



# Production Process Improvement Using Value Stream Mapping: A Case Study of Organic Coffee Firms in Thailand

## การปรับปรุงกระบวนการผลิตด้วยการใช้แผนพังสายราชสีห์คุณค่า: กรณีศึกษาธุรกิจกาแฟอินทรีย์ในประเทศไทย

Asst. Prof. Supareuk Tarapituxwong\*

Dr. Nuttiya Tantranon\*\*

Assoc. Prof. Dr. Chackrit Duangpatra\*\*\*

### Abstract

Although coffee (Arabica) production based on an organic agricultural system could provide numerous competitive advantages, production based on such a system would bring high production costs and low productivity during the initial period of implementation. The purpose of this article is to improve the manufacturing process through the application of value stream mapping (VSM) to develop the manufacturing process by reducing waste in the organic coffee production process. This is a case study of organic coffee producers through the practical implications of VSM in order to acquire an analysis of the entire production process. The program evaluation and review technique (PERT) has been used to calculate the average time for each standard scheduled process. After the 3 months experimental implementation, it was found that the organic coffee producers in Baan Khun Lao (OCPKL) could improve the production process-reducing the total lead time (TLT) from 11 days to 5 days (80.40%), the total cycle time (TCT) from 68 hours to 66 hours (3.44%), reducing the work-in-process (WIP) inventory from 700 kilograms to 61 kilograms (91.28%) as well as cutting down the manpower in the manufacturing process from 31 to 15 men (51.61%).

\* Student in Doctor of Philosophy in Community Economy and Technology Development Program, Asian Development Institute for Community Economy and Technology, Chiang Mai Rajabhat University.

E-mail: hongte\_t@hotmail.com

\*\* Asian Development Institute for Community Economy and Technology, Chiang Mai Rajabhat University (Advisor)

\*\*\* Faculty of Commerce & Accountancy, Chulalongkorn University (Co-Advisor)

## Keywords

Value Stream Mapping, Lean Production System, Supply Chain Management, Organic Coffee, Program Evaluation and Review Technique

## บทคัดย่อ

การผลิตกาแฟ (อาราบิก้า) ในระบบเกษตรอินทรีย์สามารถสร้างความได้เปรียบเชิงการแข่งขันได้เป็นอย่างดีอย่างไรก็ตามการผลิตในระบบดังกล่าวส่งผลต่อต้นทุนการผลิตสูงและผลผลิตต่ำในช่วงแรก ดังนั้นวัตถุประสงค์ของบทความนี้จึงมุ่งปรับปรุงกระบวนการผลิตโดยการใช้แผนผังสายธารแห่งคุณค่า ซึ่งเป็นหนึ่งในเครื่องมือของแนวคิดการผลิตแบบลีนเพื่อพัฒนากระบวนการผลิตโดยลดความสูญเปล่าที่เกิดขึ้นในกระบวนการผลิตกาแฟอินทรีย์ โดยศึกษาจากการนีศึกษาของกลุ่มเกษตรกรผู้ปลูกกาแฟอินทรีย์บ้านขุนลาว ด้วยการประยุกต์ใช้แผนผังสายธารแห่งคุณค่าในการวิเคราะห์กระบวนการผลิต และใช้เทคนิคการประมวลผลและการทบทวนโครงการในการคำนวณหาเวลาเฉลี่ยสำหรับการกำหนดเวลาตามมาตรฐานในแต่ละกระบวนการผลิต ผลศึกษาแนวทางการปรับปรุงกระบวนการผลิตด้วยแผนผังสายธารแห่งคุณค่า พบว่าจากการทดลองปฏิบัติตามแผนดำเนินงานเป็นเวลา 3 เดือน สามารถปรับปรุงกระบวนการผลิตโดยลดเวลานำร่วมลงได้จาก 11 วันเหลือเพียง 5 วัน (ร้อยละ 80.4) รอบเวลาการผลิตรวมลดลงจาก 68 ชั่วโมงเหลือเพียงประมาณ 66 ชั่วโมง (ร้อยละ 3.44) ลดงานระหว่างทำคงคลังจาก 700 กิโลกรัมเหลือเพียง 61 กิโลกรัม (ร้อยละ 91.28) และลดกำลังคนในการกระบวนการผลิตจาก 31 คนเหลือเพียง 15 คน (ร้อยละ 51.61)

## คำสำคัญ

แผนผังสายธารแห่งคุณค่า ระบบการผลิตแบบลีน การจัดการใช้อุปทานกาแฟอินทรีย์ เทคนิคการประมวลผลและการทบทวนโครงการ

## Introduction

An effective production process could help businesses gain competitive advantages (Lewis, 2000) since a good production management system would eliminate, or at least minimize, mistakes in the production process and any related production costs (Russell & Taylor, 2003). In the past, production businesses typically applied the concepts of the Lean production system (LPS) to keep waste in the manufacturing process to a minimum and to achieve a maximum rate of the continuous production process, in order to achieve a level of business excellence (Womack, Jones & Roos, 1990; Mejabi, 2003; Rahman, Laosirihongthong & Sohal, 2010). One of the tools of LPS, value stream mapping (VSM) (Vinodh, Arvind & Somnathan, 2010), was popularly used to improve the planning process and to create linkages, collect and analyze performance data systematically and to connect all stages of the production process. This was done so that all components of the process could work together smoothly to improve the flow of



the delivery of the finished products to the customers with little or no waste incurred in the process (Rother & Shook, 1998; Panaskar, Gershenson & Jambekar, 2003).

In this research approach, the efficiency of production in the industry has been studied and VSM was used to assess the overall production process. This was done to find waste in the production process, as well as to improve the overall efficiency of the process of production (Womack, Jones & Roos, 1990; Jones & Womack, 2002; Hines & Rich, 1997). In Thailand, VSM is commonly used to improve the production process in the industry sector. In 2005, Taylor studied the process of agricultural production, the practical implication of VSM was used to develop the agricultural food supply chains. That study focused on the production process of product processing. Moreover, there have also been studies concerned with the development of coffee supply chains in order to enhance the distribution potential of coffee traders (Milford, 2004; Murekezi, 2011; Valkila, Haaparanta & Niemi, 2010). However, these studies only considered the larger picture and did not involve an investigation of the coffee bean production process including farmers and marketing middlemen. The studies did not assess the entire supply chain up to the point of delivery to the customers, nor did they use VSM to manage and reduce the lead-time (LT) of the production process (Rahman, Laosirihongthong & Sohal, 2010).

Therefore, this research study is intended to present Lean's concept in order to develop the efficiency of the Arabica coffee production process of the planters in the North of Thailand (Office of Agricultural Economics, 2014). Most coffee bean production processes have used the wet method together with the enhancement of organic coffee planting methods, making coffee beans a much more qualitative product, as well as being more tasteful than if the dry method had been applied (Wintgens, 2012). For the last 20 years, coffee consumers have changed their priorities and approaches in agricultural product consumption and have now began to focus more on the specialty, fair trade and organic aspects of agriculture (Ponte, 2002). Such efforts are considered the utmost used of value creation in order to gain the comparative advantage (Wheelen & Hunger, 2004). However, at the beginning stages, the costs of organic coffee production became higher, while the productivity was considered low. Thus, it became clear that Lean's production strategy was much more suitable than mass production techniques (Rasch, 1998).

This paper focuses on presenting how to develop the efficiency of the coffee production process through practical implications of VSM showing the details of how organic coffee producers in Baan Khun Lao (OCPKL) operates, as well as to consider the wastes that are generated in the production process. Then, VSM future state was developed in order to assess and improve the continuous flow process. After that, the efficiency of the process was measured using Lean's metric system to determine the methods of producing organic coffee and to develop the efficiency of the production process.

## Research Objective

This article aims to investigate the practical implications of VSM and Lean's concept to improve the efficiency of the process was measured, using Lean's metric system to determine the methods of producing organic coffee and to develop the efficiency of the production process.

## Research Methodology

This research involved the study of OCPKL in the northern part of Thailand. This area has been encouraging and supporting organic coffee production. Many plantations have been certified, and many planters have specialized in the planting of organic coffee. Therefore, this area was selected as the target of the study (Berg & Lune, 2012). The method conducted for the research was a paradigm of a single-case study (Bloomberg & Volpe, 2012) which was the way to acquire much more accurate information from the real performers. Then, the collected empirical data was experimented on in order to summarize the conclusive reasoning based on a deductive process (Creswell, 2013 ; Yin, 2003).

The principles and theories were explained to give clear reasons in the literature review. The methodology based on the principle of Lean production have been determined by, first, studying the supply chains of organic coffee production to select an appropriate production line, and by developing and analyzing the current state VSM through the program evaluation and review techniques (PERT) to estimate the average time of each process. After that, the strategy was determined to develop Lean production of the case study by the value stream manager. VSM was developed to analyze the approach in order to improve the efficiency of production by setting a kaizen working plan, as well as the achievement of an effective working plan by using Lean's metric system, which consists of measuring in total lead time (TLT), total cycle time (TCT), inventory level, delivery and manpower. The data collected from the researcher's interviews or observations were presented through speeches. The observations of events incurred during the operation activities of OCPKL could not be done through the quantitative method (Lapan, Quartaroli & Riemer, 2012). The application of VSM for improving the production process has 5 procedures as follows: (Rother and Shook, 1998):

1. Selection of a product family
2. Current state mapping
3. Future state mapping
4. Planning
5. Execution



Researchers, first of all, provided the seminar about LPS and VSM to the members of OCPKL so as to have them trained and understood. Then, the specific team work was appointed for the VSM process, as follows: the chairman of OCPKL was the facilitator supporting the data regarding all procedures of the organic coffee bean production process due to his good knowledge about all procedures of the organic coffee production process. The production manager and the distribution manager were value stream managers in charge of determining the product family and were responsible for reporting on the VSM process. The group secretary was responsible for keeping useful data and documents for establishing VSM with the help from the researcher specializing in Lean production. In addition, the researcher had to check, control, and collect the data in each different process through careful observation; do the triangulation check, and had to collect the data from semi-structured interviews to get the most accurate data for developing the production process.

## Research Results

### Application of VSM in OCPKL

The study of each event in the production process, including the conditions, might affect the results in terms of checking any unfamiliar events. A case study of OCPKL could be used for extending the approach or for assessing any doubts that exist with regard to the existing theories (McCutcheon & Meradith, 1993) by focusing on the process of production management in order to reduce waste and to investigate the key people involved in the coffee supply chains. The process of the case study analysis provided competitive data on the operation during the different events. The team developed the production system based on the VSM process involving five procedures (Rother & Shook, 1998), as follows:

#### 1. Selection of a Product Family

OCPKL has been an area of qualitative coffee production through the process of production control based on the organic system certified by the government organization, while the areas without certification have sold their coffee through the general distribution channels. It has been noted that the main OCPKL products have been organic coffees, which cost more than general coffee. However, the newer processes require more time being spent during each stage of the process resulting in more production costs than general coffee production. That was the reason to more efficiently improve the production process. The OCPKL productivity types include three kinds: cherry coffee, dry parchment coffee and graded and non-graded green coffee.

Most OCPKL customers were sub-contractors wanting organic coffee productivities to process them into roast coffee. Therefore, most orders were for green coffee sold at the highest price of all the products. Nevertheless, the production costs of green coffee were rather high. That facilitated the

decision to analyze VSM for green coffee products and to find ways to improve the production process.

## 2. Current State Mapping

The efficiency development of the organic coffee production process through the practical implications of VSM presents the current state mapping of green coffee production. The wastes incurred in the production process were found, reduced or eliminated (Womack & Jones, 2002), since they would affect the efficiency development of coffee bean production throughout the supply chain of OCPKL. Figure 1 shows the mapping of SIPOC identifying the basic components of the process presented in the target operation (George, Rowlands, Price & Maxey, 2005) for the purposes of selecting the value stream. The targets of the study included three aspects: 1) to study the flow of raw materials from the productivity of harvest process to customers, but not including the planting activities at the upstream stage; 2) to investigate the activities in the coffee production process or wet process affecting the quality, as well as the most tasteful products; and 3) to determine the selected products according to the first procedure and deliver them to the sub-contractors as the OCPKL customers at the downstream stage (Sadler, 2000).

Suppliers	Inputs	Process	Outputs	Customers
Agricultural equipment distributors	Agricultural equipment	Harvesting	- Cherry coffee	Sub-contract
Seedling shops/ agricultural research center	Coffee seedlings	Wet process	- Dry parchment coffee	- in area
Organic fertilizer shops	Organic fertilizer	Drying	- Green coffee beans	- out of area
Employees	Labor	Inspection		
		Green coffee		
		Packing		
		Delivery		

Figure 1: SIPOC Mapping Showing the Production Process of OCPKL

The structure of SIPOC was used to draw the process-mapping image based on the flow diagram chart. It was also used to design a model of a business system or sub-business system (Paper, Rodger & Pendharkar, 2002) presenting the procedures of the OCPKL production process to classify the activities from the harvest procedure, dry parchment (wet method), hulling, sorting, packing, warehousing and delivery to customers, as shown in Figure 2.

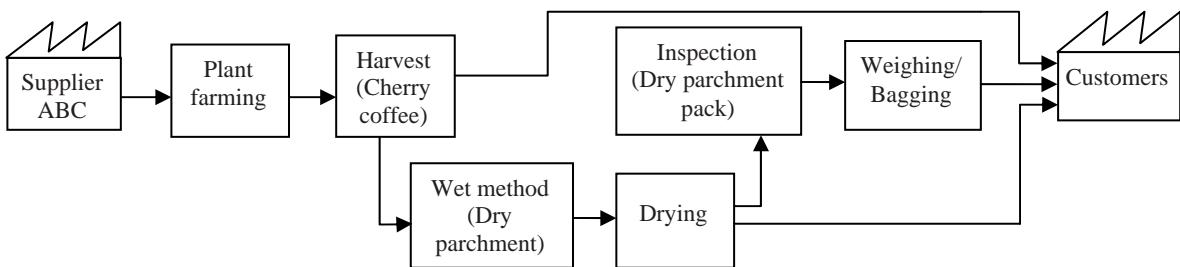


Figure 2: Schematic Picture of the Value Stream for OCPKL

The flowchart and SIPOC process mapping were made to specify the scope and the procedures of the OCPKL operation process and then to draw the current state of VSM, as shown in Figure 3, through the use of the following information.

### 2.1 Customer Demand

According to customer demand, OCPKL could harvest 50,000 kg of cherry coffee throughout 6 months during the harvest time from October to March. 100 kg. of cherry coffee, 23.3 kg of dry parchment or 19 kg. of green coffee (Wintgens, 2012) could be produced. According to the daily delivery schedule, customers would take the goods to suit their needs.

### 2.2 Physical Flow

The physical flow of the process mapping showed the flow of physical activities in the OCPKL coffee production process. To make the current state of VSM, the time spent in each process was determined. According to the case of OCPKL, the exact working time of each activity could not be determined due to the differences between planters. Thus, this study had to determine working time as a variable randomization using PERT to estimate the time spent on each activity of the organic coffee production process (Render, Stair & Hanna, 2006) using the equation for the mean time ( $t_e$ ) and by displaying the time spent on each activity, as shown in Table 1.

$$t_e = \frac{(a + 4m + b)}{6}$$

Table 1

Analysis of verage time and classification of activities in the coffee bean production process

No.	Activities	Average time ( $t_e$ ) (min)	Activity type	Activity value
A	Harvest cherry coffee	12	operation	VA
B	Weigh	5.5	operation	NVA
C	Transport from orchard to warehouse	42	operation	NVA
D	Inspect quality	30	inspection	VA
E	Clean cherry coffee	2.5	operation	VA
F	Bark (Mill cherry coffee skin)	7.2	operation	VA
G	Sort out perfect parchment coffee	30	operation	VA
H	Ferment parchment coffee in well	700	operation	NNVA
I	Mucilage removal (by hand)	20.8	operation	VA
J	Wash with clean water	5.5	operation	VA
K	Soak in well with clean water (for a good smell and fresh taste)	700	operation	VA
L	Drain	5.3	operation	NNVA
M	Drying (Turn periodically)	2,390	operation	VA
N	Collect from drying place	5.8	operation	NVA
O	Contain in sacks	5.3	warehousing	NVA
P	Move sacks and store at low temperature throughout year	18.3	transportation	NVA
Q	Inspect quality	19.16	inspection	VA
R	Transport to mill	28	transportation	NVA
S	Mill	58.2	operation	VA
T	Sort out sizes of green beans	7.2	operation	VA
U	Store	-	operation	NVA
V	Weighting	3.5	operation	NNVA
W	Bagging	5	operation	VA
X	Deliver to customers	43.3	transportation	VA

OCPKL had started using machinery in some processes, such as in the pulping, milling, and grading of green coffee beans. When the machines broke down, it was difficult to repair and maintain them due to a lack of experience in using the machinery. Moreover, the hurdles of moving fresh cherry coffee from the plantation that existed due to the fact that the plantations were located in mountainous areas, caused much more difficulties in the transportation of the coffee and this required a greater amount of time. VSM should display non-value adding activities and focus on improving the delay process, the lead-time and the lack of continuity in the flow of the process.

### 2.3 Information Flow

Regarding information flow, when customers needed goods, they would contact OCPKL by phone or fax. Then, the production department would check the stocks. If the desired products were available, they would be delivered to the customers. In the event there were not any goods left in the warehouse, production would be initiated. Due to the fact that there were some limitations of

manpower in the harvesting of cherry coffee, and the fact that the storage yard could store only a limited quantity of goods, an estimated 200 kg. were targeted in the production cycle. The co-ordination in the production process was controlled daily by the production manager.

An analysis of the current state mapping in Figure 3 shows that the TCT took about 68.35 hours (68 hours 22 minutes), which involved about 245 hours of the TLT, while most activities required a long time and there might have been necessary or unnecessary waiting periods. The improvement on the system focused on the design of a new production process to reduce LT occurring within the process. Furthermore, there were also up to 700 kilograms of work-in-process (WIP) inventory in the process of OCPK coffee bean production.

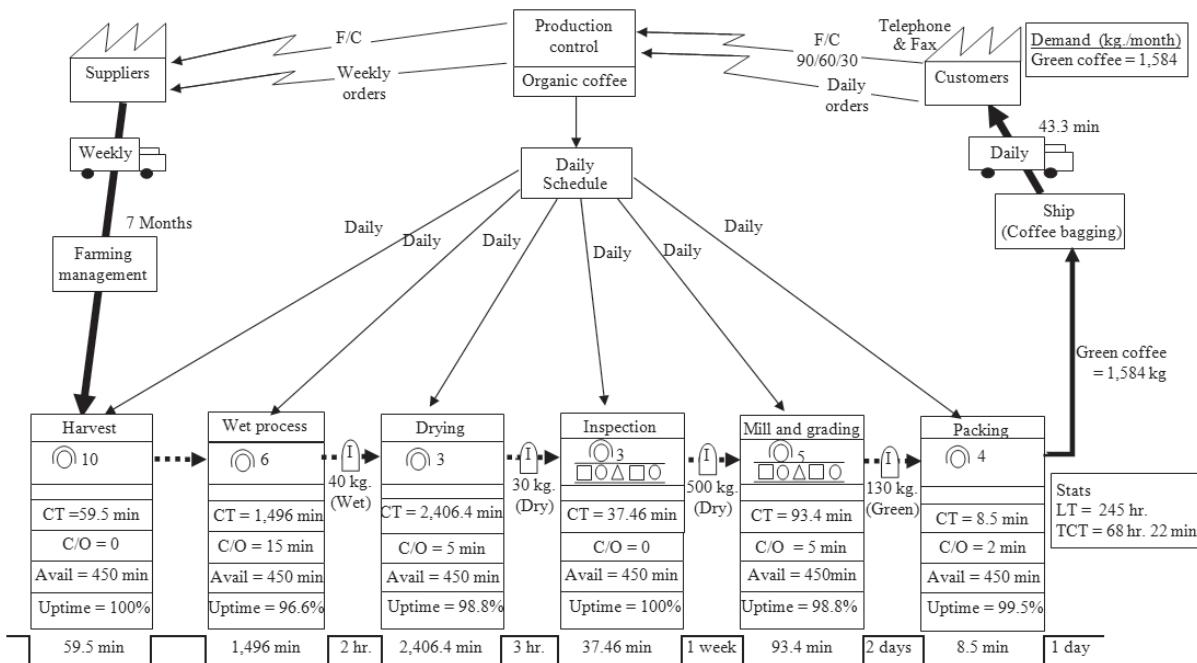


Figure 3: Current State Map of OCPKL

Most activities in the process of OCPKL coffee bean production were activities creating value, as is shown in Table 2. This meant that the improvement of operational efficiency did not only aim at reducing the cycle time (CT) of the NNVA and NVA activities, but also the time of the VA activities. That would reduce the TCT of the production to set approaches for tracking the progress in the operation towards the set goals by determining Lean metric analysis, including inventory levels, TCT, TLT, manpower and on-time delivery rates. Ultimately, the future state of the VSM was drawn.

Table 2

Analysis of average time and classification of activities in the coffee bean production process

Activities	Time (Min)	Percentage
VA	3,330.86	80.37
NNVA	708.8	17.10
NVA	104.9	2.53
<b>Total</b>	<b>4,144.56</b>	<b>100.00</b>

### 3. Future State Mapping

In the future state mapping of VSM shown in Figure 5, the data that was obtained from the current state could be taken as approaches for developing the efficiency of the OCPKL manufacturing processes by planning three key steps of the future state of VSM, as follows:

#### 3.1 Customer Demand

Customer demand was found by calculating the TAKT time of OCPKL under the limitations to the productivity amount. The production quantity was determined equally over a period of six months. Customer demand equaled 60.9 kg. per day. The TAKT time was marked at 7.39 minutes and pitch was recorded at 369.5 minutes.

Due to inconsistent fluctuations of agricultural production capacity, as well as uncertainty of customer demand, OCPKL needed to use the supermarkets to store finished goods, and this was where coffee bean sacks were kept according to customer demand per day. To achieve continuous flow in the production process, coffee beans were packed in sacks as soon as customers had ordered the coffee. Moreover, to keep service levels, buffer stock, as well as safety stock, was filled up to prevent any uncertainty in production capacity equaling customer demand per day (this was because coffee beans could be kept longer without going rotten).

It was seen that process improvement to meet customer demand had changed. That might have resulted in inventory reductions or unfamiliarity with the new system affecting wastes. Therefore, the 5s system was used for eliminating wastes within the customer delivery process.

#### 3.2 Production flow

According to the production flow process, OCPKL controlled continuous flow from the product line balancing by combining operations utilizing employees' skills, as well as by using the concepts of location-sharing, within each process. That could possibly reduce any time wasted in any given process. As seen in Figure 4, there were only 12 activities that spent less cycle time less than the TAKT time. The greater amounts of time spent in the activities that required more time than the TAKT time could be addressed by substituting supermarket distribution methods for the transportation activity. Machinery could replace labor, such as in the processes of inspecting, sorting and packing the goods.

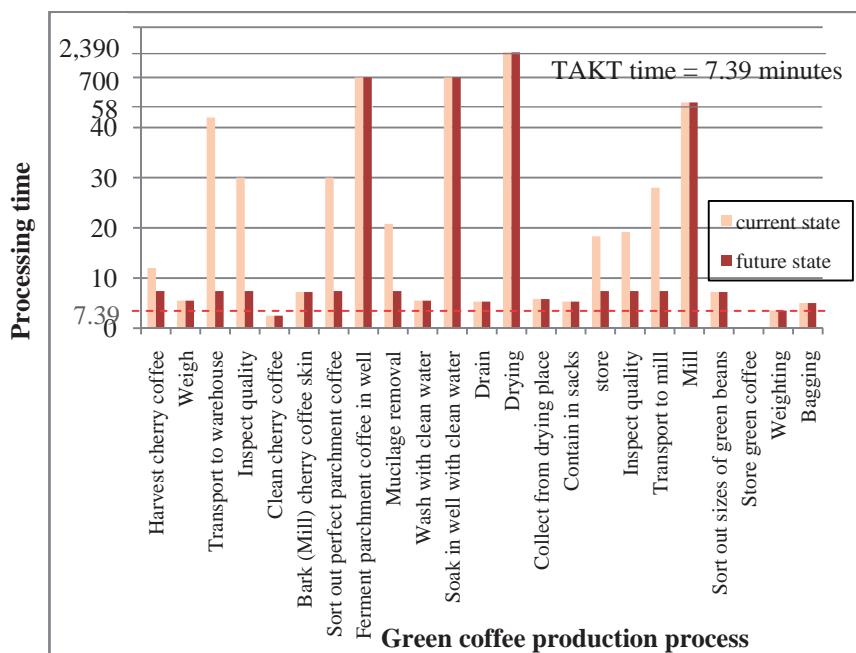


Figure 4: Comparison Cycle Time of Current State Map and Future State Map

The OCPKL production process could be improved to support the flow process by determining three work cells of the future state, as follows:

Work cell 1 was a combination of activities, such as drying, inspection and milling and grading, which reduced wastes concerning movement, inventory and waiting. That made the cycle time of work cell equal to 1457.65 minutes. Due to the design of the new main task, it was necessary to determine how to work by using 5s system, the kanban system and the FIFO lane to reduce obstacles affecting the continuous flow process.

Work cell 2 was a combination of activities, such as the harvesting and wet processes, which were both labor intensive. The cycle time was 2493.97 minutes and this could reduce transportation waste. To control the new system, OCPKL used the FIFO system to pull physical flow and to achieve continuous process flow towards the next activity by using the 5s system to control and organize the work area.

Work cell 3 was improved to facilitate efficient delivery to the customers by focusing on improving interoperability of weighing and packing by putting them in the same process and by then organizing the process by using the 5s system. Furthermore, waiting times were reduced by working in the u-shaped cell in response to the new policy of OCPKL. The warehousing department was added to control the amount of the finished goods to prevent over production. The working system implemented the kanban system to enhance potential in customer delivery by reducing inventory waste.

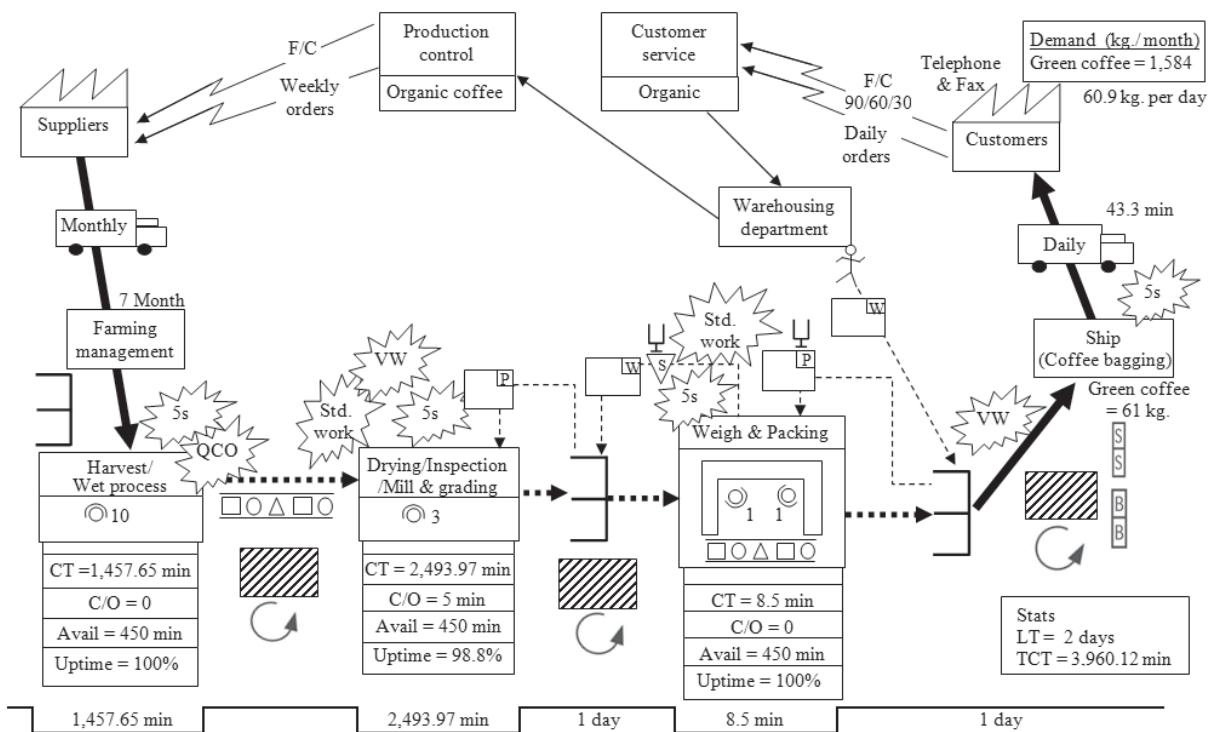


Figure 5: Future State Map of OCPKL

### 3.3 Leveling production

With regard to OCPKL, it was rather difficult to make the flow process smooth in the drying procedure. Thus, it was necessary to use supermarkets during the production process to store dry parchment coffee so that the next task could flow continuously. Withdrawal kanban has been applied to indicate the amount of dry parchment coffee, that was ordered from the supermarket or to account for the weighing and packing of the finished goods that needed to be transported.

Leveling production of customer delivery was important. OCPKL was used to establish the warehouse and to appoint the warehouse manager as the material handler who ordered the products. Withdrawal kanban has been applied towards the supermarket finished goods, according to the customer orders. If the stock of goods were found to be at the reorder point, the manager would order production kanban through the production department by determining whether the safety stock equaled the amount of the customers' needs per day.

### 3.4 Planning

The improvement of the production process based on the future state of VSM involved the production process focusing on the flow process, using withdrawal and production kanban systems



to control the pace of production to most efficiently meet the customer's needs. But the capacity of production was inadequate for the customer's needs each day, so it was necessary to use the concept of the production system in order to maintain a process of continuous flow and the concept of safety stock to prevent demand variability. According to the goals of the action plan as mentioned above, the lead-time in the production process was reduced gradually from 11 days to only 2 days, as planned in the future state VSM. During the first three months, the goal of the harvest was to reduce the LT to only 5 days. Then, working behavior was adjusted by building a co-operative learning process, which could reduce LT to 2 days at the end of the harvest period. The action plan was presented in four steps, as follows:

- 1) Plan working procedures and determine the working regulations of each responsibility for the people concerned.
- 2) Improve and develop the design of operational areas including the warehousing of new products.
- 3) Supply necessary machinery, such as packaging machines, pulping machines for cherry coffee, and grading machines which affect the flow process. When the process runs continuously, equipment concerning inventory management should then be supplied.
- 4) Begin improving material movement continuously by focusing on operational efficiency based on the action plan and production tools, as have been determined above.

### 3.5 Execution

According to operations in the first period of the OCPKL coffee productivity harvest, data was collected from October 2013 to January 2014. After planning the action, it showed that OCPKL could achieve the target goals by reducing LT to 5 days and also revealed that the members began to understand the overview of production operations resulting in a more continuous flow. However, there were still some parts of 5s that they could not be managed completely. From now on, the operation of the inventory management processes would be improved by using a database system to control the entire process, both quickly and systematically.

### Discussion

The discussion of this research will be based on the objectives of the study which are comprised of three parts: 1) presenting the application of VSM for developing the coffee production process of OCPKL ; 2) using Lean metric analysis for improving the efficiency of the process; 3) determining efficient and appropriate operations of OCPKL coffee production.

## 1. Application of VSM in OCPKL

This article presented approaches of OCPKL that could apply the VSM tool to determine the relevant working methods by improving the production process of coffee beans. The main product of OCPKL was applied to create a current state VSM of the production process. It was found that activities in the manufacturing process included NNVA and NVA. Approximately 20 percent of all activities caused waste in the production process, consisting of waiting, movement, inventory and delivery. Then, TAKT time (7.39 minutes) was calculated to set targets for improvement of the activities identified within the production process. Future state VSM was made to improve a continuous flow of the production process in order to reduce LT within the production process using Lean manufacturing techniques, namely 5s, visual workplace, kanban and Quick change over systems (Boppana & Damain, 2011).

OCPKL acknowledged waste in the production process and limited the scope of the waste or eliminated them. The flow process of the system was improved since function partition was clear. Members had their own skills for working and doing different duties. However, according to the use of the Lean system in the manufacturing process to improve agricultural productivity, groups of farmers had to understand the systematical production process. The results of the implementation plan showed that the OCPKL could reduce TLT from 11 days to 5 days. However, the goal of reduction will only be two days in the future.

## 2. Improvement in Lean Metric Analysis

The results of the implementation plan based on future state VSM revealed that OCPKL could measure the efficiency of the coffee production process using Lean metric analysis, as follows:

2.1 Aim to reduce TLT in the production process reduced from 11 days to 5 days (80.4 %), in the first half of the harvest (there were 2 days left at the end of harvest). After the application of VSM, in order to improve the production process for 3 months, OCPKL did a follow-up which could be summarized as follows:

2.2 WIP inventory decreased from 700 kilograms to 61 kilograms (91.28%) of the pull production process and the pace of production fitted in with customer delivery, which also caused LT to go down.

2.3 TCT declined from 68 hours to 61 hours (3.44%) after determining work cells. The kanban system has been used to reduce time spent on doing activities, equaling the TAKT time of some activities. In addition, the number of workers could be decreased by adjusting the working model using shared resources, as well as by reducing the amount of movement waste.

2.4 Customer service was added to coordinate with customers and the warehousing department. That prevented OCPKL from product shortages due to withdrawal and the kanban production system. Therefore, there were always goods available for customers. In the event of fluctuations in customer demand,



OCPKL stored safety stock fitting in with the client's needs per day, which allowed for 100% on-time delivery.

2.5 Finally, with regard to the Lean system, especially within the agricultural production process, all members have to be provided with the related knowledge and to be made clear of agreements made within the group. Individual members should understand and accept the concepts. This would make the production process more efficient. OCPKL was used to draw VSM for the group members in order to present the process concretely. This was fairly easy to perform and could reduce manpower from 31 to 15 men (51.61%) in the manufacturing process. However, the group leader had to understand the Lean system, and control the flow of the manufacturing process continuously.

### 3. Implementation plan

The goal of the implementation plan was to reduce TLT from 11 days to 2 days by using withdrawal and the kanban production systems, in order to control the pace of production relevant to customer demand and to use safety stocks to support variable demand. According to the concepts of the operations above, OCPKL facilitated action plans that were comprised of four parts, as follows:

3.1 Plan of working procedures and determination of the working regulations of each duty for the people concerned

3.2 Improve and develop the design of the operational areas

3.3 Supply machinery to enhance the efficiency of production

3.4 Improve material movement continuously by focusing on operational efficiency based on action plans and the efficient use of production tools

After the application of VSM planned above, in order to improve the production process for 3 months, it revealed that OCPKL could achieve the target goals by reducing LT by 5 days in the first period of the experiment. From now on, some activities have to be improved, such as the 5s management system which is still incomplete, as well as by using database systems to control everything systematically, and to quickly reduce TLT by 2 days according to the target goal.

The onward production process of roasted coffee will be forwarded to sub-contractors which is more likely to be in an industrial context. Hence, to set indicators as well as the operating frame, sub-contractors can completely apply the Lean manufacturing concept. Researchers are unable to force any contractors to operate according to the plan set in future state VSM, instead only suggest the working guild lines for reducing production waste and NVA time.

## Conclusions

This research study is an attempt to develop a production process to support the creation of competitive advantages of OCPKL by presenting coffee produced through an organic system. Consequently, the Lean production system was used to improve the manufacturing process by applying VSM. However, because of the OCPKL agricultural production process, the attempt to use the Lean concept to control the flow of the production process required an understanding of the members with regard to their duties in each process, and for them to understand how the production affects the flow process. Nevertheless, the case study of OCPKL could adjust the application of the production into the concept of Lean by comparing the results of the current state VSM study with those of the future state VSM study. It was found that the important aspect for improving the production process was the significant reduction of WIP inventory (91.28%), TCT (3.44%), TLT (80.4%), on time delivery (100%) and manpower (51.61%). Therefore, the manufacturing process was improved. The results of the operation as planned could reduce LT according to the target goals and could affect the reduction of various types of wastes, including unnecessary inventory, areas for storing unnecessary inventory, unnecessary waiting and movement, along with the improvement of the overall continuous flow in the production process. The chairman and the members of OCPKL have developed the operational approaches to improve the flow of the production process, continuously. The goals were to reduce the LT in the production process using Lean manufacturing techniques involving the following elements: 5s, visual workplace, kanban and Quick change over systems. The results of the study of the operation could achieve the target goals. Nevertheless, there are still some issues to consider in order to further improve the process.

At the strategic level, in order to develop coffee supply chain in Thailand, people who are concerned with coffee production, including the distributors at the upstream locations, farmers, marketing middlemen, consumers or downstream players, should all integrate their collaboration by developing the coffee production process in each section ranging from farm management and the processing stage until the actual delivery to the consumers. However, the government sectors should help the producers and growers promote organic agriculture. That will increase the number of organic agricultural entrepreneurs who can then, even more, manage the costs of production to the scale of the economy.

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