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Warehouse Processes Improvement Using Lean Six Sigma and RFID Technology

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Abstract

Warehouse processes are the primary activities carried out on a routine basis at a warehouse facility, including the import and transportation of goods that impact the supply chain. The goal of this research is to improve warehouse processes in garment manufacturing through the use of Lean Six Sigma and RFID technology, as well as to demonstrate that Lean Six Sigma can be used warehouse processes in addition to production processes. Lean Six Sigma methodology is focused on the Six Sigma strategy for continuous process improvement, which comprises Define, Measure, Analyze, Improve and Control (DMAIC) and lean strategy by using simple techniques. Furthermore, utilizing the Flexsim software, this study replicates warehouse processes by simulating warehouse modeling and cycle time. Cycle time was reduced by 91.5 percent once Lean Six Sigma and RFID technology were used, resulting in 13 percent in lead time.

1 Introduction

Business processes are critical to the success of every organization because they are a set of activities performed by a community of partners in order to

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fulfill a specific goal. If business processes are efficient, they will be able to reduce cost and process cycle time. Therefore, business process improvement is a fundamental methodology to increase the efficiency of the process. Lean Six Sigma is a method for improving business processes by combining Lean and Six Sigma concepts, tools, and techniques that are implemented to solve the business issues otherwise be currently affecting customers and processes. The purpose of this study is to implement Lean Six Sigma to warehouse processes in order to demonstrate an issue with the business process.

Garment manufacture is a significant industry since the growing population results in an increase in textile production. If the number of order increase, the production process must become more efficient and quicker. Hua Thai manufacturing is being used as a case study for improving the warehouse processes in this study. Modern technology such as RFID and a warehouse management system may support a warehouse's activities. The movement, handling, and monitoring of materials in a warehouse are referred to as the warehouse processes. Receiving raw materials and delivering goods on schedule, as well as controlling inventory flow quickly, are indeed indicators of an efficient warehouse processes. RFID technology is being used to assist the warehouse processes in this research. It will capture data automatically and use radio waves to monitor the product in real-time.

Hua Thai garment manufacturing has a warehouse with various fabrics of range styles, colors, and lengths in store, as well as two brands: Coach and Burberry. The fact that the organization imports cloth from other country demonstrates that many stocks are to count and many procedures to store fabric in this warehouse. This study aims to improve the warehouse processes in order to increase efficiency and speed it up.

2 Literature Reviews

2.1 Six Sigma Methodology

In the 1980s, Bill Smith engineer at Motorola created Six Sigma as a quality management methodology for the first time and known as the "Father of Six Sigma," that benefited from the full backing of Motorola's CEO, Bob Galvin, which facilitated his work. Six Sigma is a process improvement for identifying and eliminating defects, errors, or failures in processes.

According to Markarian [1], Six Sigma's process improvement should be applied not only to manufacturing processes but also to other functions such as logistics, ordering, and human resources. Kumar et al. [2] said that Six

Sigma is followed by using the Define, Measure, Analyze, Improve, Control (DMAIC) problem-solving approach to identify the factors generating casting errors and regulate these factors. The research findings are based on using several tools and methods in the DMAIC methodology, such as Pareto Analysis, Measurement System Analysis, and Design of Experiment. Pyzdek [3] DMAIC is a learning model that focuses on collecting and analyzing previous data to execute improvement activities. Gupta and Kumar [4] presented a Six Sigma to reduce HDPE bag damage in the carbon black warehouse and identify root causes via fishbone diagrams, an analytical hierarchy approach, and a Pareto chart.

2.2 Lean Manufacturing

Lean manufacturing was developed in the 1940s mostly from the Toyota Production System (TPS) or just-in-time (JIT). After World War II, the Toyota Company in Japan found success based on Henry Ford's manufacturing techniques and Edwards Deming's Statistical Quality Control ideas. Lean is described as a collection of management techniques aimed at increasing efficiency and effectiveness via waste elimination. Lean's fundamental concept is to minimize and eliminate non-value-added operations and waste. Garcia [5] mentioned that Lean principles might be used effectively in a warehouse setting. Value stream mapping can be a beneficial technique for designing and implementing lean warehouse processes, and the successful use of Lean methods results in decreased lead-time by 25 percent and order picking time by 50 percent while inventory and order processing accuracy are improved. Chen et al. [6] apply lean production and RFID technology to the warehouse for improving the efficiency using value stream mapping to draw current state mapping and future state mapping. The overall time required to integrate RFID into lean can be reduced by 87 percent from the current stage to the future stage.

2.3 Lean Six Sigma (LSS)

In 2002, Michael George and Robert Lawrence Jr. conceptualized Lean Six Sigma in book Lean Six Sigma: Combining Six Sigma with Lean Speed. Lean Six Sigma has combined the tools and methods of Lean and Six Sigma in a business strategy to increase process performance. Lean Six Sigma is a process improvement approach that focuses on identifying and solving problems, eliminating waste and defects. Snee [7] said that Lean Six Sigma is a business strategy and technique that boosts the performance of processes based on quality, cost, delivery, and customer satisfaction. The organization required because improved technique and issue solving were needed. Pepper and Spedding [8] showed that Lean Six Sigma should be seen as a forerunner to developing more responsive supply chains via better communication that results in strategic partnerships and as a platform for initiating cultural and operational change that leads to total supply chain transformation.

2.4 RFID Technology

RFID technology has emerged as an essential technology for increasing the efficiency and efficacy of manufacturing. There are several types of RFID tags, but they are generally categorized as active and passive. Ahuja and Potti [9] said that Active tags need power and are connected to either a powered device or a battery. On the other hand, passive RFID is attractive because of its independence from a power source and maintenance. Wamba et al., [10] presented that the influence of RFID technology on one RFID-enabled warehouse's picking and shipping procedures. With RFID implementation, business process redesign, data quality improvement, real-time data gathering, synchronization, and system integration may be shown. Wang et al., [11] focused on RFID technology that can increase the accuracy of product tracking and lead time, hence improving production operations.

3 Proposed Methods

The approach used in this study incorporates simulation to calculate the cycle time and lead time using business process improvement technique with Lean Six Sigma based on DMAIC methodology and RFID technology.

3.1 Define phase

Define phase is the first phase of DMAIC methodology that defines the main problem, process activities, and project goals. This phase focuses on a crucial indicator for determining the project's performance, such as lead time or working process. The tools that are used for this phase are process mapping and the SIPOC chart. Process mapping is a flowchart that depicts the flow of a process in order to determine which activities affect the process's performance. Another high-level map is SIPOC chart that stands for Suppliers, Inputs, Process, Outputs, and Customers (or the next part of the process).

This chart is used to describe the whole business process from beginning to end.

3.2 Measure phase

This phase's primary purpose is to record the data related to the inventory, cycle time, and lead time of warehouse processes by creating the current Value Stream Mapping (VSM). The VSM is a lean management tool that visualizes all significant steps in a process to calculate the amount of time quickly.

3.3 Analyze phase

Analyze the system's problem(s) in order to determine the root causes of the critical problems by using a fishbone diagram (also known as the Cause-and-Effect Diagram) and run simulation experiments by using Flexsim software.

3.4 Improve phase

Utilize brainstorming to develop suggestions for improvements and create an implementation plan into a future VSM. Utilize simulation to determine the effect of each solution on the system's performance.

3.5 Control phase

It determines a method for controlling and verifying the process by developing a strategy that anticipates the issue if performance degrades.

4 Results

4.1 Define

The warehouse's function is to store materials or organize and prepare materials for departure from storage at the prescribed time, amount, and quality. Thus, the warehouse's fundamental logistical tasks in Hua Thai warehouse include receiving raw materials, checking and controlling raw materials, storing raw materials in the warehouse, picking, and shipping. Additionally, this stage used a variety of tools, including process mapping and a SIPOC chart. Figure 1 shows the warehouse processes model (mapping process) of the current process, and Figure 2 shows the SIPOC chart of the warehouse processes.

As shown in Figure 1, this garment manufacturer imports fabrics from another counties. The import department will transmit invoices and packing lists from the supplier to the warehouse when the textiles arrive at the front of warehouse (in some cases, the supplier does not send the packing list; employees must manually check stock). Following that, workers will verify whether or not the amount and kind of items are accurate before unloading them into a temporary storage area. Next, the employees will check the quality of the materials. If the quality passes, the employee will enter data from the packing list into inventory management and prints inventory tags. Then workers will affix the tag to the top of the roll and transport products from the temporary storage area to the warehouse rack. After transferring material to a warehouse, update the location in the inventory system and the Goods Receive Note (GRN) in the AS400 system so that the merchandiser can determine the quantity of textile required for the sewing department. When an employee is required to pick up material, he or she will create requisition notes and issue fabric before moving it from the warehouse rack to the automated fabric cutter machine. After cutting the cloth, the employee will write the stock card to update the remaining fabric length. The employee will next submit the cloth to the sewing department, where an employee must sign the request notes prior to receiving the product.

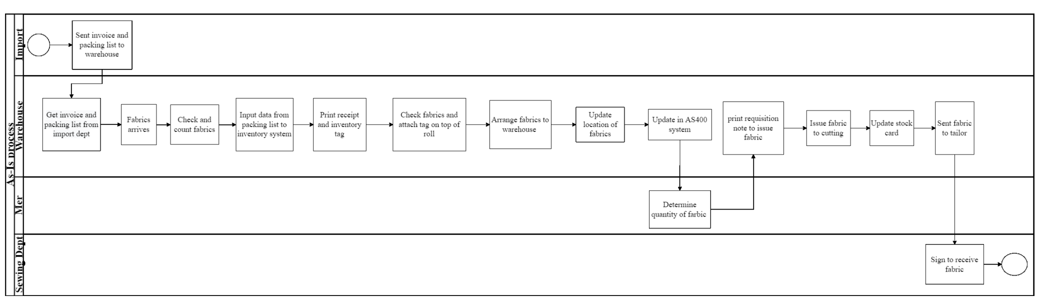

Figure 1: Warehouse processes model

As shown in Figure 2, SIPOC chart was designed to expand the warehouse process's scope for analysis and improvement. It depicts the warehouse processes and suppliers for two brands that need fabric stock separation.

Then, referring to the problem statement, the following issues arise: First, Hua Thai manufacturing counts items manually, which takes time and introduces human error; second, manual product counting requires a large number

S	I	P	O	C
• Fabrics for Burberry clothes. • Fabrics for Coach clothes.	• Raw materials. - Fabric.	• Check raw materials. • Arrange fabrics to warehouse. • Update fabric location. • Create requisition note. • Cutting fabrics.	• Fabrics for tailor.	• Sewing Department

Figure 2: SIPOC Chart

of workers.

4.2 Measure

The measure step's objective is to organize existing processes in order to create current metrics. Value stream mapping (VSM) is a technique for identifying waste throughout the distribution process. Figure 4 shows a current VSM of the warehouse processes in this manufacturing. This phase should record warehouse processes cycle time to determine the waiting time, transport time, and processes time. The current value stream mapping illustrates the warehouse processes that may be optimized to decrease lead times and processing times in the warehouse, such as reducing time spent verifying the location of inventory and time savings associated with storage of materials and preparing materials.

4.3 Analyze

This stage focuses on determining the root causes of the main reason for the problems to increase the accuracy and efficiency of the warehouse processes. Figure 3 shows the Cause-Effect diagram (fishbone diagram) of the warehouse processes.

In the product inspection section, it was determined that it takes an inordinate amount of time to verify stock and material types. Additionally, manual stock counting and material location may result in human errors, requiring additional inspection time and potentially increasing defects. Based on the analysis, it seems that there are many employees, some of whom may

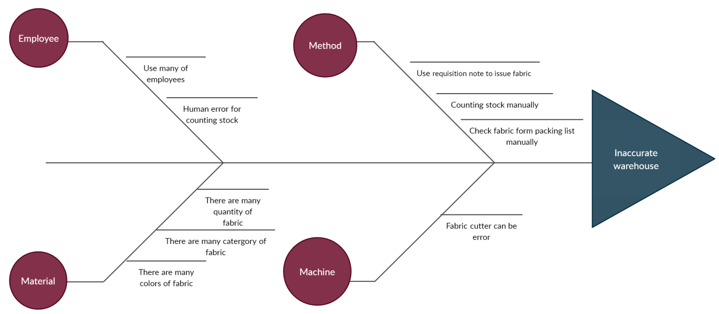

Figure 3: Cause-Effect diagram

be transferred to other manufacturing departments to increase useful in the organization.

4.4 Improve

This stage aims to improve warehouse processes actions to reduce the process wastes and cycle time. The lean improvements were shown in a future state VSM. A future state VSM presents future warehouse conditions and operational development based on lean solutions shown in Figure 5. After improving the process, it is able to decrease waste time and nonvalue-added activities, which results in process delays. This research simulation warehouse processes and cycle time using Flexsim software. After running the simulation model, the simulation time is observed, and the simulation results are analyzed, shown in Table 1 and Table 2.

Table 1: Average Stay Time of Lean Six Sigma and RFID Implementation, Before and After

Process	Average stay time before Lean Six Sigma and RFID implementation (sec)	Average stay time after Lean Six Sigma and RFID implementation (sec)
Receiving	610.00	604.07
Product inspection	86400.00	120.00
Quality Control	10800.00	7204.08
Storage	30.00	15.77
Update location	300.00	123.68
Prepare materials	900.00	305.28

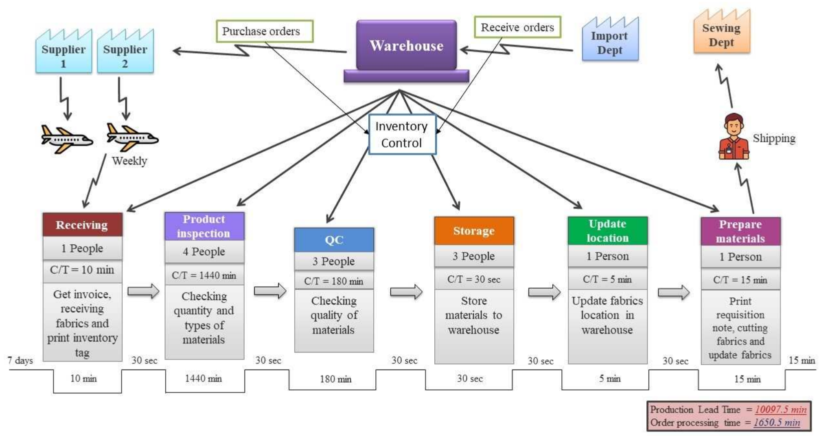

Figure 4: Current Value Stream Mapping of Warehouse Processes

Table 2: Overall Lead Time, Number of Employees and Storage Location Information at Current and Future Stages.

	Current Process	After Lean Six Sigma and RFID implementation
Overall lead time for the warehouse processes	11748.00 Min	10232.48 Min
Number of employees	15 people	11 people
Storage location information	Manually	Automatically and real time

Table 1 shows a comparison before and after lean Six Sigma, and RFID implementation average stays time of the process. After implementing Lean Six Sigma and RFID technology, the average time required to complete all activities was reduced by 91.5 percent, owing to the reduction in cycle time. Table 2. compares the overall lead time for the warehouse processes, show the number of employees and storage location information at the current and future stages. The overall lead time after implementation is decreasing by 13 percent, and the workforce is decreasing. Additionally, analyzing warehouse processes enables more appropriate worker allocation and speeds up the process. Furthermore, the position of materials is updated in real-time and with greater precision, making it easier to count and locate materials.

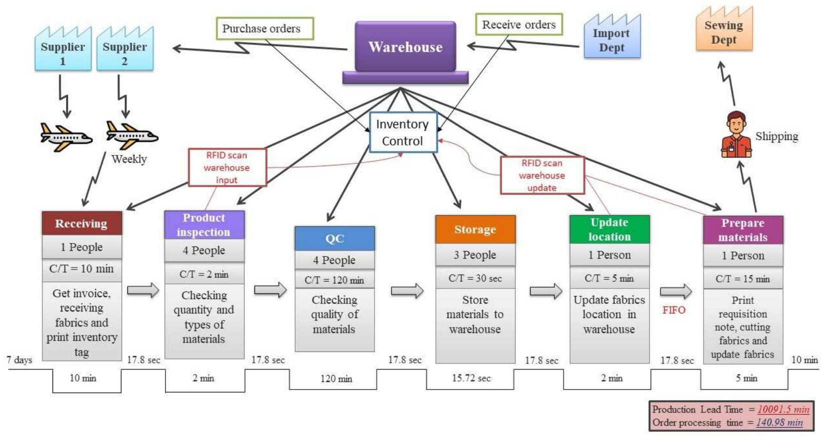

Figure 5: Future Value Stream Mapping of Warehouse Processes

4.5 Control

In the last step, called the Control phase, the goal is to maintain the benefits obtained via improved processes by monitoring and controlling operations. Thus, the warehouse processes will need to establish a control phase to ensure that the suggested improvement techniques are maintained. During this phase, control and monitoring techniques for the relevant processes are expanded across manufacturing, including process mapping updates and staff training.

5 Conclusion

This study applies Lean Six Sigma (Lean and Six Sigma tools on DMAIC steps) to the warehouse processes and combines with RFID technology in a case study of garment manufacturing. Although the LSS method is mostly used in the production sector, this study demonstrates that it can be modified in the warehouse sector. The focus was on VSM in lead time and cycle time, then analyzing the roots caused by the Cause-Effect diagram to identify problem to improve the process. However, future VSM can identify waste time and processes in the warehouse. The Flexsim software was used to simulate the warehouse processes to run simulation time. RFID can assist in the faster checking of materials and location updates. RFID is used in conjunction with LSS, and it can help the warehouse processes run more efficiently and accurately. According to the result of the research, after improving the warehouse processes, there was a reduction in cycle times by 91.5 percent and a reduction in lead times by 13 percent. Therefore, LSS and RFID technology can be used to develop a warehouse for another manufacturing business to be more beneficial. For future work, LSS can be combined with another technology to increase workplace convenience.

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