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## Applying a Value Stream Mapping (VSM) to Improve Supply Chain Performance of Agricultural Products: A Case of Thai Exported Canned Lychee

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**Abstract:** A value chain concept has been applied to business to improve supply chain performance of various product. However, it was found that there is a few research in fruit value chain improvement. This paper, we applied a value stream mapping technique to improve supply chain performance of an agricultural product, lychee. This study aimed to analyze activities and linkages in the Thai canned lychee supply chain and to identify problems and obstacles including how to improve its efficiency and effectiveness. Data were collected from a survey of key players in the supply chain including farmers, local lychee collectors, agricultural cooperatives, canned lychee factories, exporters and importers. In addition, this research has also applied the value stream mapping (VSM) to classify the supply chain activities into three main activities include value added (VA), non- value added (NAV) and necessary non-value added activities (NNVA). After analyze value stream mapping in the current state this research found that NVA can be eliminated or reduced such as activities of intermediaries and some production process. The new VSM can reduce the supply chain activities significantly. This paper provides insights into a global fruit value chain with empirical evidence of improvement.

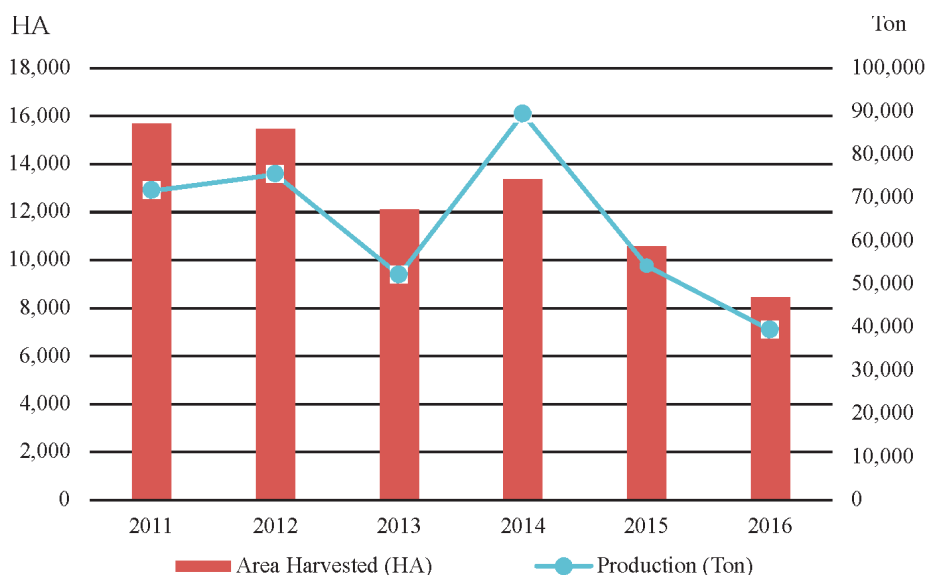
**Keywords:** Canned Lychee, Value Stream Mapping, Supply Chain Management, Lychee, Thailand

### I. INTRODUCTION

Thailand is located near the equator, and has a tropical climate. In general, the weather is hot all year round. However, the temperature varies between regions and seasons. Areas in various regions, from the central

up to the north, have diverse temperatures between summer and winter. Therefore, Thailand has a proper weather condition to grow many commercial fruits. As a result, Thailand is famous for production and exports high quality tropical and subtropical fruits.

Lychee (or litchi) is a subtropical fruit, originated in China and was introduced in Thailand in 1854 (Sethpakdee, 2002). Nowadays, China is the main producer of lychees, followed by India, and other countries in Southeast Asia, such as Vietnam, and Thailand, respectively (Mitra, 2002)). In a case of Thailand, lychee is classified as a critical economically important and high value export. The major plantations of lychee are in the Northern of Thailand, particularly in Chiang Mai (8,157.56 hectare (ha)) and Chiang Rai (2814.23 ha) provinces that contribute more than 56.25 percent of the overall acreage (10,971.83 ha). The low temperature cultivars which are grown mainly in the north are “Hong Huay” which contributes more than two-third of the total production followed by Chakrapad, Kim Cheng and O-Hia.



**Figure 1: Cultivated area and lychee production in Thailand during 2011-2016**

Source: Office of Agricultural Economics, Thailand (2017).

The major problem of Thai lychee is the declining of harvested area with 20.99% in 2015 and 20.21% in 2016 because of farm price falling, short postharvest life and changes in weather conditions. Consequently, the total lychee production dramatically decreases with -39.28% of 2015 and -27.49% of 2016 (see Figure 1). The main reason is the sharp fall in farm-gate prices in 2012 (10.97 Baht/kg), with more than -59.51% compared to 2011 (27.09 Baht/kg). Therefore, fruit farmers change to other crops such as rubber, pineapple, mango that yield higher. As a result, fresh lychee, which is the raw material for the production of canned lychee, is volatile in terms of quantity, price and quality.

In order to add value to fresh lychee, it is processed into various forms such as canned lychee, lychee juice or lychee concentrate, or dried lychee. These processed lychee products are sold not only in domestic market by also foreign markets. Figure 2 shows the export quantity of fresh and processed lychee. In last decade, the fresh and canned lychee are main exports of Thailand to the whole world. The export quantity

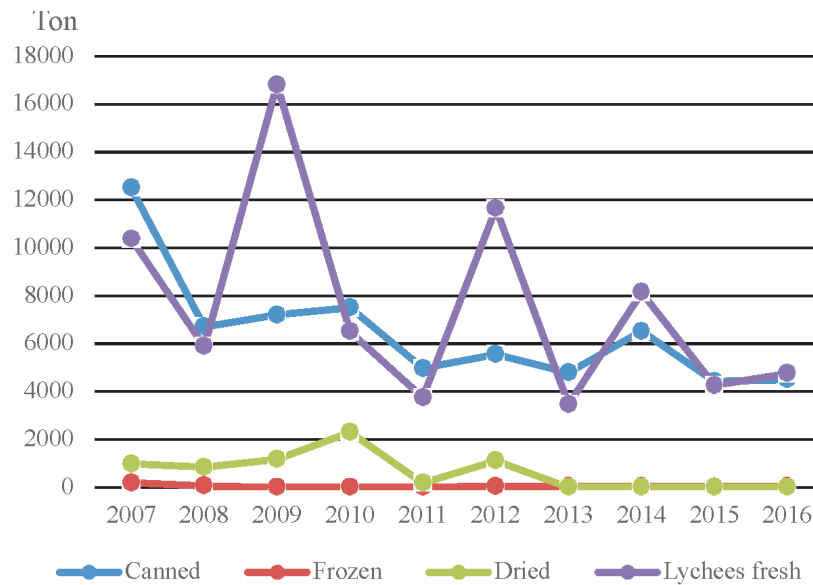


Figure 2: Export quantity of fresh lychee, canned lychee, lychee frozen and dried lychee: 2011-2016

Source: Thai Custom (2017).

of canned lychee and fresh lychee fluctuates. Some years of exporting canned lychee is more than fresh lychee. In 2016, the major fresh lychee import country is China, while canned lychee is Malaysia (Thai Custom, 2017). In case of China, although China is the world's number one fresh lychee producer and exporter, China imports fresh lychee from Thailand because the lychee season in Thailand is a month prior to China. Thus, Thai lychees sold in China are like pre-harvest product before Chinese lychee harvest season. In canned lychee trade market, China is the most important trading competitor.

Figure. 3 shows the export quantities and prices of China and Thailand. It is clear that China has higher price competitiveness than Thailand because China has more lychee cultivation area, leading to better productivity and cheaper than Thailand, so export quantity of china is greater than Thailand. In 2016, China exported 28,444 tons while Thailand exported only 4,481 tons. Figure 4 presents the share of canned fruit for export and canned lychee are the export share in fourth place, after canned mango, canned longan, and canned rambutan with pineapple. Therefore, the research question is that how to make Thai canned lychee have more potential to export. Li *et al.* (2006) mentioned that supply chain management is a tool and techniques to gain a competitive advantage.

In the literature, we found some supply chain management in many kinds of Thai fruit exported to different countries. In a case of mango, Watanawan *et al.* (2010) studied supply chain management of mango for export in Eastern Thailand, Kantabutra (2012) applied supply chain and logistics management to study exporting Thai fresh mango sold in Japan, and Panichsakpatana (2013) studied supply chain collaboration in the management of Nam Dok Mai mango exports from Thailand to Japan. For longan exportation, Sopadang (2012) applied value chain management to longan industry. Later, Tansuchat, *et al.* (2016) applied supply chain management and logistics to explore opportunities and threats of Thai fruits to India. Suvittawa (2014) studied the Thailand's banana supply chain management in order to identify export success factors.

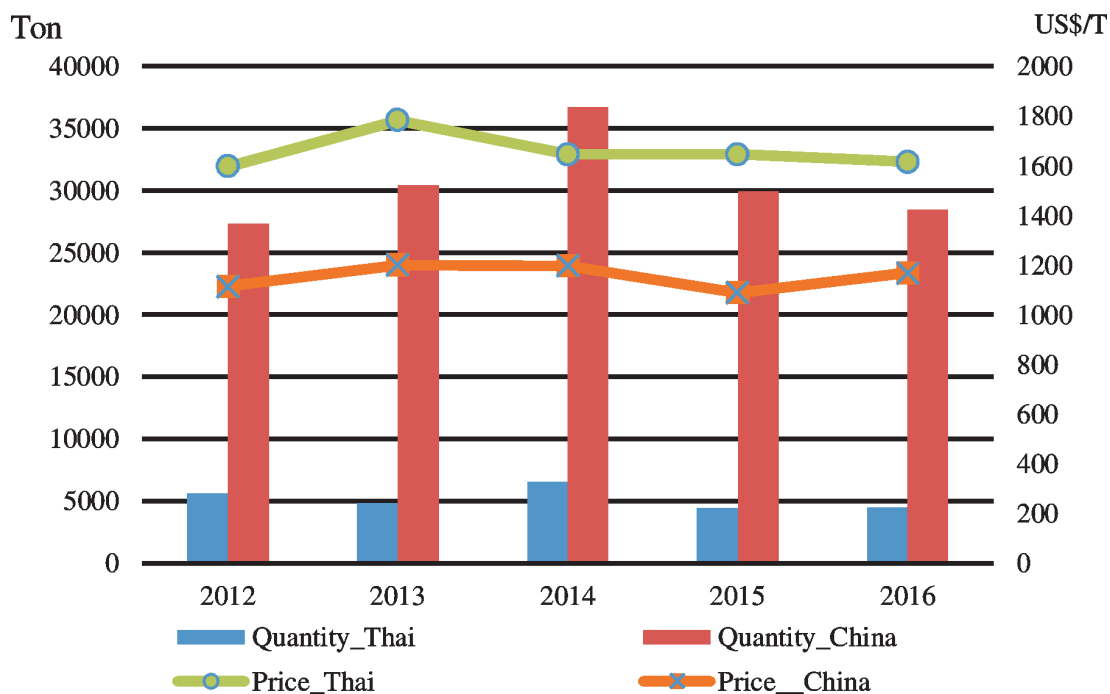


Figure 3: Canned lychee export of Thailand and China: 2012-2016

Source: Thai Custom (2017).

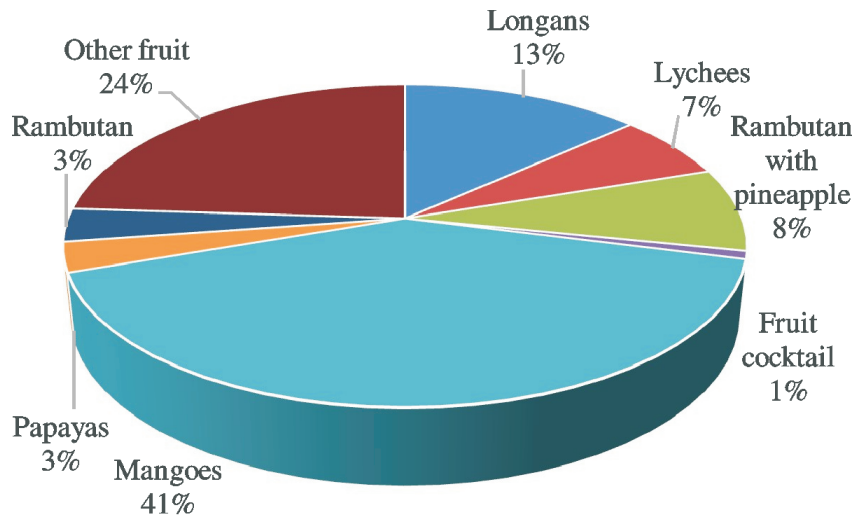


Figure 4: Share of canned fruit export of Thailand

Source: Thai Custom (2017).

In case of lychee, most of the supply chain studies have done in India (Kumar *et al.*, 2014). Purbey (2014) studied and explained supply chain management of lychee. Pathak (2016) analyzed supply chain of litchi in Muzaffarpur District of Bihar. In Southeast Asia, Chien and Klein (2003) explained lychee supply chain in the case of Bacgiang, Vietnam. In Thailand, only Chomchalow *et al.* (2008) studied marketing and

export of major tropical fruits from Thailand. Also, fruits are exported through the border, where supply chain is more challenging (Saowadee *et al.*, 2015).

However, the study of supply chain management in canned fruit are few. Rogowsky (2007) and Eapsirimetee (2013) studied canned pineapple supply chain of Thailand. Rais and Sheoran (2015) explained supply chain management of fruits and vegetables in India. Also, the concept of value chain thinking (Simatupang *et al.*, 2017) has been emerged in the business and management research to improve performance throughout the whole supply chain. There is several supply chain research in supply chain analysis in Thailand. Tumachai *et al.* (2017) explore the incentive travel supply chain and provide the structure of supply chain based on the main activities of each players. Sangkakorn *et al.* (2016) also explore the senior tourism supply chain with extensive qualitative information to understand the needs of customers and offer solution for development. Value Stream Mapping technique (VSM) is one of the technique that has been applied widely in both goods and service such as studies of Tansuchat *et al.* (2016) for the export fruit and Piboonrunroj *et al.* (2016) for the R3A tourism route. Increasingly some researchers may apply advanced method such as Geographical Information System (GIS) to study a supply chain structure (Rungsaprangsee and Piboonrunroj, 2016). Furthermore, mathematical technique such as Data Envelopment Analysis (DEA) also has been applied in the field of supply chain management (Chaowirat *et al.*, 2014 and Chaowarat *et al.*, 2014). Moreover, to understand relationships in the supply chain such as supply chain collaboration is found critical to improve the supply chain performance, partly due to lower transaction cost economics (Piboonrunroj and Disney, 2015).

The objective of this study is to study supply chain management (SCM) of canned lychee for export, which included analyzing the 3 major categories of activities (value added, necessary non-value-added, and non-value added) based on the VSM technique, in order to decrease the lead time and achieve more efficiency in the Thai canned lychee supply chain. The remainder of this paper is organized as follows. In section 2 provider the data collect and methodology: value stream mapping (VSM). Section 3 show empirical result. Section 4 will conclude with an explanation of the model give conclusion.

## **II. RESEARCH METHODOLOGY**

The purpose of this study is to explore and the export value chain of Thai Canned lychee, this study collected data from questionnaires and in-depth interviews, which involved 200 farmers, three lychee local collectors, three agricultural cooperatives, five canned lychee factories, two exporters, and three importers. The upstream information in the supply chain obtained from key informants particularly lychee farmers by using questionnaires survey and focus groups in Chiang Mai, Chiang Rai and Phayao. These regions are the main lychee production districts in the northern part of Thailand. Thus, these areas were selected to reflect the rural production areas. The questionnaire consists of three parts. First part composes of general information of respondents such as demography, experience in orchard farming, membership of farmer groups, and training in lychee orchard management. Second part consists of lychee production information such as input utilization including lands, labors, agricultural equipment, fertilizers, pesticide, and water supply, lychee orchard management, source of funds and access to finance. The last part was problems in lychee production and suggestions.

In the midstream of lychee supply chain exporter, there are the main stakeholders which are fresh lychee collectors, middleman, agricultural cooperatives, seed removal workers, and canned lychee factory

managers. Interviews were conducted with five canned lychee factories, three lychee local collectors and middlemen, and a farmer group for seed removal. Most of them are in the northern of Thailand. A list of canned lychee factory obtained from manufacturers and exporters in the major Thailand food fair, THAIFEX – World of Food ASIA 2017.

In the downstream of the supply chain, the exporters, brokers or traders and importers were surveyed and interviewed four exporters, a broker and eight importers in United State and Malaysia were randomly selected to be the key informants. The reason is that if importers import large quantities of canned lychee, importers will contact to the factory directly, so the factory is an exporter. For example, HC Foods Co LTD and NA Trading Company in US directly contact to the lychee factories in Thailand. In the case of trading with small importers or small volume of orders, a broker acts as intermediary in the negotiation between exporters and importers.

When the data were collected, participants were asked about costs of each process. Then the data were used to develop the VSM model and categorized into three types of activities: VA, NVA, and NNVA. To analyze initial logistics cost, the time and cost of the stages used in the VSM model were obtained from farmers, seed removers workers, middlemen and factories. To model the current scenario, costs of following activities were used: quantity, order processing and information system, inventory carrying, warehousing, transportation, and customer service. Subsequently, the proposed case scenario was created by considering the current scenario and non-value added activities (such as inventory level, and warehousing) were cut down where possible. Finally, the current and proposed scenario was compared so that problems can be identified and solutions suggested.

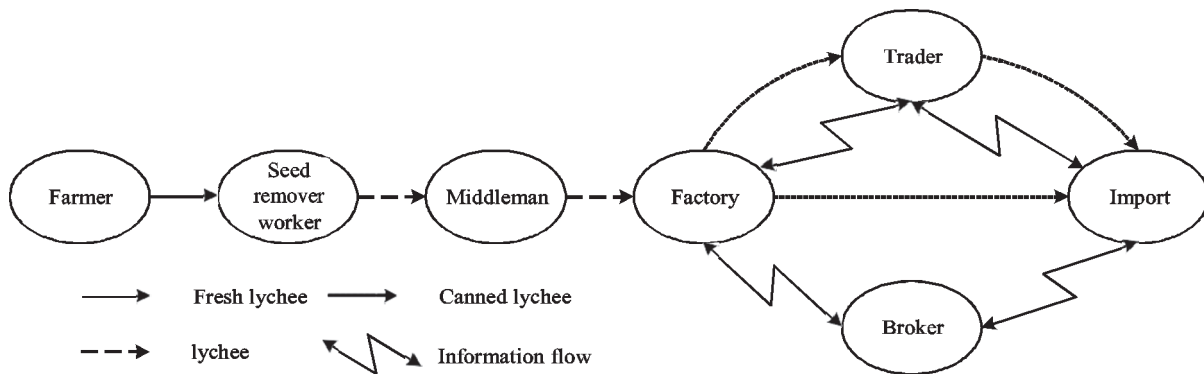


Figure 5: Thailand canned lychee supply chain for export

### III. RESULT

#### Supply Chain Management

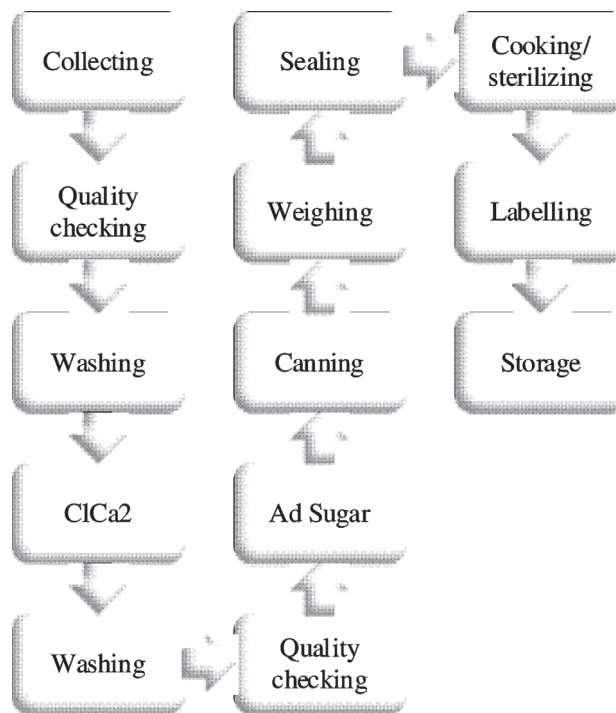
A generic supply chain of the Thai canned lychee from farmer to factory is illustrated in Figure 5. Starting from farmer harvesting lychee in April-June. Then the farmers sell lychee to seed remover worker in the area to removing seed process. In the process of removing seeds, will use all labor and takes five-six hours to remove seeds. After finishing, weight of lychee is reduced by half. After finishing seed removal, lychee is soaked in water to wait for delivery to the middleman. Middlemen will be the ones who deliver lychee to factories. After receiving lychee from the seed-removal workers, the middleman takes the lychee soaked in



calcium chloride before delivery to the factory. After the factory receives lychee from the middleman, lychee is then brought into the production process of canned lychee. Lychee canning process are show in Figure 6. This process starts from sorting and washing seed-removed lychee, Treatment of Fruit, filling, sealing, sterilizing, labeling, and storage.

### *Preparation*

In the preparation steps; middleman sorting Seed-removed lychees by size include big size quality and small size quality. Then, Seed-removed lychees were transported by truck to the factory. At the factory, seed-removed lychees were rechecked again for ensure that seed-removed lychees have a good quality. If the quality of seed-removed lychees is poor, it will be removed from the process. Finally, a quality seed-removed lychee was washed and forwarded to next process.



**Figure 6: Process diagram of canned lychee production**

During the treatment of Fruit: Calcium Chloride (CaCl<sub>2</sub>) was used to delay aging or ripening and to reduces post- harvest decay and to control the development of many physiological disorders.

The prepared seed-removed lychees were brought into plastic containers and soak them with Calcium Chloride for 20 minutes. After that, taken out seed-removed lychees and washing it again (this washing process takes more a long time than the earlier washing process). Then, rechecked qualities again.

### *Filling*

In this process, two sizes of seed-removed lychees were in the container with syrup. Even though there are two sizes of seed-removed lychees but each of them can have an equal weight. Then, automatic runway conveys the filled containers to exhausting point.

At an exhausting point, containers were reduced their internal pressure by vacuuming. Then, automatic production belt conveys filled containers through a steam tunnel to a sealing machine.

### Sealing

After passing through the steam tunnel. The automatic runway conveys the filled containers to a closing machine. The closing machine is equipped to create a vacuum in the headspace before lids are sealed.

### Heat sterilization and cooling

The containers are conveyed by automatic runway to atmospheric steam cooker. During operation, microorganisms that can cause spoilage are destroyed by heat. After heat sterilization, the containers are quickly cooled to prevent overcooking by conveying form the cooker to a rotary cooler equipped with a cold-water spray.

### Labeling and casing

After heat sterilization, cooling and drying operations. The containers are ready for labeling. Labeling machines are used for high-speed operation in this processing.

### Storage

After labeling, the labeled cans are packed into shipping cartons. Then, there were arranged in pallets and conveyed by forklifts to the storage.

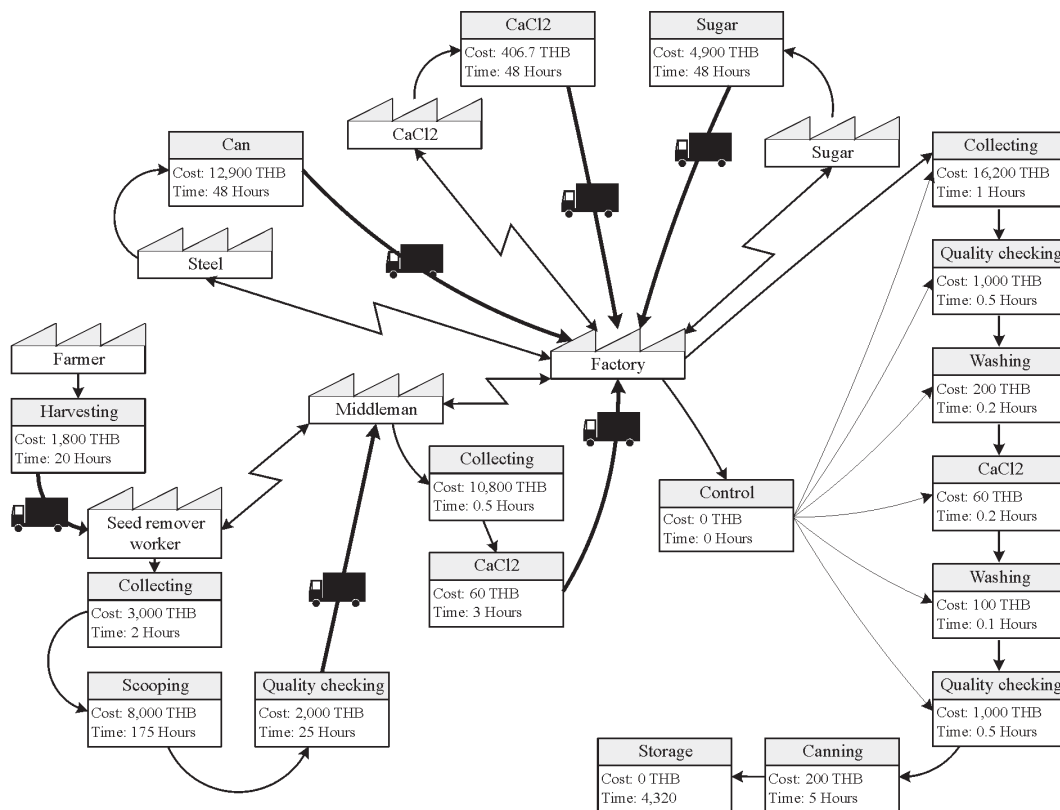


Figure 7: The current case scenario of Thailand canned lychee value stream mapping



### The Value Steam Mapping

Value Stream Map (VSM) is a fundamental tool used to undesand activities occurring in the supply chain. It identifies three types of activities: value added activities (VA), Necessary but non-value added activities (NNVA) and non-value added (NVA). For non-value added, it is considered waste to be reduced or eliminated to increase the efficiency of supply chain operations. This topic includes a chart of value stream mapping of key players who play an important role in the Thai export canned lychee supply chain.

**Table 1**  
Value stream analysis of the current case scenario

<i>Value of Activity</i>	<i>Activities</i>		<i>Cost</i>		<i>Time</i>	
	<i>No. of activities</i>	<i>%</i>	<i>THB/Ton</i>	<i>%</i>	<i>Hours</i>	<i>%</i>
Value-Added Activities (VA)	12	50.00	3,1260	49.52	231	4.91
Non-Value-Added Activities (NVA)	7	29.17	13,560	21.48	4.9	0.10
Necessary-Non-Value-Added Activities (NNVA)	5	20.83	18,306.7	29.00	4,464.5	94.98
Total	24	100.00	63,126.7	100	4,700.4	100

According to the survey, dominant players in the supply chain are farmers, seed removing workers, middlemen and factories. VSM of Thai canned lychee supply chain was illustrated into two case scenarios as shown in Figure 7 and 8, illustrating the current scenario and the proposed scenario, respectively. In the current stage, VSM starts from farmers to seed removal workers; then to middlemen and to factories. There are 24 activities in total ranging from farmers to factories, with total cost of 63,121.7 THB/Ton and total processing time of 4,700.4 hours (196 days). In Table 1, it can be seen that 231 hours is the VA activities, consisting of harvesting, removing seeds process, and production of canned lychee. NVA takes 29 hours; these activities include middleman activity and some production process. The number of activities in the NNVA category is 5, which takes 4,464.5 hours, including the purchase of raw materials from the factory, such as cans, sugar and CaCl<sub>2</sub> and storage time of the factory.

**Table 2**  
Value stream analysis of the proposed case scenario

<i>Value of Activity</i>	<i>Activities</i>		<i>Cost</i>		<i>Time</i>	
	<i>No. of activities</i>	<i>%</i>	<i>THB/Ton</i>	<i>%</i>	<i>Hours</i>	<i>%</i>
Value-Added Activities (VA)	12	70.59	31,260	63.07	231	4.92
Non-Value-Added Activities (NVA)	0	0.00	0	0.00	0	0.00
Necessary-Non-Value-Added Activities (NNVA)	5	29.41	18,306.7	36.93	4,464.5	95.08
Total	16	100.00	49,566.7	100.00	4,695.5	100.00

According to VSM evaluation of the current case scenario, VA activities should be reduced in order to improve efficiency of the value chain, leading to reduced activity, cost and processing time. Therefore,

the proposed case scenario based on the members of farming concept is recommended to improve supply chain efficiency of Thailand export canned lychee. The remaining parties in the Thailand canned lychee value chain stand to obtain a higher profit, while the business as a whole becomes more competitive in terms of responsiveness to market demand.

Consequently, the proposed scenario of canned lychee value using the direct link concept between farmers, seed removers and factories without middleman is illustrated in Figure. 8. This scenario has less NVA activities by eliminating middlemen and factories from the value stream. With fewer stakeholders, many NVA such as collecting and transportation by the middleman can be reduced leading to better performance on VSM based on time and cost. As a result, the total value stream requires only 16 activities with the total cost of 49,566.7 THB/ton, and total processing time of 4,695.5 hours (195 days). As shown in Table 2, number of VA activities is 12, and requires 231 hours in total, consisting of harvest process, and producing of canned lychee. The NVA activities can be decreased to not activities. The NNVA category has five activities and imposes 4,464.5 hours in total, relating mainly to transportation and storage.

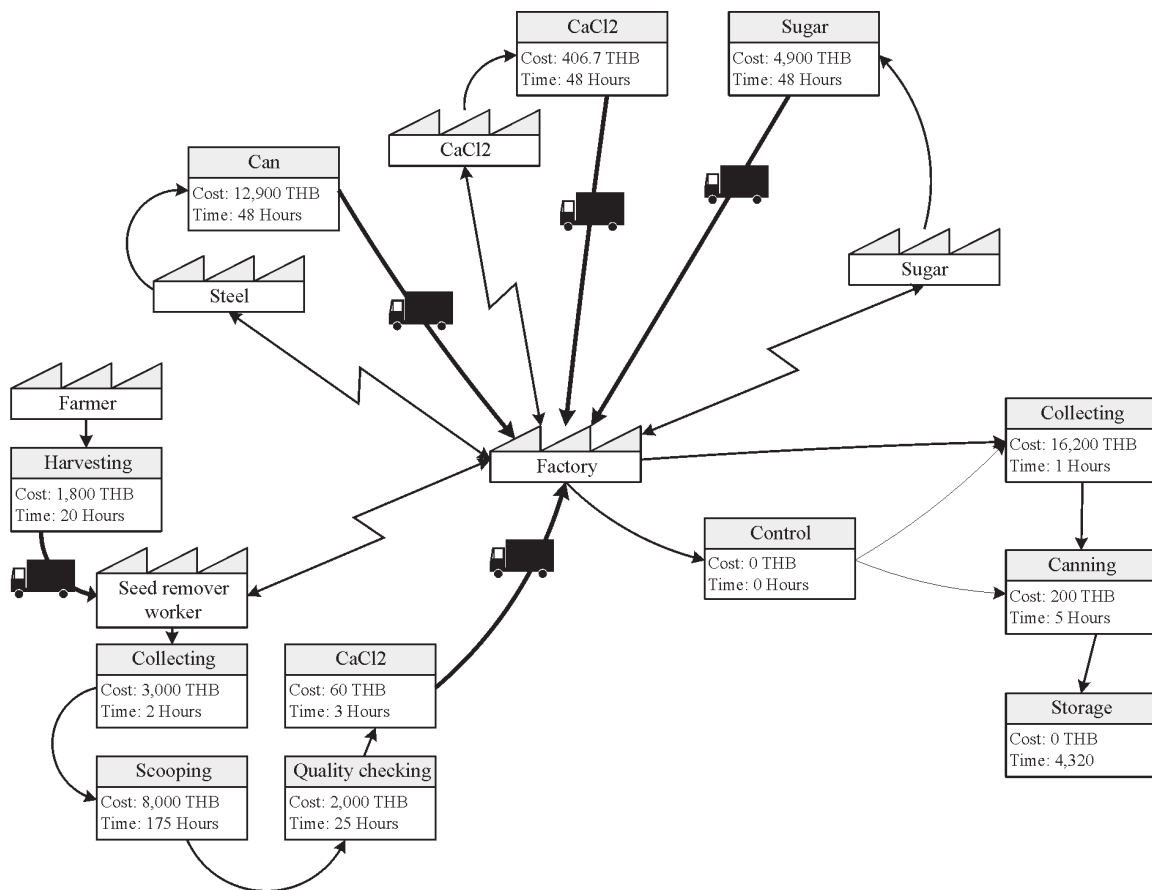


Figure 8: The proposed case scenario of Thailand canned lychee value stream mapping

#### IV. CONCLUSIONS

This present work has studied the supply chain of exported Thai lychee through VSM in order to examine the performance of SCM. The results were illustrated into two scenarios: the current and proposed scenarios.

Dominant players in the current case scenario mainly consist of the farmers, seed removal workers, middleman and factory. Of the 24 activities in VSM, 50% accounted for VA activities, 29.17% for NVA activities, and 20.83% for NNVA activities. Then the proposed scenario was presented by implementation of the direct link concept between farmers, seed removers and factories without middleman, which provides better supply chain performance by reducing stakeholders as well as number of NVA activities. Communication between remaining key players is the main advantage of member farming concept. Procurement period can be shortened. The proposed scenario consists of three key players: farmers, labors and factories. Total number of activities was reduced to 17, of which 70.59% accounted for VA activities, none for NVA activities, and 29.41% NNVA activities. Majority of VA activities occurred during the harvest of lychee at the farming stage and removing seeds process at removing seeds labor, while most of NVA activities were middleman activities and some production processes. On the other hand, NNVA activities took place during the purchasing of raw materials and storage. A result comparison of VSM between the current and proposed scenarios shown that total number of activities in value stream can be reduced from 24 to 17 (29.16% reduction), the operation cost from 63,126.7 to 49,566.7 THB/ton (21.48% decrease). The total process time reduced from 4,700.4 to 4,695.5 hours, or 5.02%. VSM improvement on Thai canned lychee can generate higher profits to the key players along the supply chain as well as to increase competitiveness in the exporting market.

### ACKNOWLEDGEMENT

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