# THE IMPROVEMENT OF THE NON-VALUE-ADDED ACTIVITIES IN THE 3-IN-1 INSTANT FOOD PRODUCTION PROCESS BY APPLYING LEAN TOOLS

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## ABSTRACT

*This research represents one of the first large-scale, automatic process control system empirical efforts to systematically investigate and apply the Lean manufacturing methodology. The Lean tools can help to define, measure, and analyze the problem in this research. This study aimed to eliminate the waste, which causes the multiple steps from material handling to the production process by analyzing and identifying the root causes. After the simulation model was developed, the author compared the As-Is and To-Be outcomes, which are significantly different. The conclusion of this study showed that the total cycle time of the whole process is reduced from 70 minutes to 36 minutes and the batch size of work-in-process was also increased from 360 kg to 500 kg per cycle. Overall efficiency is seen to have increased in all processes where Lean principles have been carefully selected and applied.*

***Key Words:*** *5S Methodology, Kaizen, Lean Manufacturing Methodology, Material Handling & Process Control, Non-Valued-Added Activities*

**บทคัดย่อ**

การวิจัยนี้แสดงถึงการใช้ระบบควบคุมแบบอัตโนมัติที่มีขนาดใหญ่ในเชิงประจักษ์เพื่อที่จะศึกษาอย่างเป็นระบบและนำการผลิตแบบลีนมาประยุกต์ใช้ เครื่องมือลีนสามารถช่วยในการแจกแจง วัดผล และวิเคราะห์ปัญหาในงานวิจัยนี้ วัตถุประสงค์ของการศึกษานี้ต้องการลดการสูญเสียไปโดยเปล่าประโยชน์ โดยการวิเคราะห์และแจกแจงต้นตอของปัญหาซึ่งเป็นสาเหตุหลักของกระบวนการจัดการวัตถุดิบในกระบวนการผลิต หลังจากการจำลองโครงสร้างตัวอย่างได้ถูกพัฒนาขึ้น ผู้เขียนได้เปรียบเทียบ ผลลัพธ์ก่อนและหลัง ซึ่งพบความแตกต่างอย่างมีนัยสำคัญ บทสรุปของการศึกษานี้แสดงให้เห็นถึงกระบวนการทำงานของทั้งระบบที่ใช้เวลาลดลงจาก 70 นาที เหลือเพียง 36 นาที ซึ่งขนาดของกำลังการผลิตมีปริมาณเพิ่มขึ้นจาก 360 กิโลกรัม เป็น 500 กิโลกรัม ต่อรอบระยะเวลาการผลิต โดยรวมแล้วประสิทธิผลการผลิตเพิ่มขึ้นในทุกๆ กระบวนการ ซึ่งหลักการทำงานของลีนได้ถูกเลือก และนำมาประยุกต์ใช้อย่างรอบคอบ

**คำสำคัญ:** 5ส ไคเซ็น การผลิตแบบลีน การขนถ่ายวัสดุและควบคุมกระบวนการ กิจกรรมที่ไม่เพิ่มคุณค่า

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# INTRODUCTION

In this case study, Java Company is a 3-in-1 instant beverage manufacturer in Myanmar that produces instant beverages such as 3-in-1 instant coffee mix, tea mix, cereal mix. There were the multiple steps cause non-value-added time, from the picking of the raw material to the production process in this study. Java Company conventionally manufactures its products and uses a manual method. Therefore, production inefficiency and working steps that cause defects in time and handling of materials are the root causes. Moreover, the multiple steps make the process time-consuming from picking the materials to the production process, which is measured at 70 minutes per cycle to finish 360 kg capacity. Defects are a major obstacle that interrupts production efficiency and capacity. Java Company must reduce the recurrence of defects or multiple steps that cause low production capacity.

This research mainly focused on the reduction of non-value-added activities from picking the raw material to the production process at Java Company based on the Lean manufacturing concept. The use of Lean thinking, which is one of the Six Sigma methods, to help solve the problems of Java Company in its production capacity and process performance. This case study of defective time in the material handling and production process and integrated Lean tools during implementation.

# LITERATURE REVIEW

### *Lean Manufacturing*

Lean manufacturing has existed for centuries, but it became popular in the 1900s. It is a principle that focuses on reducing waste within the production system. It is also known as a production system with fewer resources, or agile. Lean manufacturing is a process for streamlining, reducing waste, eliminating non-value-added activities, and using fewer resources to maximize efficiency and profit. Womack and Jones (1997) defined Lean as, a way to be less use of human effort and machines, minimalize time and space – while providing closely what the customer wanted and where it's wanted exactly".

Lean has a lot of techniques and principles: tools for analyzing processes, delay times at each process activity, focusing on value-adding activities to reduce the root causes of unnecessary processes, and can quantify and reduce the causes of complexity.

Research conducted by Susan (1996) showed that the material handling at Unilever in Italy applied a smart pallet system in the warehouse management system to apply Lean manufacturing concepts. As a result, it improved the security of the stock not only through the elimination of handling, saving time and employee errors but also by speeding up just-in-time orders. The manpower for the warehouse management was required for only one-third of the traditional process after implementing the smart pallet system.

### *Kaizen*

Kaizen aims to eliminate waste and redundancies (Lean manufacturing) in all businesses or industries through improved processes and activities. The practitioners can integrate the Kaizen method into Six Sigma efforts. Kaizen focuses on the process instead of policies, ensures cooperation, and improves cross-functional communications and standardization (Masaaki, 2012).

Cochran, Duda, Linck & Taj (1998) showed that the stimulation model in cellular production was developed from a batch production process converted into a Lean production system. There was a sequence of five production systems in the conversion. Firstly, a traditional batch production system was changed into a continuous processing system by applying a continuous improvement method (Kaizen). Then the process was converted drastically by implementing a multiple pull system. The research shows that cellular production was changed from a traditional batch processing system to a continuous production system by applying Lean principles.

***Value Stream Mapping***

Value Stream Mapping (VSM) is a process tool that shows how information and resources flow in that map and controls the flow of material, which represents the Lean concepts to identify the value-adding steps in a value stream and reduce the unnecessary steps or waste (Muda) (Khaswala & Irani, 2001). VSM is used in the Analyze phase of the Lean manufacturing concept. Furthermore, VSM reduces waste in the organization by removing unnecessary time or activities. Generally, VSM is one of the Lean tools that help businesses not only identify value-adding activities but also clarify and eliminate non-value-added activities.

Ikatrinasari, Hasibuan, and Kosasih (2018) implemented Lean and Green manufacturing through VSM in the electronic component industry located in Indonesia. They divided into two states by using two VSM models, analyzed, and optimized the targeted process, which is the "current state" of the targeted process and the "future state" of the desired process. Based on their research, the current VSM has 1742.5 minutes of total lead time for the process, 235.5 minutes of value-added activities, and 1507 minutes of non-value-added activities. According to the analysis of waste that may be reduced, they developed the future VSM, which resulted in the lead time of non-value-added activities being reduced to 1242 minutes and showed that the process was increased by 15%.

***Cause-and-Effect Diagram***

Cause and Effect Diagram Adding Cards (CEDAC) is one of the implementation tools of Lean principles. CEDAC is also known as the Cause and Effect (C&E) diagram, which is also called a Fishbone diagram. It is a picture consisting of lines and shapes to represent the significant relationships between causes and their effects. Rahman, Shaju, Sarkar, Hashem, Hasan, Mandal & Islam (2017) emphasized that improvement requires an enhanced comprehension and understanding of the process. An analysis was carried out to identify the root causes of the defects.

Ahmed and Ahmed (2011) showed the minimization of defects in the lamp manufacturing process by the implementation of the Cause-and-Effect diagram and Pareto analysis. They created a Cause-and-Effect diagram for each defect and found the main part of the cause. They recommended the Cause-and-Effect diagram as very useful in stipulating the appearance of abnormal processes in the form of excessive forms of process frameworks.

***5S Methodology***

5S is a workplace environment system that is defined by five Japanese words: seiri, seiton, seisō, seiketsu, and shitsuke. These are interpreted as sort, set in order, shine, standardize, and sustain (Agrahari, Dangle, & Chandratre, 2015). Numerous fields of businesses apply 5S not only to initiate Lean concepts but to focus on reducing unnecessary activities and unplanned downtime.

Agrahari et al. (2015) implemented the 5S approach to continuously improve a workspace in the case study of the small-scale industry. According to this study, 5S enhanced and created the operation effectively in a better working environment, built teamwork, developed discipline, and designed for workers' participation in the workplace. It has also advantages in reducing cost, preventing lost tools, better usage of the work area, increasing efficiency, reducing machine maintenance costs, and improving company standards to the next level.

# METHODOLOGY

This section focuses on the use of Lean methodology and help us identify the problem and evaluate and analyze the process systemically. There were the four main areas to clarify the root causes of the problem, such as material, warehouse, buffer zone, or preparation area for processing and production, where the non-value-added time and the unplanned downtime cause multiple steps from picking the material to the production process.

There are several possible ways to cause unplanned downtime. The data from Java Company was collected to define the root causes. Firstly, this research needed to be studied from the start to the finish of the process to know the reasons for the multiple steps that cause non-value-added time or the unplanned downtime in the process.

***Value Stream Mapping (VSM)***

This VSM model was constructed based on the current data collected from Java Company as shown in Figure 1. From the case study, the non-value-added-time was clarified and the value-added-time was clearly defined. Non-value-added-time can be seen in the material picking area, buffer zone, weighing, and loading process for production and the unplanned downtime after blending. The VSM also shows that there is less value-added time in the diagram. The production batch standard for 3-in-1 instant beverage mix products per batch is 360 kg for each mixing in one cycle and was measured to complete that one cycle, which took 70 minutes. There was unplanned downtime or non-value time from picking the material from the warehouse to the production process. The value-added time was 25 minutes or 35% of the whole process, and the non-value-added time was up to 45 minutes or 65% of the whole process.

***Cause and Effect Analysis***

The Cause-and-Effect diagram is also known as a Fishbone diagram, which can help in brainstorming to identify the root causes of problems and in sorting ideas into useful categories. It is a more systematic approach than some other tools available for brainstorming the causes of a problem (Ahmed et al, 2011). Figure 2 displays the causes of the problem which were categorized in 4M and 1E, material, movement, method, manpower, and equipment. The material was analyzed first, which was not stored in the proper location for easy selection and pick up because the warehouse management system was not used well. The waste in the movement was followed because the time and travel distance of picking the materials were also obstacles. After the Cause-and-Effect diagram was built, the diagnostic checklist of the causes were developed.

After analyzing the potential causes from the Fishbone diagram, there are five categories of causes and effects were found including method, machinery or equipment, physical (moving goods due to inefficient machine or warehouse layout), and human (human errors need to rework).

**Figure 1: Value Stream Mapping for Java Company**

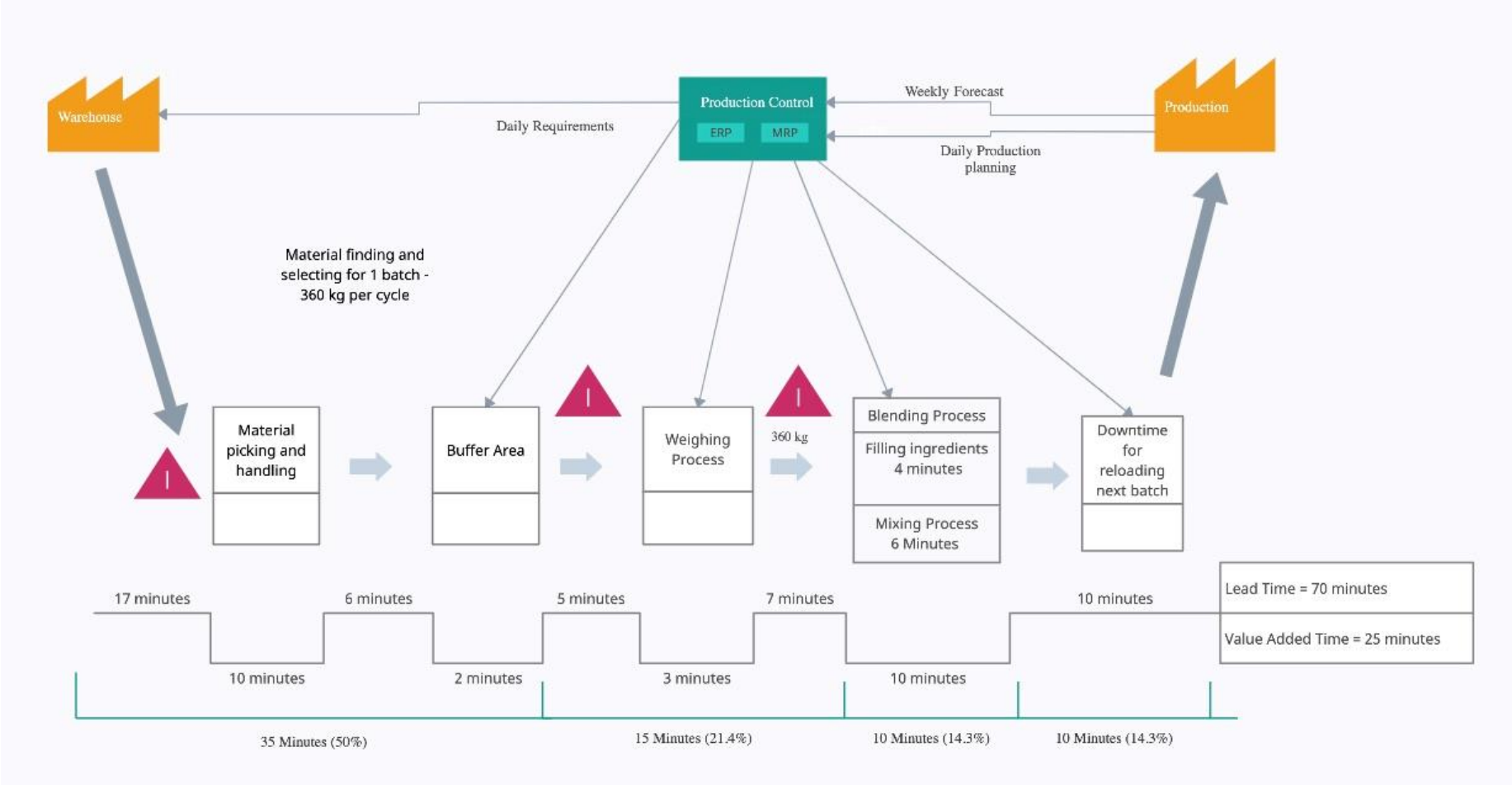
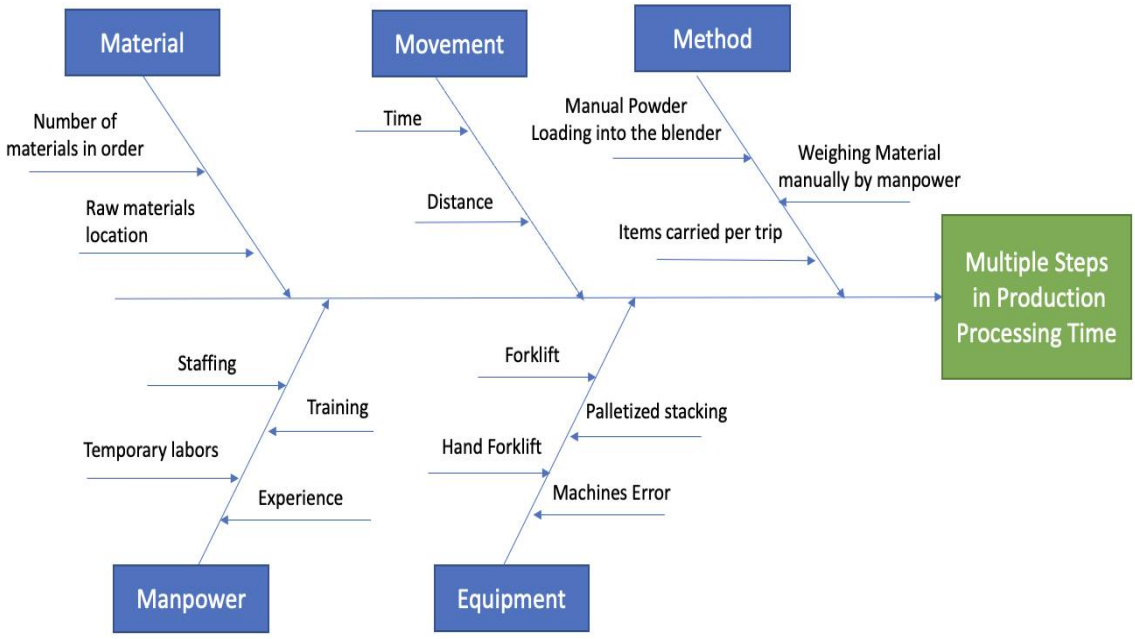


**Figure 2: Cause and Effect Diagram Analysis of Multiple Steps Causes in Production**




# RESULTS

By following the Lean manufacturing concept or Lean tools, identify, evaluate, and analyze steps were completed in previous section. The results of the As-Is workflow that caused the unplanned downtime were collected and validated. The objective of this model analysis is to decide on the best solution to reduce the unnecessary activities and non-value-added time from picking the material to the production process. The improvement actions and evaluations were developed to eliminate the waste by combining machines, methods, manpower, and process steps and then performing them within a cycle time.

***Improvement Actions***

These are the improvement solutions that can be applied to solve the non-value-added time that causes multiple steps from materials picking to the production process. The main objective of this section was to develop the appropriate processes, including material selection and picking, from the warehouse to the production line daily.

***Kaizen (Workflow Redesign)***

The proposed improvement plans were stimulated by the data on the actual situation from the Java Company. The two main parts of the upgrading steps for the current process are as follows:

1. Warehouse Storage and Management System (Material handling part)
2. Automatic bulk material handling and process control system (Processing part)

***Warehouse Storage System (Material Handling Part)***

According to the problem referred to in C&E diagram analysis, the non-value-added time occurred due to warehouse management and storage systems. Firstly, the location of raw materials storage and the materials storage method should be sorted to comply with FIFO standards.

Thus, the advanced warehouse management system called "The Pallet Shuttle Racking System" was developed not only to solve the current problems and improve the material flow process but also to reduce the waste of time consumed in selecting and transferring materials. The shuttle racking system is a racking system with high-density storage that includes racking and an electric pallet shuttle vehicle that works with the forklifts.

***Automatic Bulk Material Handling and Process Control System (Processing Part)***

The objective of this section is to eliminate WIP processes or unnecessary activities in each step of the production system and also increase the process performance and productivity. Therefore, the improvement of redesigning the process control system focuses on reducing wait time in the WIP process and increasing the production capacity. The objective of upgrading of this bulk material automation and continuous process control of this experiment is to get the optimal production capacity.

This section was conducted the simulation model of upgrading to the automatic material handling and continuous process control system achieved in cycle time reduction and increase in batch sizes. As a result, this shows that the batch size of the blending capacity has increased, and the wait time, total time, WIP output, and the need for manpower have decreased.

Due to the automation and continuous operation of the process control system, the non-value-added time was reduced. The simulation of the new process system shows that the As-Is workflow total time is 35 minutes, which decreases the To-be workflow by the total time of 16 minutes. Therefore, the production output per one cycle time also increases from 360 kg per batch to 500 kg per batch, and there will be less wait time or WIP between each process and another.

***5S Methodology - Elimination of Waste (Muda)***

The 5S methodology is one of the major steps in motion to accomplish a successful Lean manufacturing concept. It provides discipline in the workplace. The Java Company's started with Lean tools and 5S methodology which focuses on reducing unnecessary activities and unplanned downtime. Then they also implemented and maintained 5S methodology to set the discipline and continuous improvement at work for good working environment practice. Java Company has applied the 5S concept in the workplace before implementing the improvement plans, which include the development of a warehouse storage system and an automatic bulk material handling and process control system.

***After Improvement Plans***

After developing the simulation model, the results of the improvement plans were revealed after 10 months of data collection and case study. As shown in Table 1, this study's results distinguished all the processing problems of the Java company by comparing before and after the improvement actions were taken. The new automation and continuous workflow systems have helped increase productivity by 500 kg per cycle time instead of 360 kg, and also reduce non-value-added time and unnecessary activities 70 minutes to 36 minutes.

The implementation of the 5S system simply reduced non-value-added time and unnecessary activities. Deploying the 5S concept can help reduce waste or non-value-added time and maintain the standard operating working procedures before the implementation of the improvement plans and redesign workflow.

**Table 1: Before and After Results after Developing Improvement Plans**

| Material Picking and Handling Process | Before | After |
|---|---|---|
| Finding Material and Selection | 35 minutes | 20 minutes |
| Material Picking and Handling | | |
| Forklift Travelling time | | |
| Unload to Buffer Area | | |
| **Weighing Process** | | |
| Unpacked the materials for Weighing | 15 minutes | 10 minutes |
| Weighing Process | | |
| Preparing and Loading materials for Blending | | |
| **Blending Process** | | |
| Filling Ingredients | 10 minutes | 6 minutes |
| Mixing Process | | |
| **Reloading for Next Batch** | | |
| Waiting time for Next Batch Process | 10 minutes | 0 minutes |
| **Total time** | **70 minutes** | **36 minutes** |
| **Total Production Capacity per cycle (kg)** | **360 kg** | **500 kg** |

## CONCLUSION

The objectives of this study were to improve the production process by using optimal resources to reduce cycle time, which occurs as non-value-added time, and to increase the production capacity and process performance of Java Company. This study was conducted through an analysis of the effects of cycle time and batch size on 3-in-1 instant beverage manufacturing industry. The result of the Lean manufacturing concept shows a reduction in wait time (WIP), or non-value-added time, in all steps from the material selecting, handling, and picking to the production process. However, this study was conducted to identify the root causes and find the solutions by applying Lean manufacturing concept, all employees in the organization are needed to be educated about the Kaizen Management and 5S Methodology standards in warehouse and working areas before the automatic processing system was implemented. Eventually, Java Company can gain more benefits such as waste elimination, reducing unplanned downtime, decreasing unnecessary activities, continuous improvement of products, and an increase in the efficiency of employee performance.

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