly address training, quality, information technology and administration

Source: Aramyan et al. (2006, p. 58)

Referring to the Table 2.11, the SCOR® model is the method which can best describe the overall supply chain performance because of it has been initiated for supply chain management. However, the model carries an aim to fit all industries at first place; therefore, some attributes contained in agricultural products are absent from the model (Aramyan et al., 2006).

Additionally, Aramyan et al. (2006) have stated that some management factors were omitted from the SCOR® model; for instance, technology management, and Human Resource Management (HRM), which embraces the abilities to reflect the performance of management.

In the real practice, it is required that decision makers of a firm need to get into a comprehension in the decision-making structure since performance appraisal of an

agri-supply chain is multi-criteria management problem. AHP can help the decision makers in understanding firm operation by providing a simple and flexible model structure which describe the general decision operation. This research thus adopts AHP concept as a tool in identifying key performance of the integration of various existing agri-supply chain performance measurement derived from Aramyan et al.'s work (2006). Therefore, the SCOR® model and AHP methods will be explained and discussed in details in the next section.

2.5.2 Supply-Chain Operations Reference (SCOR®) model

SCOR® model has been developed by the Supply Chain Council (SCC) with the initial purpose of assisting the firms in managing supply chain performance and designing management process (Supply-Chain Council, 2008). Three main conceptual components consisting of process modeling, performance metrics and best practices are imposed in such model (Camerinelli, 2009). According to the research objectives, only the first two pillars will be discussed in this study in order that Thai durian supply chain process is to be drawn, and the performance indicators of Thai durian supply chain are documented.

In the first pillar, called process modeling, the supply chain process is divided into three basic hierarchical levels which are "Level 1 (models)", "Level 2 (strategies)", and "Level 3 (activities)" as illustrated in Figure 2.9.

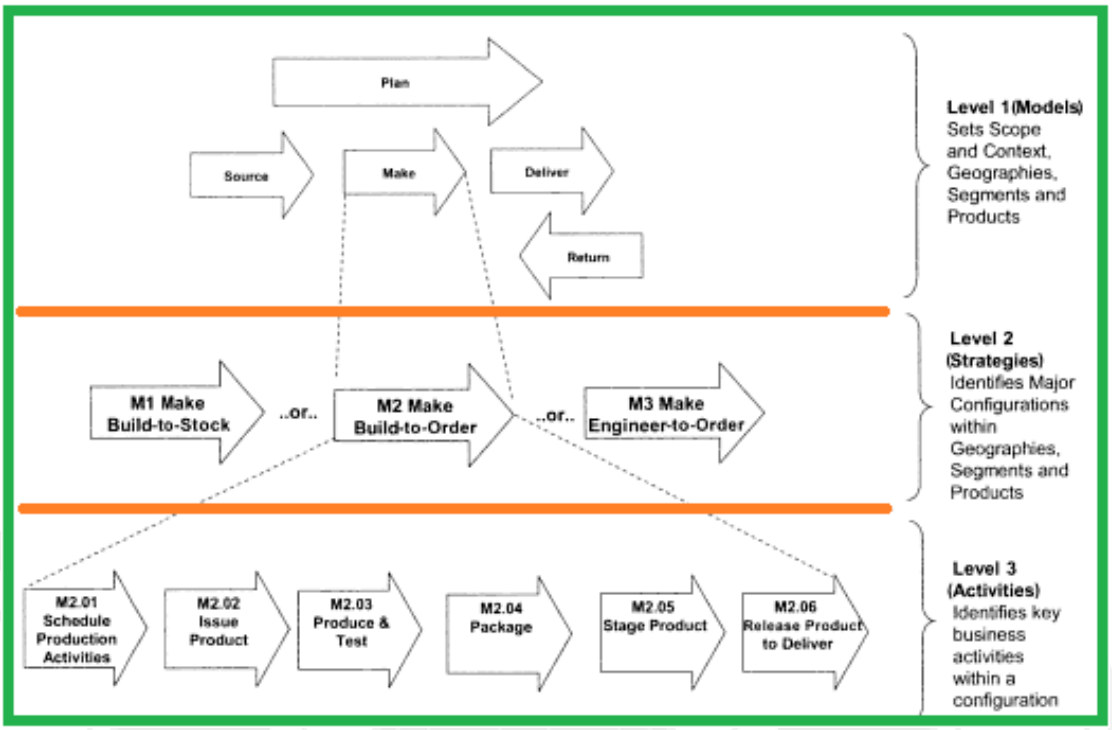

Figure 2.9 The Three Levels of the SCOR® Framework

Source: Francis, n.d., cited in Camerinelli (2009)

Level 1 (Models) requires explaining about organizational concept which are business context, market segments, products and services, and business scope in relation to supply chain. It is also needed to describe basic supply chain process of the firm which are material sourcing, production, product or service delivery, and product claims or return (Camerinelli, 2009).

Level 2 (Strategies) requires the identification of production strategies in relation to the organizational concept explained in the Level 1. The strategies will influence the direction of organizational operations and the business processes described in the next level. The strategies can be in 3 approaches which are either “Made-to-order”, “Made-to-stock”, or “Engineer-to-order”.

Finally, level 3 (Activities) requires that business core activities and processes which are consistent with the afore-mentioned business strategies are to be detailed and key performance metrics are listed.

In the Figure 2.9, level 1 is seen simple and requires few details on the supply chain management while the other two levels provide more meaningful details for supply chain strategic management.

For the second pillar, five attributes have been selected by the SCC members which can reflect the performance of a supply chain. They comprise asset utilization, costs, flexibility, reliability, and responsiveness (Camerinelli, 2009).

In Table 2.12, it can be found that each performance attributes reflect both business objectives of a firm and industry goals (Camerinelli, 2009; Supply-Chain Council, 2008). For instance, marketing departments will generally focus on service level and quality enhancement with the aim to gain competitive advantage over other rivals of the firm, occupy market share and satisfy its customers; whereas, financial and accounting departments put an emphasis on cost control and asset utilization in order to satisfy shareholders and investors, and operation department tends to focus on the first four attributes to minimize the operational costs and maximize the utilization of production factors (Camerinelli, 2009; Gunasekaran, Patel, & Tirtiroglu, 2001)

Table 2.12 Performance Attributes of the SCOR® Model

Performance Attribute	Performance Attribute Definition	Level 1 Metric	Definition	Level 2 Metric	Definition
Supply chain reliability	The performance of the supply chain in delivering the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	-Perfect order fulfilment	-The percentage of orders meeting delivery performance with complete and accurate documentation and no delivery damage	-Percentage of orders delivered in full	-The percentage of orders in which all the items are received by customer in the quantities committed
				-Delivery performance to customer commit date	-The percentage of orders that are fulfilled on the customer's original commit date
				-Documentation accuracy	-The percentage of orders delivered with on-time and accurate documentation to support them
				-Perfect condition	-The percentage of orders delivered undamaged and meeting specification, have the correct configuration, are faultlessly installed and accepted by the customer
Supply chain responsiveness	The speed at which a supply chain provides products to the customer.	-Order fulfilment cycle time	-The average actual cycle time consistently achieved to fulfil customer orders	-Source cycle time	-The average time for 'Source' processes
				-Make cycle time	-The average time for 'Make' processes
				-Deliver cycle time	-The average time for 'Deliver' processes

Performance Attribute	Performance Attribute Definition	Level 1 Metric	Definition	Level 2 Metric	Definition
Supply chain flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	-Upside supply chain flexibility	-The number of days required to achieve an unplanned, sustainable 20% increase in quantities delivered	-Upside source flexibility	-The number of days required to achieve an unplanned, sustainable 20% increase in quantity of raw materials
				-Upside make flexibility	-The number of days required to achieve and unplanned, sustainable 20% increase in production, assuming no raw material constraints
				-Upside deliver flexibility	-The number of days required to achieve an unplanned, sustainable 20% increase in quantity delivered, assuming no other constraints
				-Upside source return flexibility	-The number of days required to achieve an unplanned, sustainable 20% increase in the return of raw materials to suppliers
				-Upside deliver return flexibility	-The number of days required to achieve an unplanned, sustainable 20% increase in the return of

Performance Attribute	Performance Attribute Definition	Level 1 Metric	Definition	Level 2 Metric	Definition
					finished goods from customers
Supply chain flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	-Upside supply chain adaptability	-The maximum sustainable percentage increase in quantity delivered that can be achieved in 30 days	-Upside source adaptability	-The maximum sustainable percentage increase in raw material quantities that can be acquired/received in 30 days
				-Upside make adaptability	-The maximum sustainable percentage increase in production that can be achieved in 30 days, assuming no raw material constraints
				-Upside deliver adaptability	-The maximum sustainable percentage increase in quantities delivered that can be achieved in 30 days, assuming no constraints on finished goods availability
				-Upside source return adaptability	-The maximum sustainable percentage increase in returns of raw materials to suppliers that can be achieved in 30 days, assuming no constraints on finished goods availability

Performance Attribute	Performance Attribute Definition	Level 1 Metric	Definition	Level 2 Metric	Definition
Supply chain flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.			-Upside deliver return adaptability	-The maximum sustainable percentage increase in returns of finished goods from customers that can be achieved in 30 days
		-Downside supply chain adaptability	-The reduction in quantities ordered sustainable at 30 days prior to delivery with no inventory or cost penalties	-Downside source adaptability	-The raw material quantity reduction sustainable at 30 days prior to deliver with no inventory or cost penalties
				-Downside make adaptability	-The production reduction sustainable at 30 days prior to delivery with no inventory or cost penalties
				-Downside deliver adaptability	-The reduction in delivered quantities sustainable at 30 days prior to delivery with no inventory or cost penalties
Supply chain costs	The costs associated with operating the supply chain	-Total supply chain management cost	-The sum of the costs associated with the SCOR ™Level 2 processes of Plan, Source, Make, Deliver and Return	-Cost to Plan, Cost to Source, Cost to Deliver, Cost to Return	-These measure the global sum of the costs related with their associated processes
		-Cost of goods sold		-Cost to Make	

Performance Attribute	Performance Attribute Definition	Level 1 Metric	Definition	Level 2 Metric	Definition
Supply chain asset management	The effectiveness of an organization in managing assets to support demand satisfaction .This includes the management of all assets :fixed and working capital.	-Return on supply chain fixed assets)FA(	-The return an organization receives on its invested capital in supply chain FA	-Supply chain fixed assets	-The return an organization receives on its invested capital in supply chain fixed assets, including the FA used in Plan, Source, Make, Deliver and Return
		-Return on working capital	-Assesses the size of investment relative to a company's working capital position against the revenue generated from a supply chain . Components include accounts receivable, accounts payable, inventory, supply chain revenue, cost of goods sold and supply chain management costs.	-Asset turns	-Total gross product revenue /total net assets
				-Order fulfilment costs	-Includes costs for processing the order, allocating inventory, ordering from the internal or external supplier, scheduling the shipment, reporting order status and initiating shipment

Source: Adapted from Camerinelli (2009, p. 123)

2.5.3 Supply Chain Performance Measurements for Agricultural Products

To develop a supply chain measurement system, it is crucial to understand the nature of the supply chain since each chain may contain diverse characteristics (Aramyan et al., 2006). Generally, there are two types of agri-food supply chains which are supply chains of fresh products and supply chains of processed food products. Some specific attributes of agri-food supply chains have been summarized by Van der Vorst (2000) as follows;

1) Product perishability which limits its shelf life and product decay;
2) Time-consuming production;
3) Seasonal production;
4) Global sourcing requirement due to seasonal supply shortage;
5) Conditioned logistics operation requirement;
6) Uncontrollable external factors affecting yield of production in terms of quantity and quality; like seasonality, weather, pests and others;
7) Stocking capacity limitations due to specially required storage methods and tools;
8) Environmental and consumer-related laws and regulations;
9) Physical product features; like sensory properties such as flavor, appearance, color, size and shape;
10) Additional features: e.g. convenience of consumption;
11) Product safety;
12) Quality perception influenced by marketing practices.

Owing to the limitations of such supply chain performance measurement methods, Aramyan et al. (2006) has then added a number of specific characteristics of agri-food product into the existing performance measurement methods as a result (Van der Spiegel, 2004; Van der Vorst, 2000). A developed framework of agri-food supply chain performance indicators has been proposed as shown in Figure 2.10. The attributes regarding efficiency, flexibility, and responsiveness are contained in the framework based on the pros and cons of the existing methods while the last one is stemmed from the study of Lunning, Marcelis, and Jongen (2002) on food quality issue.

Though, the proposed framework has not yet been validated so there is still a chance that some other essential dimensions being omitted from the framework. Relevant experts and stakeholders across the entire chain ought to be provided opportunities to deliver comments and suggestions on new indicators or rejection of the

proposed ones so that feasible performance evaluation has been derived. The feasible framework should also respond to the criteria of consistency, inclusiveness, measurability, and universality (Aramyan et al., 2006).

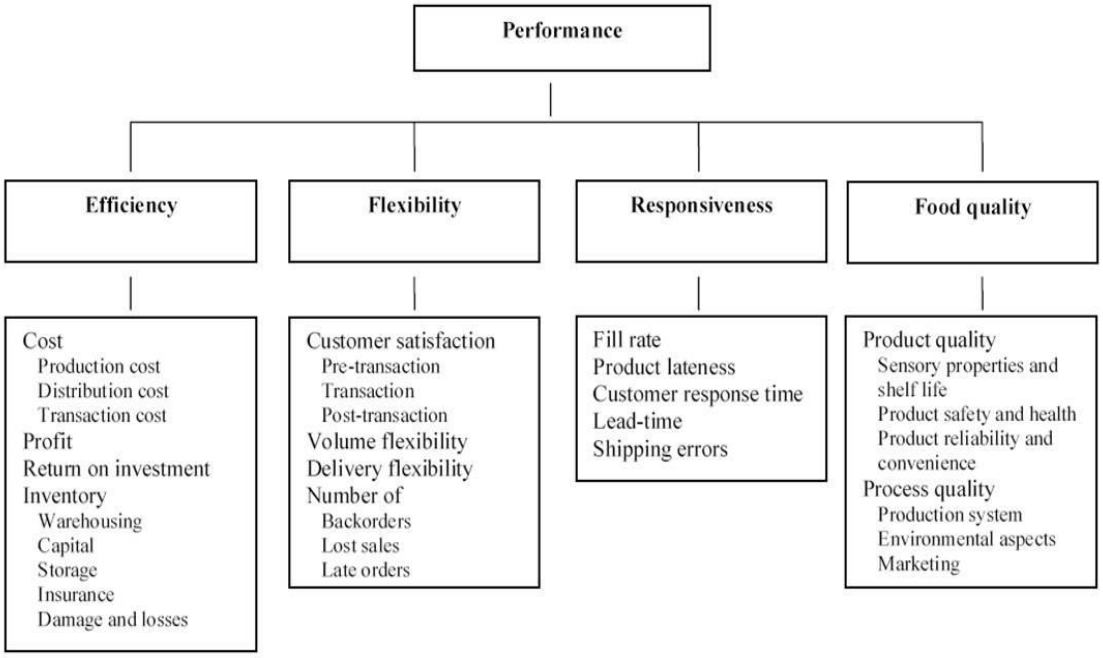

Figure 2.10 Aramyan et al.'s Conceptual Framework of Agri-Food Supply-Chain Performance Indicators

Source: Aramyan et al. (2006, p. 58)

2.6 The Analytic Hierarchy Process (AHP) and Its Application in Supply Chain Management

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making tool used in most of all decision-making enactment (Vaidya & Kumar, 2006). The AHP is thus compatible with alternative selection process. AHP can also be utilized to identify the weight of importance for decision criteria and relative ranking of appropriate choices. The advantages of the method are that it contains judgment factors and integrates diverse measures into one standardized overall score to help in making best

choice among ambiguous alternatives (Balaji, Madhumathi, Karuppusami, & Sindhuja, 2012; Rangone, 1996).

The ideological base of the Analytic Hierarchy Process (AHP) is to set and define scope of environment of problem (Saaty, 1986). It is based on systematic mathematical structure in the form of matrices while containing associated ability to attribute to reliable weight approximation through its eigenvector (Merkin, 1979; Saaty, 1980, 1994). The AHP methodology consists of the comparison on each criterion, or alternatives according to criterion based on pair wise basis. To give a clearer explanation, the comparison is performed by using a basic scale of absolute numbers validated through practical experiments and it carries a capability to reflect individual preferences through quantitative and qualitative attributes (Saaty, 1980, 1994). It transforms individual subjective preferences into numerical scale which can be mathematically computed on each different alternative. The summated figures are to be used in alternative ranking and comparison which offers the decision maker a hand in choice making. Next, matrices are constructed with respect to the rating obtained from the questionnaire and step of prioritization is then performed based on the implementation specified in the methodology of AHP (Balaji et al., 2012). In another word, the key steps of AHP methodology can be summarized that since it is an approach utilizing an Eigen value in the comparisons, numeric scale calibration is employed in the methodology for both quantitative and qualitative performance metrics. The scale, as determined in the methodology, ranges from 1 to 9, of which 1 means 'equally important', and 9 means 'absolutely more important than (the other comparable factor)' (Vaidya & Kumar, 2006).

However, to describe the process of AHP in details, it starts from problem identification followed by defining objectives of all stakeholders along the chain in comprehensive view. The third step is to set up the influential criteria underlying the actions of those stakeholders or supply chain actors. Fourth step is to arrange the problem into structure based on levels of impact, and degree of influence attributed to the criteria or sub-criteria in the third step. After that, comparison and calibration of each elements are carried out before continuing with calculating to find maximum Eigen value, Consistency Index (CI), Consistency Ratio (CR), and standardized values

of each criterion and alternative. Finally, interpreting the computed values into decision choices for making desirable decision.

The application of AHP in supply chain management field has been successful in gaining the acceptance from relevant practitioners thanks to the benefit of the arrangement of problem into hierarchical manner and the application of pair-wise comparison on the information gathered from each specialists (Salo & Hämäläinen, 1997). There is also a declaration that the AHP application is extensively practical in resource allocation, strategic planning as well as project management (Vargas, 1990). Ramanathan (2001) as well extended the utilization of AHP in Environmental Impact Assessment (EIA) according to the need of multi-criteria assessment.

For an effective supply chain management, the selection of supplier and distributor is crucial to the business, which can bring a firm success or failure, since they are normally the key players who perform a number of core operations as such material sourcing, logistics operations, as well as product and service delivery (Balaji et al., 2012). In any case, the decision on such selection is quite complicated and in unstructured form due to the characteristics of input data which is ambiguous, unclearly defined, and inconstant. Balaji et al. (2012) proposed the application of AHP into decision-making in choosing supplier and distributor by using weight assessment on performance of suppliers and distributors in the chain as a result. There is a recommendation by Tas (2012) to adopt a fuzzy analytic hierarchy process, or so-called fuzzy-AHP, into global supplier selection process in pharmaceutical business which can tackle with relevant quantitative and qualitative criteria in an efficient way . While, in bicycle business, Cheng and Tang (2009) identified critically meaningful factors for supplier selection by exercising survey and applying both fuzzy Delphi method (FDM) and then fuzzy-AHP, respectively, so that multiple criteria were appraised systematically.

In addition, Huang, Yu, Luo, and Zou (2012) employed AHP and Fuzzy Comprehensive Evaluation, abbreviated as FCE, in the analysis of conventional tourism supply chain and propose a system of e-tourism supply chain assessment index. The study was expected to contribute to coordination capacity and flexibility enhancement of tourism supply chain, as well as increase tourist satisfaction and fulfill personalized demand.

Wanga, Huang, and Dismukes (2004) proposed the addition of product characteristics into supply chain strategic management and adopt SCOR® into decision making process. As a result, an AHP with integrative approach and a multi-criteria decision-making methodology which uses preemptive goal programming, or PGP, as conceptual base is developed so that qualitative and quantitative measures are considered in the process of supplier selection. The methodological development was done by utilizing the advantages of each methods which are that the AHP is eligible for designing supply chain strategy based on quantified qualitative attribute ratings, and PGP employs mathematic calculation on optimal order quantity. However, it is needed to put an emphasis on execution of the AHP to gain accurate supplier rating data which is to be used as input data in PGP process afterwards. Otherwise, the analysis may lead to the wrong decision on supplier selection.

Various exceptional papers have exposed the benefits of the application of AHP in different fields such as planning, resource allocation, conflict resolution, alternative selection, and etc. (Vaidya & Kumar, 2006; Vargas, 1990; Zahedi, 1986). Such applications pinpoint the flexibility of AHP method and potential of usage extension toward other different techniques as such Linear Programming, EIA, Fuzzy methods, and etc. This helps in extracting the benefits of each methods to be used in improving the quality of decision making for a better desirable outcomes (Vaidya & Kumar, 2006).

2.7 Research Framework

Before starting of the durian performance measurement system, this research intends to really comprehend durian market situation. As a result, the characteristics of durian supply chain will be determined and its structure will be drawn out.

As shown in Figure 2.11, there are three elements of research framework.

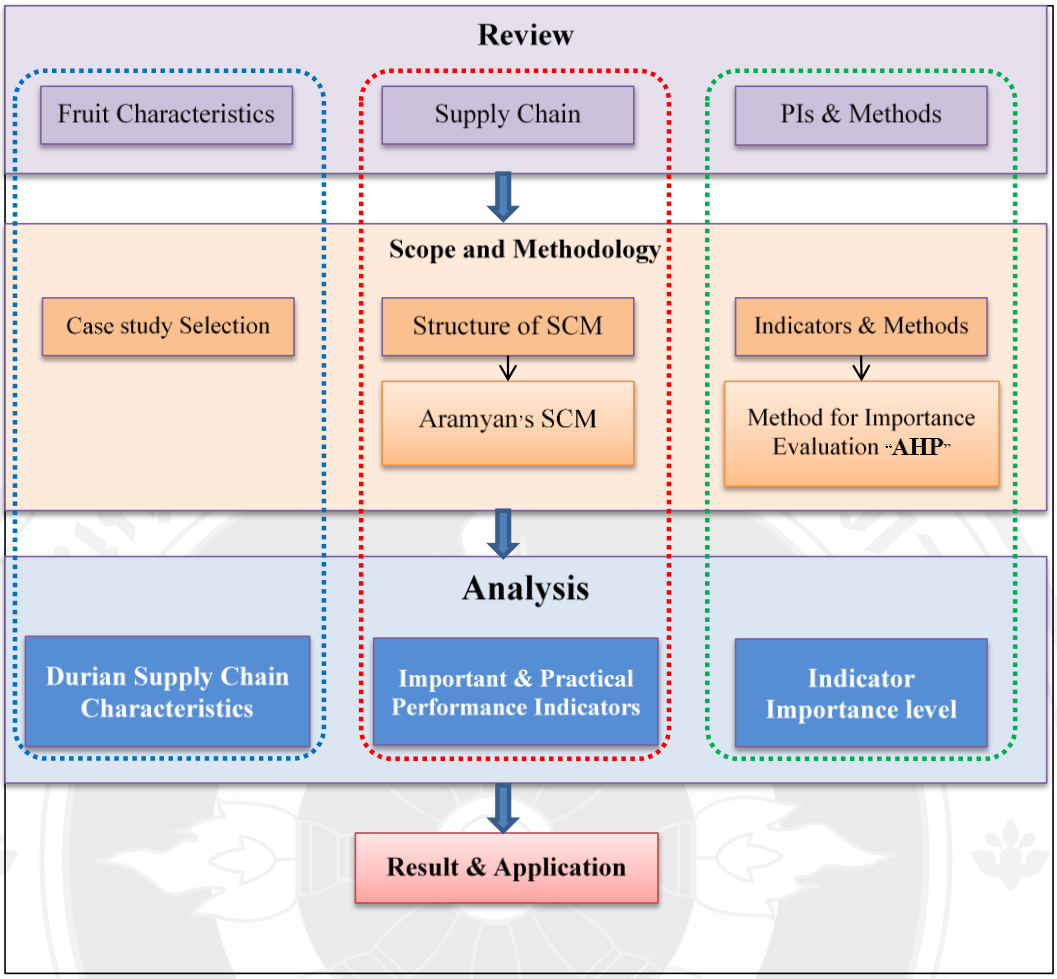

Figure 2.11 A Research Framework of This Study

1) Supply chain characteristics: the characteristics are developed based on literature review yet have never been empirically and practically tested. This review pays more attention on agri-food supply chains and focuses deeply on durian market of Thailand as a case study. The supply chain characteristics are obtained from various stakeholders of durian business, which are composed of farmers, collectors, processors, wholesalers, exporters, retailers, and facilitators. Since fruit business players agree that they don't have proficiency in all areas of business, they might develop information transfer and relationship among players based on their experience and practices. The relationship will be in any form of collaboration in nature. This will allow fruit business players to maximize the efficiency of their business capabilities, resources with cost reduction (Achim & Ritte, 2003). Thus, the relationship (strategic alliance) will be evidently observed as stated in RQ1. Also, durian supply chain practices influence

supply chain performance indicators since the “Performance Measurement System” (PMS) of each different supply chains should be designed individually based on the strategy, chain characteristics, and business ecosystem.

2) Performance indicators (PIs): the indicators were also selected from literature review as same as the first element. Agri-food supply chain performance indicators proposed by Aramyan et al. (2006) has been chosen. There are 4 dimensions of performance consisting of efficiency, flexibility, food quality, and responsiveness. These indicators are going to be improved through the analysis process by using the set of durian supply chain practices and context. They are the set of intra and inter organizational practices between stakeholders or players which intended to enhance the supply chain performance. According to the Figure 2.12, each performance indicator contributes to the added value of the chain and also gain profit for their business. These PIs are based on the function of business players. Consequently, these PIs, which reflect practicality for durian context, will be defined in order to comprehend the Thai durian market and enhance the performance of durian supply chain as stated in RQ2. Table 2.13 illustrates the indicators used in the research study.

3) Important level of Indicators: to understand level of important of each indicator as stated in RQ3 is vital for performance measurement. The competitive advantage is defined as the extent to which an organization is able to create a position in a particular market over its rivals (McGinnis & Vallopra, 1999; Porter, 1985). Supply chain management also serves as a basic management foundation toward achieving competitive advantage through enhancing the quality of sourcing, processing and logistic functions across all players (Li, Rao, Ragu-Nathan, & Ragu-Nathan, 2005). The level of achievement depends on the performance measurement system. Therefore, important level of each indicator plays an important role in strategic setting, performance evaluation and future courses of actions determination. According to various indicators, AHP (Analytic Hierarchy Process) has been selected to determine important level of indicators since AHP provides robust and rational framework for decision makers who are dealing with multiple criteria. AHP uses a hierarchical structure and can integrate both quantitative and qualitative attributes into considerations on prioritization. Moreover, relative importance of each decision aspect shall be measured systematically by AHP method.

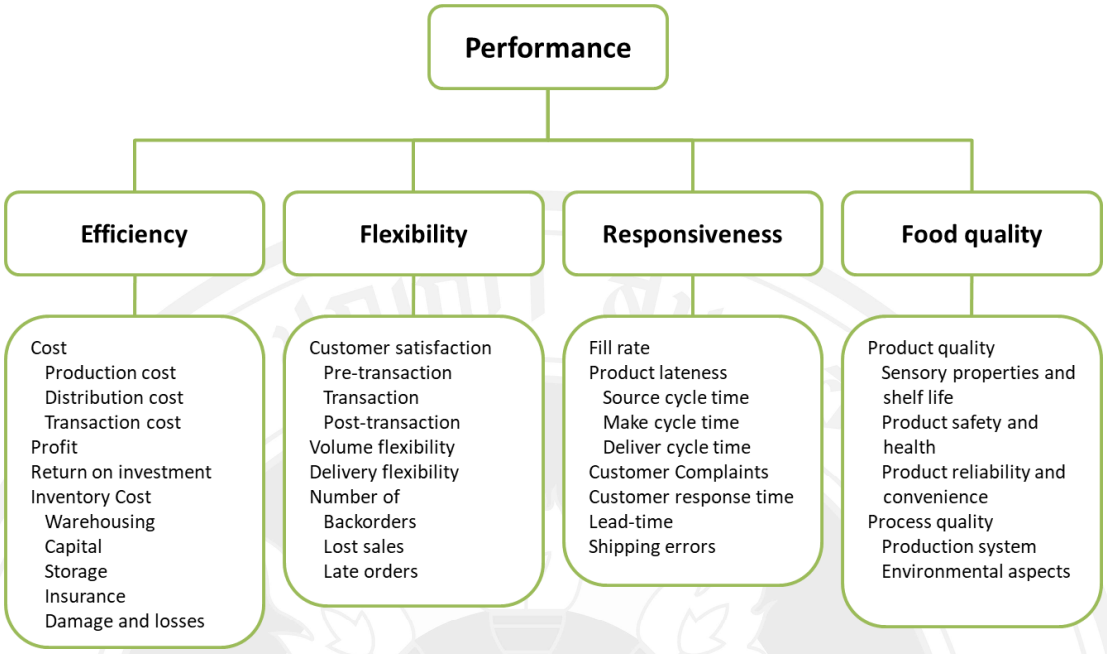

Figure 2.12 Reviewed Agri-Food Supply Chain Performance Indicators

Table 2.13 Performance Indicators Used in the Framework

Indicators	Definitions	Measures
Efficiency[a]		
Production Costs	Combined costs of raw materials and labour in producing goods	The sum of the total costs of inputs used to produce output/services (fixed and variable costs)
Distribution costs	Combined costs of distribution, including transportation and handling cost	The sum of the total costs of inputs used to produce output/services (fixed and variable costs)
Transaction costs	The costs other than the money price that are incurred in trading goods or services (e.g. searching cost, negotiation costs, and enforcement costs)	The sum of searching costs (the costs of locating information about opportunities for exchange) negotiation costs (costs of negotiating the terms of the exchange) enforcement costs (costs of enforcing the contract)
Profit	The positive gain from an investment or business operation after subtracting all expenses	Total revenue less expenses
Return on investments	A measure of a firm's profitability and measures how effectively the firm uses its capital to generate profit	Ratio of net profit to total assets
Inventory	A firm's merchandise, raw materials, and finished and unfinished products which have not yet been sold such warehousing, capital, storage, insurance, and damage and losses	The sum of the costs of warehousing of products, capital and storage costs associated with stock management and insurance

Indicators	Definitions	Measures
Flexibility*		
Customer satisfaction	The degree to which the customers are satisfied with the products or services during pre-transaction, transaction and post-transaction	The percentage of satisfied customers to unsatisfied customers
Volume flexibility	The ability to change the output levels of the products produced	Calculated by demand variance and maximum and minimum profitable output volume during any period of the time
Delivery Flexibility	The ability to change planned delivery dates	The ratio of the difference between the latest time period during which the delivery can be made and the earliest time period during which the delivery can be made and the difference between the latest time period during which the delivery can be made and the current time period
Backorders	An order that is currently not in stock, but is being re-ordered (the customer is willing to wait until re-supply arrives) and will be available at a later time	The proportion of the number of backorders to a total number of orders
Lost sales	An order that is lost due to the stock out, because the customer is not willing to permit the backorder	The proportion of the number of lost sales to a total number of sales
Late orders	An order that do not reach the destination on time	The proportion of the number of late orders to a total number of sales
Responsiveness*		
Fill rate	Percentage of units ordered that are shipped on a given order	Actual fill rate is compared to the target fill rate
Product lateness	The amount of time between the promised product delivery date and the actual product delivery	Delivery date minus due date
Documentation Accuracy	The first step of synchronizing material flow (physical flow) and data flow (virtual flow).	Number of errors
Customer response time	The amount of time between an order has been done and its corresponding delivery	The difference between the amount of the time an order has been done and its corresponding delivery
Lead time	Total amount of time required to produce a particular item or service	Total amount of time required to complete one unit of product or service
Shipping errors	Wrong products shipments	The percentage of wrong shipments
Traceability	Traceability is the ability to trace the history, application or location of an product using recorded identifications	Information availability, use of barcodes, standardization of quality systems
Food Quality**		
Product quality**		
Sensory properties and shelf life		
Appearance	Combination of different attributes (colour, size and form, firmness, lack of blemishes and damages)	Number of damages, color scale, size and form scale
Taste	Determined by the sweetness, mealiness and aroma of a vegetable/fruit	Brix value, which is measurement of a soluble dry substance in a liquid (providing an approximate measure of sugar content)
Shelf life	The length of time a packaged food will last without deteriorating	The difference in time between harvesting or processing and packaging of the product and the point in time at which it becomes unacceptable for consumption
Product safety and health	The quality of the products being healthful and nutritious	Nutritional value and lycopene content
Salubrity	Product does not exceed an acceptable level of risk associated with pathogenic organisms	Lab checks and monitoring processes according to certification schemes

Indicators	Definitions	Measures
Product safety	or chemical and physical hazards such as microbiological, chemical contaminant in products, micro-organisms	
Product reliability and convenience	Refers to the compliance of the actual product composition with the product description	Number of registered complaints
Product reliability	The information provided on the packaging is useful, complete and easy understandable	Number of registered complaints
Convenience		
Process quality**		
Production system characteristics	Standard conditions required for transportation and storage of the products that is optimal for good quality	Measure of relative humidity and temperature, complying with standard regulations
Storage and transport conditions	Standard condition that ensure a hygienic, safe working environment, with correct handlings and good conditions	Compliance with standard regulations
Working conditions		
Environmental aspects	The amount of energy used during production process	The ratio of cubic meter gas used per squire meter glasshouse
Energy use	The amount of water used during production process	The ratio of a liter water used per squire meter land under the vegetables
Water use	A permitted amount of pesticides used in production process	The amount and the frequency of the pesticide use complying with standard regulations
Pesticide use	Collected used product from crop, packaging etc. that is disassembled, separated and	Percentage of materials recycled/re-used
Recycling/re-use	processed into recycled products, components and/or materials or re-used, distributed or sold as used, without additional processing	

* Sources: Beamon (1998, 1999), Bowersox and Closs (1996), Hobbs (1996), Persson and Olhager (2002), Lai, Ngai, and Cheng (2002), Womack and Jones (2002), Gunasekaran et al. (2001), Supply-Chain Council (2008), Berry (2006) cited in Aramyan et al. (2006)

** Sources: Lunning et al. (2002), Van der Spiegel (2004), Valeeva (2005), Beamon (1999), Berry (2006) cited in Aramyan et al. (2006)

2.8 Thai Durian Supply Chain

In order to effectively evaluate the performance of supply chain management, it is necessary to understand its chain structure and characteristics (Aramyan et al., 2006). Pattana Jealviriyapan, Rattana Kuayjareanpanich, and Suppada Koywiwattrakul (2001) had conducted a study and illustrated Thai durian supply chain networks which can be seen in Figure 2.13

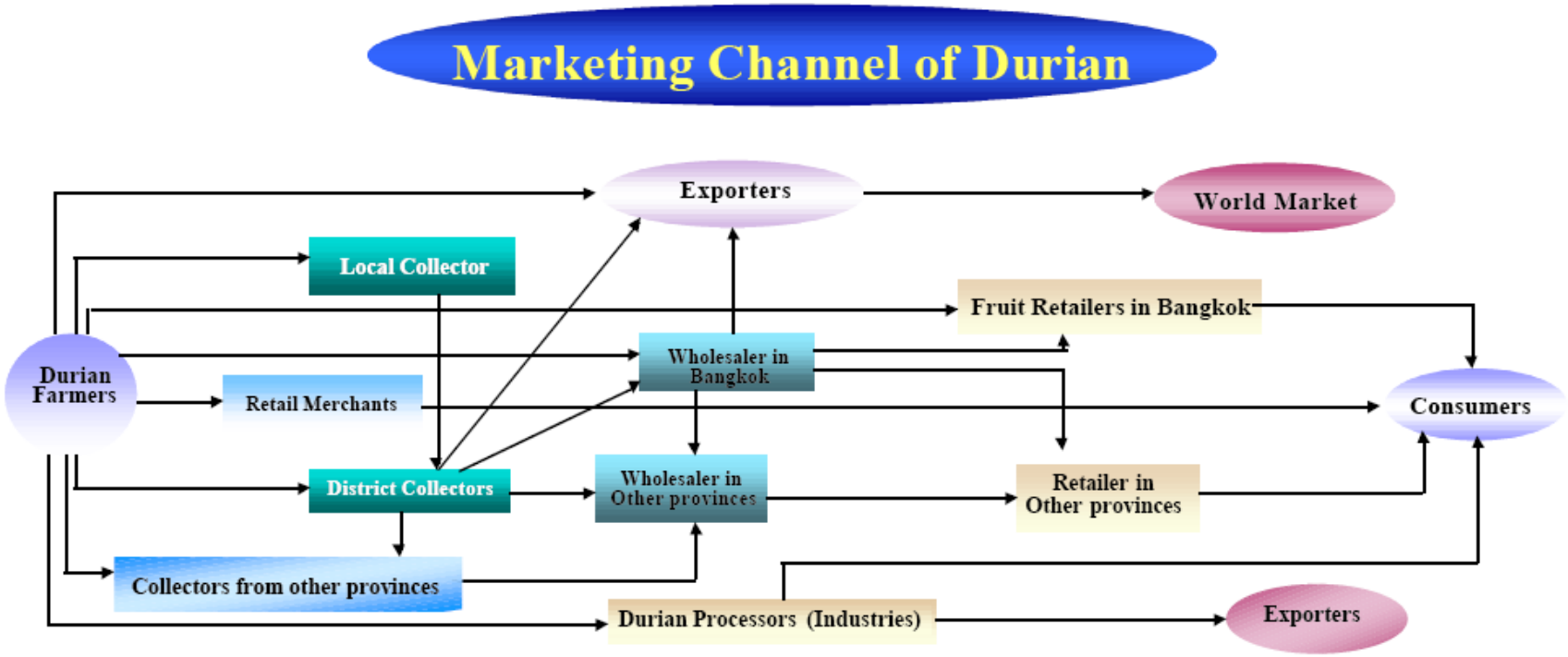

Figure 2.13 Marketing Channel of Durian

Source: Pattana Jealviriyapan et al. (2001, p. 2)

In the Figure 2.13, there are 11 actors along the durian supply chain performing different chain activities, which consist of trading, sorting and grading, packing and packaging, transshipment and transportation, with the same purpose of transferring good quality durian to the destination at a right time with lowest acceptable cost. However, this study had been done almost 20 years ago with the business context different from the present time. In specific, during the period of that study, China had not yet involved in the durian industry. Yet, recently, China is the largest export market of Thai durian. Therefore, the durian supply chain structure needs to be examined whether there are any changes according to the change of business context or not so that the performance indicators are properly identified (Gunasekaran et al., 2004; Mapes, New, & Szwejczewski, 1997; Slack, Chambers, Harland, Harrison, & Johnston, 1995; Van der Vorst, 2006).

2.9 Conclusions

Several performance measurement systems which are in use today have their own advantages and disadvantages. According to the limitations of each existing measurement methods, the SCOR® model is the only one which can best provide an explanation on the performance of supply chain in holistic view since it has been initiated to serve supply chain management objective. However, the model carries an aim to fit all industries at first place; therefore, some attributes contained in agricultural products are absent from the model. Accordingly, Aramyan et al. (2006) has added the attributes reflecting the nature of agricultural products into the existing measurement methods and proposed an updated framework of agri-food supply chain performance indicators which contains four dimensions of the indicators such efficiency, flexibility, food quality and responsiveness.

As measuring the performance of an agri-supply chain fundamentally is a multi-criteria problem, this research is originally applied Analytical Hierarchy Process (AHP) concept as a tool to measure key performance to the proposed agri-supply chain performance. Since AHP is a decision-making tool which can contribute to the relative weight of multiple criteria or multiple categories. The next chapter is to explain the overall methodology of this research.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

This chapter begins with a description of the sample group that is in the interest of this study. It then follows by detailed explanation of the research design and methodology employed in each stage to fulfill the research objective so as to provide a better understanding on the research process performed in this study. Its details consist of questionnaire development, data collection, and data analysis method.

3.1 Sample Group

This study focuses on drawing a conclusion of supply chain structure, relationship among supply chain actors, and supply chain performance indicators of Thai durian industry as well as the priority level of such indicators from the relevant supply chain members. Therefore, the sample group needs to be chosen from every supply chain member group existed along the supply chain which consists of seven groups which are farmer, processor, wholesaler, retailer, exporter, government official, and market operator.

Based on the data of Office of Agricultural Economics (2016), there are 128,167 registered durian farmers who plant durian in 30 provinces throughout Thailand. However, among 30 provinces, Chantaburi is the largest durian plantation area of 332 million sq.m., roughly, with production capacity of 43.88 percent of total production. Chumporn is ranked as the second largest durian plantation area with the capacity of 17.60 percent of total production.

However, among the seven groups of supply chain members, farmer is the only group of which number of populations is available. The population number of the other groups cannot be identified since there may not be official records nor accessibility.

As a result, the most meticulous sampling approach for this research is purposeful sampling whereby informants are selected from their specialization to

contribute meaningful insights (Sekaran, 2003). However, snowball sampling is also employed and supported by convenience sampling in order that a reasonable sample size is gained (Sekaran, 2003). In addition, as this research employs a focused interview, the respondents need to be limited to only those who deal with or have sufficient comprehension and experience in Thai durian business or supply chain in order that only the information relevant to the field is obtained.

The sampling process starts from purposive sampling. As a result, the representatives belonging to the groups of producers, traders and trade facilitators are recruited based on their proficiencies and experiences in durian supply chain which are implicitly indicated by the number of years they deal with durian business. Therefore, the minimum number of eight to ten-year-experience in durian business and/or general acknowledgement by others as experts of the industry are determined as selection criteria in order that the realistic and relevant information is collected. To deal with the limitation regarding inaccessibility to the key informants, the snowballing technique and convenience sampling will then be utilized in the sampling process as well. The respondents belonging to the trade facilitator group are chosen since they embrace authorities in strategic formulation and implementation relating to durian products in both national and local levels.

For the performance indicator, AHP is applied to determine the important level of each indicator. AHP is a structured technique for organizing and analyzing complex decisions and not a statistical technique. Therefore, there are not any specifications on the required sampling techniques to be adopted. However, the most important point is to decompose decision problem into a hierarchy. The elements of the hierarchy should relate and cover all aspects of decision problem which are required from the experts concerning with the problem. Therefore, the sampling process of this study must consider all related stakeholders in durian business - farmers, processors, wholesalers, consolidators, retailers, exporters, and facilitators. Nonetheless, even all relevant stakeholders are to be recruited, the sample size should be limited. This is because the size of sample group has a positive association with the degree of data inconsistency (Waris et al., 2019).

In reference with the sampling process explained above, 21 participants were recruited into focused interview by purposive sampling, snowballing techniques and convenience sampling which can be classified in Table 3.1;

Table 3.1 Number of Participants

Group	Subgroup	Sampling method
Producer	Farmer (F)	1 from purposive sampling and 2 from snowballing technique
	Processor (P)	2 from purposive sampling and 1 from snowballing technique
Trader	Wholesaler (W)	1 from purposive sampling and 2 from convenience sampling
	Retailer (R)	3 from purposive sampling
	Exporter (E)	2 from purposive sampling and 1 from snowballing technique
Trade Facilitator	Government Agency (G)	3 from purposive sampling
	Market Operator (M)	3 from purposive sampling

Each interviewee was coded in place of individual name in this study for the reason of confidentiality by using ‘F’ as farmer, ‘P’ for processor, ‘W’ for wholesaler, ‘R’ for retailer, ‘E’ for exporter, ‘G’ for government officials, and ‘M’ for market operator.

From the Table 3.2, the sample group consists of three informants with less-than-10-year experience in durian business field, three informants with 10-to-19-year experience, and fifteen informants with more-than-20-year experience. For the group with least experience, even they do not have as much experience as the other two groups but one of them was assigned by the executive of government agency, another one has been appointed as an executive of durian-related association of Thailand, and the last

one is the owner of a top-five-level durian processing company of Thailand. They then had been recruited to participate into this study.

When considering the position level of each informant, twelve of them are the business owners, two are executive officers, four are managers, and three are supervisors. The diversity of positions tends to be beneficial to the study in terms of coverage of perspective from strategic level to operational level.

The recruited informants were likely to deliver information which reflects the idea of business firms of every size since the personal income per year or company sales per year ranges from 31,250 USD per year to 4.5 billion USD per year.

Table 3.2 Brief Profile of Informants

Code of informant	**Number of years of durian experience**	**Current position**	**Personal income per year/ Company sales per year (USD)**
F1	30	Owner	625,000
F2	30	Owner	31,250
F3	40	Owner	156,250
P1	4	Owner	109,375,000
P2	40	Owner	1,875,000
P3	20	Owner	93,750
W1	24	Manager	62,500,000
W2	15	Owner	93,750
W3	35	Owner	969,531.25
R1	27	Manager	937,500,000
R2	22	Executive	937,500,000
R3	20	Manager	93,750,000
E1	25	Owner	12,500,000
E2	9	Owner	6,250,000
E3	40	Owner	N/A
G1	22	Supervisor	N/A
G2	11	Supervisor	N/A
G3	5	Supervisor	N/A
M1	30	Executive	3,421,875,000
M2	16	Manager	4,562,500,000
M3	20	Owner	684,375,000

3.2 Describing the Structure of Thai Durian Supply Chain and Its Relations

To fulfill the first research objective, focused interviews with the sample group are employed in this study. The focused interview offers some advantages which are 1) the information obtained will be filtered and only information relating to the research subject is obtained; and 2) while the interviewee is autonomous in answering the open-ended questions, the researcher is still able to steer the direction of the interviews to be on track (Kothari, 2008; Yin, 2009).

The focused interviews were conducted in person each time separately at the place and time that were most convenient to the participants. The interview process started with few general questions asking about personal information so as to make the interviewee feel comfortable. Then, each interviewee was asked whether to draw a diagram reflecting the existing durian supply chain structure in his/her perception by himself/herself or explain the researcher the details about the structure and let the researcher draw the diagram for them. In the case that the researcher drew the diagram for them, the interviewee would be asked to give an approval on the drawing before using the diagram in further analysis. During the interview, the conversations were recorded by using digital voice recorder and transcribed.

After the interview, data source triangulation were executed on the data obtained from the interview process to prove the validity and reliability by examining the data obtained from different players, or data sources (Miles and Huberman, 1994, cited in Berkowitz, 1997; Thurmond, 2001). The validation, at this step, was performed based on differences in business proficiencies and experiences of each informants stemmed from the actual business practices along the supply chain which comprised production sector (farmer, processor and consolidator), trade sector (local distributor, wholesaler, retailer, and exporter), and trade facilitation sector (government officials, and market operators).

After the data had been validated, two relevant analyses consist of supply chain structure and its relations were clarified and illustrated using these data. Using case study, supply chain structure and its relations were analyzed by using the constant comparison method in which the information obtained from different players will be

compared and contrasted with the existing supply chain structure, merged, and summarized as a single durian supply chain map (Dye, Schatz, Rosenberg, & Coleman, 2000). Moreover, the advantage of case study can emphasize the individuality and uniqueness of business. This study can result in the practical durian supply chain structure and relevant insights which reflect the comprehension and perspectives on supply chain of different players with updated conditions.

The flow chart of durian supply chain structure analysis can be illustrated as shown in Figure 3.1.

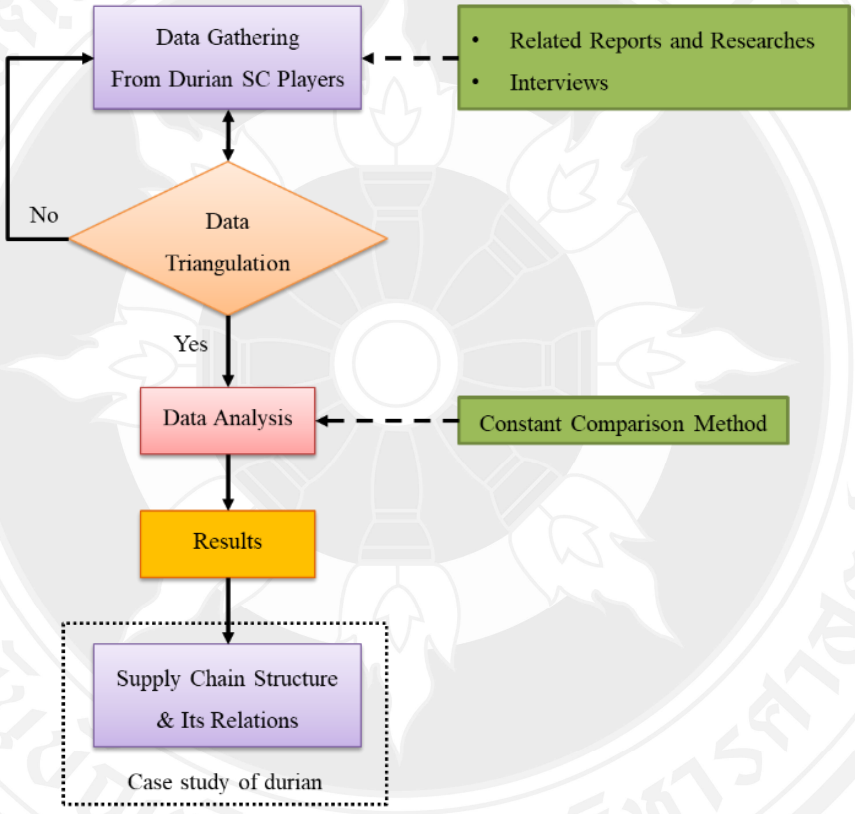

Figure 3.1 Durian Supply Chain Structure Analysis

3.3 Identifying the Corresponding Performance Indicators

In the same interview, after the respondents were asked to provide information regarding Thai durian supply chain structure, they would subsequently be asked to rate the feasibility score of every single indicators in the predefined list (Figure 2.12),

developed based on Aramyan et al.'s conceptual framework (2006), by using five-point Likert scale, with 1 being "Least important or Not important at all" and 5 being "Most important or Unavoidably important", so that the listed indicators were filtered until only meaningful and valid performance indicators were remained.

In order to screen only the performance indicators which are critically meaningful to Thai durian supply chain, those rated indicators must obtain average rating score not less than 4.00 (Aramyan et al., 2006). In this stage, the interviewees were also asked whether there were any recommendations about any new supply chain performance indicators missing and whether any predefined indicators were supposed to be withdrawn from the study.

3.4 Determining the Level of Each Performance Indicator Using AHP Technique

After the first stage interview had been conducted, a complete Thai durian supply chain structure and a list of screened key performance indicators were derived. Then, a questionnaire with pairwise comparison had been developed for using in the second stage interview.

The second stage interview was to determine the relative importance weight of each attribute at different levels. In this step, there were a number of sub-steps needed to be performed (Elgazzar, Tipi Nicoleta, Hubbard Nick, & Leach David, 2010). It first started with conducting face-to-face surveys with the same sample group. The respondents were asked to determine weights of significance of each attribute by adopting pairwise basis into 9-scale comparison within the studied case. Such pairwise comparison can be illustrated as seen in Figure 3.2.

After that, it continued with assessing the supply chain performance according to each attribute by using performance rating scale, and then performed a calculation on each weighted performance rating score of each attribute by multiplying the weight of importance by performance rating score.

The final sub-step was to summate such weighted performance rating score of each attribute across all SC performance measurement aspects by using the weighted

averaging aggregation method to find out the performance index of Thai durian business supply chain.

The fundamental scale of AHP, or absolute values from 1 to 9 and their reciprocals given in Table 3.2, was used in conducting a pairwise comparison (Rabbani & Rabbani, 1996).

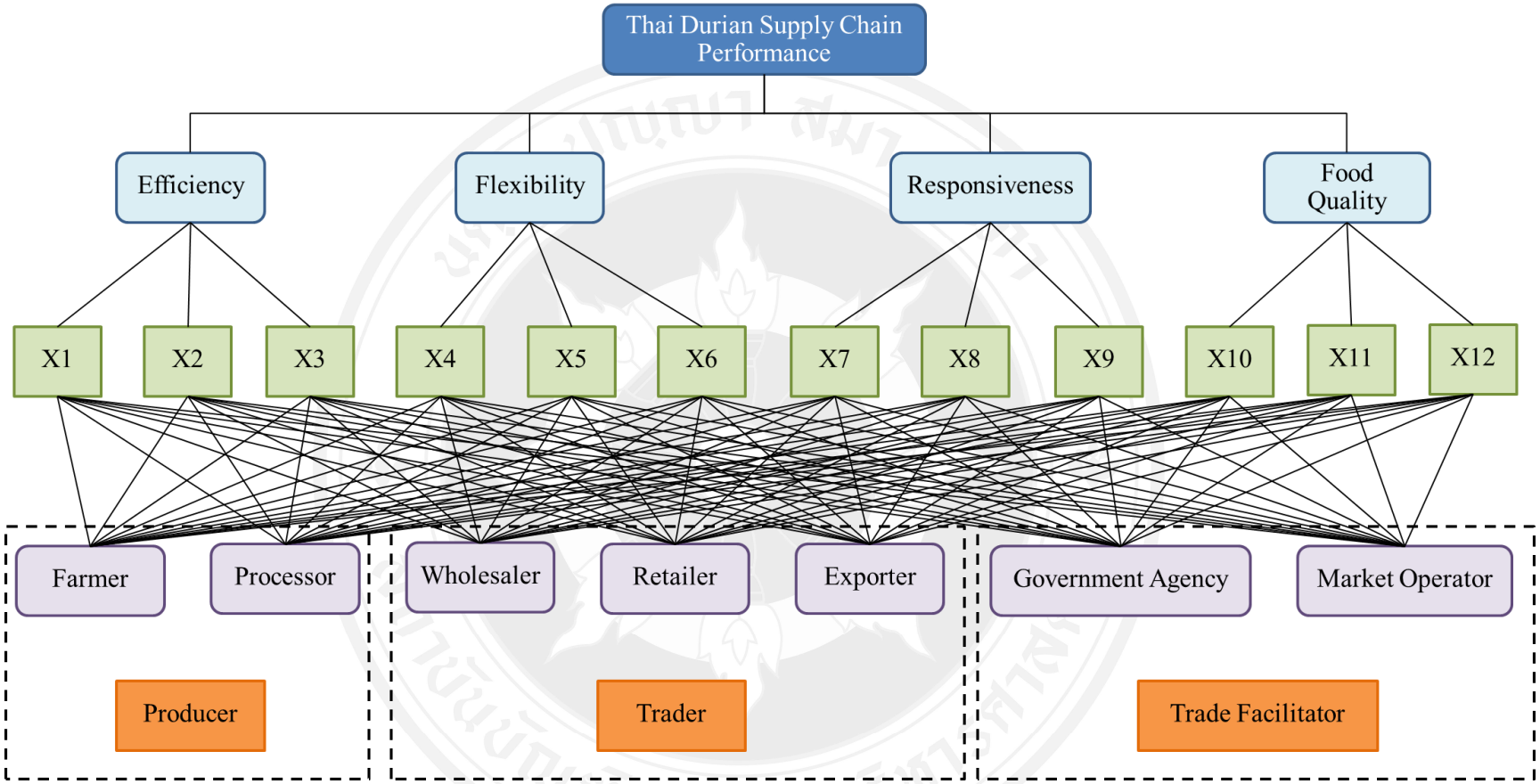

Figure 3.2 Proposed Hierarchical Structure for Thai Durian Supply Chain Performance

The comparison was done with only among the same comparable elements. Clustering was needed to help grouping and comparing such elements in different clusters. Because of the homogeneity requirement, one attribute rarely compares with others more than seven attributes so that consistency of the comparison was maintained at acceptable level. If there were more than seven attributes, they can be separated into different clusters. However, each clusters needed to contain at least one common attribute so that the two clusters were combined seamlessly after deriving the relative score of each clusters (Saaty, 1995).

Table 3.3 Scale for Pairwise Comparisons

Scale	Meaning	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one over the other
5	Strong or essential importance	Experience and judgment strongly favor one over the other
7	Very strong or demonstrated importance	Experience and judgment very strongly favor one over the other. Its importance is demonstrated in practice
9	Extreme importance	The evidence favoring one over the other is of the highest possible validity.
2,4,6, 8	Intermediate values	When compromise is needed

Source: Rabbani and Rabbani (1996)

In this study, the basic concept of AHP analysis based on the principle that Saaty (1990) explained is demonstrated in the following section with the assumption that *n* alternatives are being considered with respect to the following goals:

To provide judgements on the relative importance of these activities;

To ensure that the judgements are quantified to an extent which also permits a quantitative interpretation of the judgement among all activities.

Let us consider the element (criteria) $C_1,\ldots,C_n$ of some level in a hierarchy. We wish to find their weights of influence, $w_1, \ldots, w_n$, on some elements (alternatives) in the next level.

Our basic tool is *n*-by-*n* matrix of numbers, representing our judgment of pairwise comparisons. We denote by a_{ij} the number indicating the strength of C_i when compared with C_j.

The matrix of these number a_{ij} is denoted *A*, or,

$$A = (a_{ij}), \quad (i, j = 1,2, \dots, n) \tag{3.1}$$

The entries a_{ij} are defined by the following entry rules.

Rule1; If $a_{ij} = \alpha$, then $a_{ij} = 1/\alpha$, $\alpha \neq 0$.

Rule2; If C_i is judged to be of equal relative importance as C_j, then $a_{ij} = 1$; in particular $a_{ij} = 1$, for all *a* which is in the cell that $i = j$.

Thus, the matrix *A* has the form

$$A = (a_{ij}) = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \cdots & 1 \end{bmatrix} \tag{3.2}$$

Thus, our matrix A of judgements is reciprocal. If our judgment is perfect in all comparisons of can be exactly measured, then $a_{ik} = a_{ij}$ x a_{ik} for all *i*, *j*, *k* and we can call the matrix A consistent.

An obvious case of a consistent matrix is one in which the comparisons are based on exact measurements; that is, the weights $w_1, \dots w_n$ are already known. Then

$$a_{ij} = \frac{w_i}{w_j} \quad (i, j = 1, \dots, n) \tag{3.3}$$

and thus

$$a_{ij} = \frac{w_i}{w_j} = \frac{1}{w_i/w_j} = \frac{1}{a_{ij}} \ (i, j = 1, \dots, n) \tag{3.4}$$

Also,

$$a_{ij} \cdot a_{jk} = \frac{w_i}{w_j} = \frac{w_j}{w_k} = \frac{w_i}{w_k} \tag{3.5}$$

Consider the matrix equation

$$A.x = y \tag{3.6}$$

where $x = (x_1,\ldots, x_n)$ and $y = (y_1,\ldots, y_n)$, is a shorthand notation for the set of equations.

$$\sum_{j=1}^{n} a_{ij}\, x_i = y_i \qquad i = 1, \ldots, n \tag{3.7}$$

Now, we observe that from Equation (3.7) we obtain

$$a_{ij} \cdot \frac{w_i}{w_j} = 1 \qquad i, j = 1, \ldots, n \tag{3.8}$$

and subsequently

$$\sum_{j=1}^{n} a_{ij}\, w_j \frac{1}{w_i} = n \qquad i = 1, \ldots, n \tag{3.9}$$

or

$$\sum_{j=1}^{n} a_{ij}\, w_j = n w_i \qquad i = 1, \ldots, n \tag{3.10}$$

which is equivalent to

$$Aw = nw \tag{3.11}$$

In matrix theory, this formula expresses the fact that *w* is an eigenvector of A with eigenvalue *n*. When written out fully this equation is as follows:

$$Aw = (a_{ij})w = \begin{matrix} \\ A_1 \\ A_2 \\ \vdots \\ A_n \end{matrix} \begin{matrix} \begin{matrix} A_1 & A_2 & \cdots & A_n \end{matrix} \\ \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \end{matrix} \times \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} \tag{3.12}$$

However, in practical case, in which the a_{ij} are not based on exact measurements, but on subjective judgments, the Equation 3.10 no longer holds since a_{ij}

will deviate from the "ideal" ratios w_i / w_j. Two facts of matrix theory are then considered. The first one is this. If $\lambda_i, \ldots, \lambda_n$ are the numbers satisfying the equation

$$Ax = \lambda x \tag{3.13}$$

i.e., are the eigenvalues of A, and if $ai; = 1$ for all i, then

$$\sum_{i=1}^{n} \lambda_i = n \tag{3.14}$$

Therefore, if (3.11) holds, then all eigenvalues are zero, except one, which is *n*. Clearly, then, in the consistent case, *n* is the largest eigenvalue of A.

The second helpful fact is that if one changes the entries a_{ij} of a positive reciprocal matrix A by small amounts, then the eigenvalues change by small amounts.

Combining these two results we find that if the diagonal of a matrix A consist of ones ($a_{ii} = 1$), and if A is consistent, then small variations of the a_{ij} keep the largest eigenvalue, λ_{max}, close to *n*, and the remaining eigenvalues close to zero.

Therefore, if A is the matrix of pairwise comparison values, in order to find the priority vector, the vector w must be found to satisfy

$$Aw = \lambda_{max} w \tag{3.15}$$

Since it is desirable to have a normalized solution, *w* is slightly altered by setting $\propto = \sum_{i=1}^{n} w_i$ and replacing *w* by $(\frac{1}{\propto})w$. This ensures uniqueness, and also that $\sum_{i=1}^{n} w_i = 1$

Observe that since small changes in a_{ij} imply a small change in λ_{max}, the deviation of the latter from *n* is a measure of consistency. It enables us to evaluate the closeness of our derived scale from an underlying ratio scale, which we wish to estimate. Thus, the consistency index (*C.I.*) can be calculated as the below equation.

$$\frac{\lambda_{max} - n}{n-1} \tag{3.16}$$

For each size of matrix n, random matrices were generated and their mean *C.I.* value, called the random index (*R.I.*), was computed; these values are illustrated in

Table 3.4. Using these values, the consistency ratio (*C.R.*) is defined as the ration of the *C.I.* to the *R.I.* as shown in Equation (3.17). According to the criteria, *C.R.* is satisfactory when its value is lower than 0.1.

$$C.R. = \frac{C.I.}{R.I.} \tag{3.17}$$

Table 3.4 Random Inconsistency Index (R.I.)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: Golden, Wasil, and Harker (1989)

After the AHP analysis was performed, the results regarding importance weight estimation of the supply chain performance indicators were then interpreted and discussed at the final stage.

CHAPTER 4

RESULTS

This chapter will report the results of the research conducted following the methodology detailed in the previous chapter. There are three parts of the result to be considered which are (1) Thai durian supply chain structure as perceived by each actor along the chain, (2) the list of performance indicators which is feasible to Thai durian supply chain derived from the analysis of importance rating collected from every single informants by conducting first-stage interview, and (3) the result of Analytical Hierarchical Process (AHP) analysis on the set of screened indicators derived from the prior stage in which the significance level of each indicator can be specified at this stage.

4.1 Thai Durian Supply Chain Structure and Its Relation

Pursuing the first research objective determined earlier in the previous chapter, "To illustrate the structures of Thai durian supply chain processes and their relations in Thailand", focused interviews were conducted with the research sample group so that relevant detailed information could be sufficiently drawn out. The data collected in this study is to be described in the following section.

4.1.1 Data Triangulation

After the interview had been conducted, the data validity and reliability were examined through the process of data triangulation. Since the data in the study was collected from twenty-one informants, triangulation was then performed by comparing data collected from different sources. Its result is summarized as shown in Table 4.16.

From the Table 4.16, thirteen themes of key information can be drawn from the interviews. Each theme was mentioned by the informants in the same way without contradiction. The number of responses and response rates are displayed in the table with the range between two to eleven responses.

Table 4.1 Data Triangulation Result

Theme of key information obtained from interview	**Code of informant**	**Quotes of informant contributing to the theme**	**Number of responded informants**
1. Farmer is the very beginning point of durian supply chain	F1	"…It starts from the orchard…"	11 (52.38%)
	F2	"…We have the task to produce quality durian only for selling to consolidator and other tasks will be performed by consolidator. Consolidator is the one who manages the durian fruits by cleaning, grading, and delivering to each different market…"	
	P2	"…To be a producer, we need to have our own tree…"	
	W2	"…The durian is started from the farmer, first…"	
	R2	"…After we set up our selling plan and schedule, we will go to talk with individual farmer, farmer group, cooperative, private sourcing firms about the quantity, the period, and quality specification of products we are going to buy. We source products from various sources to diversify the risk…"	
	E1	"…To start trading, we need to consider whether such durian farm meets its standard or not…"	
	E2	"…The starting point of durian supply chain is farmer…"	
	E3	"…Farmer is the starting point as main player…"	
	G1	"…Durian supply chain starts from farmer…"	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
	G2	"…Steps of supply chain in Thailand, it starts when durian coming out from farm…"	
	M2	"…All agricultural produce, not just durian, will first start from farmers. Then, those produce will come to the central market through mediator or local collector who gathers the produce from the area of production and sells to the wholesale merchants in our market…"	
2. Online trade on durian	F1	"…If the harvest quantity is few, it will be sold to small-scale merchants. Another channel is to sell online that my daughter is running it. This is the channel done during when not many produces are fruitful, in particular, off-season…" "…We deliver it to individual customer we know from Facebook, Line, Instagram something like that…" "…In the past, technology was still underdeveloped which is different from the present time. We then make use of such development…"	4 (19.05%)
	F2	"…There is online trade in some parts. New-generation-farmers do sell this way. Enterprise likes us also does. Some sell durian meat online…"	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
	R3	"…Some farmers or relatives of them also sell durian via online. They sell in the form of whole fruit not yet peeling. Yet, it is not traded that seriously…"	
	E2	"…Another new channel is the channel that the e-commerce platform operator, like Line@, directly makes a deal with farmer. This channel starts to grow continuously. They do not need to hold any stocks but only perform marketing tasks…"	
3. Processor is seen as one of the destination markets	F1	"…Another channel of farmer is to send to processing group…"	6 (28.57%)
	F3	"…Disqualified durian will be sent to domestic market and processing market…"	
	R2	"…The durian fruits which are disqualified for export will be sent to processing house to produce frozen durian, fried durian, or durian paste…"	
	R3	"…Soft-meat durian will be sent to frozen durian processor…" "…Some exporters will peel the durian which is failed to be exported and sell only durian meat to durian processor…"	
	E1	"…Durian failed to be exported will be sent to processing market and sold in the country…"	
	E2	"…If there are any problems in relation to shipment error which causes the durian too ripened, the best destination for them is not any one but processing market…"	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
4. Supply chain members before processor are seen as durian suppliers	F1	"…The processor sources durian from farmer, packing house, and cooperative…"	4 (19.05%)
	F3	"…Processing factory also sources durian from consolidator…"	
	P1	"…We considered ourselves as producer, wholesale trader, and product distributor…" "…Supply side, we get durian from consolidator on one hand; on the other hand, we take it directly from farmer by dealing through provincial commercial office, through provincial cooperative promotional office…"	
	P3	"…The 1st stage processor buy durian from every channel they can get access to the whole year…" "…and the fried durian group buy durian directly from farm as well…"	
5. Relationship between farmer and processor has been formed via 'Contract Farming'	P1	"…we do have. Our company has determined a management policy that at what price we are going to buy durian at a specific time and assigning consolidator to buy durian from farmers at the price we set. It can be considered as using indirect contract farming or contract farming via consolidator as mediator. The contractual parties signed in the contract will be between our company and farmers. Yet,	2 (9.52%)

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
		contract farming will be used only sometimes depending on the seasonal period, not always…" "…Using contract farming helps us control the goods we purchased. We can control the cost of goods sold, selling price, and quantity as well as quality of products produced. It helps in negotiating with our customers regarding the price of products sold and the shipment period…"	
	P2	"…We purchase durian in every channel, including contract farming, to feed raw material into the process during on-season…"	
6. Processor supplies durian products to downstream business	F1	"…The processing factory does not sell the products on its own but it sells via supermarket and retail shop. Sometimes, they receive the orders from foreign countries; then, they export the products…"	5 (23.81%)
	P3	"…We sell our products to souvenir shops and supermarket…"	
	W1	"…There are two export channels of processed durian products. The first one is in the way that the traders make a deal by issuing L/C (Letter of Credit) in advance. This is done for whole frozen durians which are packed in boxes and will be resell abroad such as America. Another type of product is frozen durian meat which may	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
		be used in Thai restaurants and supermarkets in foreign countries. The second method is that durian is processed as material for further production. This will be exported in the meat-only form and reproduced as freeze-dried durian in destination country…"	
	R3	"…Nowadays, there are some who export only durian meat through air freight to USA…"	
	E1	"…Processors, like freeze-dried durian, frozen durian, fried durian, or durian paste, will export to foreign market themselves. Domestically, they sell to convenience store, supermarket, souvenir shops…"	
7. Processor is divided into two stages	P1	"…processed durian products will only be exported. There is also some domestic demand that they want which are ice-cream company and those who want to buy to produce freeze-dried durian. Because freeze-dried durian production needs to use frozen durian in the production process…"	2 (9.52%)
	P3	"…Our firm buy durian as raw material from the merchant who processes like fried durian. It is too ripened to fry then they send to us…"	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
8. Wholesaler and retailer are the suppliers to the downstream businesses	F3	"…Retail merchant comes to buy durian at farmgate but very few merchants still exist…"	6 (28.57%)
	P2	"…Big-scale retail merchant or supermarket will buy at wholesale amount but resell in retail market…"	
	W2	"…Some retailers also directly go to buy from farmers…"	
	R1	"…For us, we have suppliers performing durian gathering from farmgate and central market and sell to us which we will resell via our branch stores to ultimate consumers…"	
	R2	"…Our customers mostly are individual consumers and some are small-scale food shops. We cannot actually identify which group our customers belong to. However, we used to see some customers buy durian meat from us to make ice-cream, cake, or smoothie beverages. The benefits for them are that they do not need to bear durian stock. Additionally, they do not need to bear risk because, in each day, they cannot predict how many customers will visit their shops…"	
	E2	"…Retailer or supermarket tend to buy from wholesaler in the central market since it costs them less than direct purchase from consolidator…"	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
9. Consolidator is the critical member of the chain	F3	"…Consolidator is a big merchant who links with the sourcing agent or small merchant who supplies durian to consolidator and those who demands for durian. We need to depend on this mechanism…" "…The quality of durian sold in the market, whether mature or immature, depends on sourcing agent and consolidator…" "…Presently, consolidator is the center of all things about durian…"	2 (9.52%)
	M2	"…Today, consolidator becomes the most influential player in durian supply chain. They are now the one who determines the market price, which is used as reference price by other players, and quantity of durians traded in the market…" "…Consolidator becomes the center of durian trade where the durian products are gathered, the price are quoted based on quality, the product treatment and handling are performed, as well as product distribution to each destination market is done. It can be considered that all activities are performed in one stop…"	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
10. Consolidator is exporter	F2	"…Consolidator and exporter are the same actor. They all are hired by foreign importer to gather durian from farm, grading, packing, and transport to destination country in one shot…"	5 (23.81%)
	F3	"…Exporter is consolidator. Currently, these two parties become one since to survive in durian business as exporter also requires grading skills which consolidator is keen on…"	
	P1	"…Consolidator steps forward to export by themselves and exporter steps backward to play as consolidator…"	
	E1	"…Nowadays, packing house or consolidator and exporter becomes one party already because of the facilitation service that manages the export procedures on behalf of them…"	
	E2	"…Consolidator plays at least two roles which are packing house and exporter. Mostly, in practical, all activities are done at one place but just being divided by the name of juristic persons in the relevant documents…"	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
11. Roles of exporter consist of quality inspection, grading, sorting, product treatment, product handling, and exportation.	F2	"…We have the task to produce quality durian only for selling to consolidator and other tasks will be performed by consolidator. Consolidator is the one who manages the durian fruits by cleaning, grading, and delivering to each different market…" "…Consolidator is just quality inspector of post-harvest produce…"	9 (42.86%)
	F3	"…In the past, consolidator would select only A and B graded durian but, recently, they buy every unit, A, B, C, D grade, they buy them all and classify each unit to each market. A and B to be exported. C and D are sold in the country…"	
	P1	"…Consolidator steps forward to export by themselves and exporter steps backward to play as consolidator…"	
	W1	"…There are two export channels of processed durian products. The first one is in the way that the traders make a deal by issuing L/C (Letter of Credit) in advance. This is done for whole frozen durians which are packed in boxes and will be resell abroad such as America. Another type of product is frozen durian meat which may be used in Thai restaurants and supermarkets in foreign countries. The second method is that durian is processed as material for further production. This will be	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
		exported in the meat-only form and reproduced as freeze-dried durian in destination country…”	
	R3	“…Some exporters also play the role of wholesalers who supply durian which is failed to be exported to domestic market, like in central market…”	
	E1	“…From farmer, durian will be passed to consolidator to be graded, dipped into liquid substance and turmeric water, piled up, packed into box, load into conditioned container, and shipped abroad…”	
	E2	“…Consolidator plays at least two roles which are packing house and exporter. Mostly, in practical, all activities are done at one place but just being divided by the name of juristic persons in the relevant documents…”	
	G2	“…After it comes out from farm, it will be shipped to consolidator to be graded. At consolidator’s site, it will be graded, cleaned, treatment by heat blowing for the purpose of pest repellent or elimination and dip into yellow-color liquid medicine, pack in ten-kilogram box or three units of durian, and load into container…."	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
	M2	"…Today, consolidator becomes the most influential player in durian supply chain. They are now the one who determines the market price, which is used as reference price by other players, and quantity of durians traded in the market…"	
12. Labor policy should be deregulated and fair trade should be promoted	F1	"…Government must take the interest of farmer into consideration. They must deregulate the migrated labor policy because we are short of labors during harvesting period. It affects at least ten thousand farming plots…"	2 (9.52%)
	E3	"…Government must sufficiently fulfill the necessary resources to entrepreneurs, and they need to create fairness in trading by not letting the market manipulation or domination happen, as well as relieve the controlling scheme; particularly the scheme about labor, trading regulations and standards…"	
13. Roles of government sector deals with business matching, trade promotion, product and process certification.	P1	"…Supply side, we get durian from consolidator on one hand; on the other hand, we take it directly from farmer by dealing through provincial commercial office, through provincial cooperative promotional office…" "…In the part that we deal with the farmers through government sector, we will ask the government officials to participate in making a suggestion to or educating durian farmers about farm management and durian quality development so that the desired	4 (19.05%)

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
		quality durian is obtained. If the farmer can supply a quality one, we will buy them all. It is because the cost of quality management tends to keeps higher everyday…"	
	R2	"…we talked with Department of Internal Trade and found that it matched with our objectives regarding promotion on production based on domestic demands. This helps us getting products with good quality that matches domestic demand because such department segment the market based on quality attributes which is consistent with our approaches…"	
	E3	"…Government must control the access of foreign traders not to be able to get direct access to the farmgate nor to invest in constructing their own trading sites…" "…not just arranges a meeting to talk about problem resolution but to consider what consolidators are lack of. Government must fulfill it not just set up rules to control them. If they are short of labors or trucks, provide them the sufficient resources…"	
	G2	"…Durian farm, the farm, that farmer must be certified according to standard practice system of Department of Agriculture…" "…in the evening, durian will be transferred to grading consolidator. If consolidator will classify durian into each different grade, grade A will be exported, grade B and	

Theme of key information obtained from interview	Code of informant	Quotes of informant contributing to the theme	Number of responded informants
		C will be sold within the country. If consolidator is to perform the grading task, they must be certified GMP (Good Manufacturing Practice) by Department of Agriculture…"	

It can be seen from the Table 4.1 that ‘farmer is the starting point of the durian supply chain’ holds the highest response rate among thirteen themes with 52.38% of the total number of informants. Meanwhile, there are four themes holding the lowest rate of 9.52% of total number of informants which consist of;

- Relationship between farmer and processor has been formed via ‘Contract Farming’
- Processor is divided into two stages
- Consolidator is the critical member of the chain
- Labor policy should be deregulated and fair trade should be promoted

However, even though some of the thirteen themes embrace a low response rate from the interview, no objection or contradiction had been found. All thirteen themes are still retained in this study with the awareness of low reliability for further analysis as a result.

4.1.2 Supply Chain Structure in the View of Producer

The producer group comprises two subgroups which are durian farmer and processor. The former subgroup holds the function of plantation, farm management, and harvest while the latter one inspects the quality of durian purchased as input material, controls product quality, provides warehousing, produces durian-based products, inventory management, product handling and shipment, and other business-related activities.

4.1.2.1 Farmer’s perspective

The farmer’s understanding of the durian supply chain structure was seen by the three respondents as illustrated in Figure 4.1;

As seen in Figure 4.1, the farmer was the sole source of durian production for every actor along the supply chain. They need to focus on the production process mainly since it is affected by various numbers of uncontrollable factors; for example, labor shortage, inclement weather conditions, water resource shortage, pests, and others. This is summarized from the quotes of farmers and supporting statements from other groups as displayed in Table 4.2.

Table 4.2 Summary of Interview Dialogues Stating about the Starting Point of Supply Chain

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
F1	"…my income is reliant on. It is all problematic. The problem of labor, the problem of drought, the problem of inclement weather influences the maturity stage of fruit which may delay the harvesting time. Especially, we mostly need to rely on climate…" "…To estimate the maturity of durian, area of plantation and the condition of durian tree, durian cultivar, and the shape of durian need to be taken into account of. It is the duty of farmer to take care of and jot down their own farming period; like the bloom of durian flower, the bear fruit period, and so on…"
F2	"…We have the task to produce quality durian only for selling to consolidator and other tasks will be performed by consolidator. Consolidator is the one who manages the durian fruits by cleaning, grading, and delivering to each different market…"
P2	"…To be a producer, we need to have our own tree…" "…After the durian fruit is away from farm, it will come to our processing site…"
G1	"…Durian supply chain starts from farmer…"
G2	"…Steps of supply chain in Thailand, it starts when durian coming out from farm…"
E1	"…To start trading, we need to consider whether such durian farm meets its standard or not…"
E2	"…The starting point od durian supply chain is farmer…"
E3	"…Farmer is the starting point as main player…"
W2	"…The durian is started from the farmer, first…"
R2	"…After we set up our selling plan and schedule, we will go to talk with individual farmer, farmer group, cooperative, private sourcing firms about the quantity, the period, and quality specification of products we

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	are going to buy. We source products from various sources to diversify the risk…"
M2	"…All agricultural produce, not just durian, will first start from farmers. Then, those produce will come to the central market through mediator or local collector who gathers the produce from the area of production and sells to the wholesale merchants in our market…"

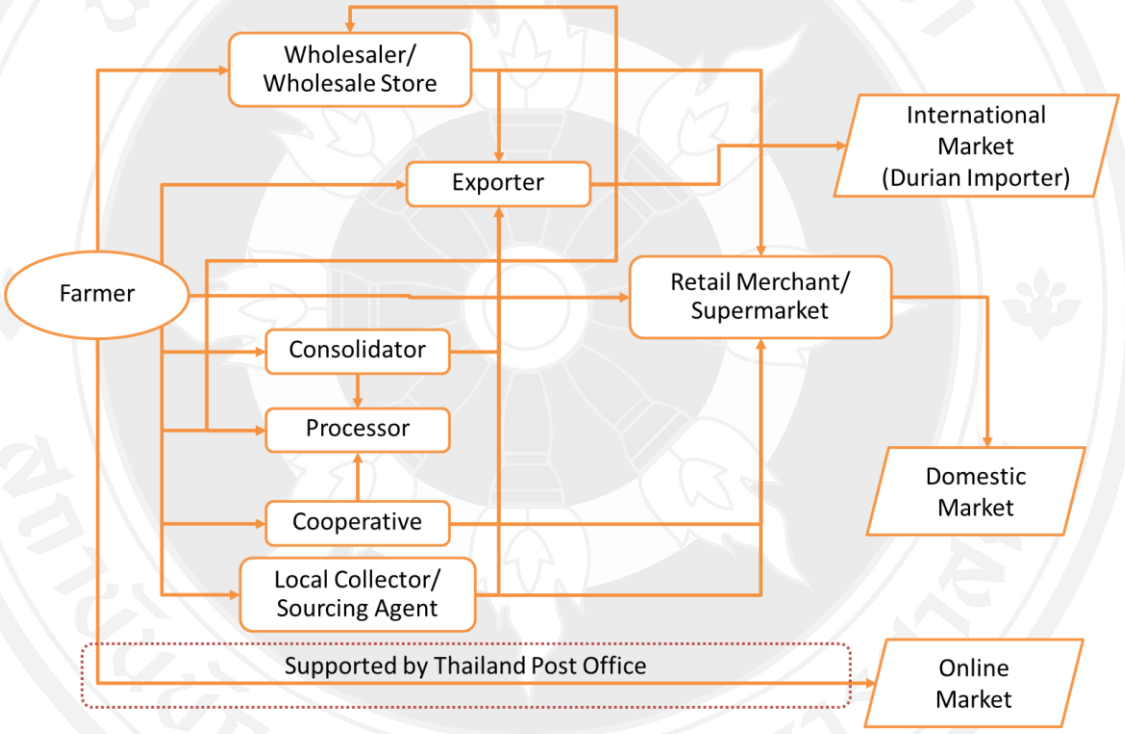

Figure 4.1 Durian Supply Chain Characteristics Based on Farmer's Viewpoint

However, all three farmers defined the durian processor as one of their markets or trade destinations because when durian is delivered to the processing site, either in the form of whole durian fruit or durian meat without rind, it is transformed into other forms of product which are difficult to identify by weight, and require different quality measurement approaches. Additionally, the processed durian will be packaged

differently from the fresh one, which requires different methods of product shipment and handling.

Moreover, two out of three farmers mentioned a new supply chain channel which is online trade. This online market just started being popular around five years ago. This is due to the communication technological advancement of the nation which connects them to the online community, especially through 'Facebook', 'Line', and 'Instagram'. This provides them the opportunity to create a connection to their market or final consumer directly with the support from Thailand Post Office in terms of onsite product pickup and delivery service. This new marketing channel is starting to grow gradually. Quotes and supporting statements from other groups are listed in Table 4.3.

Table 4.3 Summary of Interview Dialogues Stating about Online Trade on Durian

Code of Informant	**Comments/ Opinions of Supply Chain Actors contributing to the Status Quo**
F1	"…If the harvest quantity is few, it will be sold to small-scale merchants. Another channel is to sell online that my daughter is running it. This is the channel done during when not many produces are fruitful, in particular, off-season…" "…We deliver it to individual customer we know from Facebook, Line, Instagram something like that…" "…In the past, technology was still underdeveloped which is different from the present time. We then make use of such development…" "…About the logistics or product shipment system, Thailand Post Office is the major player who comes here to pick up the products. It is the service that serve its customers to compete with other private delivery service providers…"
F2	"…There is online trade in some parts. New-generation-farmers do sell this way. Enterprise likes us also does. Some sell durian meat online…" "…sell via post office. They will send order to us or seek for customers for us and we then need to deliver the goods by using their service…"

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
E2	"…Another new channel is the channel that the e-commerce platform operator, like Line@, directly makes a deal with farmer. This channel starts to grow continuously. They do not need to hold any stocks but only perform marketing tasks…"
R3	"…Some farmers or relatives of them also sell durian via online. They sell in the form of whole fruit not yet peeling. Yet, it is not traded that seriously…"

4.1.2.2 Processor's perspective

After considering the quotes of other groups displayed in Table 4.4, it appears that this group is seen as one of the markets in the others' points of view. However, their functions still make them considered as a producer group in the durian trade system. In this regard, they view the supply chain as appeared in Figure 4.2.

Table 4.4 Summary of Interview Dialogues Stating about the Role of Processor as Destination Market

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
F1	"…Another channel of farmer is to send to processing group…"
F3	"…Disqualified durian will be sent to domestic market and processing market…"
E1	"…Durian failed to be exported will be sent to processing market and sold in the country…"
E2	"…If there are any problems in relation to shipment error which causes the durian too ripened, the best destination for them is not any one but processing market…"
R2	"…The durian fruits which are disqualified for export will be sent to processing house to produce frozen durian, fried durian, or durian paste…"

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
R3	"…Soft-meat durian will be sent to frozen durian processor…" "…Some exporters will peel the durian which is failed to be exported and sell only durian meat to durian processor…"

In the perception of this group, they view the actors before them as their suppliers who supply durian as raw material into their production processes. In the same time, durian farmers classify durian processors as another group of fresh durian customers. This can be summarized from the quotes listed in Table 4.5.

Table 4.5 Summary of Interview Dialogues Stating about Suppliers of Durian Processor

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
F1	"…The processor sources durian from farmer, packing house, and cooperative…"
F3	"…Processing factory also sources durian from consolidator…"
P1	"…We considered ourselves as producer, wholesale trader, and product distributor…" "…Supply side, we get durian from consolidator on one hand; on the other hand, we take it directly from farmer by dealing through provincial commercial office, through provincial cooperative promotional office…"
P3	"…The 1st stage processor buy durian from every channel they can get access to the whole year…" "…and the fried durian group buy durian directly from farm as well…"

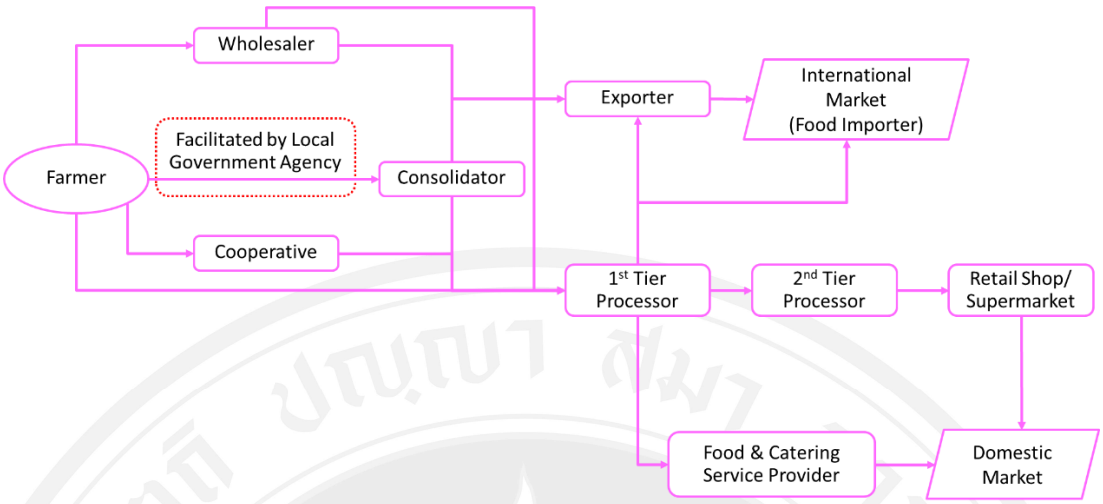

Figure 4.2 Durian Supply Chain Characteristics Based on Processor's Viewpoint

This group has formed a business relationship with a farmer group by enforcing a farming contract, or so-called 'Contract Farming'. Under such a contract, the processor is likely to inform the farmer about the amount of produce to be purchased, quality of goods, buying price, delivery period, and the like. In addition, to assist farmers to fulfill the contractual conditions, the processor chooses to get involved in the farm management process of the farmer by educating the farmer about suitable farming and harvesting methods and conducting on-field monitoring from time to time with the aim to minimize the risk of undesirable harvested produce and to ensure supply consistency. This is drawn from the explanations of processors as displayed in Table 4.6.

Table 4.6 Summary of Interview Dialogues Stating about Relationship between Processor and Farmer

Code of Informant	**Comments/ Opinions of Supply Chain Actors contributing to the Status Quo**
P1	"…Basically, we will inform the farmer that what kind of durian produce we will make a purchase, how much for good grade, how much for undersized grade. Then, they will know what to be sold to us…"

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	"…we do have. Our company has determined a management policy that at what price we are going to buy durian at a specific time and assigning consolidator to buy durian from farmers at the price we set. It can be considered as using indirect contract farming or contract farming via consolidator as mediator. The contractual parties signed in the contract will be between our company and farmers. Yet, contract farming will be used only sometimes depending on the seasonal period, not always…" "…Using contract farming helps us control the goods we purchased. We can control the cost of goods sold, selling price, and quantity as well as quality of products produced. It helps in negotiating with our customers regarding the price of products sold and the shipment period…" "…In the part that we deal with the farmers through government sector, we will ask the government officials to participate in making a suggestion to or educating durian farmers about farm management and durian quality development so that the desired quality durian is obtained. If the farmer can supply a quality one, we will buy them all. It is because the cost of quality management tends to keeps higher everyday…"
P2	"…We purchase durian in every channel, including contract farming, to feed raw material into the process during on-season…"

After the production, the role of processor is transformed from customer to supplier of durian-based products for downstream businesses, like food and catering service providers, supermarkets, and export businesses. This conclusion is drawn from the quotes listed in Table 4.7.

Table 4.7 Summary of Interview Dialogues Stating about the Role of Processor as Supplier

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
F1	"…The processing factory does not sell the products on its own but it sells via supermarket and retail shop. Sometimes, they receive the orders from foreign countries; then, they export the products…"
P3	"…We sell our products to souvenir shops and supermarket…"
E1	"…Processors, like freeze-dried durian, frozen durian, fried durian, or durian paste, will export to foreign market themselves. Domestically, they sell to convenience store, supermarket, souvenir shops…"
W1	"…There are two export channels of processed durian products. The first one is in the way that the traders make a deal by issuing L/C (Letter of Credit) in advance. This is done for whole frozen durians which are packed in boxes and will be resell abroad such as America. Another type of product is frozen durian meat which may be used in Thai restaurants and supermarkets in foreign countries. The second method is that durian is processed as material for further production. This will be exported in the meat-only form and reproduced as freeze-dried durian in destination country…"
R3	"…Nowadays, there are some who export only durian meat through air freight to USA…"

Moreover, this group has divided themselves into two categories which are 1st tier processor, who performs primary durian processing from medium to mature durian meat, like crispy durian, and 2nd tier processor, who produces durian paste from the ripe or overmatured durian meat. This interpretation stems from the quotes listed in Table 4.8.

Table 4.8 Summary of Interview Dialogue Stating about Types of Processor

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
P1	"…processed durian products will only be exported. There is also some domestic demand that they want which are ice-cream company and those who want to buy to produce freeze-dried durian. Because freeze-dried durian production needs to use frozen durian in the production process…"
P3	"…Our firm buy durian as raw material from the merchant who processes like fried durian. It is too ripened to fry then they send to us…"

However, although their business activities are similarly named as the activities performed by other groups of traders, they perform them with different approaches; for example, packing, product handling and shipment, as well as quality control. They perform all these activities based on the standard, measures, and requirements of food products and industrial practices which are different from the other groups that carry out based on agricultural standards and requirements. This is contributed from the quotes displayed in Table 4.9.

Table 4.9 Summary of Interview Dialogues Stating about Activities Performed by Processor

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
P1	"…We will send QC officer to perform quality control and inspection at consolidator's sites…" "…After the production, we must comply with our relevant industrial standard, like GMP, HACCP, as usual, and also perform general business functions, like packing and packaging, quality control, inventory control, as well as shipment to destination determined by our customers…"

4.1.3 Supply Chain Structure in the View of Trader

The trader group comprises three subgroups which are durian wholesaler, retailer, and exporter. The first subgroup trades durian at wholesale level. This group can also be classified as a domestic product distributor who supplies durian to retail operators and food-related businesses while sometimes, like when there is excess supply, they perform cross-border trade to adjacent countries such as Lao PDR and Cambodia via border markets. The second subgroup resells durian from various sources, such as durian farmers, agricultural cooperatives, wholesalers, consolidators, exporters, and sourcing agents, to the domestic market. The last subgroup is considered by most actors along the chain as the key product manager since they hold the largest amount of durian trade in the system. Moreover, they are the party that performs durian grading, quality treatment, price setting, and supplying durian to other domestic and international downstream businesses.

4.1.3.1 Wholesaler's perspective

The durian supply chain in the perception of selected wholesalers can be drawn as shown in Figure 4.3;

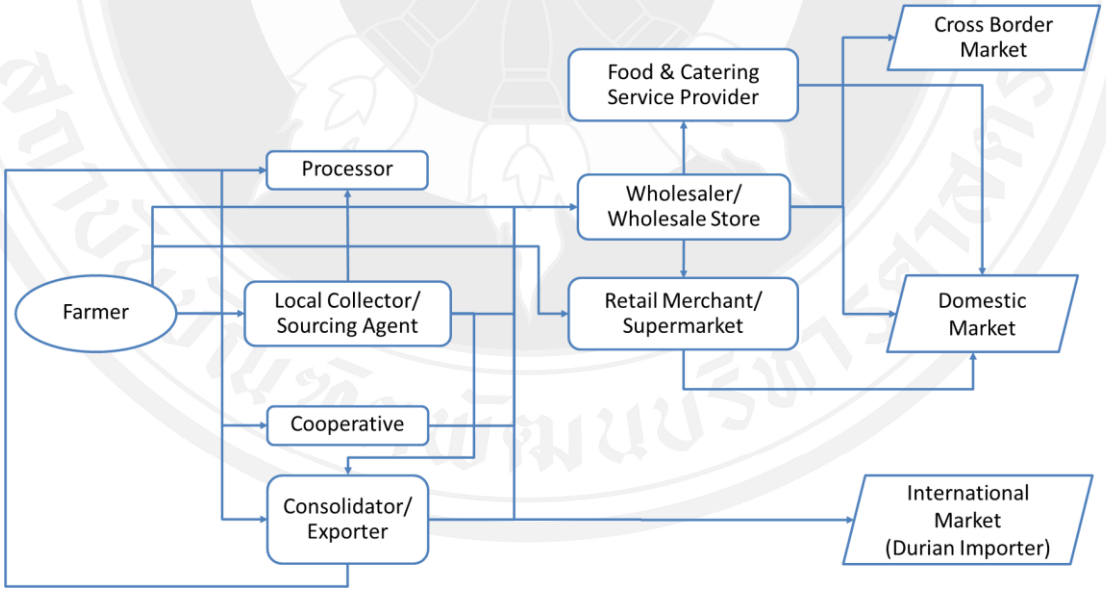

Figure 4.3 Durian Supply Chain Characteristics Based on Wholesaler's Viewpoint

Farmers are still the only source of durian supply in the system. The processor is seen as a customer instead of another type of producer. Food & catering service

providers have stepped into the system as downstream businesses who serve domestic market demand for durian food. The wholesaler not only plays the role of durian distributor within the country but also outside the country, through the border market as well. The major difference between cross-border trade and overseas export to other nations is that there is an import duty and customs clearance exemption on the goods brought across the border at a specific amount for the former method while the latter needs to comply with all international trade regulations and agreements as well as proceed through customs clearance procedure. Some wholesale traders, then, make use of this customs policy gap to extend their businesses to accessible markets. This information is interpreted from the quotes appearing in Table 4.10.

Table 4.10 Summary of Interview Dialogues Stating about Roles and Activities Performed by Durian Wholesaler

Code of Informant	**Comments/ Opinions of Supply Chain Actors contributing to the Status Quo**
P1	"…Both wholesale stores and supermarkets have their own supply channels which are purchasing durian directly from farmer, consolidators, as well as central market…"
E1	"…After grading, the disqualified for export will be sent to wholesaler in central market in Bangkok and other territories as well as processor…"
E3	"…Merchants in central market located in Bangkok and other territories come to purchase at the origin of production and resell in each territory throughout the whole country…"
W1	"…We buy durian from farmers no matter whether they are individual or group…" "…Yes, consumer comes to buy at our stores. Other two groups also come to buy which are merchant group who resell durian in fresh form, and those who buy durian for their production and resell as food products. Those who reselling in fresh form will buy and peel durian and then resell only durian meat…"

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	"…and there will be merchants from foreign market come into country to buy directly from merchants in central market and resell in their own countries, like Lao PDR…" "…The retailers also buy durian from wholesale merchants in each central market in different provinces, like Udonthani, Chantaburi, Bangkok and its territories…" "…Wholesale traders also perform grading durian. Those which suit export will be delivered to consolidators. Those which fail to be exported will be sold by themselves at their shops in central market…"
W2	"…There will be like retail merchants come to buy from us. We can also be counted as distributor within the country who links durian fruits from farm to retailer…" "…There will be dealer going to the farm to buy and gather durian fruits for us…"
R1	"…There are durian collectors in the production area who gather durian fruits from each farm and deliver to merchants in central market…"
M1	"…after they come to the merchants in central market, they will be sold to the group of modern traders who are both wholesale store and retail store…"
M2	"…Those merchants who come to trade in our market must wholesale only. No retails are allowed. Then, wholesalers and retailers from other provinces will come to buy in our market…" "…The large-scale entrepreneurs who come to buy durian for serving markets in other provinces; there will be other small-sized markets in-between before reaching end customers. Sometimes, durian fruits depart from our market, where is the largest agricultural wholesale market, to central agricultural market in Udonthani. There will then be a number of ways to go whether to be sold directly to end consumers, or sold through local or community market to consumers, or even traded

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	across border to adjacent countries, like Lao PDR, Myanmar, and Cambodia...”
M3	“…After that, there will be traders who go to collect durian from consolidator’s site and deliver to merchants in the central market. Then, there will be both wholesale and retail merchants in both big-scale and small-scale who come to purchase durian from the central market. Yet, they are mostly wholesaler…”

4.1.3.2 Retailer’s perspective

In retailer’s perception extracted from the interview dialogues shown in Appendix C, the durian supply chain can be illustrated as Figure 4.4. The processor is seen by retailers as another durian reseller who serves both international and domestic demand for durian-based products in the system.

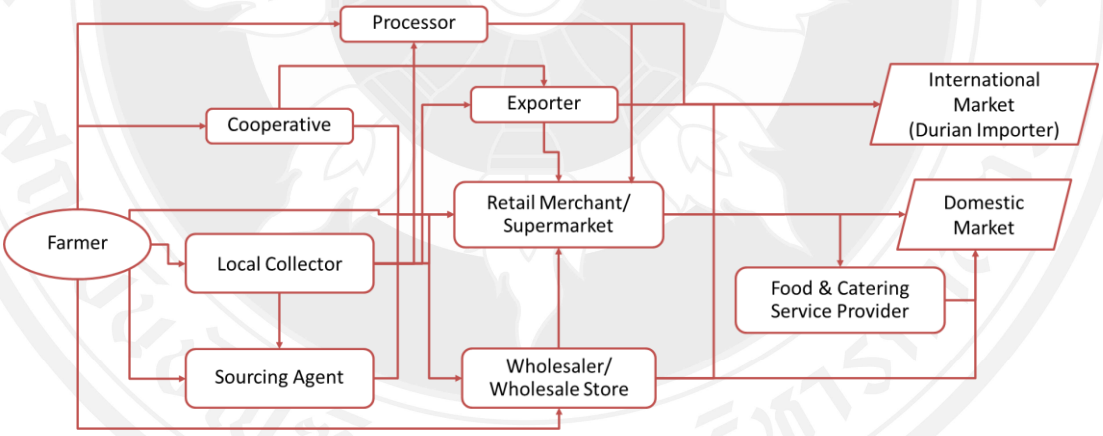

Figure 4.4 Durian Supply Chain Characteristics Based on Retailer’s Viewpoint

Nonetheless, comparing the information obtained from the wholesaler group, the wholesaler is not the only supplier of the downstream business but the retailer also supplies durian to this kind of business as well. Even though both groups supply durian as raw material for production by downstream businesses, they do it at different levels. The wholesaler tends to focus serving the demands of medium to large scale

downstream businesses while the retailer positions itself as a warehouse to stock the inventory for small to medium enterprises in order to help the small-scale business save the cost of inventory. This can be interpreted from the quotes listed in Table 4.11.

Table 4.11 Summary of Interview Dialogues Stating about Roles of Wholesaler and Retailer

Code of Informant	**Comments/ Opinions of Supply Chain Actors contributing to the Status Quo**
F3	"…Retail merchant comes to buy durian at farmgate but very few merchants still exist…"
P2	"…Big-scale retail merchant or supermarket will buy at wholesale amount but resell in retail market…"
E2	"…Retailer or supermarket tend to buy from wholesaler in the central market since it costs them less than direct purchase from consolidator…"
W2	"…Some retailers also directly go to buy from farmers…"
R1	"…For us, we have suppliers performing durian gathering from farmgate and central market and sell to us which we will resell via our branch stores to ultimate consumers…"
R2	"…We are sellers and supporters as well. We cannot be just retailers but to be developers who develop production origin…" "…Our customers mostly are individual consumers and some are small-scale food shops. We cannot actually identify which group our customers belong to. However, we used to see some customers buy durian meat from us to make ice-cream, cake, or smoothie beverages. The benefits for them are that they do not need to bear durian stock. Additionally, they do not need to bear risk because, in each day, they cannot predict how many customers will visit their shops…"
M2	"…The 3rd tier of supply chain will be the one who delivers durian to consumer…"

4.1.3.3 Exporter's perspective

This group perceives that they are the only group which serves international demand via both oversea and cross-border export as illustrated in Figure 4.5. This group also perceives processors as another market different from the conventional one.

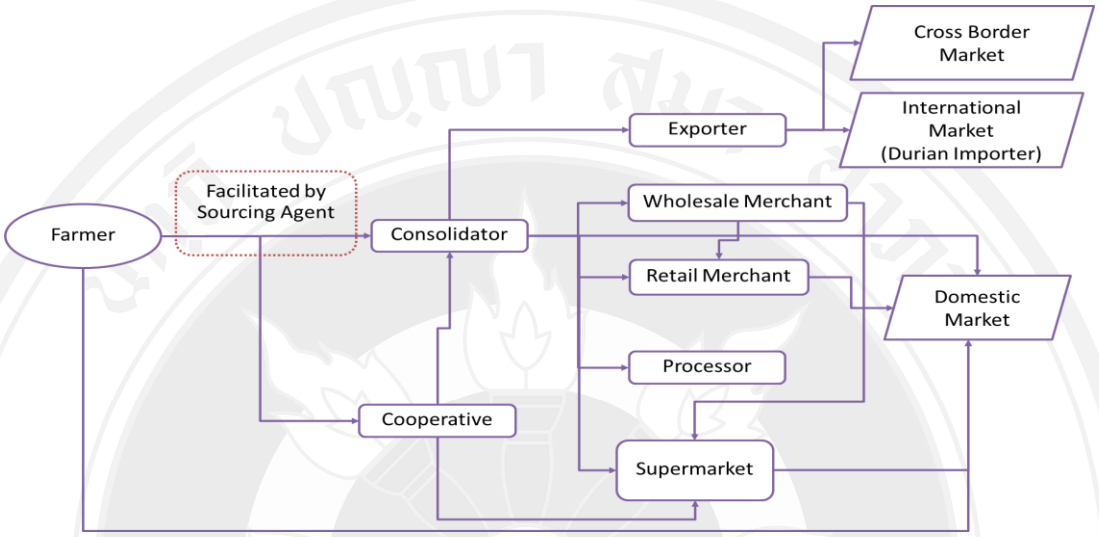

Figure 4.5 Durian Supply Chain Characteristics Based on Exporter's Viewpoint

In the durian system, the consolidator tends to be the actor who supplies the goods to almost every trader along the chain. Thus, the consolidator holds the core business activity in the system which is quality grading before reselling durian to each market with different requirements on product attributes such as shape, maturity, percentage of durian meat, external condition of durian fruit, and others. However, the consolidator mostly requires facilitation support from sourcing agents to gather fresh durian from the farm site. In many cases, consolidators are perceived as exporters since they are hired by foreign importers to deal with all processes from farm to ports. This summary is supported from the quotes of exporters and supporting quotes of other groups displayed in Table 4.12.

Table 4.12 Summary of Interview Dialogues Stating about Roles and Activities Performed by Consolidator

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
F2	"…Local collector changes to be subordinate hired by consolidator. In the past, local collector collected durian from each farm and resold to unknown customers in the market with markup price for profit. Recently, consolidator hires local collector to gather durian for them to save cost of tools and equipment, like trucks, scales…" "…Consolidator is just quality inspector of post-harvest produce…" "…Consolidator and exporter are the same actor. They all are hired by foreign importer to gather durian from farm, grading, packing, and transport to destination country in one shot…"
F3	"…Consolidator is a big merchant who links with the sourcing agent or small merchant who supplies durian to consolidator and those who demands for durian. We need to depend on this mechanism…" "…The quality of durian sold in the market, whether mature or immature, depends on sourcing agent and consolidator…" "…local collector is sourcing agent…" "…In the past, consolidator would select only A and B graded durian but, recently, they buy every unit, A, B, C, D grade, they buy them all and classify each unit to each market. A and B to be exported. C and D are sold in the country…" "…Presently, consolidator is the center of all things about durian…" "…Exporter is consolidator. Currently, these two parties become one since to survive in durian business as exporter also requires grading skills which consolidator is keen on…"
P1	"…Consolidator steps forward to export by themselves and exporter steps backward to play as consolidator…"
G2	"…After it comes out from farm, it will be shipped to consolidator to be graded. At consolidator's site, it will be graded, cleaned, treatment

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	by heat blowing for the purpose of pest repellent or elimination and dip into yellow-color liquid medicine, pack in ten-kilogram box or three units of durian, and load into container….”
E1	“…From farmer, durian will be passed to consolidator to be graded, dipped into liquid substance and turmeric water, piled up, packed into box, load into conditioned container, and shipped abroad…” “…Nowadays, packing house or consolidator and exporter becomes one party already because of the facilitation service that manages the export procedures on behalf of them…”
E2	“…Before harvesting, there will be a group of people whether belong to our firms or outsider who will seek for goods and are called as buyers. They will reserve the goods, make a deposit, and sign willing-to-buy contract in advance. Then, they will make a selling offer to consolidator…” “…Consolidator plays at least two roles which are packing house and exporter. Mostly, in practical, all activities are done at one place but just being divided by the name of juristic persons in the relevant documents…”
R3	“…Some exporters also play the role of wholesalers who supply durian which is failed to be exported to domestic market, like in central market…”
M1	“…From farmer, there will be collectors who transfer durian to consolidator’s site…”
M2	“…Today, consolidator becomes the most influential player in durian supply chain. They are now the one who determines the market price, which is used as reference price by other players, and quantity of durians traded in the market…” “…Consolidator becomes the center of durian trade where the durian products are gathered, the price are quoted based on quality, the product

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	treatment and handling are performed, as well as product distribution to each destination market is done. It can be considered that all activities are performed in one stop…"
M3	"…In durian trade system, farmer will gather the product and deliver to consolidator's site…"

Further information gained is that the farmer group has its own channel direct to the domestic market in the form of agritourism to serve individual customers. Agritourism holds the activities where tourists or customers can visit the durian farm with a durian buffet program and durian products are sold as souvenirs at the farm gate. This channel is different from the direct link to the market explained by the farmer group in the previous section. This interpretation stems from the quotes of exporter E2 which is displayed in Table 4.13.

Table 4.13 Interview Dialogue Stating about Agro-Tourism Market

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
E2	"…Some consolidators arrange durian buffet program in their own sites or considered as B-to-C channel. Some farmers also do B-to-C marketing, whether through online channel, or on-site consumption. This holds interesting growth rate and continues to expand…"

4.1.4 Supply Chain Structure in the View of Trade Facilitator

The trade facilitator group comprises two subgroups which are government officials and market operators. The former subgroup has its duty of policy-making in various approaches which are likely to have an impact on the whole durian supply chain system such as promotion, control, permission, restriction, inspection, problem resolution, and so on. While the latter group invests and constructs an agricultural market where fruit produce, including durian, are traded. They can then be considered

as the trade facilitator in the supply chain system since they create and provide marketing channels for agricultural trade as well as dispute resolution regarding the trading activities through their markets.

4.1.4.1 Government agency's perspective

The representatives of government agencies are the officials concerned with production and trade promotion in the area of Chantaburi province, which is the target area of this research, and the policy has been implemented and formulated and administered in the central department or head office.

This group tends to view the durian supply chain structure in overview since they need to take the requirements of every single stakeholder along the supply chain into account when they design or formulate any policies. As a result, they are able to provide complete general information about the supply chain structure while the other groups deliver specific information in their own fields.

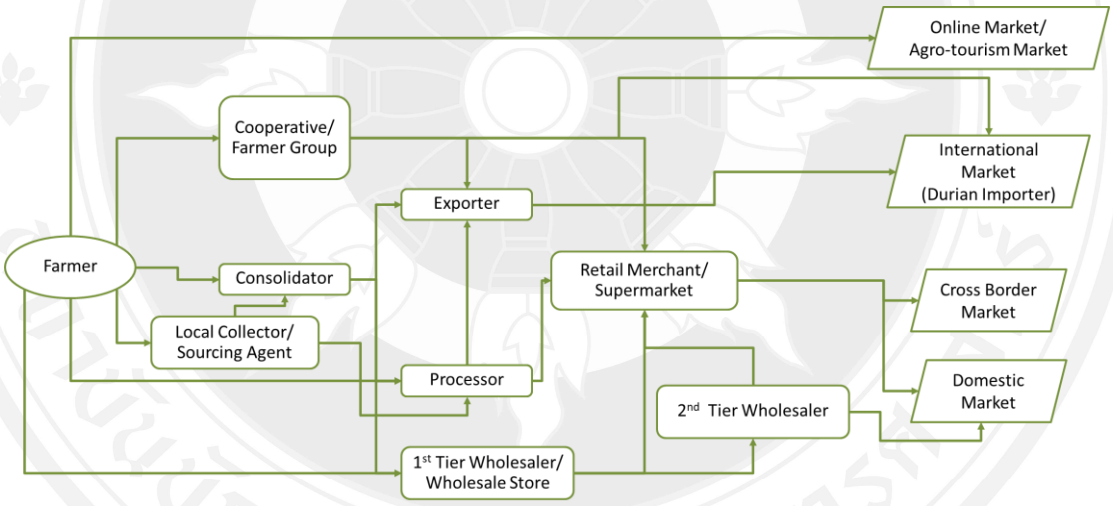

Figure 4.6 Durian Supply Chain Characteristics Based on Government's Viewpoint

From the interview, it appears that the government group tends to view the supply chain structure in a way that combines the comprehension of all groups together. However, this group divides wholesalers into two stages which are 1st tier wholesalers, who trade durian within the area of production, and 2nd tier wholesalers, who trade durian from the source of production to other areas or provinces. This is derived from the quote of wholesaler W2 displayed in Table 4.14.

Table 4.14 Interview Dialogue Stating about Stages of Wholesale Trade

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
W2	"…The sourcing agents will sell durian to wholesale merchants in central market in Bangkok before delivering again to wholesale traders in other provinces…"

Regarding the tasks of the government agency, there is an expectation from the other groups that the government must be the one who facilitates the trade by all means, not just organizing a promotional event or trading fraud suppression but to deploy other courses of action; for instance, subsidization of business resources, fair-trade creation, trade-related deregulation, and others. This is drawn from the quotes in Table 4.15.

Table 4.15 Summary of Interview Dialogues Stating about Roles of Government Agency

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
F1	"…Government must take the interest of farmer into consideration. They must deregulate the migrated labor policy because we are short of labors during harvesting period. It affects at least ten thousand farming plots…"
E3	"…Government must sufficiently fulfill the necessary resources to entrepreneurs, and they need to create fairness in trading by not letting the market manipulation or domination happen, as well as relieve the controlling scheme; particularly the scheme about labor, trading regulations and standards…" "…Government must control the access of foreign traders not to be able to get direct access to the farmgate nor to invest in constructing their own trading sites…"

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	"…not just arranges a meeting to talk about problem resolution but to consider what consolidators are lack of. Government must fulfill it not just set up rules to control them. If they are short of labors or trucks, provide them the insufficient resources…"
G2	"…Durian farm, the farm, that farmer must be certified according to standard practice system of Department of Agriculture…" "…in the evening, durian will be transferred to grading consolidator. If consolidator will classify durian into each different grade, grade A will be exported, grade B and C will be sold within the country. If consolidator is to perform the grading task, they must be certified GMP (Good Manufacturing Practice) by Department of Agriculture…"
R2	"…we talked with Department of Internal Trade and found that it matched with our objectives regarding promotion on production based on domestic demands. This helps us getting products with good quality that matches domestic demand because such department segment the market based on quality attributes which is consistent with our approaches…"

4.1.4.2 Market operator's perspective

This group facilitates agricultural traders by providing trade facilities such as physical space for trade, area for inventory storage, loading and unloading service, information sharing service, quality inspection control, dispute settlement service, and others. This makes the market the center of agricultural trade where sellers, buyers, and intermediaries gather in the same place. Referring to the quotes of the market operator group and supporting quotes of other groups displayed in Table 4.16, the market operator is rated as one of the crucial trade facilitators as a result.

Table 4.16 Summary of Interview Dialogues Stating about Roles of Market Operator

Code of Informant	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
M2	"…All trading activities are performed by the traders in our market. Our tasks are just facilitation by offering various activities such as area, electricity, security, parking area, promotion. That's all…" "…If there are any disputes between buyer and seller, we will let them resolve by themselves, basically. If they cannot come to a desirable end, we will step in to be mediator to resolve the problem…" "…If durian market price is manipulated, the products will overflow into central market…"
M3	"…As a trade facilitator, we serve the traders in our market by offering them the area for inventory storage for rent, labor provision, cleaning service, dispute resolution, and sometimes we do a product sample test and examination on quality and chemical residue at a random basis…"

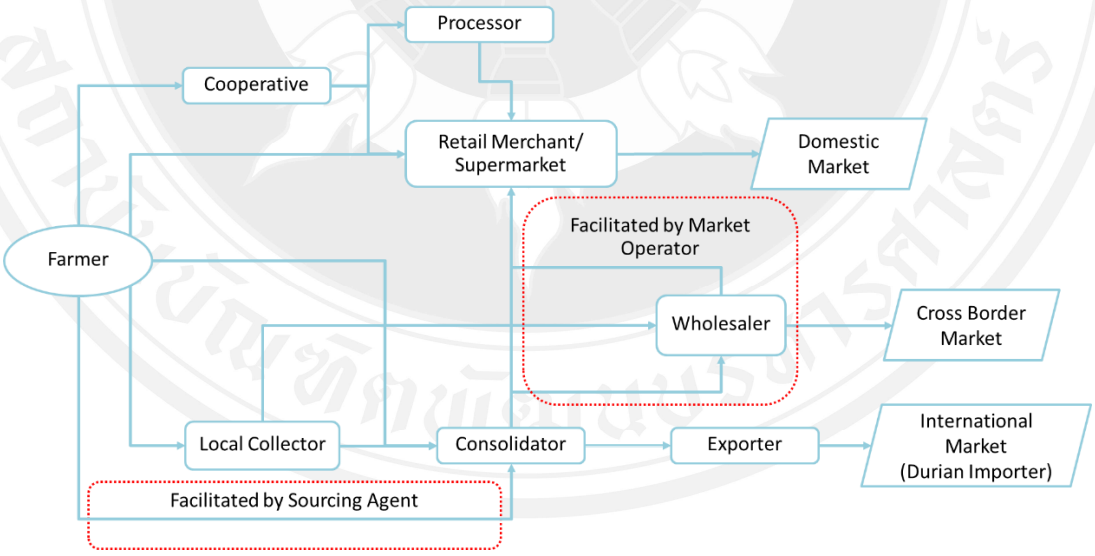

Figure 4.7 Durian Supply Chain Characteristics Based on Market Operator's Viewpoint

The durian supply chain structure in market operator's perception is not seen differently from the other groups but is less complicated since they position themselves as only observers, not players in the field.

4.1.5 Summary of Thai Durian Supply Chain Structure

From the interview collected from 21 informants belonging to 7 groups of supply chain actors, no contradictory information has been found. All information obtained from different groups are consistent with each other. The data obtained can then be implicitly counted as valid and reliable. Consequently, the complete durian supply chain map can be drawn as shown in Figure 4.8.

As it can be seen in the Figure 4.8, the farmer is the sole supplier for fresh durian to the durian system and the destination of durian in both fresh and processed form consists of five markets which are domestic market, international market, cross-border market, agritourism market, and online market.

In the durian trade, there are three actors who can be considered as the most influential traders in the system, which are (1) Local collector/sourcing agent, (2) Consolidator, and (3) Cooperative/farmer group. They are the ones who gather durian produce at their sites to perform a number of treatment activities before distributing to other parties after them. The activities performed by those three are product gathering, quality grading, classification, price evaluation, packing and handling, and delivery to destination. Since these three handles most of the durian produce harvested from farms, they then play the most critical role in the system from the supply side.

However, on the other hand, supply is not the only factor determining the success of business, but also demand information or market access. The bargaining power in the system is then balanced, or sometimes dominated, by these supply chain actors on the other side who hold marketing information and access. They comprise four parties which are (1) wholesaler, (2) retailer, (3) exporter, and (4) processor. The main business activities executed by these four actors are quite similar, which are quality inspection of the durian purchased, product classification based on market requirements or production process, purchased price bargaining to control the cost of goods, quality control of the products sold to the markets, packing and packaging,

inventory management, marketing and selling, and even post-purchase service or customer relationship management.

The group of food and catering service providers is the group with least impact on the durian system since this group does not put an emphasis on durian production but only creates added value in their service by using durian as a means. Even so, this group embraces marketing potential in adding value into durian products, apart from durian processors, which may affect the marketing price of durian somehow.

The last group of supply chain actors is trade facilitators who support the trade in durian in the supply chain system. Starting with market operators, this type of facilitator can assist durian trading activities limited to only those trades taking place within its own marketplace, due to the nature of business. Therefore, the government organization is the key player to perform this duty on a larger scale since it embraces the legal authority to do so. Some supporting activities performed by these two groups partially overlap, like quality inspection of the durian traded in the market, and promotional campaign organization. Conversely, some activities can only be performed by government agencies like business-to-business (B-to-B) matching, trade control, financial and non-financial subsidization, farm and business accreditation, and the like.

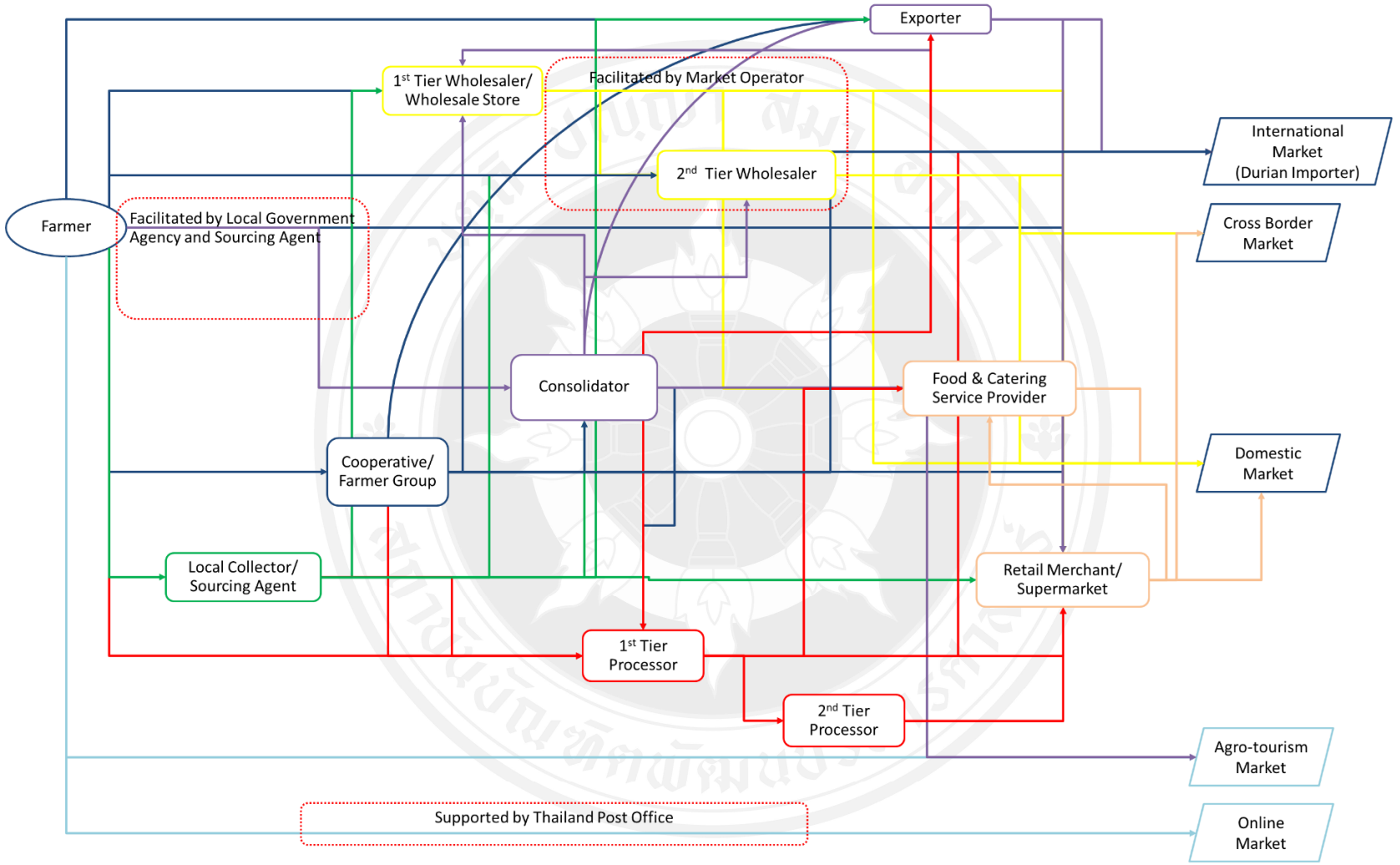

Figure 4.8 Complete Thai Durian Supply Chain Structure

However, to simplify the complicated Thai durian supply chain structure, the concept of schematic diagram of supply chain (Lazzarini et al., 2001, cited in Van der Vorst, 2006) has been employed and the supply chain structure can be redrawn as appears in Figure 4.9.

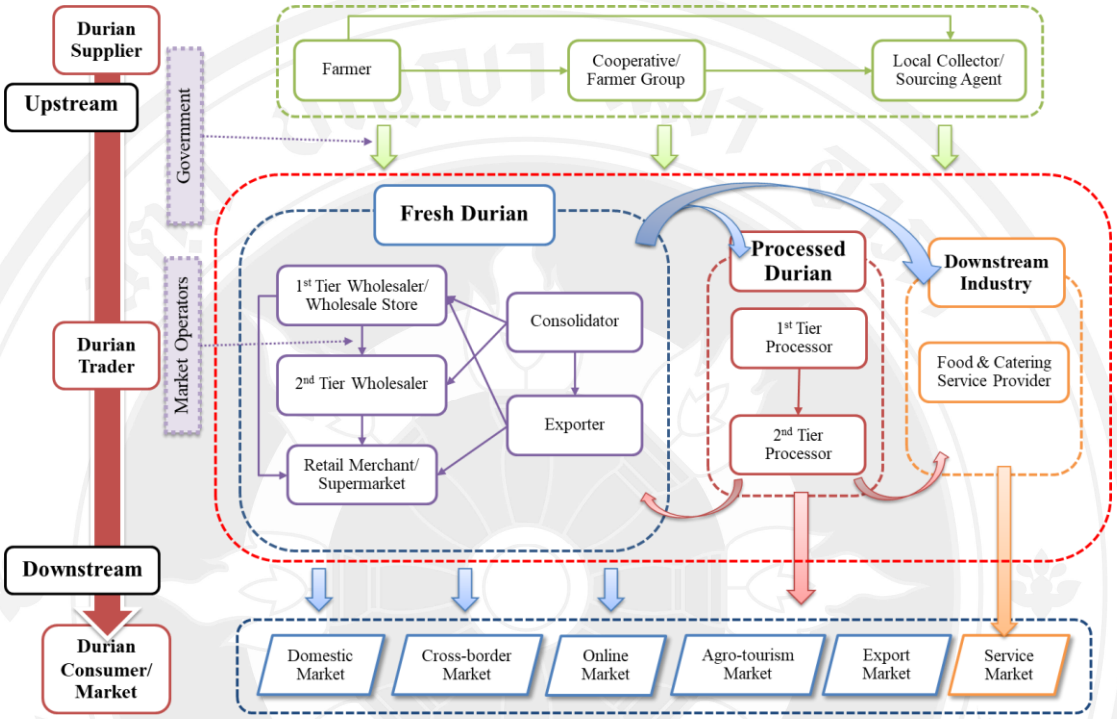

Figure 4.9 Schematic Diagram of Thai Durian Supply Chain

In Figure 4.9, it can be seen that the durian fruits are traded mainly in two forms which are fresh durian and processed durian. The groups of supply chain actors are regrouped by using the stage of industry (upstream, mid-stream, and downstream) as a criterion instead of business function. It appears that the cooperative/farmer group, and local collector/sourcing agents become one of the durian suppliers of the industry instead of being one of the durian traders. In the meantime, the groups of processors are in the mid-stream instead of being in the same group with farmers as producers since the durian used in the processing plant is supplied by durian farmers in the upstream industry.

As seen in the Figure 4.9, the group of supply chain actors in the upstream industry is the group that supplies or transfers fresh durian fruits from the durian

orchards to the production sites of the midstream industry. Not just trading across the industry stages, the members of the same stage also trade with each other while the durian farmer is still the sole supplier who plants and harvests durian from the orchards and sells to other members.

The farmer group or cooperative is a group of durian farmers who embrace the same objective to strengthen their bargaining power in the market by offering their trading partners quality-controlled products, stable price offerings, and consistency of product quantity. To establish a group or cooperative, the group of farmers need to comply with the regulations specified by the Ministry of Agriculture which covers the process of member directory establishment, registration, meeting arrangement, management team appointment, management execution, accounting and auditing, and others. Therefore, with the advantages of being a member of a cooperative, some durian farmers select to sell their products to the group and expect for higher profit/benefit sharing than individual sales. After the products are sold and income is earned, the net profit will be shared among the group or cooperative members on a fair basis based on the production contribution of each member to the group.

Sometimes, if too few durian fruits in the orchards are mature, it will be costly for an individual farmer to transfer them to sell at the market while bearing the risk of getting too low a price which may not cover the cost of production. The local collector/sourcing agent is the player who steps into the chain to resolve the problem by purchasing each small quantity of mature durian produce from each orchard and resell them to the mid-stream entrepreneurs. Nonetheless, the local collector/sourcing agent does not form formal relationships with any specific farmers but wanders around the area to mostly perform a one-time purchase based on market price with any farms where there are durians available to be sold.

In the mid-stream to downstream stage, the industry can be divided into 3 clusters which are fresh durian, processed durian, and downstream business that uses durian as a raw material/ingredient in their business. In this stage, durian produce is likely to be traded across and within clusters before delivering the products to the destination markets.

As mentioned earlier, the consolidator is the actor who purchases and gathers durian produce at their sites to perform a number of treatment activities before

distributing to other parties after them. Most of the durians that come to the site are from the collaboration between the consolidator and the durian farmers who are the partners of the consolidator. On some occasions when there is overwhelming demand from the market, the consolidators will also source durian from other farmers who are not their usual partners to fulfill the orders on their hands. The activities performed at the consolidator's site comprise quality grading, sorting, price evaluation, packing and handling, and delivery to destination. Since they carry most of the durian produce harvested from farms in their hands, they then play the most critical role in the system.

For the group of fresh durian traders, according to the information collected from the interviews, it appears that the destination markets of this group consist of four markets which are domestic market, cross-border market, agritourism market, and export market.

The cluster of processed durian trade uses durian from the group of fresh durian traders. The trading transaction can be in the form of either one-time purchase or contract farming. However, to ensure a consistent supply chain, the processor is likely to enforce contract farming with some durian farmers.

The production of 1st tier processors requires good quality durian and can be divided into two types which are preserved durian products and durian-based products. The former requires only basic processing methods such as deep-frying, freezing, dehydrating, crispy baking and pasting. The latter requires more complicated methods for products such as durian lasagna, durian ice-cream, durian soup, etc. The durian-based products tend to create more value to the durian trade yet it requires very much effort in executing the marketing and business strategies.

However, the 2nd tier processor is the actor who produces durian products by using the disqualified durian or durian with quality too poor to be traded in fresh form, such as overripe durian, misshaped durian, or partially rotten durian. Normally, this group of processors will be supplied the raw material from the 1st tier processor who is their trading partner. This actor will sort and peel durian to get only the durian meat. The durian meat will be used in producing durian paste and durian candy for sale in souvenir shops, supermarkets, export markets and online markets which are their business partners.

For the group of processed durian businesses, it appears that the destination markets of this group consist of four markets which are the domestic market, through souvenir shops and supermarkets, export market, online market with small amounts, and business market by selling to food and catering service providers.

The last cluster of the mid-to-downstream stage is the food and catering service provider. This group is the sole player linking durian from orchards to the service market. This group is supplied durian by the other trader groups who are its suppliers both in fresh and processed forms. The food and catering service providers are the group that use durian as one of the ingredients in making other products to serve their customers through their service business. For example, restaurants, ice-cream shops, cake shops, etc.

Nevertheless, another interesting piece of data collected from the interview is that durian has recently been traded via online platforms mainly by farmers directly to individual customers within the country. This channel tends to offer a number of advantages to farmers such as higher price than conventional trade, lower risk of being unable to sell the product after harvest, predictable amount of orders from the market, etc.

Additionally, on some occasions, mostly during the pre-season and mid-season period of durian, the government sector is likely to get involved in the durian trade and engage in various kinds of facilitating activities. Those activities consist of educating the durian farmers regarding cost control and production quality management, inspecting and suppressing poor quality durian traded in the market, organizing durian trade business matching, promoting online trade through door-to-door delivery facilitation service which directly transfers durian from orchard to customer's hands, as well as arranging durian sales promotional events or campaigns in the consumer market with a reasonable level of subsidization of the product shipment or selling space rentals. These activities have the aim to minimize the cost of production and trade, promote the trade of good quality durian, and generate marketing linkages from farm to table. However, the ultimate expected outcome of such activities is to elevate the income level of durian farmers while minimizing cost.

4.2 Screening Result of Thai Durian Supply Chain Performance Indicators

The primary stage of identification of Thai durian supply chain performance indicators starts with a test of validity on the list of supply chain performance indicators adopted from the framework of Aramyan et al.'s (2006), which formed the theoretical basis of this research. Based on the particular framework, there are nineteen indicators to be tested by asking all informants to rate the importance scores individually.

Referring to the data collection process detailed in the previous chapter, the key informants were to rate importance scores on those performance indicators so that the predefined list of indicators were filtered until only those indicators feasible to Thai durian are obtained. The average scores are computed as displayed in Table 4.17.

Table 4.17 Average Importance Rating Score on Thai Durian Supply Chain Performance Indicators

Code	Name of Indicators	Average Importance Rating Score of				Decision
		Producer Group	Trader Group	Trade Facilitator Group	All Groups	
EFF1	Cost of Production/ Distribution/ Transaction	4.67	4.88	4.00	4.52	Keep
EFF2	Profit	4.17	4.38	4.86	4.48	Keep
EFF3	Return on Investment	3.83	3.13	4.14	3.67*	Remove
EFF4	Inventory Cost	2.50	2.50	3.71	2.90*	Remove
FLX1	Customer Satisfaction	5.00	4.88	4.86	4.90	Keep
FLX2	Volume Flexibility	3.50	3.13	4.29	3.62*	Remove
FLX3	Delivery Flexibility	4.67	3.50	3.29	3.76*	Remove
FLX4	Backorder	3.50	3.38	3.86	3.57*	Remove
FLX5	Lost Sale	3.50	3.63	3.14	3.43*	Remove
FLX6	Late Orders	3.50	4.50	4.14	4.10	Keep
RSP1	Fill Rate	3.67	4.00	4.29	4.00	Keep
RSP2	Product Lateness	3.83	4.00	3.86	3.90*	Remove
RSP3	Customer Response Time	3.00	4.25	4.00	3.81*	Remove
RSP4	Lead Time	3.17	4.25	3.14	3.57*	Remove
RSP5	Customer Complaints	4.67	4.63	4.00	4.43	Keep
RSP6	Shipping Error	3.17	4.00	3.43	3.57*	Remove

Code	Name of Indicators	Average Importance Rating Score of				Decision
		Producer Group	Trader Group	Trade Facilitator Group	All Groups	
FDQ1	Product Quality	5.00	5.00	4.86	4.95	Keep
FDQ2	Process Quality	5.00	4.38	4.57	4.62	Keep

Remark: *Performance indicators with average importance rating score below 4.00 are withdrawn from further analysis (Aramyan et al., 2006)

As seen in the Table 4.1, there are ten indicators failing to meet the cut-off criteria determined earlier in the previous chapter. As a result, there are only eight indicators with high importance levels remaining for further analytical processing.

In the first element, 'Efficiency', two out of four indicators are perceived as unimportant which are 'Return on investment' and 'Inventory cost'. There is an explanation that the investment is perceived as a business requirement which is unavoidable. Those who would like to play in the agricultural business then need to make an investment whether large or small. Additionally, Thai durian is traded mostly in fresh form with a short lifespan so they do not require any inventory to be held in the trading system. The supply chain actors mostly consider only the profit on each trading transaction, short-term profit, more than return on investment, long-term gain, as a result.

In the second dimension, 'Flexibility', only two of six indicators are maintained which are 'Customer satisfaction' and 'Late orders'. The former indicator is seen as important since it correlates with product quality and market share retention. If the players along the chain cannot satisfy their customers, they tend to lose sales. The 'Late orders' is seen as important because it relates to the quality of the product, since Thai durian is mostly traded in fresh form and lateness will cause the product quality to deteriorate. Therefore, if a poor-quality product is sold to customers, the customers are likely to be dissatisfied which leads to lost sales. However, even though the remaining four indicators obtain moderately important scores, they are likely to be removed since this research aims to focus on measuring the importance level of only those performance indicators which are critical to the general Thai durian supply chain. Those

four indicators are perceived as important to only some actors, not mutually agreed upon by all groups of actors.

In the group of 'Responsiveness', four performance indicators are to be removed since they fail to reach the cut-off score of 4.00. 'Product lateness' is seen as unnecessary since the production of Thai durian is done seasonally when the farmer has sufficient time for preparation. Moreover, the durian plantation process needs to be performed as scheduled which requires accuracy. Lateness is then considered to be unlikely to happen. The trade in Thai durian mostly is done before the durian is harvested; thus, the immediate response to the customer has been seen as unnecessary. This makes 'Customer response time' to be judged unimportant. In the Thai durian business, the actors said that lead-time had never been considered because Thai durian is traded in fresh form which requires speedy actions. Accordingly, they do not pay much attention to the time spent in the process yet they focus on the product freshness and quality. The supply chain actors explained that shipping activities do not concern them since they are outsourced to shipping service providers; which then makes 'Shipping error' fail to be in their consideration.

For the last performance dimension, the quality of the product and process are seen as most important since they correlate to the income, sales, market share, profit, and success of their businesses. Process quality is seen to determine product quality. If the processes of cultivation, harvesting, grading, sorting, packing, handling, etc. are done with quality, the product is likely to be of good quality as well. In the agri-food business, product quality is considered most important by all supply chain actors since it indicates the price of durian sold in the market which further indicates their short-term and long-term earnings. All actors focus heavily on these two indicators as a result.

4.3 Analytical Hierarchical Process (AHP) Analysis Result of Thai Durian Supply Chain Performance Indicators

After obtaining the list of valid Thai durian supply chain performance indicators, the pairwise comparison on those indicators was performed by the same group of respondents. The scores obtained in this stage were computed based on the

Analytical Hierarchical Process (AHP) method and the results are presented in Tables 4.18– 4.21.

Starting with Table 4.18, the pairwise comparison scores of each performance dimension and indicator are presented. The displayed scores are the points identifying the distance of importance level between each pair of performance dimensions or indicators in the perception of each informant. For example, the score “EFF-FLX” (Efficiency-to-Flexibility) of F1 (Farmer 1) equals to 8. The 8 point-score means that “in the perception of Farmer 1, Efficiency is more important than Flexibility by 8 points”. Another example is the score “FLX-RSP” (Flexibility-to-Responsiveness) of F1 (Farmer 1) equals to 1/4. The 1/4 point-score means that “in the perception of Farmer 1, Flexibility is less important than Responsiveness by 4 points, or, Responsiveness is more important than Flexibility by 4 points”.

Table 4.18 Geometric Mean Score Calculation Based on Score Obtained from Face-To-Face Questionnaire

Respondent Code	EFF-FLX	EFF-RSP	EFF-FQL	FLX-RSP	FLX-FQL	RSP-FQL	Cost-Profit	Satis-Late Order	Fill Rate-Complaints	Prod-Process
F1	8	4	1	1/4	1/4	1/3	1	2	8	1/4
F2	9	4	1/2	1/3	1/4	1/3	1	1	8	1/6
F3	8	3	1	1/4	1/8	1/2	3	4	7	1/2
P1	7	3	4	1/5	1/5	1	1	4	7	1
P2	8	1	1	1/5	1/6	1/2	3	1	7	2
P3	7	5	2	1/4	1/7	1	1	5	8	1
W1	1	3	1/5	5	1/5	1/5	1	5	2	1
W2	9	1/8	1/9	1/9	1/9	1/2	9	1/9	9	1
W3	7	1	1/4	1/5	1/7	1/2	5	4	5	1
R1	2	1	1/4	1	1/4	1	1	4	7	8
R2	1	1	1	1	1/8	1/8	1	1/8	1	1
R3	4	2	1/4	1/3	1/6	1/4	5	1/5	3	1/3
E1	6	6	1	1	1/6	1/4	1	5	9	1
E2	6	7	1	1	1/6	1	1	5	9	1

Respondent Code	EFF-FLX	EFF-RSP	EFF-FQL	FLX-RSP	FLX-FQL	RSP-FQL	Cost-Profit	Satis-Late Order	Fill Rate-Complaints	Prod-Process
E3	1	1	1	1	1/5	1/5	1	5	9	1
G1	8	7	5	1/5	1/6	1	6	7	5	5
G2	8	7	7	3	2	1	9	7	9	9
G3	9	6	5	0.2	0.17	1	2	6	6	4
M1	6	3	1/2	1	1/6	1/3	2	3	4	1
M2	1	1	1	1/2	1	1	2	1	6	1
M3	5	3	1/2	2	1/4	1	6	3	1/5	1/4
G.M.	4.57	2.35	0.88	0.52	0.21	0.51	2.09	2.17	4.90	1.08

Remark**:** F = Farmer, P = Processor, W = Wholesaler, R = Retailer, E = Exporter, G = Government Officer, M = Market Operator

EFF-FLX = Efficiency-to-Flexibility, EFF-RSP = Efficiency-to-Responsiveness, EFF-FQL = Efficiency-to-Food Quality, FLX-RSP = Flexibility-to-Responsiveness, FLX-FQL = Flexibility-to-Food Quality, RSP-FQL = Responsiveness-to-Food Quality

Cost-Profit = Cost-to-Profit, Satis-Late Order = Customer Satisfaction-to-Late Order, Fill Rate-Complaints = Fill Rate-to-Customer Complaints, Prod-Process = Product Quality-to-Process Quality

Table 4.19 Standardized Comparison Matrix of All Groups

Performance Dimensions	Efficiency	Flexibility	Responsiveness	Food Quality
Efficiency	1.00	4.57	2.35	0.88
Flexibility	0.22	1.00	0.52	0.21
Responsiveness	0.43	1.94	1.00	0.51
Food Quality	1.14	4.69	1.96	1.00
TOTAL	2.79	12.20	5.82	2.60

Table 4.20 Normalized Comparison Matrix of All Groups

Performance Dimensions	Efficiency	Flexibility	Responsiveness	Food Quality	Weight Score Estimation
Efficiency	0.36	0.37	0.40	0.34	0.37
Flexibility	0.08	0.08	0.09	0.08	0.08
Responsiveness	0.15	0.16	0.17	0.20	0.17
Food Quality	0.41	0.38	0.34	0.38	0.38
TOTAL	1.00	1.00	1.00	1.00	1.00

Table 4.21 Weighted Average of Normalized Score for Consistency Ratio Calculation

Performance Dimensions	Efficiency	Flexibility	Responsiveness	Food Quality	Weighted Normalized Score	Eigenvector
Efficiency	0.37	0.38	0.40	0.33	1.48	4.011
Flexibility	0.08	0.08	0.09	0.08	0.33	4.009
Responsiveness	0.16	0.16	0.17	0.19	0.68	4.005
Food Quality	0.42	0.39	0.33	0.38	1.52	4.014
					λ Max	4.01
					Consistency Index (C.I.)	0.0033
					Random Consistency Index (R.I.)	0.90
					Consistency Ratio (C.R.)	0.00367*

Then, based on the AHP calculation method for group decision making, geometric mean scores of the scores obtained from face-to-face surveys with each respondent are computed and displayed in the last row of Table 4.18. A standardized comparison matrix of performance dimensions was then constructed to display the geometric mean scores of each pair of performance dimensions from Table 4.18 in the matrix format, as shown in Table 4.19. For example, the score 4.57 of the row 'Efficiency' in the Table 4.19 is the geometric mean score of "EFF-FLX" appearing in the last row of Table 4.18. The score of 2.35 of the row 'Efficiency' in Table 4.19 is the geometric mean score of "EFF-RSP" appearing in the last row of Table 4.18.

Next, to identify the weight scores of performance dimensions on a scale of 100 percent, the scores in Table 4.19 needs to be normalized so that the total sum score equals 1.00 or 100 percent which can be seen in Table 4.20. The scores displayed in Table 4.20 are obtained by dividing each number in Table 4.19 by the summated score of each column. For instance, the number 0.36 of "Efficiency-to-Efficiency" in Table 4.20 is from the division of 1.00 by 2.79. The number of 0.37 of "Efficiency-to-Flexibility" in Table 4.20 is from the division of 4.57 by 12.20. After each normalized score is computed, the scores in each row are then averaged to identify weight score estimation of each performance dimension on the scale of 100 percent as shown in the last column of Table 4.20.

The normalized scores in Table 4.20 were then used in the calculation of a consistency ratio in order to check whether the consistency ratio of the specific set of data is less than 0.10, which is the cut-off criterion, as seen in Table 4.21. Referring to the calculation formula explained in the previous chapter, the consistency ratio can be calculated with the following equation;

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

λ_{max} = 4.01, n = 4 then,

$$C.I. = \frac{(4.01 - 4)}{4 - 1}$$

$$C.I. = 0.0033$$

Then, as specified in the Table 4.22, random inconsistency index (R.I.) of this case is then equal to 0.90 because there are 4 factors (n) to be compared.

Table 4.22 Random Inconsistency Index (R.I.)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: Golden et al. (1989)

After Consistency Index (C.I.) and Random Inconsistency Index (R.I.) have been identified, the Consistency Ratio (C.R.) is then computed by using the following equation;

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

$$C.R. = \frac{0.0033}{0.90}$$

Then; $$C.R. = 0.00367$$

It is found that the data collected in this study contains satisfactory consistency levels with the ratio of 0.00367 which is lower than cut-off criteria at 0.10. It means that the set of data used in this study is consistent, or free of errors, and valid for AHP analysis.

The same steps have then been applied to the pairwise comparison scores of the remaining pairs of performance indicators and the calculations have been executed in three aspects which are 1) overview result, 2) results of each group of supply chain actor categorized by functions (producers, traders, and trade facilitators), and 3) results of each individual group of supply chain actor (farmer, processor, wholesaler, retailer, exporter, government officer, market operator). The summary of AHP calculation results are as shown in Table 4.23 (Detailed calculations are presented in Appendix D).

In the Table 4.23, it can be seen that 'Food Quality' and 'Efficiency' are considered by all groups as the most important performance dimension among the four dimensions with the weight scores of 0.38 and 0.37 respectively. They are followed by 'Responsiveness' with the weight score of 0.17 and 'Flexibility' with the weight score of 0.08.

When considering the combined weight scores of all groups toward each performance dimension, it is found that 'Cost' is more important than 'Profit' with scores of 0.68 and 0.32 respectively. In overview, 'Fill Rate' (0.68) is considered as two times as important as 'Late Orders' (0.32). All players in the Thai durian supply chain

Table 4.23 Weight Scores of Each Performance Attribute Categorized by Groups Of Informants

Performance Attributes	All	Producer	Trader	Trade Facilitator	Producer		Trader			Trade Facilitator	
					Farmer	Processor	Wholesaler	Retailer	Exporter	Government Sector	Market Operator
Overall Performance Dimension Results											
Efficiency	0.37	0.45	0.24	0.5	0.41	0.47	0.16	0.2	0.38	0.68	0.32
Flexibility	0.08	0.05	0.09	0.1	0.06	0.05	0.07	0.1	0.1	0.06	0.13
Responsiveness	0.17	0.18	0.16	0.16	0.14	0.21	0.18	0.16	0.12	0.12	0.18
Food Quality	0.38	0.32	0.52	0.24	0.39	0.27	0.58	0.53	0.41	0.14	0.37
C.R.	0.0036	0.0091	0.0079	0.0111	0.0345	0.0102	0.063	0.0019	0.0207	0.0152	0.0378
Efficiency Performance Index Results											
Cost	0.68	0.59	0.65	0.79	0.59	0.59	0.78	0.63	0.5	0.83	0.74
Profit	0.32	0.41	0.35	0.21	0.41	0.41	0.22	0.37	0.5	0.17	0.26
Flexibility Performance Index Results											
Fill rate	0.68	0.7	0.59	0.79	0.67	0.73	0.57	0.32	0.83	0.87	0.68
Late Order	0.32	0.3	0.41	0.21	0.33	0.27	0.43	0.68	0.17	0.13	0.32
Responsiveness Performance Index Results											
Customer Satisfaction	0.83	0.88	0.83	0.77	0.88	0.88	0.82	0.73	0.9	0.87	0.63
Customer Complaints	0.17	0.12	0.17	0.23	0.12	0.12	0.18	0.27	0.1	0.13	0.37
Food Quality Performance Index Results											
Product Quality	0.52	0.37	0.53	0.65	0.22	0.56	0.5	0.58	0.5	0.85	0.39
Process Quality	0.48	0.63	0.47	0.35	0.78	0.44	0.5	0.42	0.5	0.15	0.61

tend to focus on creating ‘Customer Satisfaction’ (0.83) rather than dealing with ‘Customer Complaints’ (0.17). Lastly, ‘Product Quality’ (0.52) tends to be a little bit more important than ‘Process Quality’ (0.48) in the understanding of all players.

However, when AHP calculation is repeated with the combined scores of each group of supply chain actors categorized by functions, it appears that the consistency ratio of the group of producers, traders, and trade facilitators are 0.0091, 0.0079, and 0.0111, respectively. This shows that all combined scores embrace consistency ratio lower than 0.10 which are considered as satisfactory.

Subsequently, when considering the weight scores of each group of supply chain players, interesting meaningful information was found. From the results displayed in Table 4.23, it appears that the group of traders is the only group that considers ‘Food Quality’ as the most important factor in managing the Thai durian supply chain. Whereas the other two groups, which are producer and trade facilitator, put an emphasis on managing ‘Efficiency’, or cost and profit of the chain instead.

When considering each performance dimension, it appears that, to manage supply chain ‘Efficiency’, all three groups agree that supply chain ‘Cost’ is more important than ‘Profit’ gained. To manage the supply chain ‘Flexibility’, among the three groups, traders are the group that gives the highest weight to ‘Late Orders’ (0.41). However, all three groups still rate the ability to fill up orders (Fill Rate) as more important than late delivery (Late Order). In the aspect of ‘Responsiveness’, all three groups hold the same weight as the overview result that scores ‘Customer Satisfaction’ higher than ‘Customer Complaints’. Lastly, in the aspect of ‘Food Quality’, the producer group is the only group that is concerned about quality of process more than quality of product. This may be because they are the only group which is in charge of all production processes in the durian orchards while other groups perform only trade activities and transactions.

Next, when performing AHP calculation with the scores of each individual group of supply chain actors, it appears that the computed scores of seven groups still deliver a satisfactory level of consistency (C.R. < 0.10).

In the level of performance dimension, when comparing the direction of the scores of the supply chain group with the scores given by the group members, the directions of weight scores are consistent with each other except the weight scores of

‘Market Operator’ which are contradictory to the combined score of the group it belongs to.

The trade facilitator group focuses on ‘Efficiency’ more than ‘Food Quality’ by giving a weight of 0.5 to the former one and 0.24 to the latter one. Yet, ‘Market Operator’ which is the member of this group considers ‘Food Quality’ as a little bit more important than ‘Efficiency’ with the weight scores of 0.37 and 0.32, respectively.

When considering at performance indicator level, it is found that among the combined weight scores given to the indicators of the performance dimension of ‘Efficiency’, exporters are the only group that considers ‘Cost’ and ‘Profit’ to be equally important while the other combined scores are consistent with each other that ‘Cost’ is more important than ‘Profit’.

Among the combined weight scores of the indicators belonging to the performance dimension of ‘Responsiveness’, retailers are the only group that emphasizes ‘Late orders’ more than ‘Fill Rate’.

In the performance dimension of ‘Flexibility’, it is the consensus of all groups in all combined levels that ‘Customer Satisfaction’ is given more weight than ‘Customer Complaints’.

In the performance dimension of ‘Food Quality’, both ‘Product Quality’ and ‘Process Quality’ the importance scores are weighted almost at the same level (0.52 and 0.48, respectively). However, when considering the scores in detail, only the group of producers sees process quality as more important than product quality. Within the group of producers, only the farmers that care about process quality more than product quality, while the processors are more concerned about product quality rather than quality of process. This is perhaps because the farmers are the only group that is involved with the production process on the farm while the others are not. For the processors that focus more on product quality than process quality, this may be because the production process in the processing plant is mechanically operated with precision. The processors do not put much emphasis on the quality of the process or machine operations as a result.

In conclusion, the data collected in this study contains satisfactory consistency levels and can contribute to valid AHP analysis. The discussion on the research findings will be presented in the following section.

CHAPTER 5

DISCUSSION AND CONCLUSION

The research findings and results concluded in the previous section are to be discussed in a wide aspect so that the potential research contribution and relevant extensive knowledge are presented. The discussion points will cover only the critical management issues which are likely to have a considerable impact on the Thai durian trade industry. Finally, potential further study will be suggested for the benefit of future research.

5.1 Discussion

5.1.1 Thai Durian Supply Chain Structure and Its Relations

Starting from the discussion of the structure of the Thai durian supply chain processes and its relations in Thailand, it is found that Thai durian supply chain structure gained from this study is mostly similar to but not the same as the durian supply chain of the previous study conducted by Pattana Jealviriyapan et al. (2001), as displayed in Figure 2.13. Relevant additional insights are discussed in this section, accordingly.

The most interesting point is that the online platform has been chosen by Thai durian farmers as one of the new channels for accessing the market. This phenomenon is considered as consistent with the theory of 'Technology Acceptance Model' (Davis, 1986). To be specific, the perceived ease-of-use of the durian farmers with limited digital literacy toward social networking mobile applications can be considered as one of the major factors that drive them to adopt information technology into their durian businesses to acquire the perceived usefulness which they are looking for such as market access, communication channels with end-customers, etc. This possibly stems from the advancement in information technology infrastructure of the nation that makes internet access available widely.

Another issue different from the previous work is that the supply chain actors, i.e. farmers and consolidators, do not only perform trade functions but extend their businesses toward the service industry by offering sales of durian with a tourism package, which is the so-called ‘agritourism’. In this case, they offer tourists the combination of a durian buffet program at their own production site, either the durian farm or packing house, and durian is sold as souvenirs at the same place, which can be considered as another approach to value addition practice. Tourism programs can add value to products at least 2 times higher than the average price.

Next, horizontal integration within the durian farmer groups by establishing cooperatives or forming up ‘Big-plot-farming groups’ tend to be more influential since it helps decrease costs and increase the bargaining power of durian farmers. Some individual durian farmers then choose to sell their own produce to the farming group instead of individually selling to buyers. With enhanced bargaining power of the groups, the members are likely to obtain a better price.

Additionally, the role of a consolidator tends to be so influential and powerful that they become the critical actor of the Thai durian supply chain. This is because they are occupied with the information about and durian orders of the major market which is the export market in their hands, which commands 75 percent of total durian production each year (Global Trade Atlas, 2018e; Office of Agricultural Economics, 2016). With the marketing insights in hand, they can wield the highest bargaining power in the system which allows them to set, or even manipulate, the market price, and control the product flow in the market. In contrast, they were not mentioned at all in the study of Pattana Jealviriyapan et al. (2001).

Furthermore, there tends to be a situation equivalent to backward integration existing in the durian supply chain in at least two points which are (1) farmer-1st tier processor and (2) local collector-consolidator. This first integration pattern is in the form that the 1st tier processor communicates with farmers regarding the quality requirements and gets involved into the cultivation process in order to maximize chain effectiveness in terms of product quality. The second integration between local collector and consolidator exists in the way that the consolidator extends the operation to cover the activities of harvesting and produce gathering by hiring, or in some cases partnering with, local collectors. This approach benefits both parties in that the local

collector can minimize the operational risk, or the risk of being unable to sell the product, while consolidator can maximize not just efficiency, in terms of cost-saving and consistency of supply, but also effectiveness, in terms of product quality.

Finally, from the interview results, district collectors and collectors from other provinces disappear from the system but their functions, like grading, product classification, product treatment, as well as product shipment and handling, are performed by consolidators instead in order to avoid redundant activities in the system which leads to enhanced chain efficiency.

In summary, with the changes in the durian supply chain structure and its relations, all existing supply chain members need to be aware of the changes and adjust their business plans toward such changes in the trade system. The existing supply chain members may need to consider possible new channels to get access to the market such as the online market, service industry or agritourism, in order to extend their market base and diversify the market. Moreover, this study has already proved that the integration along the chain both horizontally and vertically is possible in the durian industry. Therefore, the supply chain actors should reconsider how they can make use of this opportunity to integrate their businesses with partners along the chain so that the business cost and critical information can be efficiently and effectively shared among integrative partners while maximizing mutual shared benefits such as consistency of the supply, the ability to control durian quality, etc.

5.1.2 Thai Durian Supply Chain Performance Indicators

After the application of Analytical Hierarchical Process (AHP) analysis on the proposed framework developed by Aramyan et al. (2006), it appears that not all proposed indicators are feasible with the case of Thai durian supply chain. In specific, only eight of nineteen indicators remain to reflect each performance dimension as illustrated below in Figure 5.1.

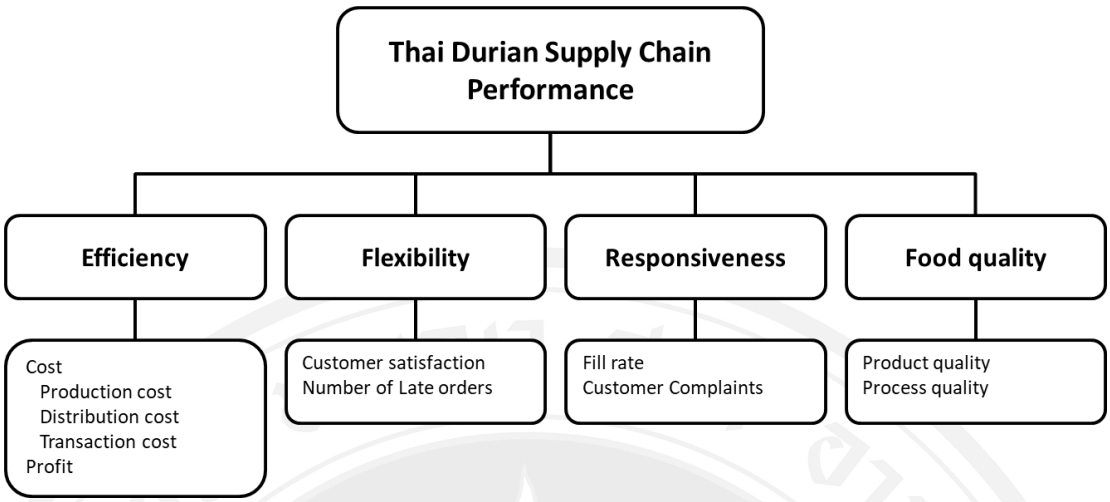

Figure 5.1 Thai Durian Supply Chain Performance Indicators Framework Derived from the Study

Among four performance dimensions, 'Food Quality' and 'Efficiency' are rated as the most two important attributes followed by 'Responsiveness' and 'Flexibility'. This means that to manage Thai durian supply chain effectively, the relevant players are expected to prioritize quality of durian as well as cost and profit of business activities as most important. The players should then control the quality of durian fruit and products while they need to control cost to maximize profit gains.

Since the durian market is a kind of demand-pull market, customer opinions tend not to be very influential to the effectiveness of supply chain management. Thus, 'Responsiveness' is rated as third in importance among the four performance factors.

Referring to the interview results, durian is mostly traded in fresh form which is by nature perishable. Therefore, the supply chain actors mostly try to keep performing supply chain activities as planned, or scheduled, and avoid changing them since the alteration may be detrimental to the quality of the product. The fourth priority is given to 'Flexibility' as a result.

Nevertheless, one interesting finding is that when the scores are separately computed by groups of players, producer groups prioritize 'Efficiency' and 'Food Quality' at a similar level. On the contrary, traders focus on 'Food Quality' more than 'Efficiency' while trade facilitators are vice versa. This can be interpreted to mean that while the trader, who is the one reaching and communicating with the market or

customer directly, attempts to create value addition through quality attributes, the farmer and government agency, who are the policy makers, still focus on efficiency of the chain. In other words, it implies that the current plantation orientation and public policy direction are still executed by emphasizing minimizing the cost of production, increasing short-term profit gains, and maximizing production yield without responding to the needs of customers.

Such differences may stem from differences in the business concepts of each group. To be specific, the group focusing on ‘Efficiency’ may hold the production concept while the group emphasizing on ‘Food Quality’ may embrace the product concept (Kotler, 2000). In other words, while the traders need durian with good quality to sell in the market according to demand, the producers still focus on lowering the production cost and increasing production capacity and yield, without giving much thought to quality. Such differences may impede the supply chain from achieving maximum performance since the chain members run their own business in their own ways without sharing ideas or critical insights with each other. Moreover, this difference may negatively influence the overall chain performance.

Therefore, to enhance the performance of the whole supply chain, it is necessary for all supply chain members to exchange their business ideas with each other so that they embrace the same business concept. The government sector may formulate a policy which provides the chain members an opportunity to exchange information, creates business paradigm shifts among chain members, or helps the chain members to perform chain integration. Apart from that, to enhance the responsiveness of public policy, relevant stakeholders should be encouraged to participate in the policy management process ranging from formulation to implementation and evaluation.

However, with the overall weight score obtained from this study, it can be seen that among the eight performance indicators, four indicators were rated by supply chain actors as the most important factors. They consist of cost, fill rate, customer satisfaction, and product quality. This implies that the Thai durian supply chain may perform well in these four aspects. In other words, the strengths of Thai durian are well-controlled cost, adequate product availability, ability to satisfy customer requirements, and good product quality.

With reference to the weight score derived from the AHP analysis in the previous chapter, it appears that, in the ‘Efficiency’ aspect, all supply chain actors put an emphasis on cost-controlling activities rather than making profit in the market. It can be assumed that since all chain players in Thailand are not durian price-setters in the export market in which 75 percent of durian are traded, they then need to focus on the activities at production origin to control the cost instead of price. This limitation can lead the Thai durian industry to suffer market opportunity loss in the long run.

To manage supply chain ‘Flexibility’, all three groups view the ability to fill the customer order as more important than late delivery. However, traders are the only group among the three that gives the highest score to ‘Late Orders’. This is because traders are the only group that needs to handle the durian fruit after harvest. After the durian is picked from the tree, it will gradually ripen as time passes. If the activities along the chain are executed in a delayed manner, the durian will become too ripe to be shipped abroad which will lead to loss. Thus, lateness is seen as crucial to them.

To enhance supply chain ‘Responsiveness’, all three groups of chain players embrace the same view to maximize ‘Customer Satisfaction’ rather than resolving unpleasant problems of customers stemming from product consumption.

In the dimension of ‘Food Quality’, producers seem to focus more on quality of process than quality of product. This is because the producer is the only group that is concerned with the farming or production process while the other two groups are not involved.

5.2 Practical Implication

5.2.1 Thai Durian Supply Chain Characteristics and Its Relation

With reference to the results presented in the previous section, it can be seen that the supply chain structure and its relations can contribute to a better understanding by the existing durian business entrepreneurs and those who are interested in starting a durian business. They can understand the entire trading system of the durian business, the current activities performed by the existing supply chain actors, as well as the existing relationships among the supply chain actors in each stage of industry. After they get an understanding of the system, they may be able to seek new business

opportunities to penetrate such industries, or even find gaps to be filled. This can further lead to innovation developments in the durian business or relevant fields.

With respect to the rise of online trade, a firm may take this opportunity to consider whether its business should be extended to digital platforms or not, so as to compete in this newly emerging market. However, to make a business extension, meticulous consideration is necessary since various management issues may need to be adjusted such as selling and payment systems, data management, marketing management, operation management, customer relationship management, inbound and outbound logistics, forward and reverse logistics, technical management, and many more.

5.2.2 Thai Durian Performance Indicators

With reference to the results regarding durian supply chain performance, the relevant managers, business owners, or operation officers will be able to assess business alternatives before making a decision in not just the strategic level but also the operational level as well by using the weight scores from this study as an evaluation template.

For example, in the case of downstream businesses, it may be necessary to make a choice on seeking new durian suppliers. The weight scores from this study can be utilized in evaluating and comparing the performance of various suppliers before selection. In this case, a manager can evaluate the performance of each supplier by performing a pairwise comparison among choices of suppliers and construct a comparison matrix of each performance dimension. Assuming that there are three suppliers to be chosen, the comparison matrix will be constructed as seen in Table 5.1;

Table 5.1 Sample Comparison Matrix

Efficiency

Supplier	A	B	C	G.M.	Weight
A	1	2	3	1.82	0.54
B	1/2	1	2	1.00	0.30
C	1/3	1/2	1	0.55	0.16
				3.37	

Flexibility

Supplier	A	B	C	G.M.	Weight
A	1	1/4	1/3	0.44	0.117
B	4	1	3	2.29	0.614
C	3	1/3	1	1.00	0.268
				3.73	

Responsiveness

Supplier	A	B	C	G.M.	Weight
A	1	3	2	1.82	0.54
B	1/3	1	1/2	0.55	0.16
C	1/2	2	1	1.00	0.30
				3.37	

Food quality

Supplier	A	B	C	G.M.	Weight
A	1	1/5	1/4	0.37	0.11
B	5	1	2	2.15	0.64
C	4	1/2	1	1.26	0.37
				3.78	

In Table 5.1, the pairwise comparison scores of each supplier are displayed. The displayed scores are the points identifying the degree of performance level between each pair of suppliers in the perception of the appraiser. For example, the score A-to-B

under the matrix of 'Efficiency' equals 2. It means that "in the perception of the appraiser, supplier A is more efficient than supplier B by 2 points". Another example is where the score C-to-B under the same matrix equals to 1/2. It means that "in the perception of appraiser, supplier C is less efficient than supplier B by 2 points".

After all performance attributes of each supplier have been assessed, an alternative evaluation matrix is constructed as shown in Table 5.2.

Table 5.2 Sample Alternative Evaluation Matrix

Alternative evaluation

Performance Attributes / Supplier	Efficiency	Flexibility	Responsiveness	Food quality	Performance
A	0.54	0.117	0.54	0.11	0.343
B	0.30	0.614	0.16	0.64	0.431
C	0.16	0.268	0.30	0.37	0.272

The performance scores of each supplier are then computed by using the following equation;

$$Performance = [0.37(Efficiency) + 0.08(Flexibility) + 0.17(Responsiveness) + 0.38(Food\ quality)]$$

From Table 5.2, it can be seen that when considering all performance aspects, supplier B is the top performer and should be selected to be the new supplier for the business.

However, if the appraiser would like to embrace a more specific view in their evaluation, more performance indicators can be added into the comparison matrix, and alternative evaluation performed by adopting the set of weight scores obtained in this study.

Furthermore, if the appraiser belongs to any specific groups of supply chain actors such as wholesaler, retailer, processor, etc., the series of weight scores used in alternative evaluation can be changed according to the role of each actor.

5.3 Academic Contribution

The results of this study provide a number of contributions to not only the general field of supply chain management but also the specific field of agri-food supply chain management. In the first place, the existence of supply chain integration found in this study provides additional proof of the concept of supply chain integration (Chopra & Meindl, 2007; Christopher, 1998, 2005; Mangan, Lalwani, & Butcher, 2008). The result also proves that both horizontal and vertical chain integration are beneficial to the chain members in their own way.

Secondly, the application of Analytic Hierarchy Process (AHP) in this research is a proof of extending utilization of this particular method. In common, this method is adopted in various fields of study, such as industrial supply chain management (Salo & Hämäläinen, 1997), resource allocation, strategic planning, project management (Vargas, 1990), Environmental Impact Assessment (EIA) (Ramanathan, 2001), pharmaceutical supply chain (Tas, 2012), and tourism supply chain (Huang et al., 2012), in addition to the agri-food supply chain. However, the field of agri-food supply chain still needs more exploratory study to confirm this extension.

Thirdly, the result from this research regarding the screened performance indicators provides evidence that the agri-food supply chain performance framework of Aramyan et al. (2006) is partially compatible with the performance of the Thai durian supply chain. However, in order to adopt this framework in other cases of agricultural goods, such a framework needs to be further studied by taking unique characteristics of each product into account.

Lastly, considering that there are a limited number of durian business management studies, the findings of this research can extend the academic base and contribute to better understanding of this specific field in terms of supply chain structure, feasible performance attributes, as well as key performance indicators.

5.4 Policy Recommendation

5.4.1 Government Sector

With reference to the interview results, it is found that the market structure of Thai durian seems to be gradually changing from the past. First of all, the agritourism market seems to be emerging along with the durian consumption trend. This kind of tourism service initially embraces an aim to serve the foreign tourist groups, specifically the Chinese. Thus, to make use of this opportunity, the relevant public agencies should formulate an integrative agritourism branding strategy by imitating the tourism promotion in Japan, where the decoration of tourist attractions, brand mascots, souvenir design, and others are coordinated. The brand of agritourism should be initiated with the participation of relevant stakeholders who are in the area of durian production in order to create the sense of belonging toward the brand. After the branding is recognized, there will be plentiful ways to add value to durian and other fruit products.

Secondly, the rise of online durian trade mentioned during the interviews can be considered as a sign of the shift in trading patterns of agri-food products. Thus, the government agencies related to agri-food can make use of this trend to formulate a holistic online agricultural trade promotional strategy. This strategy should embrace the aim to create a desirable online agricultural business ecosystem which supports every enterprise, not just existing ones but new startup businesses as well. The strategy should specify a promotional scheme which covers at least a financial support scheme for business initiation, short-term loans for liquidity enhancement, technological and technical support, online trade training courses, online trade one stop service center establishment with an information center, a business consultant service, including a business match-making service, and so on.

Thirdly, as supply chain integration, either horizontal or backward, exists along the chain which are beneficial to the chain members, the government sector should promote and support the chain members in performing chain integration. The promotional scheme can take various forms such as training course arrangement, business match-making activity, tax privilege, financial or non-financial support, and so on. Furthermore, the integration can range from cooperation and coordination to collaboration. It depends on a number of factors such as firm readiness, degree of

mutual benefits gained, costs of integration, compatibility of management policy, possible trade-offs, etc.

Fourthly, with the implication of the overall weight scores discussed in the previous section, the government sector should communicate the four strengths of Thai durian business through branding, like the 'Amazing Thailand' slogan of the Tourism Authority of Thailand. This newly created brand can integrate with the agritourism brand discussed earlier so that both brands correspond with each other and are communicated effectively. The branding can also add value to both durian products and durian tourism programs which will hopefully increase the total revenue throughout the whole chain.

5.4.2 Relevant Association or Public Sector

With regard to the earlier discussion about the differences in importance weight scores derived from AHP analysis which reflect the differences in business paradigm, the public sector should then arrange a networking activity and/or even create a virtual community to be used as a channel for them to communicate with each other. However, the networking should create linkages not just among individuals but also among groups and associations existing along the supply chain. This policy is expected to be beneficial to the chain in terms of minimizing chain vulnerability and maximizing chain robustness and resilience (Mangan et al., 2008; Tang, 2006).

5.5 Recommendations for Future Research

This study has been carried out along the research methodology explained in the prior sections which may still lack practicality somehow since the information collected is opinion-based even though the informants are specialists in the area of study. As a result, experimental research should be conducted in the future to empirically validate the findings obtained from this study and to test whether it can contribute to meaningful management policy or strategic recommendations so that the performance measurement system is properly fine-tuned for practical application.

Moreover, with the natural limitation of the qualitative approach which lacks external validity or generalizability (Kothari, 2008), a quantitative approach should be

conducted to ensure the causality of each indicator toward supply chain performance so that the idiosyncrasy of the study can be resolved. However, the supply chain performance correlates with operational performance of a firm which may sometimes be considered as sensitive information for firms listed in the stock market. Therefore, it may be somehow difficult to get access to such information as the performance evaluation may have an impact on the business value of the firms.

To extend the coverage of the performance measurement system, additional performance dimensions such as the four characteristics of Sakka and Botta-Genoulaz. (2009), Business Excellence Model of The European Foundation for Quality Management (2012), and others, should be further explored so that potential factors influencing the supply chain are not overlooked. Apart from that, to enhance the comprehension of the study, other groups of informants missing from this study should be recruited so that potential different opinions about the durian business are included.

Finally, with the nature of business that needs to face dynamic changes of external factors continuously, for instance international trade policy, environmental issues, and the like, it is possible that such external sources may sometimes have an effect on the supply chain performance of a firm. Therefore, a study on the effect of external factors toward business supply chain performance is recommended for future research so that the knowledge base and comprehension in this particular field are significantly extended.

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APPENDIX A

1st Stage Interview Questionnaire

แบบสอบถามเกี่ยวกับ
การประเมินประสิทธิภาพห่วงโซ่อุปทาน (Supply Chain Performance)
ของทุเรียนในประเทศไทย

แบบสอบถามนี้เป็นส่วนหนึ่งของงานวิจัย ประกอบการจัดทำวิทยานิพนธ์ ระดับปรัชญาดุษฎีบัณฑิต (ปริญญาเอก) สาขาการจัดการ วิทยาลัยนานาชาติ สถาบันบัณฑิตพัฒนบริหารศาสตร์ (NIDA)

โดยหัวข้องานวิจัยนี้ คือ THAI DURIAN SUPPLY CHAIN PERFORMANCE INDICATORS ซึ่งเป็นงานศึกษาเพื่อวิเคราะห์ปัจจัยที่มีความสำคัญต่อการประเมินและพัฒนาประสิทธิภาพของห่วงโซ่อุปทาน สำหรับทุเรียนในประเทศไทย ซึ่งผลลัพธ์ที่คาดหวัง คือ การมีเครื่องมือช่วยในการประเมินประสิทธิภาพของห่วงโซ่อุปทาน สำหรับทุเรียนในประเทศไทย เพื่อการพัฒนาความสามารถในการแข่งขันของธุรกิจทุเรียนในประเทศไทย

ทั้งนี้ข้อมูลที่ได้จากการสัมภาษณ์นี้ มีวัตถุประสงค์เฉพาะใช้ประกอบงานวิจัยสำหรับจัดทำวิทยานิพนธ์ดังกล่าวข้างต้นเท่านั้น โดยข้อมูลในแบบสอบถามนี้จะถูกจัดเก็บเป็นความลับ ไม่เผยแพร่กับหน่วยงานใดทั้งสิ้น

<u>ส่วนที่ 1: ข้อมูลส่วนบุคคล</u>

1.1 ประสบการณ์การทำงาน หรือประกอบธุรกิจ เกี่ยวกับทุเรียน.....ปี

1.2 อายุ.....ปี

1.3 เพศ

[ ] ชาย [ ] หญิง

1.4 กลุ่มในห่วงโซ่อุปทาน

[ ] กลุ่มผู้ผลิต/ ผู้เพาะปลูก (Production)

[ ] กลุ่มผู้ค้าขาย (Trade)

[ ] กลุ่มผู้สนับสนุนการค้า (Trade Facilitator)

1.5 อาชีพ

[ ] เกษตรกร (Farmer) [ ] ผู้แปรรูป (Processor)

[ ] ผู้คัด บรรจุผลไม้ (Consolidator) [ ] ผู้ส่งออก (Exporter)

[ ] ผู้รวบรวม ขนส่ง และกระจายสินค้า (Distributor) [ ] ผู้ค้าส่ง (Wholesaler)

[ ] ผู้ค้าปลีก (Retailer) [ ] เจ้าหน้าที่รัฐ (Government agency)

1.6 ระดับการศึกษา

[ ] มัธยม / ปวช. หรือ ต่ำกว่า [ ] ปวส. [ ] ปริญญาตรี

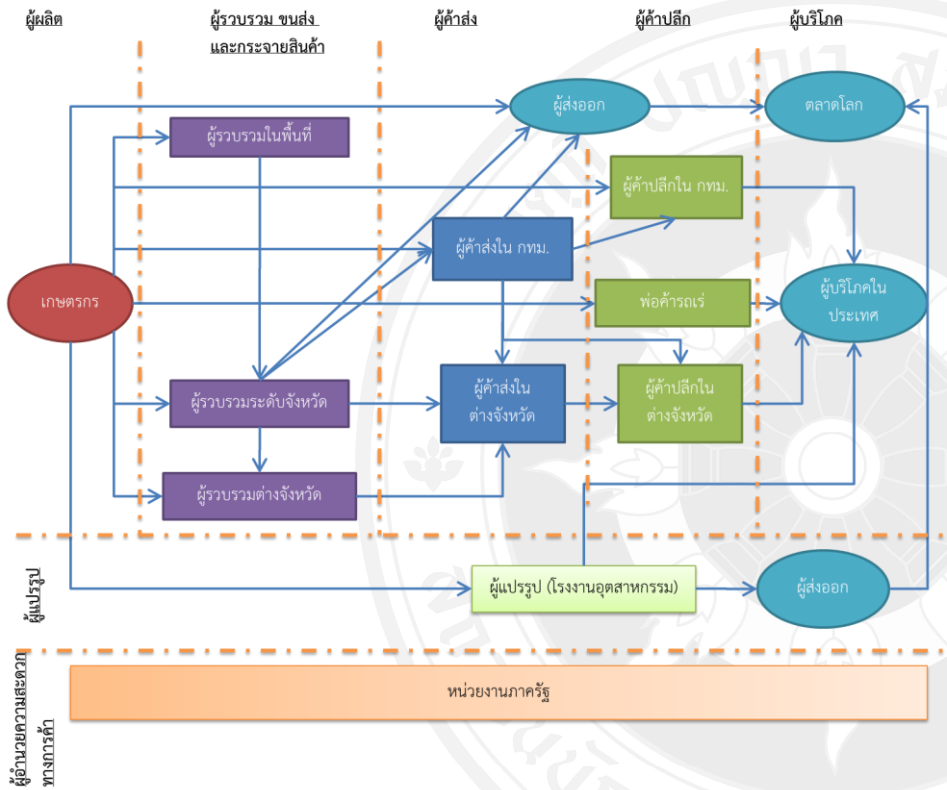
[ ] ปริญาโท หรือ สูงกว่า [ ] อื่นๆ โปรดระบุ .....

1.7 รายได้ครัวเรือน .....บาท/เดือน

ส่วนที่ 2: แบบสอบถามเกี่ยวกับห่วงโซ่อุปทาน (Supply Chain) ของทุเรียนในประเทศไทย

2.1. อธิบายลักษณะและขั้นตอนของ ห่วงโซ่อุปทาน (Supply Chain) ของทุเรียนในประเทศไทย

2.2. กรุณาตรวจสอบและให้ความเห็นเกี่ยวกับ ห่วงโซ่อุปทาน (Supply Chain) ของทุเรียนในประเทศไทย จากผลสรุปการทบทวน ในการศึกษานี้



<u>ส่วนที่ 3: ปัจจัยด้านประสิทธิภาพของห่วงโซ่อุปทาน (Supply Chain Performance Factor)</u>

3.1 ท่านมีความเห็นและให้คะแนนความสำคัญสำหรับปัจจัยในการวัดประสิทธิภาพของห่วงโซ่อุปทาน (Supply Chain) ของทุเรียนในประเทศไทย (1 = สำคัญน้อยที่สุด และ 5 สำคัญมากที่สุด)

รายการปัจจัย			รายละเอียด	ตัวชี้วัด	คะแนนความสำคัญ					ข้อเสนอแนะ
					1	2	3	4	5	
1	ประสิทธิภาพ (Efficiency)									
	1.1	ต้นทุนการผลิตและการตลาด (Cost of Production/Distribution/Transaction)	รายจ่ายของต้นทุนการผลิต การจัดเก็บ การจัดส่ง การบริหารและการตลาด	ต้นทุนการผลิตและการตลาด/ต้น						
	1.2	ผลกำไร (Profit)	ผลกำไร	(รายได้ – รายจ่าย)						
	1.3	ผลตอบแทนการลงทุน (Return of Investment)	อัตราส่วนของกำไรเมื่อเปรียบเทียบกับต้นทุน	ผลกำไร/ต้นทุน						
	1.4	ต้นทุนในการจัดเก็บ (Inventory Cost)	รายจ่ายสำหรับการจัดเก็บสินค้า เพื่อรอจัดส่งหรือจำหน่าย ตลอดกระบวนการ รวมถึงค่าประกันภัย ค่าเสียหายและค่าความสูญเสีย	ต้นทุนการจัดเก็บ/ต้น						
2	ความยืดหยุ่น (Flexibility)									

รายการปัจจัย			รายละเอียด	ตัวชี้วัด	คะแนนความสำคัญ					ข้อเสนอแนะ
					1	2	3	4	5	
	2.1	ความพอใจของลูกค้า (Customer Satisfaction)	ระดับความพอใจของลูกค้า ตลอดกระบวนการทั้งก่อน ระหว่าง และหลังการทำธุรกรรม	สัดส่วนลูกค้าที่พอใจ/ลูกค้าไม่พอใจ						
	2.2	ความยืดหยุ่นของผลผลิต (Volume Flexibility)	ความสามารถในการเปลี่ยนแปลงปริมาณการผลิต	profitable (max output, min output)						
	2.3	ความยืดหยุ่นในการจัดส่ง (Delivery Flexibility)	ความสามารถในการเปลี่ยนแปลงวัน รูปแบบ และวิธีการจัดส่ง	สัดส่วน (ช้าสุด-เร็วสุด)/(ช้าสุด-ค่าเฉลี่ยในปัจจุบัน)						
	2.4	Backorder	สัดส่วนการขอคืนสินค้า	Back order/total order						
	2.5	Lost Sale	สัดส่วนการสูญหาย	Lost sale/total sale						
	2.6	Late Orders	สัดส่วนการส่งสินค้าล่าช้า	Late order/total order						
3	ความสามารถในการตอบสนอง (Responsiveness)									
	3.1	อัตราการเพิ่มเติม (Fill Rate)	สัดส่วนของที่ส่งได้เทียบกับรายการสั่ง	เทียบสัดส่วน Actual fill rate /target fill rate						
	3.2	ความล่าช้าของสินค้า (Production Lateness)	ความล่าช้าของการส่งสินค้า	จำนวนวันที่ล่าช้าจากวันที่กำหนด						
	3.4	การตอบสนองต่อลูกค้า (Customer Response Time)	ระยะเวลาในการส่งนับจากที่ได้รับการสั่งสินค้า	จำนวนวันที่สามารถจัดส่งได้หลังจากรับการสั่งสินค้า						

รายการปัจจัย			รายละเอียด	ตัวชี้วัด	คะแนนความสำคัญ					ข้อเสนอแนะ
					1	2	3	4	5	
	3.5	ระยะเวลาตามกระบวนการในการปฏิบัติงานในห่วงโซ่อุปทาน (Lead Time)	ระยะเวลาในการผลิต	ระยะเวลาในการผลิต						
	3.6	การร้องเรียนของลูกค้า (Customer Complaints)	การจัดการข้อร้องเรียนของลูกค้า	สัดส่วนจำนวนข้อร้องเรียนที่ได้รับการจัดการหรือแก้ไขปัญหาต่อจำนวนข้อร้องเรียนของลูกค้าทั้งหมดที่ได้รับแจ้ง						
	3.7	ความผิดพลาดในการจัดส่ง (Shipping Error)	การส่งสินค้าผิดพลาด	สัดส่วนการขนส่งสินค้าผิดเทียบกับการสั่งสินค้าทั้งหมด						
4	คุณภาพของสินค้า (Food Quality)									
	4.1	คุณภาพของสินค้า (Product Quality)	คุณภาพของสินค้า ทั้งด้านรสชาติ อายุการใช้งาน รูปลักษณ์ ความปลอดภัย ความน่าเชื่อถือสินค้า ความสะดวกในการใช้งาน	ค่าต่างๆที่วัดได้จากสินค้าที่สะท้อนถึงคุณภาพสินค้า เช่น สี ขนาด ระยะเวลาของอายุสินค้าตั้งแต่เก็บผลผลิตจนถึงสินค้าเน่าเสีย ความแม่นตรงของสินค้าเทียบกับฉลากอธิบายสินค้า รวมถึงจำนวนข้อร้องเรียนเกี่ยวกับสินค้า						
	4.2	คุณภาพกระบวนการ (Process Quality)	กระบวนการผลิต ความเป็นมิตรกับสิ่งแวดล้อม และการตลาด	จำนวนขั้นตอนการผลิตที่ได้ตามมาตรฐานที่กำหนดไว้ ของการผลิต จัดส่ง ทุเรียน เช่น การปลูก การจัดเก็บ การจัดเก็บโกดัง การขนส่ง เป็นต้น						

APPENDIX B

2nd Stage Interview Questionnaire

แบบสอบถามเกี่ยวกับ
การประเมินประสิทธิภาพห่วงโซ่อุปทาน (Supply Chain Performance)
ของทุเรียนในประเทศไทย ขั้นที่ 2

ตามที่ท่านได้กรุณาให้ความร่วมมือในการให้สัมภาษณ์ในขั้นที่ 1 ที่ผ่านมา ผู้วิจัยได้ดำเนินการวิเคราะห์ข้อมูลที่ได้รับจากท่านในการสัมภาษณ์ขั้นที่ 1 และได้ดำเนินการออกแบบแบบสอบถามฉบับนี้ขึ้น เพื่อเก็บรวบรวมข้อมูลเพิ่มเติมเพื่อให้การวิเคราะห์ผลสำหรับงานวิจัยเกี่ยวกับการประเมินประสิทธิภาพห่วงโซ่อุปทาน (Supply Chain Performance) มีความสมบูรณ์มากยิ่งขึ้น

ผู้วิจัยจึงขอแสดงความขอบคุณล่วงหน้า สำหรับความอนุเคราะห์ของท่านที่สละเวลาอันมีค่าในการให้ข้อมูลสำหรับงานวิจัยครั้งนี้

แบบสอบถามนี้เป็นส่วนหนึ่งของงานวิจัย ประกอบการจัดทำวิทยานิพนธ์ ระดับปรัชญาดุษฎีบัณฑิต (ปริญญาเอก) สาขาการจัดการ วิทยาลัยนานาชาติ สถาบันบัณฑิตพัฒนบริหารศาสตร์ (NIDA) ภายใต้หัวข้อ เรื่อง THAI DURIAN SUPPLY CHAIN PERFORMANCE INDICATORS ซึ่งเป็นงานศึกษาเพื่อวิเคราะห์ปัจจัยที่มีความสำคัญต่อการประเมินและพัฒนาประสิทธิภาพของห่วงโซ่อุปทาน สำหรับทุเรียนในประเทศไทย ซึ่งผลลัพธ์ที่คาดหวัง คือ การมีเครื่องมือช่วยในการประเมินประสิทธิภาพของห่วงโซ่อุปทาน สำหรับทุเรียนในประเทศไทย เพื่อการพัฒนาความสามารถในการแข่งขันของธุรกิจทุเรียนในประเทศไทย ทั้งนี้ ข้อมูลที่ได้จากแบบสอบถามนี้ มีวัตถุประสงค์เฉพาะใช้ประกอบงานวิจัยสำหรับจัดทำวิทยานิพนธ์ดังกล่าวข้างต้นเท่านั้น โดยข้อมูลในแบบสอบถามนี้จะถูกจัดเก็บเป็นความลับ ไม่เผยแพร่กับหน่วยงานใดทั้งสิ้น

แบบสอบถามสำหรับการประเมินเปรียบเทียบความสำคัญของปัจจัยตัวชี้วัด สำหรับห่วงโซ่อุปทาน สำหรับทุเรียนสดในประเทศไทย

แบบสอบถามฉบับนี้เป็นส่วนต่อเนื่องจากการให้ลำดับความสำคัญของปัจจัยต่างๆที่เกี่ยวข้องกับการประเมินประสิทธิภาพสำหรับห่วงโซ่อุปทาน (THAI DURIAN SUPPLY CHAIN PERFORMANCE INDICATORS) สำหรับทุเรียนสดในประเทศไทย ซึ่งจะเป็นปัจจัยที่ได้รับการคัดกรองจากการให้คะแนนความสำคัญ เพื่อนำมาเปรียบเทียบในแต่ละด้านสำหรับการประมวลผลน้ำหนักความสำคัญของแต่ละปัจจัยหลักและปัจจัยย่อย ซึ่งในการเปรียบเทียบจะทำการเปรียบเทียบแบบจับคู่ (Pairwise Comparison) ระหว่างแต่ละปัจจัย

โดยในแบบสอบถามนี้จะทำการประเมินเปรียบเทียบความสำคัญดังนี้

1. การเปรียบเทียบปัจจัยหลักแต่ละปัจจัย ประกอบด้วย
   1.1. ปัจจัยด้านประสิทธิภาพ (Efficiency)
   1.2. ปัจจัยด้านความยืดหยุ่น (Flexibility)
   1.3. ปัจจัยด้านความสามารถการตอบสนอง (Responsiveness)
   1.4. ปัจจัยด้านคุณภาพสินค้า (Food Quality)
2. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านประสิทธิภาพ (Efficiency) ประกอบด้วย
   2.1. ต้นทุนการผลิตและการตลาด (Cost of Production/Distribution/Transaction)
   2.2. ผลกำไร (Profit)
3. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านความยืดหยุ่น (Flexibility) ประกอบด้วย
   3.1. อัตราการเพิ่มเติม (Fill Rate)
   3.2. การส่งสินค้าล่าช้า (Late Orders)
4. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านความสามารถการตอบสนอง (Responsiveness) ประกอบด้วย
   4.1. ความพอใจของลูกค้า (Customer Satisfaction)
   4.2. การร้องเรียนของลูกค้า (Customer Complaints)
5. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านคุณภาพสินค้า (Food Quality) ประกอบด้วย
   5.1. คุณภาพของสินค้า (Production Quality)
   5.2. คุณภาพกระบวนการ (Process Quality)

<u>กรุณาทำเครื่องหมาย ✓ ในช่องคะแนนความสำคัญที่เปรียบเทียบระหว่างปัจจัยในแต่ละข้อ</u>

1. การเปรียบเทียบความสำคัญของปัจจัยหลัก

ปัจจัยด้านซ้าย	ปัจจัยด้านซ้ายสำคัญกว่า								เท่ากัน	ปัจจัยด้านขวาสำคัญกว่า								ปัจจัยด้านขวา
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1 ประสิทธิภาพ (Efficiency)																		2 ความยืดหยุ่น (Flexibility)
1 ประสิทธิภาพ (Efficiency)																		3 ความสามารถตอบสนอง (Responsiveness)
1 ประสิทธิภาพ (Efficiency)																		4 คุณภาพของสินค้า (Food Quality)
2 ความยืดหยุ่น (Flexibility)																		3 ความสามารถตอบสนอง (Responsiveness)
2 ความยืดหยุ่น (Flexibility)																		4 คุณภาพของสินค้า (Food Quality)
3 ความสามารถตอบสนอง (Responsiveness)																		4 คุณภาพของสินค้า (Food Quality)

2. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านประสิทธิภาพ (Efficiency)

ปัจจัยด้านซ้าย	ปัจจัยด้านซ้ายสำคัญกว่า								เท่ากัน	ปัจจัยด้านขวาสำคัญกว่า								ปัจจัยด้านขวา
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1 ต้นทุนการผลิตและการตลาด (Cost of Production /Distribution/Transaction)																		2 ผลกำไร (Profit)

3. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านความยืดหยุ่น (Flexibility)

ปัจจัยด้านซ้าย	ปัจจัยด้านซ้ายสำคัญกว่า								เท่ากัน	ปัจจัยด้านขวาสำคัญกว่า								ปัจจัยด้านขวา
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1 อัตราการเพิ่มเติม (Fill Rate)																		2 การส่งสินค้าล่าช้า (Late Orders)

4. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านความสามารถการตอบสนอง (Responsiveness)

ปัจจัยด้านซ้าย	ปัจจัยด้านซ้ายสำคัญกว่า								เท่ากัน	ปัจจัยด้านขวาสำคัญกว่า								ปัจจัยด้านขวา
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1 ความพอใจของลูกค้า (Customer Satisfaction)																		2 การร้องเรียนของลูกค้า (Customer Complaints)

5. การเปรียบเทียบปัจจัยย่อยของปัจจัยด้านคุณภาพสินค้า (Food Quality)

ปัจจัยด้านซ้าย	ปัจจัยด้านซ้ายสำคัญกว่า								เท่ากัน	ปัจจัยด้านขวาสำคัญกว่า								ปัจจัยด้านขวา
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1 คุณภาพของสินค้า (Production Quality)																		2 คุณภาพกระบวนการ (Process Quality)

APPENDIX C
Summary of Interview Dialogue contributing to Supply Chain Structure

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
Figure 4.1 Durian Supply Chain Characteristics based on Farmer's Viewpoint	**F 1 –** "…my income is reliant on. It is all problematic. The problem of labor, the problem of drought, the problem of inclement weather influences the maturity stage of fruit which may delay the harvesting time. Especially, we mostly need to rely on climate…" "…To estimate the maturity of durian, area of plantation and the condition of durian tree, durian cultivar, and the shape of durian need to be taken into account of. It is the duty of farmer to take care of and jot down their own farming period; like the bloom of durian flower, the bear fruit period, and so on…" "…If the harvest quantity is few, it will be sold to small-scale merchants. Another channel is to sell online that my daughter is running it. This is the channel done during when not many produces are fruitful, in particular, off-season…" "…We deliver it to individual customer we know from Facebook, Line, Instagram something like that…" "…In the past, technology was still underdeveloped which is different from the present time. We then make use of such development…" "…About the logistics or product shipment system, Thailand Post Office is the major player who comes here to pick up the products. It is the service that serve its customers to compete with other private delivery service providers…" **F 2 -** "…We have the task to produce quality durian only for selling to consolidator and other tasks will be performed by consolidator. Consolidator is the one who manages the durian fruits by cleaning, grading, and delivering to each different market…" "…There is online trade in some parts. New-generation-farmers do sell this way. Enterprise likes us also does. Some sell durian meat online…" "…sell via post office. They will send order to us or seek for customers for us and we then need to deliver the goods by using their service…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	P 2 - "…To be a producer, we need to have our own tree…" "…After the durian fruit is away from farm, it will come to our processing site…" **W 2 -** "…The durian is started from the farmer, first…" **R 2 -** "…After we set up our selling plan and schedule, we will go to talk with individual farmer, farmer group, cooperative, private sourcing firms about the quantity, the period, and quality specification of products we are going to buy. We source products from various sources to diversify the risk…" **R 3 -** "…Some farmers or relatives of them also sell durian via online. They sell in the form of whole fruit not yet peeling. Yet, it is not traded that seriously…" **E 1 -** "…To start trading, we need to consider whether such durian farm meets its standard or not…" **E 2 -** "…The starting point od durian supply chain is farmer…" "…Another new channel is the channel that the e-commerce platform operator, like Line@, directly makes a deal with farmer. This channel starts to grow continuously. They do not need to hold any stocks but only perform marketing tasks…" **E 3 -** "…Farmer is the starting point as main player…" **G 1 -** "…Durian supply chain starts from farmer…" **G 2 -** "…Steps of supply chain in Thailand, it starts when durian coming out from farm…" **M 2 -** "…All agricultural produce, not just durian, will first start from farmers. Then, those produce will come to the central market through mediator or local collector who gathers the produce from the area of production and sells to the wholesale merchants in our market…"
Figure 4.2 Durian Supply Chain Characteristics based on Processor's Viewpoint	**F 1 -** "…Another channel of farmer is to send to processing group…" "…The processor sources durian from farmer, packing house, and cooperative…" "…The processing factory does not sell the products on its own but it sells via supermarket and retail shop. Sometimes, they receive the orders from foreign countries; then, they export the products…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	F 3 - "…Disqualified durian will be sent to domestic market and processing market…" "…Processing factory also sources durian from consolidator…" **P 1 -** "…We considered ourselves as producer, wholesale trader, and product distributor…" "…Supply side, we get durian from consolidator on one hand; on the other hand, we take it directly from farmer by dealing through provincial commercial office, through provincial cooperative promotional office…" "…Basically, we will inform the farmer that what kind of durian produce we will make a purchase, how much for good grade, how much for undersized grade. Then, they will know what to be sold to us…" "…we do have. Our company has determined a management policy that at what price we are going to buy durian at a specific time and assigning consolidator to buy durian from farmers at the price we set. It can be considered as using indirect contract farming or contract farming via consolidator as mediator. The contractual parties signed in the contract will be between our company and farmers. Yet, contract farming will be used only sometimes depending on the seasonal period, not always…" "…Using contract farming helps us control the goods we purchased. We can control the cost of goods sold, selling price, and quantity as well as quality of products produced. It helps in negotiating with our customers regarding the price of products sold and the shipment period…" "…In the part that we deal with the farmers through government sector, we will ask the government officials to participate in making a suggestion to or educating durian farmers about farm management and durian quality development so that the desired quality durian is obtained. If the farmer can supply a quality one, we will buy them all. It is because the cost of quality management tends to keeps higher everyday…" "…processed durian products will only be exported. There is also some domestic demand that they want which are ice-cream company and those who want to buy to produce freeze-

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	dried durian. Because freeze-dried durian production needs to use frozen durian in the production process…" "…We will send QC officer to perform quality control and inspection at consolidator's sites…" "…After the production, we must comply with our relevant industrial standard, like GMP, HACCP, as usual, and also perform general business functions, like packing and packaging, quality control, inventory control, as well as shipment to destination determined by our customers…" **P 2 -** "…We purchase durian in every channel, including contract farming, to feed raw material into the process during on-season…" **P 3 -** "…The 1st stage processor buy durian from every channel they can get access to the whole year…" "…and the fried durian group buy durian directly from farm as well…" "…We sell our products to souvenir shops and supermarket…" "…Our firm buy durian as raw material from the merchant who processes like fried durian. It is too ripened to fry then they send to us…" **W 1 -** "…There are two export channels of processed durian products. The first one is in the way that the traders make a deal by issuing L/C (Letter of Credit) in advance. This is done for whole frozen durians which are packed in boxes and will be resell abroad such as America. Another type of product is frozen durian meat which may be used in Thai restaurants and supermarkets in foreign countries. The second method is that durian is processed as material for further production. This will be exported in the meat-only form and reproduced as freeze-dried durian in destination country…" **R 2 -** "…The durian fruits which are disqualified for export will be sent to processing house to produce frozen durian, fried durian, or durian paste…" **R 3 -** "…Soft-meat durian will be sent to frozen durian processor…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	"…Some exporters will peel the durian which is failed to be exported and sell only durian meat to durian processor…" "…Nowadays, there are some who export only durian meat through air freight to USA…" **E 1 -** "…Durian failed to be exported will be sent to processing market and sold in the country…" "…Processors, like freeze-dried durian, frozen durian, fried durian, or durian paste, will export to foreign market themselves. Domestically, they sell to convenience store, supermarket, souvenir shops…" **E 2 -** "…If there are any problems in relation to shipment error which causes the durian too ripened, the best destination for them is not any one but processing market…"
Figure 4.3 Durian Supply Chain Characteristics based on Wholesaler's Viewpoint	**P 1 -** "…Both wholesale stores and supermarkets have their own supply channels which are purchasing durian directly from farmer, consolidators, as well as central market…" **W 1 -** "…We buy durian from farmers no matter whether they are individual or group…" "…Yes, consumer comes to buy at our stores. Other two groups also come to buy which are merchant group who resell durian in fresh form, and those who buy durian for their production and resell as food products. Those who reselling in fresh form will buy and peel durian and then resell only durian meat…" "…and there will be merchants from foreign market come into country to buy directly from merchants in central market and resell in their own countries, like Lao PDR…" "…The retailers also buy durian from wholesale merchants in each central market in different provinces, like Udonthani, Chantaburi, Bangkok and its territories…" "…Wholesale traders also perform grading durian. Those which suit export will be delivered to consolidators. Those which fail to be exported will be sold by themselves at their shops in central market…" **W 2 -** "…There will be like retail merchants come to buy from us. We can also be counted as distributor within the country who links durian fruits from farm to retailer…" "…There will be dealer going to the farm to buy and gather durian fruits for us…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	R 1 - "…There are durian collectors in the production area who gather durian fruits from each farm and deliver to merchants in central market…" **E 1 -** "…After grading, the disqualified for export will be sent to wholesaler in central market in Bangkok and other territories as well as processor…" **E 3 -** "…Merchants in central market located in Bangkok and other territories come to purchase at the origin of production and resell in each territory throughout the whole country…" **M 1 -** "…after they come to the merchants in central market, they will be sold to the group of modern traders who are both wholesale store and retail store…" **M 2 -** "…Those merchants who come to trade in our market must wholesale only. No retails are allowed. Then, wholesalers and retailers from other provinces will come to buy in our market…" "…The large-scale entrepreneurs who come to buy durian for serving markets in other provinces; there will be other small-sized markets in-between before reaching end customers. Sometimes, durian fruits depart from our market, where is the largest agricultural wholesale market, to central agricultural market in Udonthani. There will then be a number of ways to go whether to be sold directly to end consumers, or sold through local or community market to consumers, or even traded across border to adjacent countries, like Lao PDR, Myanmar, and Cambodia..." **M 3 -** "…After that, there will be traders who go to collect durian from consolidator's site and deliver to merchants in the central market. Then, there will be both wholesale and retail merchants in both big-scale and small-scale who come to purchase durian from the central market. Yet, they are mostly wholesaler…"
Figure 4.4 Durian Supply Chain Characteristics based on Retailer's Viewpoint	**F 3 -** "…Retail merchant comes to buy durian at farmgate but very few merchants still exist…" **P 2 -** "…Big-scale retail merchant or supermarket will buy at wholesale amount but resell in retail market…" **W 2 -** "…Some retailers also directly go to buy from farmers…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	R 1 - "…For us, we have suppliers performing durian gathering from farmgate and central market and sell to us which we will resell via our branch stores to ultimate consumers…" **R 2 -** "…We are sellers and supporters as well. We cannot be just retailers but to be developers who develop production origin…" "…Our customers mostly are individual consumers and some are small-scale food shops. We cannot actually identify which group our customers belong to. However, we used to see some customers buy durian meat from us to make ice-cream, cake, or smoothie beverages. The benefits for them are that they do not need to bear durian stock. Additionally, they do not need to bear risk because, in each day, they cannot predict how many customers will visit their shops…" **E 2 -** "…Retailer or supermarket tend to buy from wholesaler in the central market since it costs them less than direct purchase from consolidator…" **M 2 -** "…The 3rd tier of supply chain will be the one who delivers durian to consumer…"
Figure 4.5 Durian Supply Chain Characteristics based on Exporter's Viewpoint	**F 2 -** "…Local collector changes to be subordinate hired by consolidator. In the past, local collector collected durian from each farm and resold to unknown customers in the market with markup price for profit. Recently, consolidator hires local collector to gather durian for them to save cost of tools and equipment, like trucks, scales…" "…Consolidator is just quality inspector of post-harvest produce…" "…Consolidator and exporter are the same actor. They all are hired by foreign importer to gather durian from farm, grading, packing, and transport to destination country in one shot…" **F 3 -** "…Consolidator is a big merchant who links with the sourcing agent or small merchant who supplies durian to consolidator and those who demands for durian. We need to depend on this mechanism…" "…The quality of durian sold in the market, whether mature or immature, depends on sourcing agent and consolidator…" "…local collector is sourcing agent…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
	"…In the past, consolidator would select only A and B graded durian but, recently, they buy every unit, A, B, C, D grade, they buy them all and classify each unit to each market. A and B to be exported. C and D are sold in the country…" "…Presently, consolidator is the center of all things about durian…" "…Exporter is consolidator. Currently, these two parties become one since to survive in durian business as exporter also requires grading skills which consolidator is keen on…" **P 1 -** "…Consolidator steps forward to export by themselves and exporter steps backward to play as consolidator…" **R 3 -** "…Some exporters also play the role of wholesalers who supply durian which is failed to be exported to domestic market, like in central market…" **E 2 -** "…Some consolidators arrange durian buffet program in their own sites or considered as B-to-C channel. Some farmers also do B-to-C marketing, whether through online channel, or on-site consumption. This holds interesting growth rate and continues to expand…" **G 2** - "…After it comes out from farm, it will be shipped to consolidator to be graded. At consolidator's site, it will be graded, cleaned, treatment by heat blowing for the purpose of pest repellent or elimination and dip into yellow-color liquid medicine, pack in ten-kilogram box or three units of durian, and load into container…." **M 1** - "…From farmer, there will be collectors who transfer durian to consolidator's site…" **M 2** - "…Today, consolidator becomes the most influential player in durian supply chain. They are now the one who determines the market price, which is used as reference price by other players, and quantity of durians traded in the market…" "…Consolidator becomes the center of durian trade where the durian products are gathered, the price are quoted based on quality, the product treatment and handling are performed, as well as product distribution to each destination market is done. It can be considered that all activities are performed in one stop…" **M 3 -** "…In durian trade system, farmer will gather the product and deliver to consolidator's site…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
Figure 4.6 Durian Supply Chain Characteristics based on Government's Viewpoint	**F 1 -** "…Government must take the interest of farmer into consideration. They must deregulate the migrated labor policy because we are short of labors during harvesting period. It affects at least ten thousand farming plots…" **W 2 -** "…The sourcing agents will sell durian to wholesale merchants in central market in Bangkok before delivering again to wholesale traders in other provinces…" **R 2 -** "…we talked with Department of Internal Trade and found that it matched with our objectives regarding promotion on production based on domestic demands. This helps us getting products with good quality that matches domestic demand because such department segment the market based on quality attributes which is consistent with our approaches…" **E 3 -** "…Government must control the access of foreign traders not to be able to get direct access to the farmgate nor to invest in constructing their own trading sites…" "…not just arranges a meeting to talk about problem resolution but to consider what consolidators are lack of. Government must fulfill it not just set up rules to control them. If they are short of labors or trucks, provide them the insufficient resources…" "…Government must sufficiently fulfill the necessary resources to entrepreneurs, and they need to create fairness in trading by not letting the market manipulation or domination happen, as well as relieve the controlling scheme; particularly the scheme about labor, trading regulations and standards…" **G 2 -** "…Durian farm, the farm, that farmer must be certified according to standard practice system of Department of Agriculture…" "…in the evening, durian will be transferred to grading consolidator. If consolidator will classify durian into each different grade, grade A will be exported, grade B and C will be sold within the country. If consolidator is to perform the grading task, they must be certified GMP (Good Manufacturing Practice) by Department of Agriculture…"

Status Quo of Durian Supply Chain	Comments/ Opinions of Supply Chain Actors contributing to the Status Quo
Figure 4.7 Durian Supply Chain Characteristics based on Market Operator's Viewpoint	**M 2 -** "…All trading activities are performed by the traders in our market. Our tasks are just facilitation by offering various activities such as area, electricity, security, parking area, promotion. That's all…" "…If there are any disputes between buyer and seller, we will let them resolve by themselves, basically. If they cannot come to a desirable end, we will step in to be mediator to resolve the problem…" "…If durian market price is manipulated, the products will overflow into central market…" **M 3 -** "…As a trade facilitator, we serve the traders in our market by offering them the area for inventory storage for rent, labor provision, cleaning service, dispute resolution, and sometimes we do a product sample test and examination on quality and chemical residue at a random basis…"

APPENDIX D
Analytical Hierarchical Process (AHP) Results

Table 1.1 Standardized Comparison Matrix on Efficiency of All Groups

Efficiency Indicators	Cost	Profit
Cost	1.00	2.09
Profit	0.48	1.00
TOTAL	1.48	3.09

Table 1.2 Normalized Comparison Matrix on Efficiency of All Groups

Efficiency Indicators	Cost	Profit	Weight Score Estimation
Cost	0.68	0.68	0.68
Profit	0.32	0.32	0.32
TOTAL	1.00	1.00	1.00

Table 1.3 Standardized Comparison Matrix on Flexibility of All Groups

Flexibility Indicators	Customer Satisfaction	Late Order
Customer Satisfaction	1.00	2.17
Late Order	0.46	1.00
TOTAL	1.46	3.17

Table 1.4 Normalized Comparison Matrix on Flexibility of All Groups

Flexibility Indicators	Customer Satisfaction	Late Order	Weight Score Estimation
Customer Satisfaction	0.68	0.68	0.68
Late Order	0.32	0.32	0.32
TOTAL	1.00	1.00	1.00

Table 1.5 Standardized Comparison Matrix on Responsiveness of All Groups

Responsiveness Indicators	Fill Rate	Customer Complaints
Fill Rate	1.00	4.90
Customer Complaints	0.20	1.00
TOTAL	1.20	5.90

Table 1.6 Normalized Comparison Matrix on Responsiveness of All Groups

Responsiveness Indicators	Fill Rate	Customer Complaints	Weight Score Estimation
Fill Rate	0.83	0.83	0.83
Customer Complaints	0.17	0.17	0.17
TOTAL	1.00	1.00	1.00

Table 1.7 Standardized Comparison Matrix on Food Quality of All Groups

Food Quality	Product Quality	Process Quality
Product Quality	1.00	1.08
Process Quality	0.93	1.00
TOTAL	1.93	2.08

Table 1.8 Normalized Comparison Matrix on Food Quality of All Groups

Food Quality	Product Quality	Process Quality	Weight Score Estimation
Product Quality	0.52	0.52	0.52
Process Quality	0.48	0.48	0.48
TOTAL	1.00	1.00	1.00