ELIMINATING NON-VALUE-ADDED ACTIVITY THROUGH VALUE STREAM MAPPING: A CASE STUDY OF THE THAI SUGAR INDUSTRY

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ABSTRACT
Purpose –This paper aims to analyze the Thai sugar industry supply chain and investigate the use of Value Stream Mapping (VSM) to identify waste.

Design/methodology/approach – VSM is the main tool used to identify opportunities for improvement and elimination of waste in processes. Then, this paper proposes an approach to improve the sugar supply chain.

Findings – The results of current state map found that non-value-added and necessary non-value-added activities, which are waiting times, took 735 minutes, representing 56.84% of production time. An approach sequencing and scheduling arrival of sugar cane trucks proposes to improve the sugar supply chain in the future state map. Simulation results that eliminate waiting time associated with non-value-added activity save 185 minutes, reducing non-value-added activity to 49.19% of production time.

Research limitations/implications – The findings are limited due to the focused nature of the case study.

Originality/value – This paper is a real case study showing VSM applications and simulation approach sequencing and scheduling arrival of sugar cane trucks to eliminate waste in the process. In future research, this approach will be applied to reduce non-value-added activity in the Thai sugar industry.

Keyword: Sugar industry, Value Stream Mapping, waste reduction

Introduction

The Thai sugar industry is a promising export industry. Thailand's export of sugar had been growing in the past two decades, and by 1996 the country became the world's second-largest exporter after Brazil. The export value of the Thai sugar industry grew steadily from 2007 to 2011, as shown in Figure 1. The Thai sugar industry has endeavored to create more competition, increase quality, and reduce waste in sugar manufacturing to compete with challengers. Products from the sugar industry of Thailand bring in more revenue and economic development from export than any other country in Asia. Sugar cost and farmer latency are factors supporting the growth trend in the sugar industry, as the world's sugar cost has continued to increase and farmers have the capacity to develop and improve productivity in sugar cane agriculture.

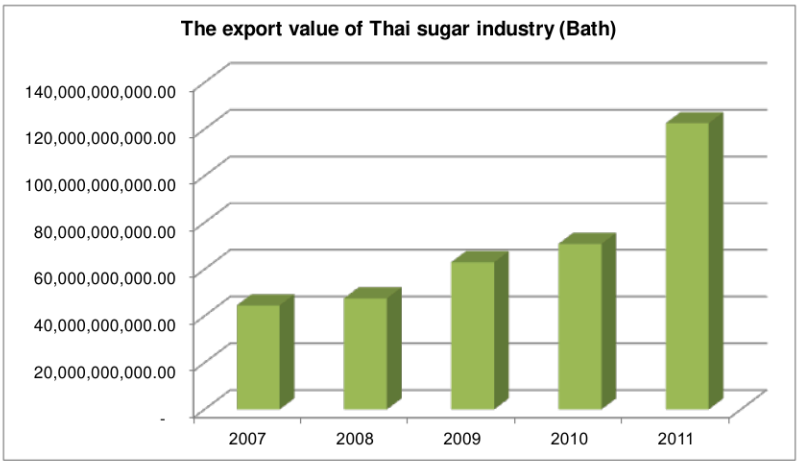

Figure 1: Export value of Thai sugar industry from 2007 to 2011
(Office of the Cane and Sugar Board, 2011)

Thailand's main competitor in the sugar industry is Brazil which leading sugar manufacturer in the world. The nature disasters or climate changes have decreased its productivity in the last four years. Thailand has enjoyed an export advantage because of these difficulties.

Currently, Thailand has competitive advantage in sugar manufacturing and exporting. It is the biggest sugar exporter in the Association of Southeast Asian Nations (ASEAN), with exports of 2.73 million tons in 2011 (Office of the Cane and Sugar Board). However, by 2015 the ASEAN member countries plan to integrate economically into the ASEAN Economic Community (AEC). This reorganization will reduce price differentials on a global level. Thailand is the biggest regional supplier of sugar, and will benefit from the AEC. The coming cross-border transport of sugar cane plants presents an opportunity to bring more revenue to our country.

Although Thailand has greater sugar export value, the sugar supply chain has several problems, the greatest of which is that trucks need to wait during the production process. This logistical problem increasingly affects costs. The study of supply chains can reduce waste, increase efficiency, and help Thailand compete with other countries. This paper studies the supply chain of the Thai sugar industry using a case study to identify waste through Value Stream Mapping (VSM). VSM was the main tool used to identify opportunities for improvement and elimination of waste in the process. The paper proposes an approach to improve the sugar supply chain using VSM in the future, (TO-BE) including suggested models to improve the supply chain in the industry. The paper is based on a case study of one of Thailand's top ten sugar exporters.

The selected company is considering using our approach to improve the supply chain from sugar cane farms to the processing factory. In the future, this approach will be applied to eliminate non-value-added activity across the Thai sugar industry.

Literature review

Several issues relating to the study are briefly reviewed as follows.

Sugar Supply Chain

Sugar, produced in more than 110 countries, is the most widely produced agricultural commodity in the world. Sugar's price is set by the world market, making it necessary to keep production costs as low as possible to ensure that there is always some profit margin. The cutting and loading of cane in the fields is a complex logistical operation at harvest time. It involves transportation by truck with a trailer to factories and unloading the cane in the factory (Diaz and Ptrez, 2000). A supply chain is concerned with planning sugar manufacturing, starting with the production of sugar cane by the farmer, through processing by millers, and finally delivery to the consumer (Masuku and Kirsten,

2004). The Thai sugar industry needs to operate as efficiently as possible to survive and compete with other countries. It is therefore important that transportation costs and selection of appropriate vehicle combinations be investigated and evaluated.

Value Stream Mapping (VSM)
VSM is a tool used to analyze and design the flow of materials and information required to bring a product or service to a consumer. It is used to create a map of both value and waste in a given process (Wanitwattanakosol and Sopadang, 2011). The map can help organizations reduce lead times and inventory, improve quality, and achieve better on-time delivery and use of resources (Goriwondo *et al*., 2011). The goal of VSM is to identify, demonstrate, and decrease waste in the process.

VSM usually includes the physical mapping of the current flow of information and material as a product goes through the manufacturing process. The current state VSM is analyzed and unnecessary non-value-added waste eliminated. The future state VSM is drawn after assessment of the current state VSM (*Teichgräber* and de Bucourt, 2012). It suggests how to create a flow that reduces or eliminates waste and minimizes non-value-added activities (Goriwondo *et al*., 2011).

Many researchers have applied VSM to reduce waste and lead time. For example, VSM was applied to the food supply chain system of cooked chicken products to Japan to identify kinds of activities that were value added (VA), necessary non-value-added (NNVA), and non-value-added (NVA) (Payongyam *et al*., 2010). Bread manufacturing in Zimbabwe used VSM to analyze both information and material flows. Then, VSM helped to demonstrate exactly how the process operated, with detailed timing of step-by-step activities (Goriwondo *et al*., 2011).

Reduction of Waste
Waste is a concept in the Toyota Production System (TPS). There are seven types of waste: overproduction, waiting, transportation, inappropriate processing, inventory, unnecessary movement, and defects (*Teichgräber* and de Bucourt, 2012). Waste can be found at any time and in any place and does not add value to the product. It is necessary to eliminate waste to add value to the product. Waste reduction is able to drive competitive advantage. It focuses on more productivity and quality. Goriwondo *et al*. (2011), using the kaizen blitz approach, obtained waste reduction through structured brainstorming sessions with shop floor employees. The elimination of all non-value-adding activities and waste from the business was a step when VSM techniques were applied to the procurement of endovascular stents in interventional radiology services *(Teichgräber* and de Bucourt, 2012).

These relevant papers can apply many issues to identify and analysis of process activity in the next step. Then, find an approach to improve the sugar supply chain.

Value Stream Mapping: Current State Map

The study of the Thai sugar supply chain, which was conducted by studying the sugar process and interviewing factory managers and process engineers, found that the supply chain of the Thai sugar industry, shown in Figure 2, has both material flow and information flow. Material flow originates from sugar cane famers upstream in the supply chain. They plant sugar cane and transfer it to the sugar factory that manufactures raw sugar. After that, raw sugar is stored in warehouses and distributed to customers. Customers for this case study are both domestic and foreign. Sugar factories have a second material flow, which is transfer of raw sugar to white sugar and refined sugar factories. Then, white and refined sugar is also stored in warehouses.

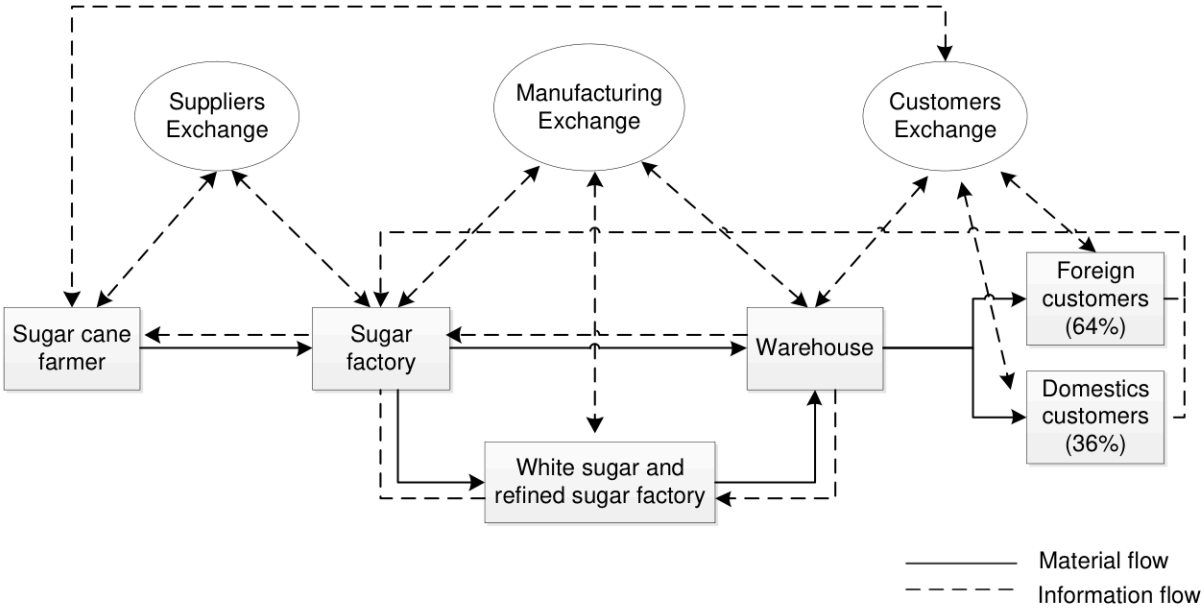

Figure 2: Flow of Thai sugar industry supply chain
(Office of the Cane and Sugar Board, 2011)

Information flow begins with the customers. They order finished goods (raw sugar, white sugar, and refined white sugar) from the sugar factory. Then, the sugar factory purchases raw materials (sugar cane) from sugar cane farmers. The sugar cane farmers deliver raw materials during approximately four months (December to March), which is the manufacturing season. Warehouses, which store finished goods, report inventory levels to the sugar factory.

The flow of the supply chain in the selected company shows direction of materials and information, typical of the sugar supply chain. We analyzed the sugar supply chain systematically by applying VSM techniques.

The VSM Current State Map shows the actual material and information flows as a product goes through the manufacturing process (Goriwondo *et al.,* 2011). The current state of the information flow is realized according to the original data from customers that purchased sugar products. This design represents the starting point to improve upon. Next, the map of material flow is shown to verify materials movement among activities. Initial conditions for the analysis of the VSM are shown in Figure 3.

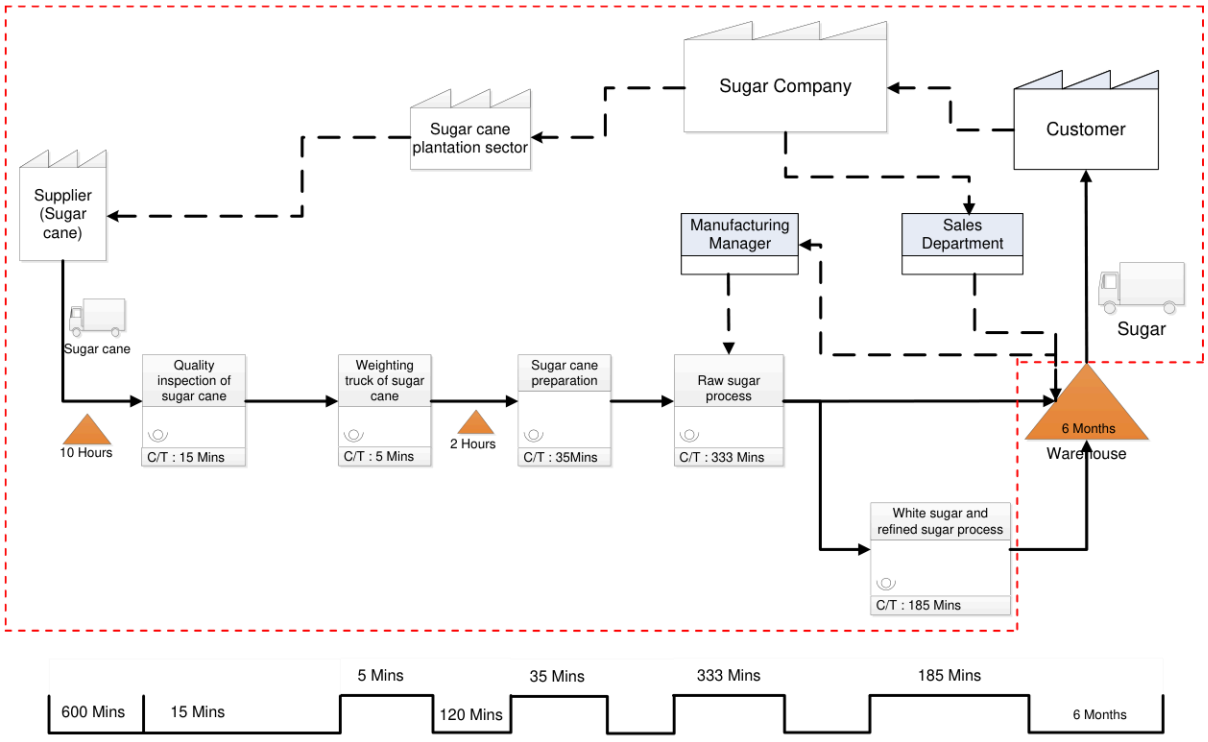

Figure 3: Value stream mapping in current state (AS-IS)

Figure 3 shows flows of information and materials in the sugar supply chain and identifies value added, necessary non-value-added, and non-value-added activities. The figure shows in dashed lines the scope of the process, except the warehouse process, which is shown in solid lines. Because sugar cane is a seasonal agricultural good, the sugar factory must store products for distribution to customers during the whole year. However, in the future, sugar warehouses will reduce storage time by extending the period of sugar manufacturing, by improved warehouse management, or other improvements that can reduce waiting time. Warehouse management can plan production of the three types of sugar, raw, white, and refined, equal to customer demands for the year for each sugar factory. The manufacturing department needs to use forecasting tools to predict consumer demand.

Results from the selected company found a total value-added activities time of 558 minutes, representing 43.16% of production time; a non-value-added activities time of 720 minutes, representing 55.68% of production time, and a necessary non-value-added activities time of 15 minutes, or 1.16% of production time. The VSM approach involves the identification of value-adding and waste activities (Hines *et al.*, 1999). Then, process activities analysis identifies waste activities in value streams and allows identification of appropriate routes to eliminate them.

This case study identified waste activities by process activities analysis, shown in Table 1. All waste activities were waiting activities. The three types of waiting activity were waiting for quality inspection of sugar cane, quality inspection of sugar cane, and waiting for sugar processing. In the sugar supply chain of the selected company, the waste of waiting occurs whenever materials or products are not moving or being worked on. Some non-value-added activities are necessary and cannot be avoided in the process. They are called necessary non-value-added activities. This case study shows the waste of sugar cane quality inspection as necessary non-value-added activity, because it is necessary to inspect and control quality of sugar cane before manufacturing.

Process Activities Analysis	VA	NNVA	NVA (Waiting Time)
	(Min)	(Min)	(Min)
Waiting for quality inspection of sugar cane			600
Quality inspection of sugar cane		15	
Weighing truck of sugar cane	5		
Waiting for sugar processing			120
Sugar cane preparation	35		
Raw sugar processing	333		
White sugar and refined sugar processing	185		

Table 1: Process activities analysis

The next step is suggesting an approach to improve the sugar supply chain of the selected company.

Suggestion for process improvement

The previous step identified process activities and classified types of waste activities that can be eliminated. It found that if the process could reduce waiting time it would increase sugar cane quality since time affecting the sweetness of sugar cane. Good quality sugar cane has more than 10% commercial cane sugar (CCS), which is calculated by the sweetness in the cane's first expressed juice. After harvesting the sugar cane, raw sugar must be produced immediately to avoid a decrease in quality. Therefore, reduction of waiting time in the process is important because it affects sugar cane quality.

Mathematical optimization is one approach to reducing waiting time in the process through considering sequencing and scheduling the arrival of sugar cane. Study of variables associated with the sugar supply chain has led to development of a mathematical model that consists of an objective function (main problem) and a subjective function (constraint of problem). Then, an algorithm is used to find solutions to the main problem. The optimal solution to this problem, which is sequencing and scheduling sugar cane coming from plantations to the sugar factory, can reduce time spent waiting for quality inspection and for sugar processing.

Time wasted waiting for quality inspection, a necessary non-value-added activity, can be reduced by inspecting at the same time as the sugar cane trucks are weighed.

Simulation of some situations in the Future State Map can verify the model. Simulation can compare outputs to evaluate and validate the model (Abdulmalek and Rajgopal, 2007). For this case study, Arena simulation software version 11.00 was used to verify the VSM Future State Map. The result found that total waiting time decreased 23.73% when scheduling the arrival of sugar cane.

The Future State Map is a chart that suggests how to create future process improvements that address waste and associated problems identified by means of the Current State Map. The Future State Map addresses the waste of waiting, as shown in Figure 4. Simulation shows that the Future State Map can eliminate 170 minutes of non-value-added waiting time. To accomplish this, the quality inspection process is combined with the truck weighing process, which is a value-added activity. Finally, non-value-added activities in this case study decreased 185 minutes. This means non-valued-added activities eliminated by reducing waiting time represent reduction from 55.68% to 49.19% of process time. This has the effect of increasing productivity.

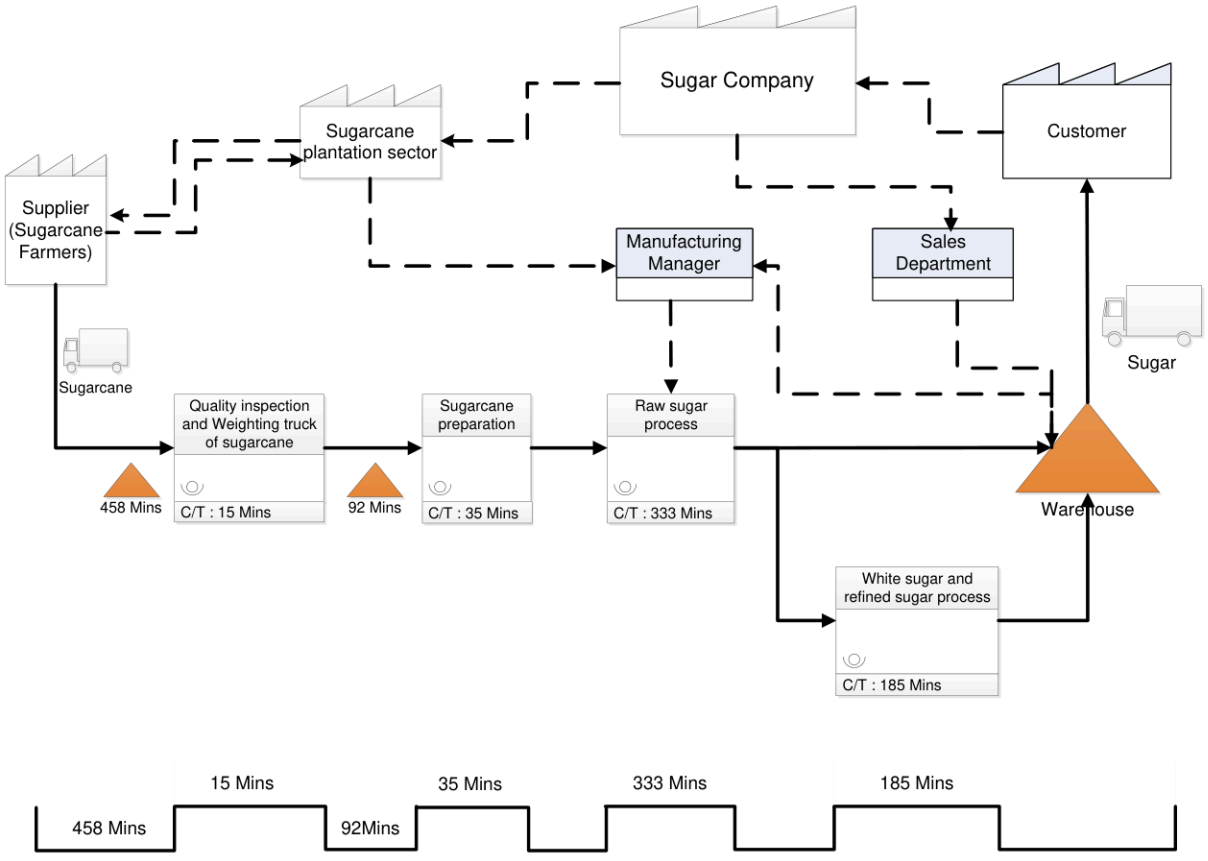

Figure 4: Value stream mapping in future state (To-Be)

Conclusion

This study applied the Value Stream Mapping tool to the sugar supply chain. The results of this case study identified waste and analyzed opportunities to eliminate it, thus improving the sugar supply chain. VSM can identify value-added activities, non-value-added activities, and necessary non-value-added activities. The waste of non-value-added activities and necessary non-value-added activities consist of waiting time, specifically waiting for quality inspection of sugar cane, waiting for sugar processing, and waiting during quality inspection of sugar cane. An approach to reduce waiting time, which decreases sugar cane quality, is mathematical optimization to sequencing and scheduling the arrival of sugar cane. This consists of performing quality inspection of sugar cane at the same time as weighing sugar cane trucks.

Future research will study factors that affect reducing wait time in this process. Then, mathematical optimization will be applied to sequencing and scheduling arrival of sugar cane trucks. This can eliminate more non-value-added activity, increasing both productivity and sugar quality.

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