Supply Chain Management of Thai Parboiled Rice for Export

Wassanai Wattanutchariya
Advanced Manufacturing Technology Research Center
Department of Industrial Engineering, Faculty of Engineering
Chiang Mai University, Chiang Mai, Thailand
wassanai@eng.cmu.ac.th

Roengchai Tansuchat
Faculty of Economics
Chiang Mai University, Chiang Mai, Thailand
roengchaitan@gmail.com

Jidapah Ruennareenard
Advanced Manufacturing Technology Research Center
Department of Industrial Engineering, Faculty of Engineering
Chiang Mai University, Chiang Mai, Thailand
jiedapah@gmail.com

***Abstract*— Although parboiled rice now forms about a quarter of Thai rice exports by quantity, its supply chain has yet to be documented. Therefore the objectives of this research are to study the supply chain of Thai parboiled rice for export, and to investigate the performance of supply chain management (SCM) based on Values Stream Mapping (VSM). Data were collected through interviews, focus groups, and questionnaires with key players in the supply chain including 249 farmers, 20 parboiled millers and 6 exporters. Through VSM, the current case scenario is analyzed alongside a proposed case scenario. Upon comparison, the number of activities can be reduced from 34 to 23 (reduction of 32.35%), the operation cost from 6,309 to 4,454 THB/Ton (reduction of 29.40%). The total process time from the rice field to the overseas market can be reduced from 5,373 to 4,755 hours, or 11.50%. Most activities occurred during the storage activities in the supply chain. Therefore, supply chain efficiency can be improved by reducing inventory period and increasing the direct connection network with the key players, which could lead to higher profits and faster responsiveness to importers.**

Keywords—Thai Parboiled rice; Supply chain management; Value stream mapping

I. INTRODUCTION

As one of the world's biggest producers and the top exporter, Thailand's agricultural economy is heavily dependent on rice (*Oryza sativa L.*). In 2014, the Thai Rice Exporters Association reported that Thailand exported 10.97 million metric tons of rice, accounting for 174 billion THB [1]. Furthermore, Thailand has a variety of rice exports such as Hom-Mali (Jasmine) rice, long grain white rice, glutinous rice and parboiled rice. The high quantity of rice exported to global market has profited every player in the rice supply chain of Thailand. Parboiled rice is one of the more important agricultural commodity products in the global market, having been exported in substantial quantity. Between 2013 and 2014, the value of parboiled rice export significantly increased from 26,422 to 45,814 million THB, or 73.39% growth. Moreover, the quantity of export parboiled rice has almost doubled from 1,650,832 to 3,261,522 metric tons, or 97.5% expansion. In 2015 (Jan-July), parboiled rice had accounted for 19.80% (by value) or 24.48% (by quantity) among total rice export [1]. It can be seen that the quantity of exported parboiled rice has risen with time. Consequently, the supply chain of rice is presently focused upon the production and distribution in order to improve the efficiency from the initial stage to the final stage, reducing time and costs to meet the higher demand. Furthermore, cost savings may be passed on to the consumer, making Thai parboiled rice more competitive.

A. Parboiled Rice Production

Parboiled rice is typically produced using a process of soaking, pressure steaming and drying prior to milling as shown in Fig. 1. It is slightly yellowish, but this mostly fades after cooking. A particular odor may be present due to the steaming process, in which the smell of rice husks permeates into the kernels [2]. The primary objectives of parboiled rice are to modify the starch for gain higher milling yield and to permit the retention of minerals and natural vitamins (Vitamin B and E) with in the kernels [3-4].

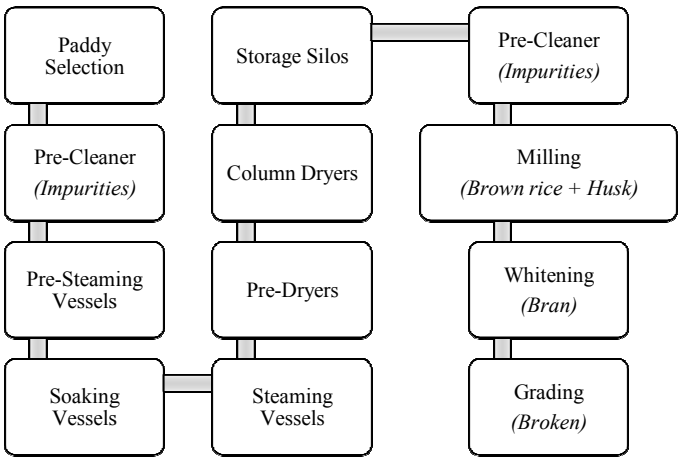

Fig. 1. Process diagram of parboiled rice production

Paddy rice is a raw material in this process. In general, rice with high amylose content is preferred for processing into parboiled rice, such as Chainat 1 and Supanburi 1 with amylose content of 35.10% and 37.20% respectively [4].The paddy rice is normally harvested with approximately 20-25% moisture. Then, the paddy rice is passed through the parboiling process which consists of cleaning, soaking, steaming and drying, Finally, it is sent to the milling process to remove the outer husk, bran and germ layers, to obtain parboiled rice.

B. Supply Chain of Parboiled Rice

Supply chain management (SCM) is implemented to improve the product flow, information flow and cost evaluation, which assists producers to develop the proper upstream/downstream flows of goods and services [5]. Sharma et al. [6] studied the supply chain of rice in India, describing the various scenarios related to cooperatives from upstream to downstream in terms of inventory management, procurement, and logistics system for re-designed supply chain model. Rath et al. [7] described a suitable logistics plan: rice production or processing orientation, and distribution model for modern rice mills in Odisha, India. In the research of Ahumada and Villalobos [8] regarding the supply chain of agricultural products and distribution planning model, it was emphasized that the models could be contrasted by the optimization approaches, the type of crops and the scope of the plans. In some literature, SCM was utilized for rice in Bangladesh and studied changes in rice quality based on unique surveys fielded at different levels of the value chain such as upstream, midstream and downstream [9]. In another study, SCM and value stream technique were applied to the Hong Kong rice supply chain, identifying risks at different stages in order to guarantee supply chain performance. [10].

The key players of the Thai parboiled rice supply chain consist of the farmer, rice collector, rice miller, middleman, exporter, broker, trader, importer, distributor, wholesaler, retailer, and final consumer. Other stakeholders in the parboiled rice supply chain include transporters (shipper), seed supplier companies, agro-chemical, and agricultural equipment companies, as well as government agencies such as the Rice department of Thailand under the Ministry of agricultures and cooperatives, inspection agencies (surveyors), department of commerce (for tax, documentation and standard export procedures), and other agencies that control the price of paddy rice according to the government policies [11-12].

C. Value Stream Mapping

Value Stream Mapping or VSM is a commonly known technique in SCM, which categorize activities in the supply chain into 3 major types of activities: Value Added (VA), Non-Value Added (NVA), and Necessary-Non-Value Added (NNVA) activities. VSM results have been interpreted by various researchers. Some researchers have studied and analyzed parboiled rice's supply chain in Thailand using VSM and SCOR Model. It was found that the non-value added activities predominantly involved inventorying at the receiving stations of each key player in the supply chain [3]. Moreover, VSM was applied to study the dried fish's supply chain in Bangladesh, which identified different supply chain intermediaries and remaining problems in dried fish's supply chain [5]. The VSM technique was utilized for analyzing wastage in logistics and supply chain of rice management in the northeastern region of Thailand; most activities occurred in the paddy rice storage station. Therefore, the operation management was focused on comparing the routes of product flow and logistical costs in order to decrease the processing time and costs [13-14].

This paper aims to study the SCM of Thai parboiled rice 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 parboiled rice supply chain.

II. DATA AND METHODOLOGY

The purpose of this study is to understand the parboiled rice value chain in Thailand from farmer to the exporter. Therefore, this study collected data from focus groups, questionnaires and in-depth interviews, which involved 249 farmers, 2 seed supplier companies, 3 paddy rice collectors, 3 agricultural cooperatives, 20 parboiled rice millers, 1 middleman (Yong), 6 exporters, and 1 inspection agency.

Upstream in the supply chain, questionnaires and focus groups were managed with key informants. The survey areas are particularly in the central region of Thailand, consisting of Nonthaburi, Nakornpathom, Kamphaengphet, Pichit, Nakornsawan, Pathumthani, Chachoengsao, Suphanburi, Chainat, and Pranakorn-sri-ayuttaya. These regions are the most important rice-producing districts of Thailand, and were therefore chosen to reflect the rural production areas. The survey queried for information on purchases, rice species, cultivation, harvesting, sales, and problems of cultivation. In the selected samples, rice farmers cultivated rice species with high amylose.

Midstream in the supply chain, the main informants were rice millers, paddy rice collector such as paddy hub, agricultural cooperative and middleman. Interviews were conducted with 20 parboiled rice millers, 3 paddy rice hub and 3 agricultural cooperatives in the central region. A list of parboiled rice millers was randomly selected, representing a range of mill sizes from the largest mills (production capacity over 2,000 tons per day) to smaller automatic/semi-automatic ones (less than 500 tons per day).

Downstream in the supply chain, the exporter and middleman were surveyed in this study. A total of 6 exporters and 1 middleman (locally called Yong) were randomly selected to be the key informants. All exporters were ranked by their exported quantity. The information acquired by the survey included purchases, sales, destination of transportation, and quality correction process.

When the data was collected, participants were asked for the typical cost of each process. Then the data was used to develop the VSM model and categorized into 3 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 the paddy rice producer, paddy rice collector, parboiled rice processing, and parboiled rice distributor. To model the current scenario, the costs of the 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 carrying, and warehousing) were cut down where possible. Finally, the current and proposed scenario was compared so that problems can be identified and solutions suggested.

III. RESULTS AND DISCUSSIONS

A. Supply Chain Management

A general supply chain of Thai parboiled rice from farmer to exporter is illustrated in Fig. 2. At the initial stage of rice, high amylose paddy rice was cultivated by farmers until harvest (less than 120 days or 4 months). After the harvesting season, paddy rice was directly sold to the nearby milling factory. If access to mills is limited by high transportation cost or poor road condition, farmers may choose to sell their produce to a paddy rice hub, agricultural cooperative, or middleman. These agencies act as the paddy rice collectors, transporting paddy rice from farms to parboiled rice processing mills, buying and selling at bargained prices. The rice-processing mills produce the parboiled rice as cleaning, parboiling, husking, and polishing process. From the data collected, a batch of paddy rice will yield on average about 60.47% of head parboiled rice, 22.61% of husk, 7.20% of bran and germ, 6.52% of broken rice, and 3.20% of impurities by weight, as shown in Fig. 3. The parboiled product is also sold directly to exporters or through another middleman (Yong). Yong acts as a link between the miller and the exporter. After an agreement, the parboiled rice is transported from the mill to the exporter's port by drum truck. The rice is then shipped to the importing country, where importers or rice traders/brokers who purchased the rice receive their order. Finally, the importers distributed the parboiled rice through their domestic market channels such as wholesaler, retailer, distribution center and importer.

B. The Value Steam Mapping

From the surveyed data, the dominant players in supply chain are the farmers, parboiled rice millers and exporters. The VSM of parboiled rice supply chain was illustrated into 2 case scenarios as shown in Fig. 4 and 5, illustrating the current case scenario and the proposed case scenario, respectively. In the current stage, VSM starts from farmer to paddy rice collector; to parboiled rice miller; to Yong and to exporter and importer. There are total of 34 activities from the rural area to overseas market, with total cost of 6,309 THB/Ton and total processing time of 5,373 hours or 224 days. In Table 1, it can be seen that 3,203 hours is the VA activities, consisting of land and seed preparation, cultivation/harvesting, and production of parboiled rice. NVA takes 560 hours; these activities include a long storage time at the paddy collector and the miller, as well as queue time before loading at the exporter's factory, and storage before quality correction at the exporter. Moreover, the NVA considers reverse logistics if the exporter returns the product back to the miller. This happens if the received batch has a poor

appearance (white index) or quality (moisture, no. of defects); reprocessing may amount to 8 hours and 180 THB per Ton. The number of activities in the NNVA category is 16, which requires 1,610 hours in total, including the paddy rice delivery from farmer to miller, procurement and information, delivery from miller to exporter, as well as the transportation from Thailand's port to foreign destinations.

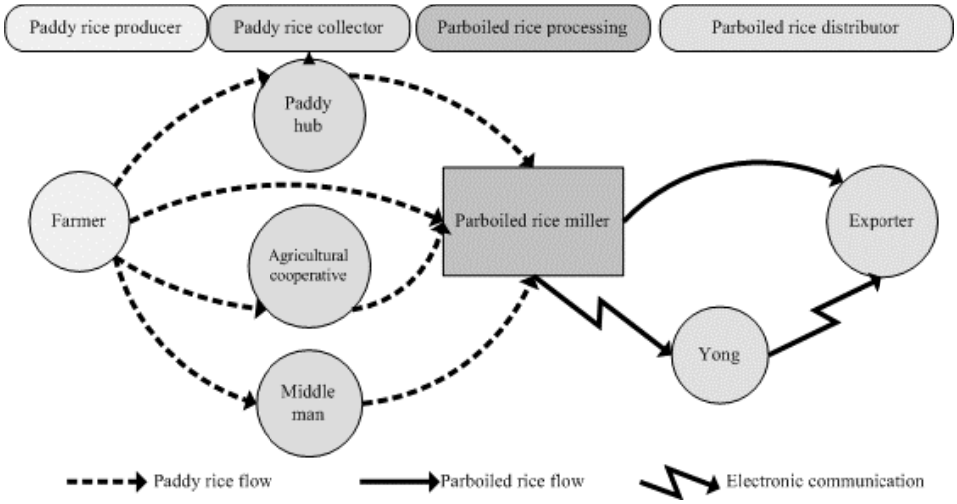

Fig. 2. Thai parboiled rice supply chain for export

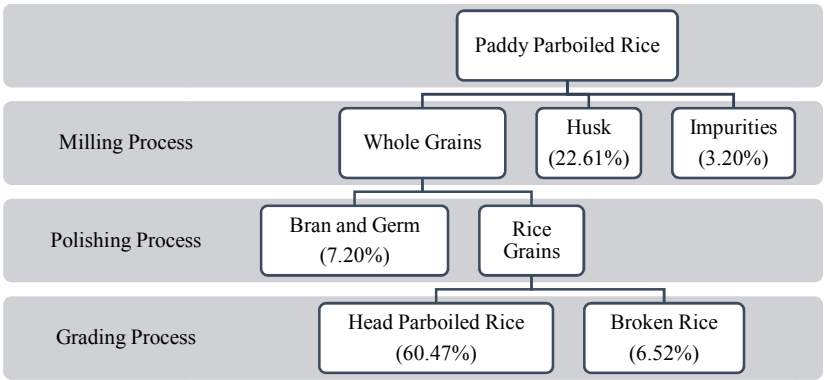

Fig. 3. Component parts of paddy parboiled rice

According to VSM evaluation of the current case scenario, the NVA activity should be reduced in order to improve the efficiency of the value chain, leading to reduced activities, cost, and processing time. Therefore, the proposed case scenario based on the contract farming concept is recommended to improve supply chain efficiency of Thai parboiled rice for export. In contract farming concept, concurrent and networking between farmer, miller, and exporter must be strengthen. Thus, middle man and Yong are not required, thereby cutting down on many NVA activities. The remaining parties in the Thai parboiled rice value chain stand to obtain a higher profit, while the business as a whole becomes more competitive in terms of responsiveness to market demand. Furthermore, in the upstream portion of the chain, farmers who form cooperatives or are grouped under the same contract would be able to procure seeds in bulk deliveries. Furthermore, the seeds would be of stipulated quality, and the farmers can be assured that their product would be purchased by the miller. Thus, the time spent at this stage can be reduced. Contract farming also allows farmers to communicate with exporters so that they can plan their next crops according to the predicted demand for the chosen type of rice. Then, the inventory period in the midstream of the value chain can be decreased from rice collector elimination, as well as through the use of contracts. In fact, contract can guarantee the order quantity and delivery time, thus reducing unnecessary periods of inventory for both farmer and miller. Finally, at the downstream stage of the chain, the exporter may save time and expenses on quality correction if the quality of the product is already of a good standard. Furthermore, the importers at the business partner country can shorten ordering time and cost if they can contact directly to the exporter of Thailand.

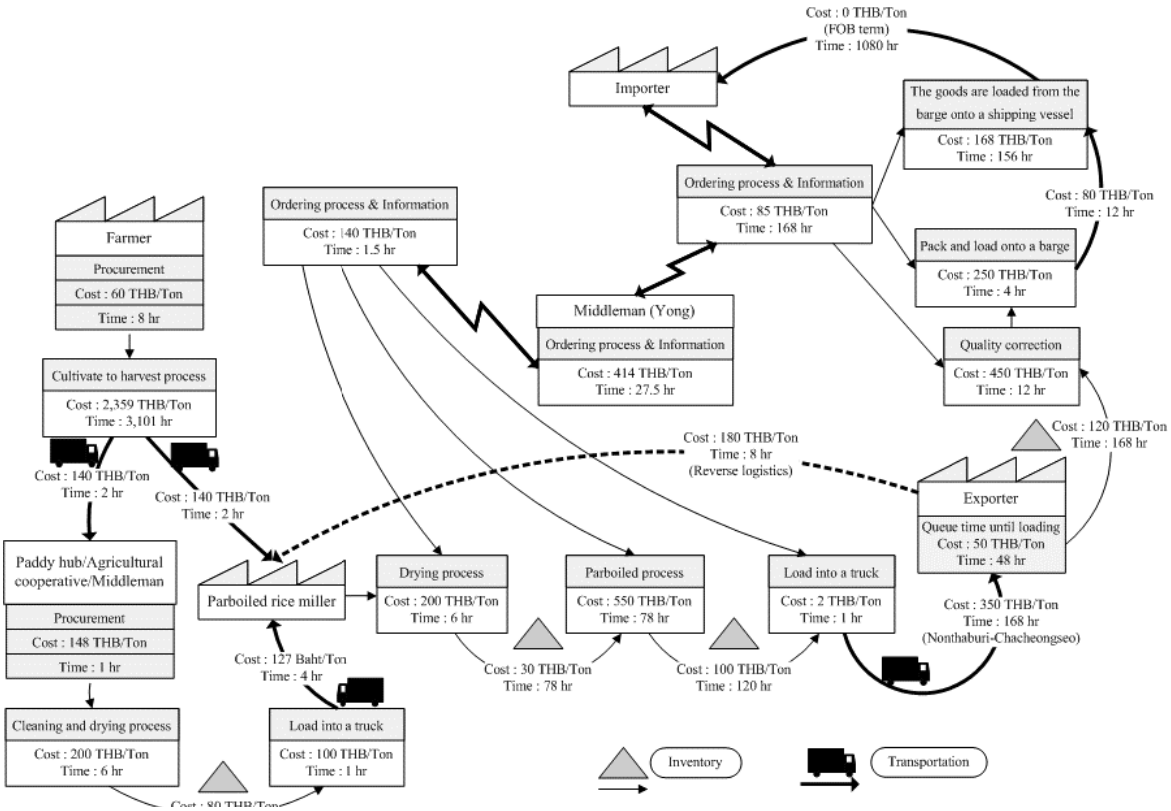

Fig. 4. The current case scenario of Thai parboiled rice value stream mapping

TABLE I. VALUE STREAM ANALYSIS OF THE CURRENT CASE SCENARIO

Value of Activity	Activities		Cost		Time	
	No. of activities	*%*	*THB/Ton*	*%*	*Hours*	*%*
Value-Added Activities (VA)	12	35.29	3,759	59.58	3,203	59.61
Non-Value-Added Activities (NVA)	6	17.65	560	8.88	560	10.42
Necessary-Non-Value-Added Activies (NNVA)	16	47.06	1,990	31.54	1,610	29.96
Total	34	100.00	6,309	100.00	5,373	100.00

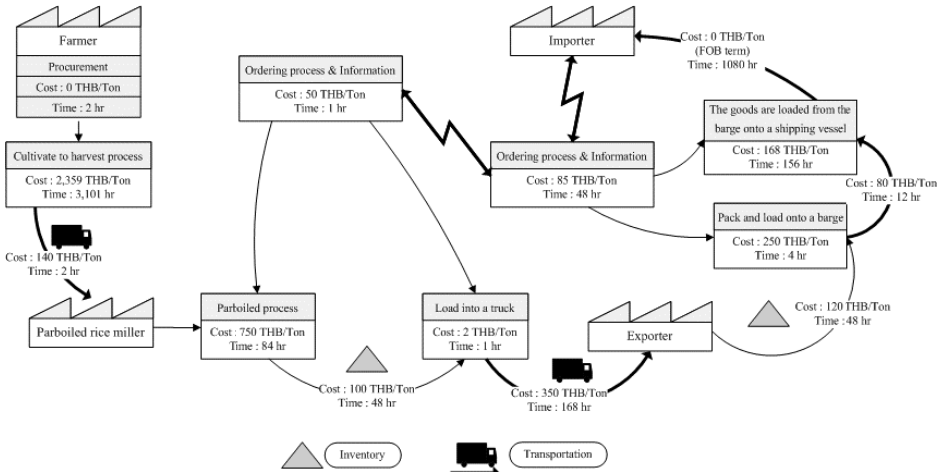

Fig. 5. The proposed case scenario of Thai parboiled rice value stream mapping

TABLE II. VALUE STREAM ANALYSIS OF THE PROPOSED CASE SCENARIO

Value of Activity	Activities		Cost		Time	
	No. of activities	*%*	*THB/Ton*	*%*	*Hours*	*%*
Value-Added Activities (VA)	10	43.48	3,109	69.80	3,185	66.98
Non-Value-Added Activities (NVA)	2	8.70	220	4.94	96	2.02
Necessary-Non-Value-Added Activies (NNVA)	11	47.83	1,125	25.26	1,474	31.00
Total	23	100.00	4,454	100.00	4,755	100.00

Consequently, the proposed scenario of parboiled value using contract farming concept is illustrated in Fig. 5. This scenario has less NVA activity by eliminating middle and Yong from the value stream. With fewer stakeholders, many NVA such as storage and transportation by the middleman can be reduced leading to better performance on VSM based on time and cost evaluation. As a result, the total value stream requires only 23 activities with the total cost of 4,454 THB/Ton, and total processing time of 4,755 hours or 198 days. As shown in Table 2, the amount of VA activities is 10, and requires 3,109 hours in total, consisting of procurement, cultivate to harvest process, and producing of parboiled rice. The NVA activities can be decreased to 2 activities, which still require 96 hours, including common inventory time at miller and exporter station. The NNVA category is 11 activities and imposes 1,474 hours in total, relating mainly to transportation.

IV. CONCLUSIONS

This present work has studied the supply chain of exported Thai parboiled rice through VSM in order to examine the performance of SCM. The results were illustrated into 2 scenario cases: the current and proposed scenarios. The dominant players in the current case scenario consist mainly of the farmer, the paddy rice collectors, the parboiled rice miller, Yong, exporter, and importer. Of the 34 activities in VSM, 35.29% accounted for VA activities, 17.65% for NVA activities, and 47.06% for NNVA activities. Then the proposed scenario was presented by implementation of contract farming concept, which provide better VSM performance by reducing stakeholders as well as number of NVA activities. Communication between remaining key players is the main advantage of contract farming. Procurement and stocking period can be shortening when accurate order and delivery period are properly issued. The proposed scenario consists of 4 key players: the farmer, parboiled rice miller, exporter, and importer. Total number of activities in VSM was reduced to 23, of which 43.48% accounted for VA activities, 8.70% for NVA activities, and 47.83% NNVA activities. Majority of VA activities occurred during the cultivation and harvest of paddy rice at the farming stage, while most of NVA activities were applied during the storage time of each key player. On the other hand, NNVA activities took place during the purchase, packing and loading, and delivery from source to destination. The comparison result of VSM between current and proposed cases shown that total activity in value stream can be reduced from 34 to 23 (a decrease of 32.35%), the operation cost from 6,309 to 4,454 THB/Ton (a decrease of 29.40%). The total process time from the rice field to the overseas market was reduced from 5,373 to 4,755 hours, or 11.50%. The improvement of VSM on Thai parboiled rice can generate higher profits to the key players along the supply chain as well as to increase competitiveness in the export market.

ACKNOWLEDGMENT

This work has been funded by the Agricultural Research Development Agency (Public Organization), and their financial support is greatly acknowledged. The research would not be successful without the collaboration of research teams from Faculty of Engineering, Economic, Business Administration, and Agricultural Chiang Mai University.

REFERENCES

[1] Thai Rice Exporters Association, 2015. "Export Quantity 2013-2015," [Online]: http://www.thairiceexporters.or.th/List_%20of_ statistic.htm. accessed: Sep 20, 2015.

[2] Bhattacharya, K.R., 1985. Parboiling of rice. In: Juliano, B.O. (Ed.), Rice Chemistry and Technology, second ed. The American Association of Cereal Chemists, St Paul, MI, USA, pp. 289–348.

[3] S. Ramingwong, W. Wattanutchariya and W. Laosiritaworn, 2011. "The Study of Parboiled Rice's Supply Chain in Thailand," Department of Industrial Engineering, Faculty of Engineering, Chiang Mai Universty, Thailand. [online]: http://preet.sesolution.com/iclt2010/Full%20Papers/Logistics%20and%20Supply%20Chain%20Management/0036-Sakgasem.pdf. Accessed: Oct 7, 2015.

[4] S. Parnsakhorn and A. Noomhorm, 2008. "Changes in Physicochemical Properties of Parboiled Brown Rice during Heat Treatment" Agricultural Engineering International: the CIGR E-journal. Manuscript, August 2008.

[5] Md. Shakhawat Hossain and A. Al Masud, 2012. "Value Stream Analysis of Dried Fish's Supply Chain in Bangladesh," Journal of Economics and Sustainable Development, Vol.3, No.9.

[6] V. Sharma, S. Giri and S. Shankar Rai. 2013. "Supply chain mangement of rice in India: a rice processing company's perspective." International Journal of Managing Value and Supply Chains (IJMVSC), Vol. 4, No. 1, pp. 25-36.

[7] B. Rath, B.K. Mangaraj, and B.P. Mishra, 2012. "Fuzzy logic based simulation for modeling of sustainable marketing policy for modern rice mills in Odisha." International Journal of Supply Chain Management, Vol. 1, No. 3, pp. 34-42.

[8] O. Ahumada, and J.R. Villalobos, 2009. "Application of planning models in the agri-food supply chain: a review." European Journal of Operational Research 195, pp. 1-20.

[9] B. Minten, K.A.S. Murshid and T. Reardon, 2013. "Food Quality Changes and Implications: Evidence from the Rice Value Chain of Bangladesh," World Development, Vol. 42, pp. 100–113.

[10] A. Lam, T. Zhang, and K.K. Lai, "A study on Hong Kong rice supply chain risk management with chain analysis" Lecture Notes in Electrical Engineering 349, Industrial Engineering, Management Science and Applications 2015.

[11] S. Muthayya, J.D. Sugimoto, S. Montgomery and G.F. Maberly, 2014. "An overview of global rice production, supply, trade, and consumption" Annals of the New York Acadamy of Sciences, Issue: Technical Considerations for Rice Fortification in Public Health.

[12] Koji Ishikawa, 2009. "Present Condition and Problems of Rice Industry under Socio-Economic Transformation in Cambodia." PhD. dissertation, Graduate School of International Development, Nagoya University, Japan. Accessed: Oct 8, 2015.

[13] S. Thoucharee and R. Pitakaso, 2012. "The application using value stream mapping for efficiency increasing logistics and supply chain of rice management in northeastern area of Thailand" (In Thai) KKU Research Journal, Vol. 17(5), pp. 687-705.

[14] S. Thoucharee and R. Pitakaso, 2012. "Logistics and supply chain management of rice in the northeastern area of Thailand." (In Thai) KKU Research Journal, Vol. 17(1), pp. 125-141.

BIOGRAPHY

Wassanai Wattanutchariya is an Associate Professor in Industiral Engineering, Faculty of Engineering, Chaing Mai University. He graduated with a doctoral degree and a Master's degree in Industrial Engineering from Oregon State University, USA in the field of advance manufacturing processes, such as the use of Computer-Integrated Design, CNC and Rapid prototypes. His research interests include agricultural supply chain management, design of experiment (DOE), modern manufacturing, optimization, operation management, product design and process development.

Roengchai Tansuchat is an Associate Professor in Economics, Chiang Mai University. He graduated with a doctoral degree, Master's degree, and Bachelor's degree in Economics, Chaing Mai University. His research interests include agricultural supply chain management, international trade, applied econometrics, applied statistics, time series analysis, financial economics, and pricing of agricultural products.

Jidapah Ruennareenard is currently a fulltime assistant reseacher in Advanced Manufacturing Technology Research Center (AMTech), Department of Industrial Engineering, Faculty of Engineering, Chaing Mai Univerity. She holds a Bachelor of Science degree in Food Processing Engineering from Chaing Mai University and a Master of Engineering degree in Industrial Engineering from the same university. Her research interests include improving the quality of agricultural products, design of experiment (DOE), quality function depolyment (QFD) management, product design and process development.