Applying value stream mapping in packaging industry: a case study

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Abstract. The aim of this paper is to increase the productivity of a packaging manufacturing process by using lean manufacturing technique. The current system of this packaging manufacturing process has been mapped using Value Stream Mapping (VSM) tool. This tool is a lean manufacturing tool, and the wastes in the current system are identified. The case study shows how the VSM tool has been utilized for identifying and decreasing the waste in the manufacturing process resulting of the total cost saving of 3,247,251 Thai Baht (THB) per year.

1. Introduction
These Thai packaging industry has played a significantly important role in the economic and industrial sector of Thailand due to the disruption of traditional culture in the sense of a way of life and the extremely fast pace of urban living increased demand for a greater level of convenience. The packaging industry in Thailand is approximated to expand from 61.4 billion units in 2018 to 71.3 billion units by 2023. This expansion can be mainly attributed to the expansion of the country’s economy, increasing disposable incomes, and spending capabilities, leading to the increased consumption of packaged products. In order to enhance the competitiveness, therefore, there is the need for the packaging companies to look at best practices to improve their performance [1].

Value Stream Mapping (VSM) is an improvement tool used for identifying, illustrating and reducing wastes, as well as creating flow in the manufacturing process. As mentioned by Rother and Shook [2], the companies must think about the flow, rather than implementing thoughtful manufacturing systems or separated enhancement processes. The VSM approach has declared itself effective by concentrating its considering flow. VSM is a framework to visibly represent the material flow and information through the manufacturing process. The aim is to determine and increase value addition together with removing or decreasing non-value added activities. VSM is defined as a part of the lean manufacturing tools. The most efficient VSM are mapped by a cross-functional team that has people from various activities in the value stream being assessed. Moreover, the VSM development is a part of the training applied for deeper understanding of the application of lean manufacturing implementation [3,4,5,6].

This research is a case study of VSM implementation at one of the biggest packaging manufacturers in Thailand. The paper intensely investigates the case study company’s manufacturing processes for identifying waste streams. A current state map is developed to identify how materials and information flow. Although, this research has been limited to a packaging manufacturer, obtainable literature demonstrates that VSM can additionally be applied to all other sectors with essential adjustments [7].
It will yield results as organizations are seeking ways for increasing the value of their products and leading to better and happier customers by eliminating wastes.

2. Case Study Manufacturer

The case study company is the manufacturer and distributor of PVC hard plastic sheets. With a production capacity of 18,000 tons per year, the manufacturing process starts from preparing raw materials, mixing ingredients according to the recipe, making the plastic extrusion with the calendar machine and cutting the plastics to size according to the customer needs, and finally packaged them for delivery (See Figure 1).

The products of the manufacturer are rigid plastic sheet products for various processing applications. They can be divided into 4 main categories: 1) plastic cards such as credit cards, ATM cards, food grade and medical plastic infection molding, 2) general printing such as packaging and plastics for upholstered furniture. The manufacturer has both domestic and international customers including Asia, USA and Europe. The Company's suppliers of raw materials come from various sources in Thailand and other countries.

The products of the manufacturer are preferred by both domestic and international customers. However, with the current competition conditions, the manufacturer deals with the problems. Both domestic and foreign competitors reduce the prices of their product. The competitors import the products from abroad to sell at lower prices. Moreover, the sales forecast from the sales department does not have complete product details resulting in purchase errors leading to inventory wastes for both raw materials and finished products. The Product delivery from raw material suppliers has also uncertain lead time and unstable control in the production process causing a delay in the delivery of work.

The manufacturing is a semi-continuous production. (semi-continuous process) and the large batch production. There are many processes that the time to set up the machine is quite high, more than 1 hour, affecting the flexibility of production (operational flexibility). The work study is used to analyse the production process. For the warehouse, advanced warehouse management concepts are used, i.e., mathematical modeling, order quantity determination, order lead time and reorder point to manage space and inventory in the warehouse.

The land transportation of goods by roads and water ways at Laem Chabang Sea Port is used with the internal organization communication using the information system. However, there is missing information in some departments and the lack of integrated supply chain management within the organization.
Results of the initial assessment of the manufacturer in accordance with lean Manufacturing guidelines compared with lean best practices, pointing out the areas that can be further improved. For example pull systems, due to the nature of the production machinery is a semi-continuous process. For Single Minute Exchange of Die (SMED), there are several processes that have a very high set-up time of more than 1 hour. The production flexibility (operational flexibility) as well as the continuous improvement are additionally should be improved, as shown in Figure 2.

3. Developing Value Steam Mapping
Value Stream Mapping (VSM) is a tool based on the fundamental principle of Lean Production or Lean Enterprise. This tool helps organizations for decreasing lead times, inventory, enhancing quality and get better on-time deliveries and utilization resources. Thus, reduction of non-productive activities (viz., wastes) keeps resources as well as accepts resource reallocation in order to improve throughput and profitability [6]. A concept of VSM is illustrated in Figure 3. Current-state map (CSM) is developed to identify how materials and information flow from the start to the endpoint of the process [5]. The detailed explanation of VSM can be investigated from the book of K. Martin and M. Osterling [8].
Figure 3. Value Stream Map Concept [5].

CSM of Packaging manufacturing process of a case manufacturer is shown in Figure 4. The line is a dedicated flow line, and several operations needed for manufacturing packaging products are also illustrated in Figure 4. CSM is the baseline perspective of the existing situation from which all improvements are determined. The map shows the product movement from suppliers through customers. At the lowest point of CSM, the timeline demonstrates the Value-Added (VA) and Non-Value Added (NVA) Process Times from the entry point of manufacturing (raw materials) into the line to the finished products. The results of this study comprise of the production flow, the waste pointed out and listed CSM. Due to prioritizing waste reduction targets, the analysis of CSM in this research can be grouped into three categories, which are raw material mixing process, calender machine adjustment and finished product inspection and movement processes. Table 1 shows the summary of the problems of the manufacturing process for improvement.
Figure 4. CSM of the Case Study Manufacturer.

Table 1. The Problems Investigated from VSM for Improvement.

| Improvement Activities | Lean Tools | Baseline | Target | Result | Diff | Cost Saving |
|------------------------|------------|----------|--------|--------|------|-------------|
| 1. Raw Material Mixing Process | Work Study | 140 Minutes | 6% Decreased | 12.66% Decreased | 6.66% | 17,935 baht/year |
| 2. Calendar Machine Adjustment | Faster Setting on the Machine | 8 Hours | 10% Decreased | 24.5% Decreased | 14.5% | 3,216,000 baht/year |
| 3. Finished Product Inspection and Movement Processes | Work Study | 227 Minutes | 10% Decreased | 11.45% Decreased | 1.45% | 13,316 baht/year |

| | | | | | | Potential Saving |
|------------------------|------------|----------|--------|------|------|-------------|
| Total | 3,247,251 baht/year | - |
4. Conclusion
After the process improvement, the case study manufacturer can enhance competitiveness. It can be concluded that VSM is a valuable planning tool and can be utilized to develop and implement lean improvement of packaging manufacturing processes. Figure 5 shows the improvement results. By optimizing production to aim for lean production standards, raw material mixing process is improved by 10% faster for raw material mixing process, calibration methods for the calender machine with 25% reduced set-up times, and 12% faster for the inspection and movement of finished goods. The total cost savings is 3,247,251 baht/year.

![Figure 5. Lean Assessment after the Improvement.](image)

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