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Application of Lean Manufacturing in Tofu Production to Reduce Waste

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Abstract

DRK Tahu is a micro business producing various types of tofu, including white ones. This business is located in Gading Rejo District, Pringsewu. There are three types of waste found in the tofu-cutting process: *transportation*, *delay*, and *storage*. Transportation activities and *delays* cause a waste of time when completing the cutting process. The time required for the entire tofu cutting activity in one process is 832.65 seconds because the cutting work method still uses a wooden frame and a knife. The percentage *of the value-added ratio* before the improvement was made was 0.33%. This research aims to reduce waste and help optimize the cutting process to be more efficient and effective. The principle *of lean manufacturing* is used as a method for overcoming problems. The *lean manufacturing* tool used in this study is *Process Activity Mapping* (PAM). PAM is used to identify value-added, necessary non-value-added, and non-value-added activities so that the production process becomes *lean*. The analysis of the factors causing waste was carried out using *a fishbone diagram*. The proposed improvement for the cause of the problem is through designing a tofu-cutting tool. The implementation results are time savings of 153.87 seconds and an increase*d value-added ratio* of 0.11%.

Keywords: *Waste, lean manufacturing, PAM, tool design, value ratio.*

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INTRODUCTION

Pringsewu Regency, Lampung, is one of the tofu-producing areas, especially in the Gading Rejo District, so most people work and even become owners of these micro businesses. Pekon Gading Rejo is a developing village, especially in the field of tofu production, which improves and develops the community's welfare. The tofu industry in Pekon Gading Rejo also has market coverage ranging from Gading Rejo Market to Gedong Tataan Market. DRK Tahu micro business is one type of business engaged in food processing (WAI, 2017). DRK Tofu's micro business processes raw materials (raw materials) in the form of soybeans into semi-finished goods, namely tofu. The process of

converting raw materials into other goods with added value (*value added*) is called the production process (Upadhyay et al., 2024). The production process includes means, methods, and techniques using resources such as supporting materials, machinery, labor, and existing funds. (Utama & Gani, 2019) (Assauri, 2018)

The tofu production business began to develop along with increasing demand and became a source of income for the local community (Ismawardani et al., 2022). DRK Tofu's micro business produces various types and sizes of tofu: white tofu, flexible tofu, yellow tofu, tofu kopong, and squeezed tofu. Each of these types of tofu is produced according to customer orders (Putri et al., 2021). Table 1 shows the average number of daily tofu requests for each type.

Table 1. Average Tofu Request Data Per Day

It	Types of Tofu	Demand
1	White tofu	5000
2	Tofu melenuk	2000
3	Yellow tofu	450
4	Tofu kong	1000
5	Tofu squeezed	2000

Source: Data Processing

Table 1 shows the fixed number of tofu requests by middlemen who subscribe to DRK Tahu micro businesses, where the data was obtained in November 2023. The amount of demand can affect the manufacturer's decision to determine the production level. The number of customer demands encourages manufacturers to continuously improve the efficiency of their production processes to meet market needs. In this case, Time and technical efficiency are necessary to avoid unnecessary waste or delays. An efficient production process will help manufacturers produce (Yusuf, 2023) *Output*, which is the same as reducing the time required for each step. (Pradhitya, 2010)

Regarding its effectiveness and efficiency, DRK Tofu's micro business experienced several problems related to the methods or techniques carried out in the production process, namely the technicalities at the tofu cutting workstation, which are carried out manually using knives and wooden frames as measuring tools. This method certainly cannot be said to be effective and efficient to increase production productivity because

the average production target that DRK Tahu micro businesses must meet in one day can reach 10,450 tofu. Figure 1 shows how the conditions present on the tofu-cutting workstation.

Figure 1. Process At Tofu Cutting Workstation
Source: Observation Results

The movement in Figure 1 can be said to be ineffective, so completing the tofu cutting activity using such a working method takes 2.57 minutes. Another problem is the identification of waste activities determined using *the Process Activity Mapping tool*. The data can be seen in Table 2.

Table 2. *Waste* Data Based on *Process Activity Mapping*

It	Activity	Time (Seconds)	Types of *Waste*
1	Moving the compacted tofu to the tofu cutting station	71,4	*Transportation*
2	Activities outside of the cutting process, namely pouring water to clean tofu flakes	37,04	*Delay*
3	Picking up a wooden frame that is hung in place	3,31	*Transportation*
4	Picking up a knife	2,02	*Transportation*
5	Inserting the knife back in place	1,56	*Transportation*
6	Hanging the wooden frame back in place	2,45	*Transportation*
7	Transferring and sorting the cut tofu into a storage bucket	510,6	*Storage*

8	Moving buckets containing tofu to the packing station	13,46	*Transportation*

Source: Observation Results

Table 2 provides data on waste activities that occurred at tofu cutting workstations. The total waste *time delay* was 37.04 seconds, *transportation* was 94.2 seconds, and *storage* was 510.6 seconds. Data related to waste was obtained based on motion time *studies* and stopwatch *time studies*. One way to solve problems related to waste is to apply the concept of *lean manufacturing.*

RESEARCH METHODS

Several methods can be used to solve problems related to waste (*Waste*) identified in the tofu-cutting process. One of the methods used in this study is *lean Manufacturing. Lean Manufacturing* is a systematic method or approach that aims to identify, reduce, and even eliminate other wastes that may occur in the production process through continuous improvement. (Ismail, n.d.) *Lean manufacturing* also seeks to reduce obstacles that may occur in a production process, where, in this case, the production in question is the production of tofu. Waste can be identified by using *Process Activity Mapping* (PAM), so the next step is to analyze which activities are wasteful and need to be eliminated. (Sumasto et al., 2023)

The *Lean Manufacturing* method can reduce waste, a problem found at the research site, and help optimize the production process to be more efficient and effective. An activity is effective and efficient if it can minimize the movement and time needed to complete the work, which is the tofu-cutting process. This research also aims to carry out an implementation, which is expected to be able to design a tool and standard operating procedures that will help process efficiency in tofu-cutting workstations as a solution to existing problems.

RESULTS AND DISCUSSION

The results of identifying problems that have been carried out using *Process Activity Mapping* Table 2 shows the bottom of the waste (*Waste*) found during the tofu cutting process consists of *transportation*, *delay*, and *storage.* This waste is triggered by operator movements that do not provide added value, so it needs to be eliminated (Szabó et al., 2024). The total time required to complete the cutting activity of 550 tofu per process based on motion and time studies was about 154.2 seconds. Given the data on the number of *demands* per day that the DRK Tofu Micro Business must fulfil in Table 1, the researcher is interested in designing a tofu cutting tool. The purpose of designing this tool is to save time while completing cutting activities so that the time needed can be reduced. (Sari et al., 2017)

The design of the tofu cutting tool considers improvements to the preexisting cutting work method (Rusdy & Muda, 2023). Through discussions between researchers, business owners, and employees, a cutting tool design was produced that replaces the sharpness of

the knife with the sharpness of a true or string (Piccirillo, 2024). Figure 2 is a form of the design of the proposed tool for the DRK Tahu Micro Business.

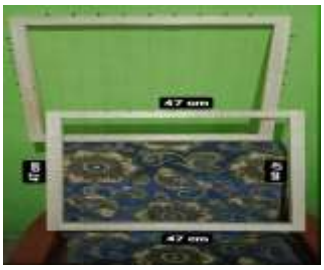

Figure 2. New Cutting Tools
Source: Research

Please note that the strings used in the cutting tool design in Figure 2 are fiber strings with a diameter of 0.30 mm and a strength of 8 lbs. In terms of its use in the field, implementation is carried out several times by researchers, operator 1, operator 2, and even business owners. The tofu-cutting process used a new tool that was successfully designed; of course, the results obtained from the experiment did not reach 100% perfection. The results of cutting tofu using the designed tool are shown in Figure 3.

Figure 3. Tofu Cutting Results From the First Trial
Source: Research

Figure 3 provides information that the operator needs to pay attention to several things when considering the quality of the tofu that is cut, including the procedure for using the tool, the condition of the string, and the cutting technique, where the operator can only press once without hesitation so as to provide the best results from the cutting process. Figure 4 shows the results of tofu with much better quality when compared to the first experiment.

Figure 4. Knowing the results from the cutting process after several experiments
Source: Research

The results in Figure 4 result from the operator's efforts in operating the new cutting tool designed and improving the working methods carried out. The main thing that has been successfully obtained from improving this work method based on *the principles of Lean Manufacturing* is *Waste reduction*. *The After Activity Mapping Process*, which contains a sequence of activities after improvement, found that cutting each tofu box into 550 smaller tofu pieces took 678.78 seconds from the original 832.65 seconds.

The time change shows that 153.87 seconds were saved from the difference between the initial time before the repair and the final time after the repair. The most reduced time came from tofu-cutting activities with new tools that had been designed, which were initially 154.2 seconds to 73.52 seconds. In addition, the reduction in transportation activities also influenced the completion of the tofu-cutting process. VA, NNVA, and NVA obtained after repairs changed the ratio values' number and percentage. Initially, VA activity, which had a percentage of 0.33%, changed to 0.44%, meaning that there was an increase in *the value ratio* for VA by 0.11% (Saul et al., 2023). Another increase was also experienced by NNVA activities, which initially had a percentage of 0.58% changed to 0.56%, meaning that activities classified as not value-added but needed have been successfully reduced because there was a reduction of 0.02% (Cruz, 2016).

CONCLUSION

Three types of waste occur in the tofu cutting process: time-consuming transportation activities, unnecessary delays, *and storage processes*. Activities that do not provide added value must be reduced or even eliminated to achieve continuous improvement, namely *continuous improvement* in accordance with the principles of *Lean Manufacturing.* The results obtained from implementing improvements in the DRK Tofu Micro Business are the reduction or reduction of the tofu cutting process time, which was initially 832.65 seconds to 678.78 seconds. The design of this simple tofu-cutting tool has provided an increase *in the Value Added Ratio* (VAR) of 0.11% in the tofu-cutting process, from the initial 0.33% to 0.44%. Implementing the designed cutting tool has also reduced transportation activities to reduce *the Necessary Non-Value Added Value Ratio* (NNVAR) by 0.02% from the initial 0.58% to 0.56%.

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