Waste Analysis in the Speaker Box Assy Process to Reduce Lead Time in the Electronic Musical Instrument Industry

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ABSTRACT

Purpose: This study aims to analyse the waste in the production line to get an efficient production lead time.

Methodology/Approach: This research uses the integration method of value stream mapping and kaizen. Based on the analysis with expert judgment, it is known that the waste comes from an inefficient factory layout. Improvements by making changes to factory layouts and merging workstations.

Findings: This research has found waste caused by ineffective factory layouts based on Focus Group Discussions (FGD). Improvements by incorporating workstations and changes to the factory layout can reduce production lead time. The results showed that the production lead time decreased from 3.21 days to 2.31 days or a decrease in the ratio of 31.15%.

Research Limitation/Implication: This research can also improve manufacturing performance such as cost efficiency, efficient layout, and labour reduction. So for similar companies, this research can be a reference for making improvements in reducing waste that can improve manufacturing performance so that they can compete in national and international markets.

Originality/Value of paper: This paper provides benefits for the musical instrument industry regarding waste reduction. According to this research, lean production can increase the productivity and quality of the production system, because it can eliminate the waste of time or the production process. The new approach of this research is used the integration methods by involving experts through FGDs to make improvements and reduce waste in the production line.

Category: Case study

Keywords: kaizen; lead time; speaker box; value stream mapping; waste

1 INTRODUCTION

Currently, the development of the manufacturing industry continues to increase. The development of this industry will lead to competition in the global market. With competition, the industry is required to make improvements in all aspects. Today, competition between manufacturing industries that have produced almost the same goods is an ongoing challenge facing the industry. One of the manufacturing industries included in the electronics sector is the musical instrument industry such as the piano. Based on the Trade Map-International Trade Center (ITC, 2019), the Indonesian musical instrument industry ranks second in the category of the most exporters. Based on the high value of exports to the global market, the market demand continues to increase (Stadnicka and Ratnayake, 2016).

The impact of increasing demand in the global market will provide a business opportunity for one the Musical Instrument Industry to develop further. It is proper for the manufacturing industry to install a strategy to win the competition with similar industries, namely to maintain the quality of the production process so that it remains effective and efficient (Nandakumar, Saleeshya and Harikumar, 2020; Baag and Sarkar, 2019).

One of the manufacturing companies located in Bekasi, Indonesia, has produced electronic musical instruments such as the main product, the piano musical instrument. This industry is a labour-intensive industry with a workforce of more than 5,000 employees. The Musical Instrument Industry is also one of the industries in which the production process from raw materials to finished products requires a fairly long process. This long period can lead to several activities that cause the production system to be not optimal. In addition, quality control that is not optimal can lead to production process activities that do not provide added value which has an impact on losses (Setiawan and Hernadewita, 2022). Based on initial observations, the production process is still found to be less than optimal. This causes the company’s productivity to decrease.

Problems from the above phenomena must be corrected immediately to get an effective and efficient production process (Haviana and Hernadewita, 2019) and with the Lean Six Sigma (LSS) approach (Kurnia and Purba, 2021). Based on previous research that uses the same method to reduce waste that occurs, the Value Stream Mapping (VSM) method is used (Setiawan et al., 2021; Baby, Prasanth and Jebadurai1, 2018). The main focus of VSM is to map the production flow and information flow of a product at the total production level (Suhardi, Putri and Jauhari, 2020; Tannady et al., 2019). VSM is useful for eliminating waste and streamlining processes (Prayugo and Zhong, 2021; Ustyugová and Noskievičová, 2013; Romero and Arce, 2017). The VSM method can also be integrated with other methods such as kaizen. Kaizen focuses on continuous improvement (Hasanah et al., 2020; Garza-Reyes et al., 2017; Pech and Vaněček, 2018).

This research is supported by several relevant studies (Chowdhury, 2016; Stadnicka and Ratnayake, 2017; Setiawan, Tumanggor and Purba, 2021). Several previous studies by (Purba, Fitra and Nindiani, 2019; Setiawan et al., 2021) focused on reducing the lead time of the production process so the research only focused on eliminating waste. Therefore, this study intends to analyse more deeply identifying waste in the production line by involving experts to make improvements. In addition to involving experts, the novelty in this study will also integrate with the kaizen method. This study aims to analyse the waste in the production line to get an efficient production lead time.

2 LITERATURE REVIEW

In this section, a review of the literature related to the subject matter will be discussed. Literature is obtained through mapping according to similar research. This grouping of literature studies is focused and conceptualized based on the selected method according to the problems in the manufacturing industry.

2.1 Value Stream Mapping

Value Stream Mapping (VSM) is one of the tools used in the Lean Principle approach (Rother and Shook, 2003). The principle of Lean theory is to reduce waste, reduce inventory and operational costs, improve product quality, increase productivity and ensure comfort while working (Sukma et al., 2022). VSM can describe the condition of the process flow from suppliers to customers through various process activities. In general, this tool interprets activities that have Value Added (VA), Non-Value Added (NVA), and Necessary Non-Value Added (NNVA) (Siregar, Ariani and Tambunan, 2019). Each process flow contains Lead Time and Cycle Time. Initially, VSM was popularly used in the Manufacturing Industry to reduce waiting times during the production process. Until now VSM has been used in various industries to reduce Lead Time such as in the Service and Construction sectors industry. In addition to reducing lead time, VSM can permanently eliminate NVA activities.

2.2 Kaizen

Kaizen is a continuous improvement effort to be better than the current condition. Kaizen is also a continuous improvement that involves all employees, both upper management and lower level management (Silva et al., 2019). The main goal of Kaizen is to eliminate wastes that do not add value to the product or service from the perspective of the consumer. These wastes need to be eliminated because they cause costs that lead to reduced profits. In addition, consumers do not want to bear these unnecessary costs. Kaizen has characteristics, namely to produce products according to a schedule based on customer demand, produce in small quantities, eliminate waste, improve production flow, improve product quality and maintain 5S hygiene. Kaizen is widely applied to improve business development because it has proven useful in many companies. Kaizen principles in increasing productivity will focus on changes that have a profit basis, such as process improvements carried out using scientific methodologies such as PDCA Cycle (Kurnia, Jaqin and Purba, 2022), DMAIC (Kurnia et al., 2021), and analysis using Pareto, 5 why analysis, cause-effect (fish-bone) and others.

3 METHODOLOGY

This study aims to shorten the lead time of the production process with a combination of VSM and Kaizen methods (Santosa and Sugarindra, 2018). This method was chosen because VSM can describe a map of the entire process and can identify non-value added. The focus of the research is on the SP Partition Board production line. The primary data used in this study is data from field observations and results from Focus Group Discussions (FGD) with expert judgment. The secondary data used is company report data such as data on the number of operators, standard time, production capacity, and others. In addition, to support this research, a literature study was also carried out to gain an understanding of research methods. This research is also carried out in steps so that this research runs in a systematic and structured manner. The flow of research from beginning to end can be seen in Figure 1.

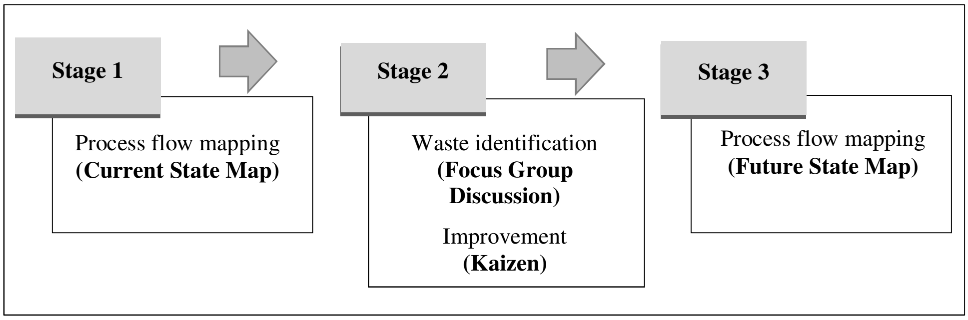

Figure 1 – Research Framework

Stage 1: The first step is mapping the Current State Map (CSM). CSM illustrates that the current production process is still not effective and efficient so the production process needs to be improved.

Stage 2: The second stage is an analysis of the causes of the problem to the long production lead time. In analysing the causes of this problem, an FGD was conducted with expert judgment. After the factors causing the problem are identified, it is continued with improvement with kaizen implementation.

Stage 3: The last step is to map the Future State Map (FSM). This map was created to describe future production processes that have been effective to be implemented. So, the new production system was successfully verified.

4 RESULT AND DISCUSSION

In this section, we will discuss data analysis from stage 1 (interpreted the problem until stage 3 (interpreted of FSM). The research implications and discussion of previous research are added in the last section. Finally, the VSM and Kaizen method is used to determine waste in the production line.

4.1 Stage 1

This research was conducted on the production line of the Speaker Box assy. The research was conducted because the lead time of this process is very long which has an impact on high production costs, long processes, and low productivity. The first step in this research is observation to find out the actual flow of the production process so that this problem is immediately corrected to get an effective and efficient production process. The production process flow of the Speaker Box is shown in Figure 2. The process of making the Speaker Box starts from the rough cutting of the Medium Density Fiberboard (MDF) material in the Running Saw Machine. The next process is the precision cutting process in Bench Saw Machine 1. After the dimensions of the material are appropriate, then the router process is carried out on the Bench Saw Machine 2. The next process is the drilling process to get the switch hole. The last process is assembly.

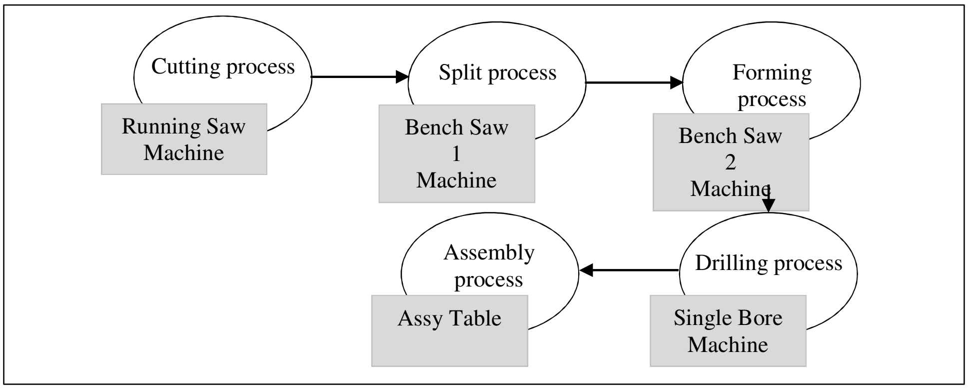

Figure 2 – Production Flow of Speaker Box Assy

The determination of the production process flow has been carried out, then the analysis begins by making VSM based on initial observations in the field. The CSM method has explained the processing time from start to finish. The CSM can be seen in Figure 3.

Based on Figure 3, it can be seen that the lead time of the Speaker Box assy manufacturing process is 3.21 days with a CT of 1,099 seconds. In this process, there are six main processes and nine operators. This process is not optimal, so it needs improvement.

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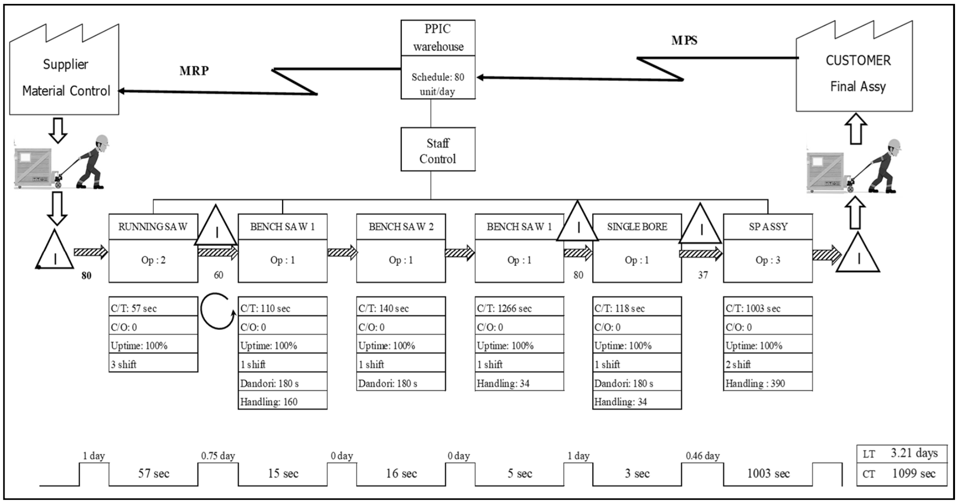

Figure 3 – Current State Map

4.2 Stage 2

After the CSM is known, the next step is to analyse the causes of the problem with the FGD. The FDG process is carried out by looking at the criteria for the team formed based on the experience of employees who are experts in the field of process improvement in reducing waste or understanding the VSM process. The FGD was conducted by the management team and five expert teams. The FGD team held an online meeting due to the Covid-19 pandemic. The analysis is carried out to find out the real cause and make improvements. Table 1 is the characteristics of expert judges who have made a decision.

Table 1 – Characteristics of Expert Judgement

Expert	**Age (year)**	**Work experience (year)**	**Position**	**Skill**	**Remark**
Expert 1	45	20	Board of Director	VSM Process	Internal
Expert 2	42	23	General Manager	VSM Process	External
Expert 3	47	17	General Manager	Quality, VSM process, TPM	External
Expert 4	52	18	Board of Director	Toyota Production System	External
Expert 5	47	20	Specialist	Supply Chain, VSM process, PPIC, Kaizen	Consultant

Based on Table 1, the FGD meeting was led by an internal party (expert 1) who asked external parties (experts 2, 3, and 4) how to overcome the waste of processing time in different places with the same type of industry, namely the electronic speaker box industry. During the session, the consultants also confirmed the causes and corrective actions to be taken by the production party.

As for the main critical points of analysis of the causes of problems in the FGD, it can be seen that several problems caused the lead time of the SP Box process to be long. There are three problems in the process of making SP Box, which are as follows:

1. Material process flow of many stations namely (WM01-WM03-WM09-WM10)
2. Total handling distance 618 steps
3. Very long production lead time of 3.21 days

The results of the FGD meeting have also provided recommendations for solutions to the production (internal) parties that several actions must be taken immediately.

4.2.1 Merging at workstations

Combine stations in the process of making SP Partition (WM03) with SP Box Assy (WM09). The improvements made are aimed at simplifying process control and eliminating the use of paper in the need for making a Completion Slip (CS). The combination at this workstation can be seen in Figure 4. The effect is that when the production process requires four slips/day for transactions from WM03 to WM09, now they don't use slips.

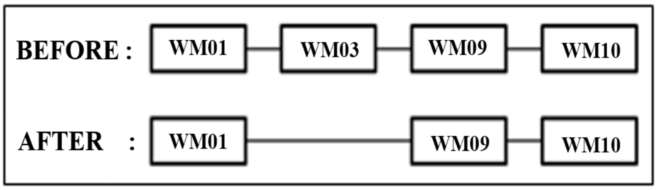

Figure 4 – Merging at Workstations

4.2.2 Merging at Single Bore Process

Combining the Single Bore process into a single process line with the Bench Saw process. The purpose of this improvement is to shorten the handling of the Bench Saw 1 engine to the Single Bore engine by 34 steps. The overall handling distance has been reduced from 618 steps to 584 steps.

4.2.3 Relayout

Factory layout change. Rearrangement at each workstation to be more effective and efficient. Changes in factory layout can be seen in Figure 5.

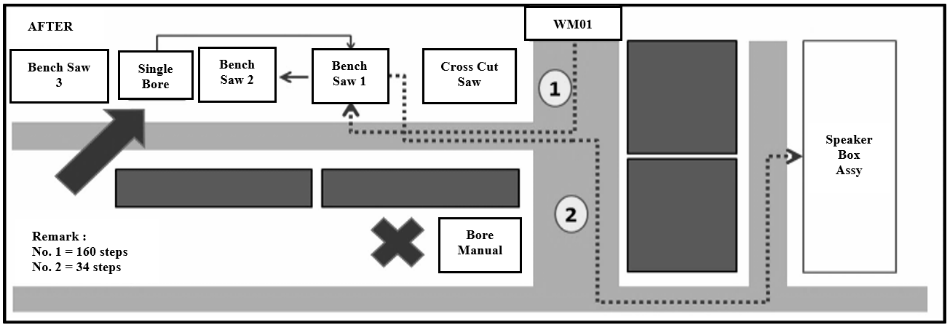

Figure 5 – Layout Production Process

4.3 Stage 3

Based on the three improvements made to the Speaker Box Assy production line, it can be seen that future processes are more effective and efficient. The production lead time of the Speaker Box Assy decreased to 2.21 days. The future production flow can be mapped and seen in Figure 6.

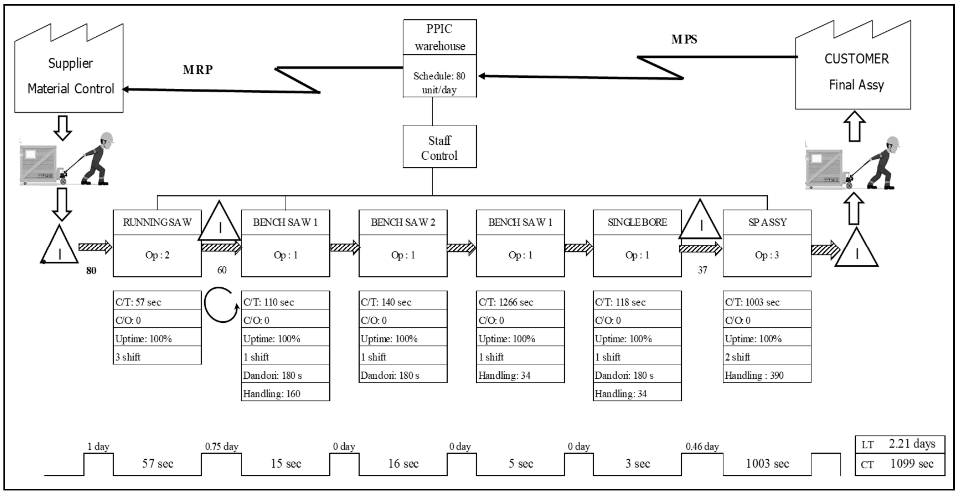

Figure 6 – Future State Map

4.4 Research Implications

Based on the improvements made to each problem factor, the production system becomes more effective and efficient. Unification of workstations and changes to factory layouts resulted in significant results in production lead time. Based on the comparison of CSM and FSM, it can be seen that the production lead time has decreased. The results of this study provide benefits for the musical instrument industry related to the reduction of waste. According to this research, lean production can increase the productivity and quality of the production system, because it can eliminate the waste of time or the production process. These upgrades can also improve manufacturing performance such as cost efficiency, efficient layout, and labour reduction. So for similar companies, this research can be a reference for making improvements in reducing waste that can improve manufacturing performance so that they can compete in national and international markets.

4.5 Discussion

Based on the results of the analysis in the previous chapter, it can be seen that the VSM and Kaizen integration methods can reduce production lead time by 30%. This means that improvements made such as merging process stations and changing layouts have a good effect on reducing lead time. The results of this study are in line with previous research conducted by Zahoor and Kader (2019). The research found that the VSM and Kaizen methods can reduce production lead time.

5 CONCLUSION

The conclusion that the author can convey is that research has succeeded in identifying wastes that occur in the production line. This research has found waste caused by ineffective factory layouts based on FGD. Improvements by incorporating workstations and changes to the factory layout can reduce production lead time. The results showed that the production lead time decreased from 3.21 days to 2.31 days or a decrease in the ratio of 31.15%. This study has limitations on a single model. Based on the results of these studies, theoretically, it can be useful for other researchers in waste analysis studies to reduce lead time in the electronics industry. Practically this research is useful in terms of improvements by including workstations and changes in factory layout can reduce production lead times to increase the efficiency of the speaker box production process. For further research, it is recommended to make improvements by calculating Single Minute Exchange Dies (SMED) so that the production lead time in the entire model can be known.

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Conceptualization, I.S. and H.K.; Methodology, I.S.; Validation, H.K., I.S. and T.A.; Formal analysis, I.S.; Investigation, T.A.; Resources, A.N.; Data curation, H.K.; Original draft preparation, H.K.; Review and editing, I.S.; Visualization, T.A.; Supervision, H.H.P. and A.N.; Project administration, T.A.

CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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