

Thai Durian Supply Chain Characteristics, Performance Indicators, and Analytic Hierarchy Process

Received: 25 May 2020

Revised: 4 August 2020

Accepted: 31 August 2020

Asdawut Siriprasertchok^{1*} and Aweewan Panyagometh²

Abstract

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. 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.

Keywords: Durian supply chain, Supply chain performance indicators, Analytic hierarchy process

* Corresponding author e-mail: hatori191@hotmail.com

¹ Ph.D. student, International College, National Institute of Development Administration e-mail: hatori191@hotmail.com

² Associate Professor, International College, National Institute of Development Administration e-mail: maweewan@gmail.com



Introduction

Durian is grown in tropical countries 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 occupying more than 98 percent of the global durian market share of which export value is more than 32 billion Thai Baht or 1,000 million USD. It is followed by Malaysia with a 1.62 percent market share and the remaining share belonging to other nations (Global Trade Atlas, 2020)

However, while Thailand is enjoying its success, a number of relevant problematic issues are abandoned. One of them is lack of improvement in Supply Chain Management (SCM) (Bank of Thailand, 2019; Pisarnwanich, 2019; Prachachatdthurakij, 2019) Therefore, to maintain its competitiveness in the market, Supply Chain (SC) and operation should be effectively managed (Humphrey & Memedovic, 2006; Tsolakis, Keramydas, Toka, Aidonis & Lakovou, 2012). To affirm that effective SCM is achieved, performance measurement is the key requirement to be performed so that firms attain desirable outcomes (Bijman, 2002; Bijman, Omta, Trienekens, Wijnands & Wubben, 2006; Gunasekaran, Patel & McGaughey, 2004; Neely, 2007; Wijnands & Ondersteijn, 2006)

This paper attempts to understand the Performance Measurement System (PMS) of the durian SC. Owing to its unique characteristics, logistics and SCM are incredibly important to ensure that quality produce is properly delivered from the hands of producers to the hands of customers. This leads to the development of research objectives presented in the next section.

Research Objectives

To fulfil the afore-mentioned aims, the four research objectives are:

- 1) To illustrate the structures of Thai durian SC processes and their relations in Thailand
- 2) To identify suitable Performance Indicators (PIs) which can reflect the SC performance of the Thai durian SC
- 3) To determine the significance level of each indicator which can be utilized in setting relevant strategies, evaluating performance and determining future courses of action
- 4) To provide recommendations for public policy in relation to the Thai durian industry or management guidelines for stakeholders in the Thai durian industry

The theoretical and conceptual base is detailed in the next section, followed by research methodology. Then research findings are analyzed. The discussion on the results and future research recommendations are presented in the last section.

Literature Review

Agri-food supply chain performance measurement

In setting global food security and hunger combatting strategies, agricultural products have been a concern of the global community as an essential factor in fulfilling global food demands and in response to the dynamic lifestyle changes of consumers in their diets (Aramyan, Hoste, & Broek, 2015; Tsolakis, Keramydas, Toka, Aidonis, & Lakovou, 2012). However, in managing agri-food business, the complexity and cost-efficiency of logistics operations have been considered as one of the most difficult challenges (Chen, Chen & Shi, 2003; Kataike, Aramyan, Schmidt, Molnár & Gellynck, 2019; Roekel, Willems & Boselie, 2002).

Tsolakis, Keramydas, Toka, Aidonis, & Lakovou (2012) have identified key issues in managing modern Agri-Food Supply Chains (AFSC) and categorized them into 3 different levels consisting of strategic, tactical and operational levels. From their classification, performance measurement is considered as strategically crucial since it determines the decision-making of future courses of action through the evaluation of earlier practices and benchmarking. Managers will be able to identify the gap between actual performance of a firm and customers' expectations, and use such information to identify weaknesses and design performance improvement programs or even redesign firms' strategy and management systems (Reese, 2001). In real practice, it can be seen that operations managers should insightfully measure the SC performance in order that long-term organizational success is ensured (Aramyan, Hoste & Broek, 2015; Caplice & Sheffi, 1994; Kataike, Aramyan, Schmidt, Molnár & Gellynck, 2019; Neely, Gregory & Platts, 2005; Tsolakis, Keramydas, Toka, Aidonis & Lakovou, 2012).

Generally, SC performance measurement is a challenging process that becomes even more complicated in the case of modern AFSC as they contain specific characteristics that require sophisticated and comprehensive managerial capabilities. Apart from that, to develop a SC PMS, it is crucial to understand the nature of the SC since each chain may contain diverse characteristics. (Aramyan, Hoste & Broek, 2015; Aramyan, Ondersteijn, Kooten & Lansink, 2006; Kataike, Aramyan, Schmidt, Molnár & Gellynck, 2019; Van der Vorst, 2000).

Therefore, Aramyan, Ondersteijn, Kooten & Lansink (2006) have added a number of specific characteristics of agri-food products into the existing performance measurement methods (Van der Spiegel, 2004; Van der Vorst, 2000). A developed framework of AFSC PIs has accordingly been proposed as shown in Figure 1. The attributes regarding efficiency, flexibility, and responsiveness are contained in the framework based on the pros and cons of existing methods while the last one stemmed from the study of Lunning, Marcelis & Jongen (2002) on the issue of food quality.

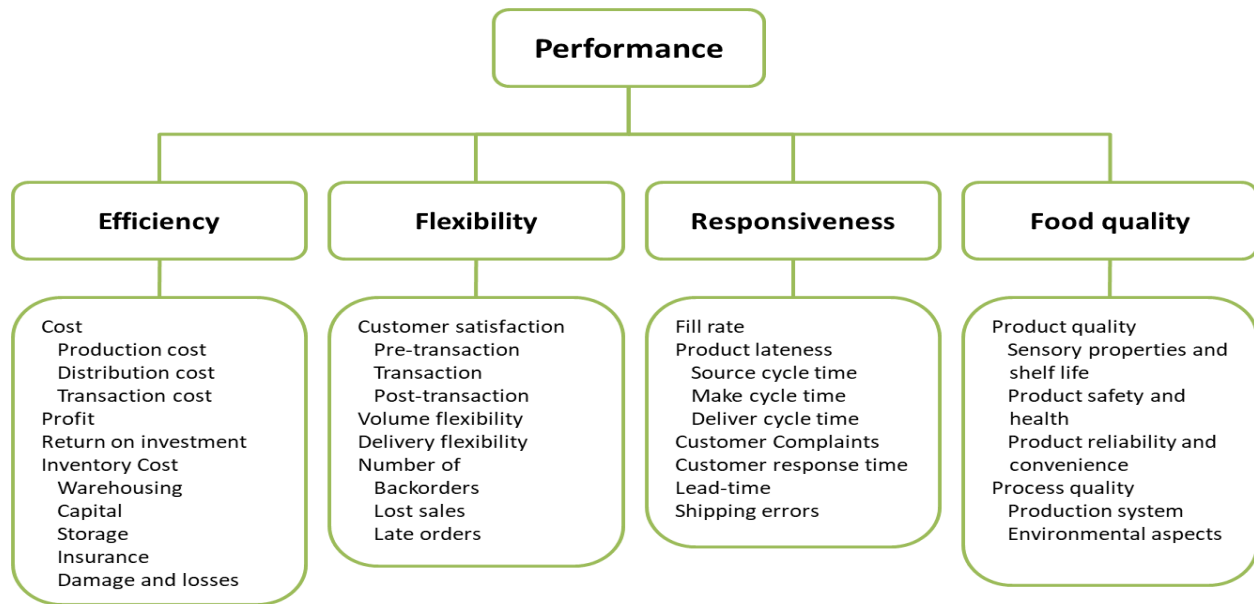


Figure 1 Aramyan et al.'s conceptual framework of AFSC PIs

Source: Aramyan, Ondersteijn, Kooten & Lansink (2006)

The Analytic Hierarchy Process (AHP) and its application in SCM

The AHP is a multi-criteria decision-making tool used mostly in 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-making 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 the best choice among ambiguous alternatives (Balaji, Madhumathi, Karuppusami & Sindhuja, 2012; Rangone, 1996).

The ideological base of the AHP is to set and define the environmental scope of the problem (Saaty, 1986). It is based on systematic mathematical structures in the form of matrices while containing an associated ability to attribute reliable weight approximation through its eigenvector (Merkin, 1979; Saaty, 1980, 1994). The AHP methodology consists of comparison of each criterion, or alternatives according to criteria based on pairwise bases by using a basic scale of absolute numbers to reflect individual preferences toward quantitative and qualitative attributes (Saaty, 1980, 1994).

The application of AHP in the SCM field has been successful in gaining acceptance from relevant practitioners. It showed the benefits of the arrangement of problems in a hierarchical manner and the application of pairwise comparison to the information gathered from each specialist (Salo & Hämmäläinen, 1997). There are also declarations that the AHP application is

extensively practical in resource allocation, strategic planning, project management (Vargas, 1990; Wanga, Huang & Dismukes, 2004), environmental impact assessment (EIA) (Ramanathan, 2001) selection of supplier and distributor (Balaji, Madhumathi, Karuppusami & Sindhuja, 2012; Cheng & Tang, 2009; Tas, 2012) supply chain assessment and multidimensional development (Huang, Yu, Luo & Zou, 2012) and others (Vaidya & Kumar, 2006; Vargas, 1990; Zahedi, 1986) Such applications pinpoint the flexibility of the AHP method and its potential for usage extension (Vaidya & Kumar, 2006).

The Thai durian SC

In order to effectively evaluate the performance of SCM, it is necessary to understand its chain structure and characteristics (Aramyan, Ondersteijn, Kooten & Lansink, 2006; Kataike, Aramyan, Schmidt, Molnár & Gellynck, 2019). Jealviriyapan, Kuayjareanpanich, & Koywiwattrakul (2001) conducted a study before China had become involved in the durian industry as illustrated in Figure 2. The study was applicable until the year 2004 when China has become until now the largest export market of Thai durians. The ascending of Chinese market was merely perceived that has somehow altered the logistics arena of Thai Durian. Therefore, the durian SC structure needs to be examined as to whether there are any changes resulting from the change of business context or not so that the PIs are properly identified (Aramyan, Hoste & Broek, 2015; Gunasekaran, Patel & McGaughey, 2004; Kataike, Aramyan, Schmidt, Molnár & Gellynck, 2019; Mapes, New & Szwejcowski, 1997; Slack, Chambers, Harland, Harrison & Johnston, 1995; Van der Vorst, 2006)

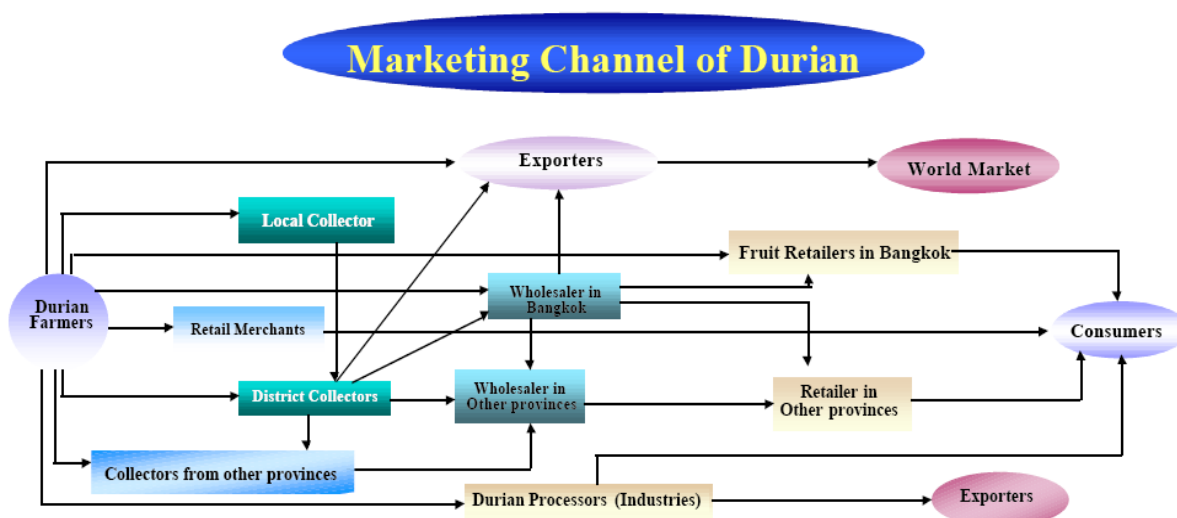


Figure 2 Marketing channels of durian

Source: Jealviriyapan, Kuayjareanpanich & Koywiwattrakul, (2001)



Methodology

1. Sample

Based on data from the Office of Agricultural Economics (2016) of Thailand, there are 128,167 registered durian farmers. However, among the seven groups of SC members, farmer is the only group for which a reliable population is available. The populations of the other groups cannot be identified since there may be no official records or they are inaccessible.

All stakeholders were purposefully selected for the focused interview. The respondents then needed to be limited to only those who deal with, or have sufficient comprehension and experience in, the Thai durian business or SC. Apart from that, since AHP is not a statistical technique, there are no specifications for the required sampling techniques to be adopted. However, the sampling process of this study must consider all related stakeholders in the durian business to cover all aspects of decision-making problems but the sample size should be limited. This is because the size of the sample group has a positive association with the degree of data inconsistency (Waris et al., 2019).

The representatives of all groups were recruited based on their proficiencies and experience in the durian SC which are implicitly indicated by the number of years they have been dealing with the durian business. Therefore, the minimum number of eight- to ten-years' - experience in the durian business and/or general acknowledgement by others as experts in the industry were determined as selection criteria in order that realistic and relevant information was collected. Twenty-one informants were then selected with a brief summary provided in Table 1.



Table 1 Brief information of key informants

Group	Code of informant	Number of years of durian experience	Current position	Type of business	Estimated annual production/ trade capacity (tons)
Farmer (F)	F1	30	Owner	Individual farmer	200
	F2	30	Owner	Individual farmer	10
	F3	40	Owner	Individual farmer	50
Processor (P)	P1	4	Owner	Processed durian exporting company	35,000
	P2	40	Owner	Domestic durian processing company	600
	P3	20	Owner	Durian processing cooperative	30
Wholesaler (W)	W1	24	Manager	Wholesale store	20,000
	W2	15	Owner	Domestic wholesaler	25
	W3	35	Owner	Domestic wholesaler	300
Retailer (R)	R1	27	Manager	Supermarket	3,000
	R2	22	Executive	Supermarket	3,000
	R3	20	Manager	Supermarket	300
Exporter (E)	E1	25	Owner	Fruit exporting company	4,000
	E2	9	Owner	Fruit exporting company	2,000
	E3	40	Owner	Fruit exporting company	N/A
Government officer (G)	G1	22	Supervisor	Local government organization	N/A
	G2	11	Supervisor	Central government organization	N/A
	G3	5	Supervisor	Central government organization	N/A
Market operator (M)	M1	30	Executive	Agricultural central market	200,000
	M2	16	Manager	Agricultural central market	270,000
	M3	20	Owner	Agricultural central market	99,000

From Table 1, the informants consisted of 7 groups which were classified and selected by their roles in the durian market including Farmer, Processor, Wholesaler, Retailer, Exporter, Government officer, and Market operator. Each group consisted of three informants who have different degree of experiences in term of number of years. This diversification and focus of selected informants provided both a scrutinized and inclusive market facts. The total of 21 informants were adequate and had enabled the non-scattered data collection, which was to be expected in this in-depth interview study. In addition, it can be seen from the table that the career positions of sample groups are diverse which tends to be beneficial to the study in terms of coverage of perspectives from the strategic level to the operational level.



2. Describing the structure of the Thai durian SC and its relations

The focused interviews were conducted in person each time separately at the place and time that were most convenient to the participants. During the interview, the conversations were recorded using a digital voice recorder and transcribed.

After the interviews, data triangulation was executed to examine validity and reliability before analyzing SC characteristics and its relations by applying constant comparison (Miles & Huberman, 1994, cited in Berkowitz, 1997; Dye, Schatz, Rosenberg & Coleman, 2000; Thurmond, 2001)

3. Identifying the corresponding PIs

After the respondents had been asked to provide information regarding the Thai durian SC structure, they were asked to rate the feasibility score of every single indicator in the predefined list (Figure 1) by using a five-point Likert scale, with 1 being “Least important or Not important at all” and 5 being “Most important or Unavoidably important”. Only PIs with average rating score not less than 4.00 will be retained for further analysis (Aramyan, Ondersteijn, Kooten & Lansink, 2006).

4. Determining the level of each PI using AHP technique

After the first stage interview had been conducted, a complete Thai durian SC structure and a list of screened key PIs were derived. Then, a questionnaire with pairwise comparison was developed for the second stage interview.

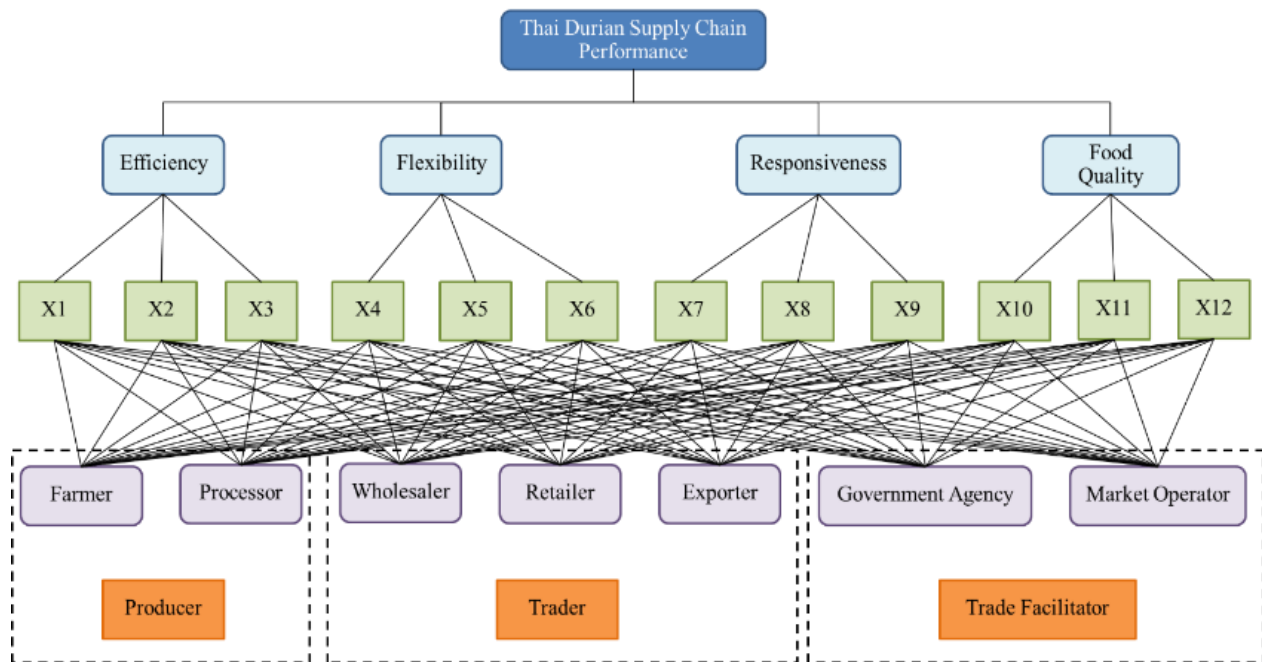


Figure 3 Proposed hierarchical structure for Thai durian SC performance
(Developed from the conceptual framework of AFSC PIs of Aramyan, Ondersteijn, Kooten & Lansink (2006) with AHP application)

The second stage interview was done by conducting face-to-face surveys with the same group of informants. Pairwise 9-scale bipolar rating questions were used to collect the importance rating scores of each attribute (Rabbani & Rabbani, 1996) After that, the pairwise rating scores were used in AHP analysis to perform weight estimation and consistency check. Such pairwise comparison can be illustrated in Figure 3. More details of AHP calculation can be found in the book named ‘Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process’ (Saaty, 2000)

Results

1. Thai durian SC structure and its relations

After the interviews had been conducted, the data validity and reliability were examined through the process of data triangulation. From Table 2, thirteen themes of key information can be drawn from the interviews. As each theme was mentioned by the informants in a consistent manner without contradiction, it can then be considered as reliable and internally valid. However, even though some of the thirteen themes received a low response rate during the interview, no



objection or contradiction had been found. All thirteen themes are retained in this study with the awareness of low reliability for further analysis, accordingly.

Table 1 Interview results

Theme of key information obtained from interview	Number of responding informants
1. The farmer is the very beginning point of the durian SC.	11 (52.38%)
2. The roles of exporters consist of quality inspection, grading, sorting, product treatment, product handling, and exportation.	9 (42.86%)
3. Processors are seen as one of the destination markets.	6 (28.57%)
4. Wholesalers and retailers are the suppliers to downstream businesses.	6 (28.57%)
5. Processors supply durian products to downstream business.	5 (23.81%)
6. The consolidator is an exporter.	5 (23.81%)
7. Durians are traded via online platform	4 (19.05%)
8. SC members before processors are seen as durian suppliers.	4 (19.05%)
9. The roles of the government sector deals with business matching, trade promotion, product and process certification.	4 (19.05%)
10. The relationship between farmer and processor has been formed via 'Contract Farming'.	2 (9.52%)
11. Processor activity is divided into two stages.	2 (9.52%)
12. The consolidator is the most critical member of the chain.	2 (9.52%)
13. Labor policy should be deregulated and fair trade should be promoted.	2 (9.52%)

From the interview data collected from 21 informants, a schematic diagram of the Thai durian SC map can be drawn as shown in Figure 4.

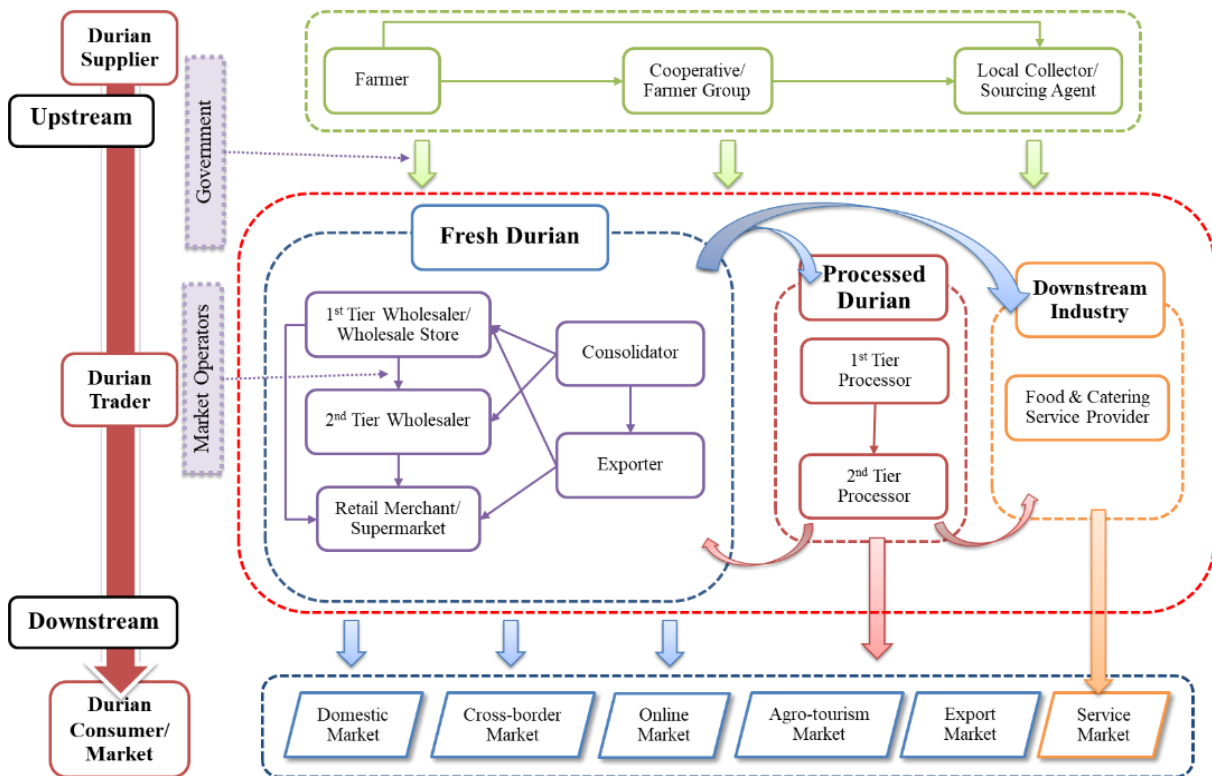


Figure 4 Schematic diagram of Thai durian SC (Developed from the interview data)

In Figure 4, it can be seen that durians are traded mainly in two forms which are fresh durian and processed durian. All SC actors trade within and across the clusters to fulfill the demand of six markets which are both domestic and international.

The group of upstream business is the group that supplies or transfers fresh durians from the orchards to the production sites of the mid-stream industry.

In the mid-stream to downstream stage, the consolidator is the actor who purchases and gathers durian produce at their sites to perform a number of treatment activities before distributing it to other parties after them. Most of the durians coming to the site are from collaboration between the consolidator and the durian farmers who are in partnership with the consolidator.

For the cluster of processed durian trade, the trading transactions can be in the form of either one-time purchase or contract farming. However, to ensure chain consistency, the processor is likely to enforce contract farming with durian farmers.



The production of the 1st tier processor 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, dehydration, crispy baking and reducing to a paste. The latter requires more complicated methods such as durian lasagna, durian ice-cream, durian soup, etc.

However, the 2nd tier processor is the actor who produces durian products using rejected or poor-quality durian unable to be traded in fresh form. Normally, this group of processors are supplied with raw materials from 1st tier processors who are their trading partners.

The last cluster of mid- to-downstream stage is food and catering service providers. This group is the sole player linking durians from orchards to the service market. This group is supplied by the other trader groups who are its suppliers of both fresh and processed forms.

The last group of SC actors is trade facilitators who support the durian trade SC system. Starting with market operators, this type of facilitator can assist durian trading activities limited only to trading taking place within its own marketplace due to the nature of the business. Therefore, government organizations are the key players performing this duty at a larger scale since it requires legal authority to do so. Some supporting activities performed by these two groups partially overlap, such as quality inspection of the durians 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.

2. Screening results of the Thai durian SC PIs.

In the first stage interview, the key informants were asked to designate a feasibility score on the predefined PIs for which average scores are computed and displayed in Table 3.



Table 2 Average importance rating score of the Thai durian SC PIs

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	Backorders	3.50	3.38	3.86	3.57*	Remove
FLX5	Lost Sales	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 Errors	3.17	4.00	3.43	3.57*	Remove
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: *PIs with an average importance rating score below 4.00 are withdrawn from further analysis (Aramyan, Ondersteijn, Kooten & Lansink, 2006)



As seen in Table 3, there are ten indicators failing to meet the cut-off criterion determined earlier in the previous section. As a result, there are only eight indicators with a high importance level remaining for further analysis.

3. Analytical Hierarchical Process (AHP) analysis result of the Thai durian SC Pls.

After obtaining the list of valid Thai durian SC Pls, pairwise comparisons of the remaining indicators were performed by the same group of respondents. The scores obtained in this stage were computed based on the AHP method for which results are presented in Tables 4. In this study, the calculations were performed for three aspects which are: 1) overview result; 2) results of each group of SC actors categorized by function (producers, traders, and trade facilitators), and; 3) results of each individual group of SC actors (farmer, processor, wholesaler, retailer, exporter, government officer, market operator) so that the overall pattern of thoughts or opinions can be clearly identified.

It is found that the overview score attains a satisfactory consistency level with a ratio of 0.00367 which is lower than the cut-off criterion at 0.10. This means that the overall data set is consistent and valid for AHP analysis. Moreover, when consistency checks were repeated for other aspects, it can be found that they all attain a consistency ratio (C.R.) of less than 0.10 which is at a satisfactory level.

Table 3 Weight scores of each performance attribute categorized by groups of informants

Overall Performance Dimension Results											
Performance Attributes	All	Producer	Trader	Trade Facilitator	Producer		Trader			Trade Facilitator	
					Farmer	Processor	Wholesaler	Retailer	Exporter	Government Sector	Market Operator
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

In Table 4, it can be seen that ‘Food Quality’ and ‘Efficiency’ are considered by all groups to be the most important performance dimension among the four dimensions with weighted scores of 0.38 and 0.37, respectively. They are followed by ‘Responsiveness’ with a weighted score of 0.17 and ‘Flexibility’ with a weighted score of 0.08.

When considering the combined weighted 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 Order’ (0.32). All players in the Thai durian SC 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.

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

Discussion

1. The Thai durian SC structure has changed

It is found that the Thai durian SC structure revealed in this study is broadly similar to, but not the same as, the durian SC of the previous study conducted by Jealviriyapan, Kuayjareanpanich & Koywiwattrakul (2001) Relevant additional insights are discussed in this section, accordingly.

Increasing trend of online platforms: The most interesting point is that online platforms, which was never found in the previous study, have been chosen by Thai durian farmers as a new form of market accesses. This phenomenon is considered to be consistent with the theory of the ‘Technology Acceptance Model’ (Davis, 1986) To be specific, the perceived ease-of-use of durian farmers with limited digital literacy in 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 access the perceived usefulness which they are looking for such as market access, communication channels with end-customers, and others.

Businesses of some SC actors have been extended to the tourism industry: Another issue changing from the previous work is that the SC actors, i.e. farmers and consolidators, do not only perform a trade function, but extend their businesses to the service industry by offering sales of durian with a tourism package, which is so-called ‘agro-tourism’. The tourism program can add value to the product of at least 2 times higher than average price.

Cooperation among durian farmers: Horizontal integration in the form of cooperatives or ‘Big-plot-farming groups’ tends to be more influential since it helps decrease costs and increase the bargaining power of durian farmers in the durian trade. Such integration was also never found in the previous study of Jealviriyapan, Kuayjareanpanich & Koywiwattrakul (2001)

Consolidators are focal SC actors: The role of consolidator tends to be so influential and powerful that they have become a critical actor in the Thai durian SC. This is because they occupy the marketing information and durian orders sector of major export markets, which demand 75 percent of total durian production each year (Global Trade Atlas, 2018)

Office of Agricultural Economics (2016) With marketing insight in hand, they can capture the highest bargaining power in the system which allows them to set, or even manipulate, the market price, and control product flow in the market. They were not, however, mentioned at all in the study of Jealviriyapan, Kuayjareanpanich & Koywiwattrakul (2001)

Backward SC integration of farmer-1st tier processor and local collector-consolidator: There tends to be a situation equivalent to backward integration existing in the durian SC at least two points which are: (1) farmer-1st tier processor, and; (2) local collector-consolidator. This

first integration pattern is in the form of the 1st tier processor communicates with farmers regarding quality requirements and becomes involved in 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 consolidators extend their operations 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 operational risk, or the risk of being unable to sell the product, while consolidators can maximize not just efficiency in terms of cost-saving and consistency of supply, but also effectiveness, in terms of product quality. These particular kinds of integration; however, were never found in the previous durian study of Jealviriyapan, Kuayjareanpanich & Koywiwattrakul (2001) as well.

Withdrawal of old SC actors: In comparison between the interview results and the previous study, district collectors and collectors from other provinces have disappeared from the system, but their functions, such as grading, product classification, product treatment, as well as product shipment and handling, have been performed by consolidators instead in order to avoid redundancies in the system which leads to enhanced chain efficiency.

2. Key performance indicators of the Thai durian SC

After the application of AHP analysis to the proposed framework developed by Aramyan, Ondersteijn, Kooten, & Lansink (2006) it appears that not all proposed indicators are feasible with the case of the Thai durian SC. Specifically, only eight of nineteen indicators remained to reflect each performance dimension as illustrated below in Figure 5.

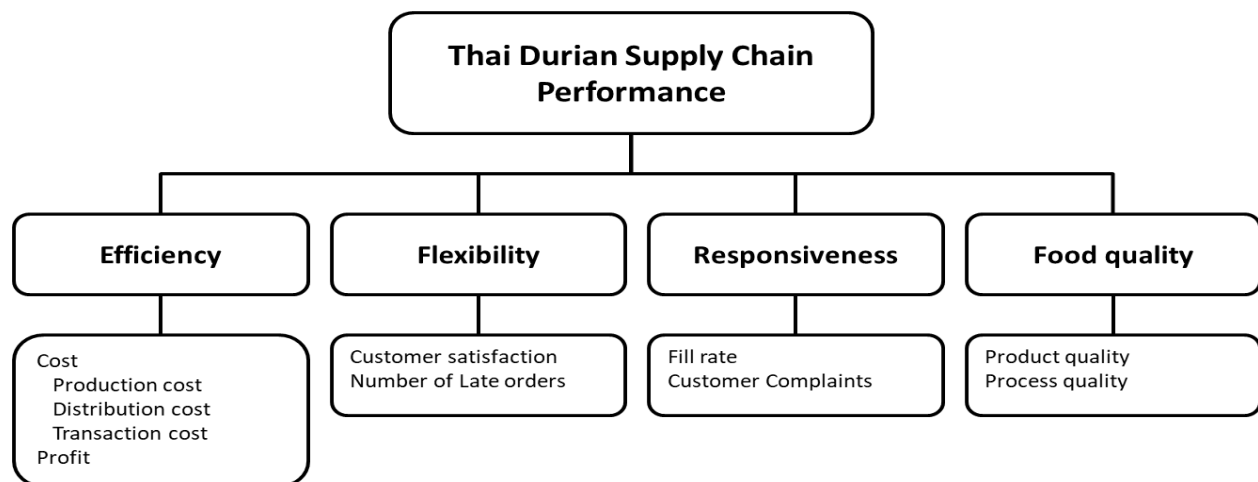


Figure 5 The Thai durian SC Pls framework derived from the study.

However, with the overall weight score obtained from this study, it can be seen that, among the eight Pls, four indicators were rated by SC actors as the most concerning factors. They

consist of cost, fill rate, customer satisfaction, and product quality. This implies that the strengths of the Thai durian SC are well-controlled cost, adequate product availability, ability to satisfy customer's requirements, and good product quality.

3. Practical implications

With reference to the results presented in the previous section, it can be found that the SC structure and its internal relationships can provide better comprehension of 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 existing SC actors, as well as the existing relationship among the SC actors at each stage of the industry. After they gain an understanding of the system, they may be able to seek new business opportunities or find the room to penetrate the industry, or even find a gap to fill. This can further lead to innovation development in the durian business or relevant fields.

With respect to the rise of online trade found in this study, a firm may take this opportunity to consider how to adjust itself to the digital revolution with aligned integration of Omni channel business practice. Also, to have a strategic plan to subsist in the Post-Digital era.

Based on the results regarding durian SC performance, the relevant managers, business owners, or operation officers will be able to assess business alternatives before making a decision at not just the strategic level but the operational level as well using the weighted scores from this study as an evaluation template.

4. Policy recommendations

4.1 Government sector

Opening new market opportunities: With reference to the interview results, it is found that the market structure of the Thai durian seems to have gradually changed. First of all, the agro-tourism market seems to be emerging according to durian consumption trends. This kind of tourism service initially embraces an aim to serve foreign tourist groups, specifically the Chinese. Thus, to make use of this opportunity, the relevant public agencies should formulate an integrative agro-tourism branding strategy with a uniformity in integrated marketing communication. Innovated creations of product should be planned and supported whilst ensuring to meet the demand of consumers, which has been changing super-rapidly. The government will have to be aware of the increment and the decrement of demand while balancing the value and volume of the market for the goal of growth.



Implementing new marketing strategies: The rise of the online durian trade can be considered as a sign of the shift in trading patterns for agri-food products. Thus, government agencies can make use of this trend to formulate a holistic online agricultural trade promotional strategy. This strategy should embrace an aim to create a desirable online agricultural business ecosystem which supports every enterprise. The strategy should specify promotional schemes which cover at least a financial support scheme for business initiation, short-term loans for liquidity enhancement in order to engage with digital markets, technological and technical support, online trade training courses, an online trade one-stop service center establishment with an information center, business consultant services including a business match-making service, and so on.

Apart from that, with the implications of the overall weight scores discussed in the previous section, the government sector should communicate the four strengths of the Thai durian business through branding, similar to the 'Amazing Thailand' of the Tourism Authority of Thailand. This newly-created brand can be integrated with the agro-tourism branding discussed earlier so that both correspond with each other and are communicated effectively. Not just that, 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.

Facilitating chain integration: As SC integrations exist along the chain which are beneficial to the chain members, the government sector should promote and support chain members in performing chain integration. The promotional scheme could be expressed in various ways such as training courses, business match-making activities, tax privileges, financial or non-financial support, and so on. Besides, integration can range from cooperation and coordination to collaboration. It would depend 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.*

4.2 Relevant associations

Creating communication channels: With regard to the earlier discussion about the differences in importance of weighted scores derived from AHP analysis which reflect the differences in business paradigms, 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, networking should create linkages not just among individuals, but also among groups and associations existing along the SC. This policy is expected to be beneficial to the chain in terms of minimizing chain vulnerability and maximizing chain robustness and resilience (Mangan, Lalwani & Butcher, 2008; Tang, 2006)

5. Academic contribution

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

Secondly, the application of AHP in this research is proof of extending utilization of this particular method to the field of AFSC. However, it still needs more exploratory study to confirm this extension.

Thirdly, the results from this research regarding the screened PIs provides evidence that the AFSC performance framework of Aramyan, Ondersteijn, Kooten, & Lansink (2006) is partially compatible with the performance of the Thai durian SC.

Finally, 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 toward this specific field in terms of SC structure, feasible performance attributes, as well as key PIs.

Recommendations

This study has been carried out following the research methodology explained in the prior sections which may still lack practicality since the information collected is opinion-based, even if the informants are specialists in the area of study. As a result, experimental research is recommended to 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 PMS is properly fine-tuned for real practice.

Moreover, with the natural limitations of a qualitative approach which lacks external validity or generalizability (Kothari, 2008) a quantitative approach should be conducted to ensure the causality of each indicator in SC performance so that the idiosyncrasies of the study can be resolved.

In addition, to extend the coverage of PMS, additional performance dimensions; such as the four characteristics (performance characteristics, relational and contextual characteristics, technical and technological characteristics, characteristics of supply chain practices) of Sakka & Botta-Genoulaz (2009) the Business Excellence Model of The European Foundation for Quality Management (2012) and others, should be further explored so that potential factors influencing SC are not overlooked. Apart from that, to enhance the comprehension of the study, the other



groups of informants missing from this study should be recruited so that potential different opinions towards the durian business are included.

Finally, with the nature of business necessarily facing continual dynamic changes in external factors, for instance, international trade policy, environmental issues, and the like, it is possible that such external changes may sometimes have an effect on the SC performance of a firm in some ways. Therefore, a study on the effects of external factors on business SC performance is recommended for future research so that the knowledge base and comprehension in this particular field are significantly extended.

References

- Aramyan, L., Hoste, R., & Broek, W. v. d. (2015). *Strategic Decision Making in Designing Sustainable Pork Supply Chains*. Retrieved March 30, 2020, from https://www.researchgate.net/publication/281620820_Strategic_Decision_Making_in_Designing_Sustainable_Pork_Supply_Chains.
- Aramyan, L., Ondersteijn, C., Kooten, O. V., & Lansink, A. O. (2006). Performance Indicators in Agri-food Production Chains. *Quantifying the Agri-Food Supply Chain*, 15,49-66.
- Aziz, N. A. A., & Jalil, A. M. M. (2019). Bioactive Compounds, Nutritional Value, and Potential Health Benefits of Indigenous Durian (*Durio Zibethinus* Murr.): A Review. *Foods*, 8(3),1-18.
- Balaji, M., Madhumathi, P., Karuppusami, G., & Sindhuja, D. (2012). AHP Based Agile Supply Chains. *International Journal of Engineering and Innovative Technology*. 1(2). 16-20.
- Bank of Thailand. (2019). *Thai Durian Dead or Alive?*. Retrieved April 7, 2020, from <https://www.prachachat.net/finance/news-373467>.
- Berkowitz, S. (1997). *Analyzing Qualitative Data. User-Friendly Handbook for Mixed Method Evaluations*. Virginia: Directorate for Education and Human Resources.
- Bijman, J. (2002). *Essays on Agricultural Cooperatives, Governance Structure in Fruit and Vegetable Chains*. ERIM Ph.D. Series Research in Management, Erasmus University, Rotterdam.
- Bijman, J., Omta, S. W. F., Trienekens, J. H., Wijnands, J. H. M., & Wubben, E. M. F. (2006). *International agri-food chains and networks: management and organization*. Wageningen: Wageningen Academic Publishers.
- Caplice, C., & Sheffi, Y. (1994). A Review and Evaluation of Logistics Metrics. *International Journal of Logistics Management*, 5(2), 11 - 28.



- Chen K. Z., Chen Y., & Shi M. (2003), Globalization, Pesticide Regulation, and Supply Chain Development: A Case of Chinese Vegetable Export to Japan, *Invited Paper presented at the FAO Scientific Workshop " Globalization, urbanization and the food systems of developing countries: Assessing the impacts on poverty, food and nutrition security,"* 8-10 October 2003, FAO Headquarters Rome, Italy.
- Cheng, J. H., & Tang, C. (2009). An Application of Fuzzy Delphi and Fuzzy AHP for Multi-criteria Evaluation on Bicycle Industry Supply Chains. *WSEAS Transaction on Systems and Control*, 4(1). 21-34.
- Chopra, S., & Meindl, P. (2007). *Supply Chain Management: Strategy, planning and operations*. New Jersey: Pearson Prentice Hall.
- Christopher, M. (1998). *Logistics and supply chain management*. London: Pitman Publishing.
- Christopher, M. (2005). *Logistics and Supply Chain Management: Creating value-adding networks*. (3rd ed.). Great Britain: Prentice Hall.
- Davis, F. D. (1986). *A Technology Acceptance Model for Empirical Testing New End-User Information System: Theory and Results*. Thesis of the Degree of Ph.D. in Management, Massachusetts Institute of Technology, Sloan School of Management.
- Dye, J. F., Schatz, I. M., Rosenberg, B. A., & Coleman, S. T. (2000). *Constant Comparison Method: A Kaleidoscope of Data*. Retrieved March 30, 2020, from <http://www.nova.edu/ssss/QR/QR4-1/dye.html>.
- Global Trade Atlas. (2018). *Export Volume for Thai Fruit 2014 - 2016*. Retrieved March 5, 2018 from <https://www.gtis.com/gta/>.
- Global Trade Atlas. (2020). *Average Market Share of Global Durian Market 2017-2019*. Retrieved April 7, 2020. from <https://www.gtis.com/gta/>.
- Gunasekaran, A., Patel, C., & McGaughey, R. E. (2004). A framework for supply chain performance measurement. *International Journal Production Economics*, 87(3), 333-347.
- Huang, L., Yu, P., Luo, Q., & Zou, C. (2012). E-Tourism Supply Chain Evaluation based on AHP and FCE Method. *Journal of Theoretical and Applied Information Technology*, 45(2), 702-709.
- Humphrey, J., & Memedovic, O. (2006). *Global Value Chains in the Agri-food Sector*. Vienna: United Nations Industrial Development Organization.



- Jealviriyapan, P., Kuayjareanpanich, R., & Koywiwattrakul, S. (2001). *Fruit Marketing System in Thailand*. Retrieved July 18, 2017, from http://www.mcc.cmu.ac.th/agbus/isam/paper/20Thai_pat.PDF.
- Kataike, J., Aramyan, L. H., Schmidt, O., Molnár, A., & Gellynck, X. (2019). Measuring Chain Performance beyond Supplier–Buyer Relationships in Agrifood Chains. *Supply Chain Management*, 24(4), 484-497.
- Kothari, C. R. (2008). *Research Methodology - Methods and Techniques*. New Delhi: New Age International Publisher.
- Lunning, P. A., Marcelis, W. J., & Jongen, E. M. F. (2002). *Food quality mangement: a techno-managerial approach*. Wageningen: Wageningen Academic Publishers.
- Mangan, J., Lalwani, C., & Butcher, T. (2008). *Global Logistics and Supply Chain Management*. United Kingdom: Wiley.
- Mapes, J., New, C., & Szwajkowski, M. (1997). Performance trade-offs in manufacturing plants. *International Journal of Operations & Production Management*, 17(10), 1020-1033.
- Merkin, B. G. (1979). *Group Choice*. New York: John Wiley & Sons.
- MK Durian Harvests Sdn. Bhd. (2018). *Global Durian Report*. Retrieved November 13, 2018, from <http://www.plantationsinternational.com/docs/durian-market.pdf>
- Neely, A. (2007). *Business Performance Measurement: unifying theory and integrating practice*. (2nd ed.). Cambridge: Cambridge University Press.
- Neely, A., Gregory, M., & Platts, K. (2005). Performance measurement system design a literature review and research agenda. *International Journal of Operations & Production Management*, 25(12), 1228 - 1263.
- Office of Agricultural Economics. (2016). *Information of Agricultural Economics by Commodities 2016*. Retrieved August 30, 2017, from <http://www.oae.go.th/assets/portals/1/files/ebook/commodity59.pdf>.
- Pisarnwanich, U. (2019, 13 June 2019). 5-Year Foresight of Thai Durian. *Thansettakij*. Retrieved March 30, 2020, from <https://www.thansettakij.com/content/403136>
- Prachachatdhurakij. (2019, 10 February 2019). China keeps an eye on "Thai Durian" inspection with a strict manner. *Prachachatdhurakij*. Retrieved March 31, 2020, from <https://www.prachachat.net/economy/news-288639>.



- Rabbani, S. J. R., & Rabbani, S. R. (1996). *Decisions in Transportation with the Analytic Hierarchy Process*. Brazil: Federal University of Paraiba.
- Ramanathan, R. (2001). A note on the use of the analytic hierarchy process for environmental impact assessment. *Journal of Environmental Management*, 63(1), 27 - 35.
- Rangone, A. (1996). An Analytical Hierarchy Process Framework for Comparing the Overall Performance of Manufacturing Departments. *International Journal of Operations and Production Management*, 16(8), 104 - 119.
- Reese, A. K. (2001). Metrics mentality. *iSource Business*, June, 67-70.
- Roekel, J. V., Willems, S., & Boselie, D. M. (2002). *Agri-Supply Chain Management: To Stimulate Cross-Border Trade in Developing Countries and Emerging Economics*. Washington, D.C: World Bank.
- Saaty, T. L. (1980). *The Analytic Hierarchy Process*. New York: McGraw Hill.
- Saaty, T. L. (1986). Axiomatic Foundation of Analytic Hierarchy Process. *Management Science*, 37(2), 841-855.
- Saaty, T. L. (1994). How to make a decision: the analytic hierarchy process. *Interfaces*, 24(6), 19 - 43.
- Saaty, T. L. (2000). *Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process*. Pittsburgh: RWS Publications.
- Sakka, O., & Botta-Genoulaz, V. (2009). A model of Factors Influencing the Supply Chain Performance. *Proceedings of International Conference on Computers & Industrial Engineering*, (913-918). France: University of Technology of Troyes.
- Salo, A., & Hämäläinen, R. (1997). On the Measurement of Preferences in the Analytical Hierarchy Process. *Journal of Multi-Criteria Decision Analysis*, 6(6), 309 - 319.
- Slack, N., Chambers, S., Harland, C., Harrison, A., & Johnston, R. (1995). *Operations Management*. London: Pitman Publishing.
- Tang, C. (2006). Robust strategies for mitigating supply chain disruptions. *International Journal of logistics: Research and Applications*, 9(1), 33-45.
- Tas, A. (2012). A Fuzzy AHP approach for selecting a global supplier in pharmaceutical industry. *African Journal of Business Management*, 6(14), 5073 - 5084.
- The European Foundation for Quality Management. (2012). *An overview of the EFQM Excellence Model*. Brussel: EFQM.



- Thurmond, V. A. (2001). The Point of Triangulation. *journal of nursing scholarship*, 33(3), 253-258.
- Tsolakis, N., Keramydas, C., Toka, A., Aidonis, D., & Lakovou, E. (2012). Supply Chain Management for the Agri-food Sector: A Critical Taxonomy. *Proceedings of 2nd Olympus International Conference on Supply Chains*. (1- 29) Katerini: Department of Logistics of Alexander Technological Educational Institute.
- Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, 169(1), 1 - 29.
- Van der Spiegel, M. (2004). *Measuring effectiveness of food quality management*. Wageningen: Ponsen & Looijen.
- Van der Vorst, J. G. A. J. (2000). *Effective food supply chains: generating, modelling and evaluating supply chain scenarios*. Wageningen: Wageningen University & Research.
- Van der Vorst, J. G. A. J. (2006). *Performance measurement in agri-food supply-chain networks - An overview*. Wageningen: Wageningen University & Research.
- Vargas, L. G. (1990). An overview of the analytic hierarchy process and its applications. *European Journal of Operational Research*, 48(1990), 2 - 8.
- Wanga, G., Huang, S. H., & Dismukes, J. P. (2004). Product-driven supply chain selection using integrated multi-criteria decision making methodology. *International Journal of Production Economics*, 91(2004), 1 - 15.
- Waris, M., Panigrahi, S., Mengal, A., Soomro, M. I., Mirjat, N. H., Ullah, M., Khan, A. (2019). An Application of Analytic Hierarchy Process (AHP) for Sustainable Procurement of Construction Equipment: Multicriteria-Based Decision Framework for Malaysia. *Mathematical Problems in Engineering*, 2019, 1-20.
- Wijnands, J. H. M., & Ondersteijn, C. J. M. (2006). *Quantifying the agri-food supply chain: Overview and research directions*. Wageningen: Wageningen University & Research.
- Zahedi, F. (1986). The Analytic hierarchy process: A survey of methods and its applications. *Interfaces*, 16(4), 96 - 108.