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Value Stream Mapping and Fishbone Diagram to Analyze Waste Analysis in Lapis Tugu Kediri

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Abstract

The Lapis Tugu Kediri is an SME facing several waste-related issues that reduce its productivity. Using a qualitative approach, the research consists of two phases. First, a value stream mapping of the production flow is created and analyzed using value stream mapping tools. Next, a fishbone diagram is developed to identify the sources of waste before proposing improvements. The research revealed several types of waste in the production process, with the most significant being overprocessing and unnecessary motion. The value stream mapping highlighted specific sections where waste occurs, while the fishbone diagram identified root causes such as the absence of a timer in the baking section and an unqualified production table. Based on these findings, targeted improvements were proposed to eliminate waste and optimize the production flow. The research has been validated using data triangulation at a single SME, providing deep insight and information. However, further research on other SMEs or using a different methodology within the same SME is encouraged. Value stream mapping and a fishbone diagram are useful combinations in terms of analyzing waste in the scope of SME. The validation of analyzing waste through value stream mapping and fishbone diagrams is well-documented and original.

Keywords: Waste analysis, Value stream mapping, Fishbone diagram, Small and Medium Enterprise, Improvement, Production process

JEL Classification: M11, M48

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1. Introduction

According to data from the Indonesian Central Bureau of Statistics, in 2022, Indonesia will host approximately 10,900 medium-to-large-scale culinary establishments, marking a 20.76% increase from the previous year. Culinary products are also recognized as an essential metric for sustainable development in a country, with the fulfillment of food needs serving as a critical indicator (Untari, 2019). Given Indonesia's high population growth rate, projected at 1.38% annually (Bappenas, 2013), the rapid expansion of the culinary industry plays an increasingly important role in meeting these food demands. In particular, bakery products are a staple in daily life, fulfilling a substantial part of individuals' nutritional needs (Scarlett, 2022).

Further supporting this trend, data from the Central Bureau of Statistics indicate that bakery product consumption in Indonesia has consistently risen year-over-year. In 2023, per capita bakery product consumption grew by 9.4% compared to 2022 and by 13.4% from 2021. Correspondingly, data from the Indonesian Chamber of Commerce and Industry show that the growth rate of SMEs (Micro, Small, and Medium Enterprises) has exhibited notable fluctuations annually. In 2023, the number of SMEs reached 66 million, reflecting a growth rate of 1.52% from the previous year. With such a substantial presence, SMEs contribute approximately 61% to Indonesia's Gross Domestic Product (GDP), totaling IDR 9,580 trillion, and employ around 117 million workers, or 97% of the available workforce. Among these SMEs, about 1.51 million are in the culinary sector (Ahdiat, 2022).

In light of these dynamics, production remains a core aspect as it directly influences the quality of products delivered to the end consumer. Beyond the end product, the production process is crucial in determining both the effectiveness and efficiency with which a business operates. Garcia-Macia et al. (2019) argue that productivity serves as a key indicator of how efficiently a company's economic resources are allocated within the production process. In terms of product quality and productivity levels, a significant issue faced by SMEs is the lack of product standardization (Ulya & Sukmana, 2021). Furthermore, the absence of standardization complicates the identification of specific waste in the production process, impeding accurate measurement of production effectiveness and efficiency (Taylor & Murphy, 2004).

This study aims to analyze waste in SMEs, with a focus on Lapis Tugu Kediri, an enterprise in the bakery sector, to gain insights into material and information flow within the production process and uncover the root causes of waste through lean management tools. With a daily production volume of 200–300 boxes, manufacturing efficiency is a priority, making effective resource allocation and waste minimization essential. However, significant waste occurs in the production process, starting from overcooking, which reduces the value of the products and happens almost daily, to the lack of standardized production counts and times. Moreover, the operational hours are uncertain, ranging from 7 AM–5 PM to 7 AM–8:30 PM due to those problems.

In order to achieve the proposed objectives, this research adopts the value stream mapping (VSM) and fishbone diagram frameworks, as they offer visual tools to map the production process and identify root causes in a simple, comprehensible format. Following the analysis, recommendations for waste reduction and manufacturing process improvements will be proposed to enhance SME production efficiency. Afterwards, data related to the project is collected through on-site observation and interview, along with fulfilling the questionnaire consisting of structured questions about waste in the manufacturing process, and will be analyzed. Subsequently, the following steps were followed: (i) creating the current state mapping of the production process, (ii) selecting the value stream mapping tools to be used based on waste prioritization, (iii) identifying the root cause of waste through the fishbone diagram framework, (iv) conducting the suggested improvements, and (v) redesigning the future state mapping.

This article is structured as follows: the first section introduces the project, covering its background, objectives, and adopted methodology; the second section provides a comprehensive literature review on lean management, value stream mapping, fishbone diagrams, and other relevant concepts; the third section details the research methodology; the fourth section presents the findings and discussion; and the final section delivers the conclusion.

2. Literature Review

Lean management is a management principle that involves operating an organization most effectively and efficiently as possible, with minimal costs and without waste, while still meeting customer demand (S. R. Shah & Ganji, 2017). This definition is reinforced by R. Shah and Ward (2007), who describe lean production as a socio-technical system focused on waste elimination within a company, as well as across its supply chain network. Originating from the Toyota Production System (TPS), developed between 1948 and 1975, and initially known as just-in-time production, Toyota successfully implemented a new standard system to achieve maximum economic efficiency using fewer resources (Dave, 2020). The core of the Toyota Production System is the elimination of all forms of waste, including any non-value-adding activities such as overproduction, excess inventory, and waiting times. This system emphasizes more efficient and optimized performance (Smith A, 2015; Tezel et al., 2016; Tiwari & Tripathi, 2016).

According to Womack and Jones (1997), the implementation of lean management is based on five fundamental principles: (1) defining the value of each product, (2) eliminating unnecessary steps in each value stream, (3) ensuring the flow of value, (4) understanding that customer demand drives all activities, and (5) continuously pursuing perfection. Womack and Jones (1997) further state that identifying waste and wasteful processes can help improve product quality and foster continuous improvement. By focusing on eliminating all waste from the manufacturing process, these principles support a smoother flow of product value through the production process.

In the context of production and lean management concepts, waste remains a critical component. Waste is defined as anything that does not add value to a product, process, or service (Ben Naylor et al., 1999; Hines & Rich, 2005) or anything that fails to provide value to the customer (Sutrisno et al., 2018). This definition is further supported by the assertion that waste can be considered non-value or worthless (Braglia et al., 2006; Moyano-Fuentes & Sacristán-Díaz, 2012), encompassing any effort that fails to add value (Arbulu et al., 2003; Hines & Rich, 2005).

Waste is generally classified into seven categories, based on the literature from Ohno and Bodek (2019) and Shingo and Dillon (1989):

1. Overproduction: Unnecessary transformation processes.
2. Transportation: The unnecessary distribution of raw materials or products.
3. Waiting: Wasted time and any delays in completing process transformations.
4. Over-processing: Unnecessary steps that are still performed in various production processes.
5. Inventory: Waste of stock, including both work-in-process items and finished goods.
6. Unnecessary motion: Waste associated with all motions or actions that do not alter or add value to a product.
7. Defects: Results from producing defective products.

These seven categories of waste represent different system variables compared to human variables. This concept of waste is further developed by Liker (2004) in terms of unused worker creativity, or the waste of talent (Protzman et al., 2018), which is often introduced as an additional form of waste. Furthermore, each of these seven categories of waste illustrates signs of inefficiency occurring in various areas within the production system, whether in manufacturing or service production systems (Shingo & Dillon, 1989; Thürer et al., 2017).

Value Stream Mapping

As a method that has been widely applied in the field of lean management, Value Stream Mapping (VSM) aims to realign production systems from a lean perspective (Pavnaskar et al., 2003; Rother & Shook, 1999; Womack & Jones, 1997). VSM helps companies illustrate and analyze their production processes through systematic logic (Langstrand, 2016). It has been recognized as one of the powerful lean management tools for analyzing waste within business processes and providing a new mapping of production processes for the future state. Tapping (2002) provide a perspective on the step-by-step procedure for applying Value Stream Mapping (VSM), which includes the following sequence: (1) selecting a product group with the production system to be developed, (2) creating a Current State Map for the previously selected product, (3) identifying and analyzing the waste present in the production process, and (4) creating a Future State Map that depicts a more ideal production process. Additionally, the creation of Value Stream Mapping must consider the commonly used map icons to facilitate the development of both the Current State Map and Future State Map.

The Current State Map that has been created will then be analyzed to identify waste within the production process. By analyzing the waste, improvements can be implemented. Based on VSM, the next step to eliminate this waste is to create a Future State Map that outlines a new production process design utilizing a more efficient production sequence. Furthermore, the Future State Map can facilitate a smoother and more balanced production process, as it addresses various production issues, such as eliminating bottlenecks, increasing productivity levels, and achieving a more effective and efficient production process, given that the identified waste has been eliminated (Langstrand, 2016; Pradana & Indiyanto, 2024; Rahani & Al-Ashraf, 2012).

Value Stream Mapping Tools

The objective of implementing Value Stream Mapping (VSM) within a production system is to eliminate the seven forms of waste. In this regard, Hines & Rich (1997) introduced the term "the seven value stream mapping tools," each serving distinct functions to address the various types of waste. These seven VSM tools are extracted from diverse fields, including industrial engineering, logistics, operations management, system dynamics, and new tools specifically developed for the VSM methodology itself. According to Hines & Rich (1997), the following are the seven value stream mapping tools and their correlations with wastes/structure. The selection of tools to be used is determined based on a simplified value stream analysis tool. Broadly speaking, the value stream must first be identified and analyzed before conducting interviews with managers or other staff members related to the value stream to identify various types of waste that need to be eliminated (Hines & Rich, 1997). An overview of each type of waste, along with explanations, will be provided to the respondents, tailored to their specific industry structure, to ascertain the weight or significance of each of the seven wastes and the overall structure. Subsequently, the appropriate tool will be selected using the VALSAT approach, which involves wastes/structures, weights, tools, and total weight (Cárdenas Peña & Veliz Veliz, 2024; Fernando & Noya, 2014). Additionally, competitor analysis may also be incorporated (Hines & Rich, 2005).

With eight factors being evaluated (the seven types of waste plus the overall structure), the most effective method for weighting is to allocate a total of 40 points across these eight factors based on the preferences of the respondents, ensuring that no single factor receives more than 10 points. If there is more than one respondent, the points assigned will be the average value from all respondents. After determining the weights of the wastes, the next step is multiplying the weight of each waste by its level of correlation and usefulness. High correlation and usefulness are assigned a value of nine, medium correlation and usefulness are given a value of three, and low correlation and usefulness are rated with a value of one.

Fishbone Diagram

The fishbone diagram, as described by Watson (2004), serves as a managerial tool to systematically identify impacts on a company’s system along with the contributing causes of those impacts. As a visual-based tool, the fishbone diagram illustrates the relationships among various factors that influence a specific impact or problem, utilizing a structure resembling a fishbone (Trout & Noria Corporation, n.d.). Consequently, fishbone analysis proves highly effective in providing a comprehensive view of an issue, facilitating the understanding of event flow, and aiding in the simultaneous detection of relevant issues (American Society for Quality, 2005).

Within the fishbone diagram, main causal factors are identified—these primary causative factors can be further specified to determine the root cause of a problem within the organization (Saori et al., 2021). These factors typically include material, machine/equipment, man/people, method/process, mother nature/environment, and measurement, or management in alternative fishbone models (Bose, 2012; Hayes, 2021; Putri et al., 2023; Sakdiyah et al., 2022). Analyzing these six main factors reveals the underlying causes of an issue, regardless of the type and level of damage.

According to Pebrianti et al. (2021), the fishbone diagram leverages actual conditions to enhance product quality, optimize company resources for efficiency and cost reduction, eliminate processes that cause product nonconformities, establish operational standards, and provide education and training for employees in decision-making and corrective actions. Furthermore, the fishbone diagram aids in identifying the root cause of a problem through a structured approach, encouraging participation, utilizing group knowledge on the process, and pinpointing areas where data collection is necessary for further study.

When combined with Value Stream Mapping, the fishbone diagram complements the waste identification process by revealing the underlying causes behind bottlenecks and inefficiencies identified in VSM. VSM visually maps the current and future production states, and the fishbone diagram diagnoses the root causes. Integrated use of these methods results in a stronger, more effective waste elimination approach within the SME production process.

3. Data and Methodology

This research methodology employs a case study strategy with a qualitative approach, as outlined by Eisenhardt (1989) and Yin (1994), and supported by the discussions of its relevance by Voss et al. (2002). This approach not only answers “how” and “why” questions but also contributes to developing new concepts, facilitating theory testing, and enabling refinement (Meredith, 1998; Snow & Thomas, 1994). The main objective of this study is to implement a combination of value stream mapping and fishbone diagram to analyze waste within the production system and propose suggested improvements to enhance production effectiveness and efficiency.

The data used in this study come from both primary and secondary sources. Primary data are obtained from key informants with direct knowledge of the production processes within the relevant business, while secondary data are sourced from existing business records. Data collection employs multiple methods to ensure depth and credibility, which are verified through data triangulation and methodological triangulation.

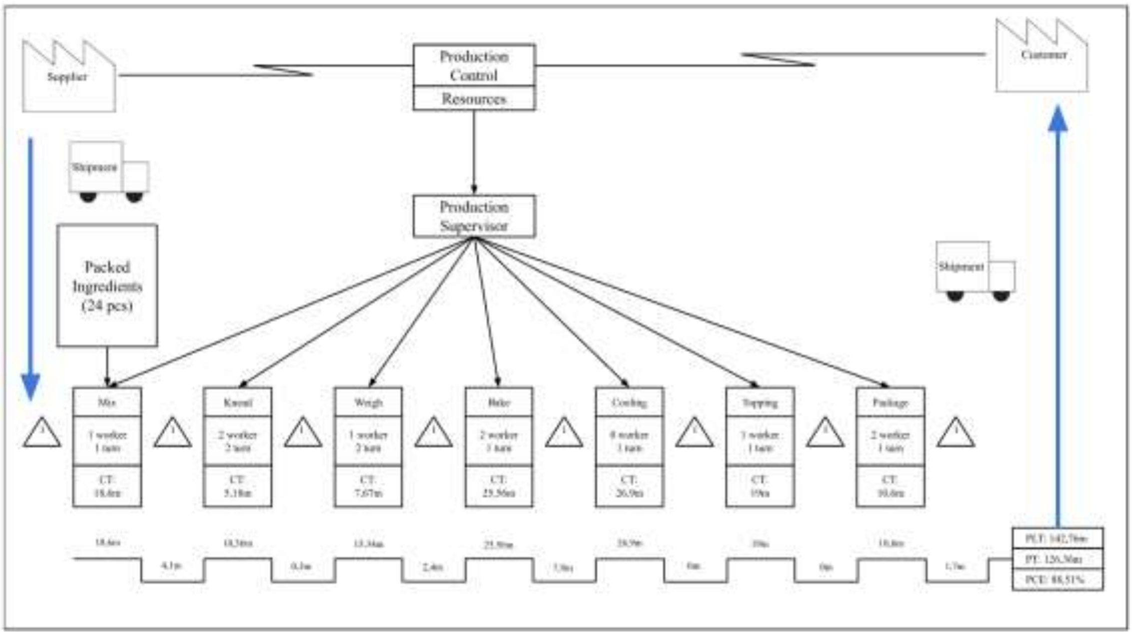
The research will be conducted in several stages. First, a literature review will be carried out, focusing on lean management, value stream mapping, and the fishbone diagram. In the second stage, an analysis of the existing production system at Lapis Tugu Kediri will be conducted. This stage involves data collection through direct observation of the production site and interviews with the owner and production workers. Additionally, a structured questionnaire on waste identification will be administered to support further analysis. The study will outline specific process steps, providing detailed insights into the production line. Third, the collected data will be processed to develop a current state mapping and to assign weightings to different types of waste, facilitating the selection of appropriate value stream mapping tools. At this stage, waste will also be further analyzed using the fishbone diagram to determine its root causes. Subsequently, suggested improvements will be formulated to address the identified root causes and eliminate waste. Finally, the study's conclusions will be presented.

4. Results and Discussion

Waste Analysis and Current State Mapping of Lapis Tugu Kediri

The production process at Lapis Tugu Kediri consists of 12 stages, beginning with (1) mixing raw materials using a mixer, (2) transferring the dough from the mixer to the mixing container, (3) manually kneading the dough by workers, (4) moving the dough from the floor to the production table, (5) placing and weighing the dough in the baking tray, (6) inserting the tray into the steaming pot, (7) baking the dough, (8) transferring the baked cake to the cooling station, (9) cooling the layered cake after baking, (10) adding toppings, (11) packaging the layered cake into boxes, and (12) moving the packaged cakes to the shipping warehouse. Based on interviews, various forms of waste have been identified in each stage of the production process, as detailed below:

1. Overproduction: producing cakes beyond demand
2. Transportation: Frequent movement between the warehouse and the production room to retrieve raw materials
3. Waiting: Delays in raw material arrival and stalled work processes due to a lack of personnel.
4. Overprocessing: Frequent occurrences of overcooking during the baking process
5. Inventory: Some products become spoiled while stored in the warehouse
6. Unnecessary Motion: Workers bending over while sitting on the floor, and excessive time spent on the weighing process
7. Defect: Overcooked products.



Source: developed by authors.

Figure 1. Current State Mapping of Lapis Tugu Kediri Production Process

Figure 1 presents a detailed depiction of the Lapis Tugu Kediri production process, including timestamps, from the mixing stage to the storage of the final product in the shipping warehouse. Each production batch consists of 24 units, with a total lead time of 142.76 minutes. The processing time is recorded at 126.36 minutes, resulting in a process cycle efficiency (PCE) of 88.51%. The longest cycle time occurs at the cooling station, requiring 26.9 minutes, whereas the shortest cycle time is observed at the kneading station, taking 10.36 minutes. The transition time between production stations varies, ranging from 0 to 7.9 minutes. These findings indicate that more than 10% of the process time consists of inefficiencies that can be optimized. The previously identified waste categories, including overproduction and defects, contribute to these inefficiencies and highlight opportunities for process improvement.

Process Activity Mapping

The structured questionnaire provides results regarding the weighting of each type of waste occurring in the Lapis Tugu Kediri production process. As shown in Table 1, the weighting analysis reveals that the most significant waste is overprocessing, with an average score of 9.3, slightly higher than unnecessary motion, which has an average score of 9. Waiting ranks third with an average score of 5.6, followed by transportation with a score of 4. The fifth and sixth positions are occupied by overproduction and defect, both with an identical average score of 3.3. Finally, inventory ranks seventh with an average score of 3, while overall structure ranks eighth with an average score of 2.3.

Table 1. Weighting of the Seven Types of Waste

No	Waste	Total	Average	Rank
1	Overproduction	10	3,3	5
2	Transportation	12	4	4
3	Waiting	17	5,6	3
4	Overprocessing	28	9,3	1
5	Inventory	9	3	7
6	Unnecessary Motion	27	9	2
7	Defect	10	3,3	6
8	Overall Structure	7	2,3	8

Source: developed by authors.

After weighing the identified waste, the appropriate tool for further analysis will be selected based on the seven value stream analysis tools. The selection process involves weighing the correlation between each tool and the previously calculated waste scores. This calculation is performed by multiplying the weight of each waste type by its correlation value with each tool, categorized as low, medium, or high. Once the calculations are completed, the tool with the highest score will be chosen, as it indicates the highest relevance and effectiveness compared to the other tools.

Table 2. Selection of Value Stream Analysis Tools Based on Waste Correlation

Value Stream Analysis Tools	Weight	Rank
Process Activity Mapping	269	1
Supply Chain Response Matrix	98,6	2
Production Variety Funnel	49,4	5
Quality Filter Mapping	44,6	6
Demand Amplification Mapping	74,4	3
Decision Point Analysis	51,9	4
Physical Structure	27,7	7

Source: developed by authors

The selected tool for detailed mapping is Process Activity Mapping (as shown in Table 2), with a weight of 269, significantly surpassing the other seven Value Stream Analysis Tools. This selection is based on its strong correlation with the previously measured seven types of waste, making it the most relevant tool for further analysis.

Table 3. Process Activity Mapping in the Lapis Tugu Kediri Production Process

Activity Details	Flow	Time (Minutes)	Category		
			VA	NVA	NNVA
Mixing raw materials using a mixer	O	18,6	18,6		
Transferring the dough from the mixer to the mixing container	T	4,1		1,6	2,5
Manually kneading the dough by workers	O	10,36	10,36		
Moving the dough from the floor to the production table	T	0,3		0,3	
Placing and weighing the dough in the baking tray	O	15,34	10	5,34	
Inserting the tray into the steaming pot	T	2,4		0,9	1,5
Baking the dough	O	25,56	25	0,56	
Transferring the baked cake to the cooling station	T	7,9		6,4	1,5
Cooling the layered cake after baking	D	26,9			26,9
Adding toppings	O	19	19		
Packaging the layered cake into boxes	O	10,6	10,6		
Moving the packaged cakes to the shipping warehouse	T	1,7			1,7
Total		142,76	93.56	15,1	34,1
Percentage		100%	65,5%	10,1%	24,4%

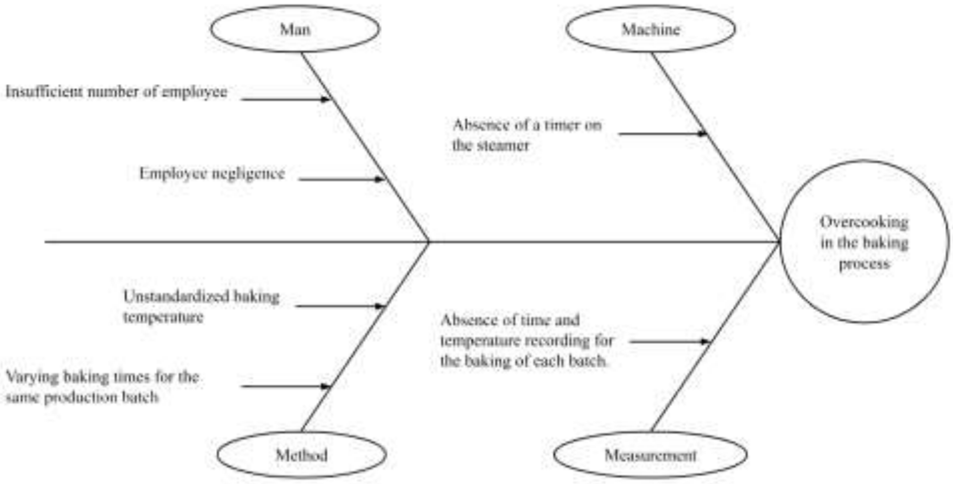
Source: developed by authors

** "O" for operation, "T" for transportation, "D" for delay*

Table 3 shows the process activity mapping of the production process, categorizes the process into operation, delay, and transportation flows. The analysis reveals an average production time of 142.76 minutes (2 hours, 22 minutes, and 46 seconds) per batch, with 65.9% value-added activities, 5.1% non-value-added activities, and 29% necessary non-value-added activities. The non-value-added activities occurred in the operation and transportation flow, with a total time of 15.1 minutes that needs to be optimized. In detail, this NVA is caused by waste in the production process, mostly overprocessing and unnecessary motion waste.

Further analysis using a Fishbone Diagram

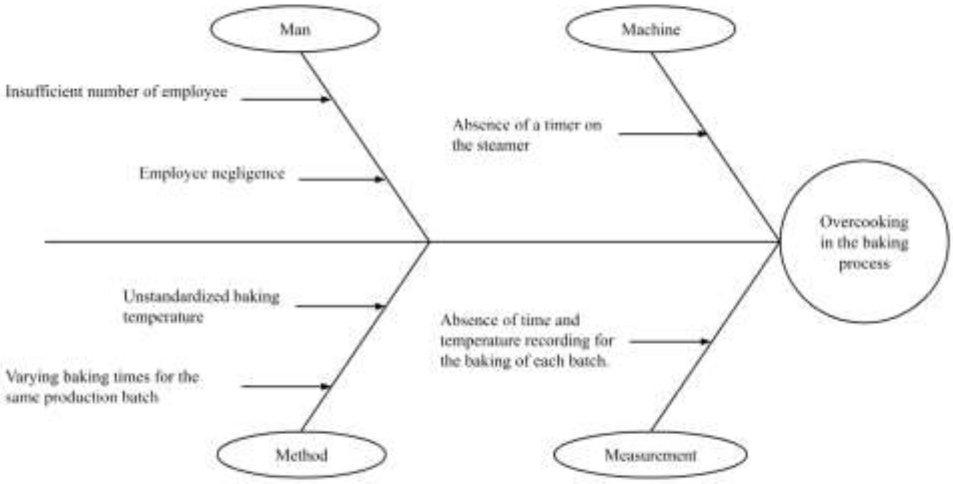
Based on the previous waste weighting, overprocessing and unnecessary motion rank first and second. Process Activity Mapping also identifies them as critical wastes to eliminate. Therefore, they will be further analyzed using a Fishbone Diagram to determine their root causes.



Source: developed by authors.

Figure 2. Fishbone Diagram Analysis for Overprocessing Waste

In the issue of overcooking, waste occurs due to several factors: (1) Machine – the absence of a timer on the steamer, (2) Man – employee negligence in monitoring the baking process and an insufficient number of staff dedicated to supervising the baking stage, (3) Method – the lack of standardized temperature control in the baking process, necessitating repeated inspections to determine the doneness of the cake, as well as variations in baking time for the same production batch due to the sequential placement of products into an already heated steamer, and (4) Measurement – the absence of recorded time and temperature data for the steaming process, preventing the identification and resolution of issues due to insufficient information.



Source: developed by authors.

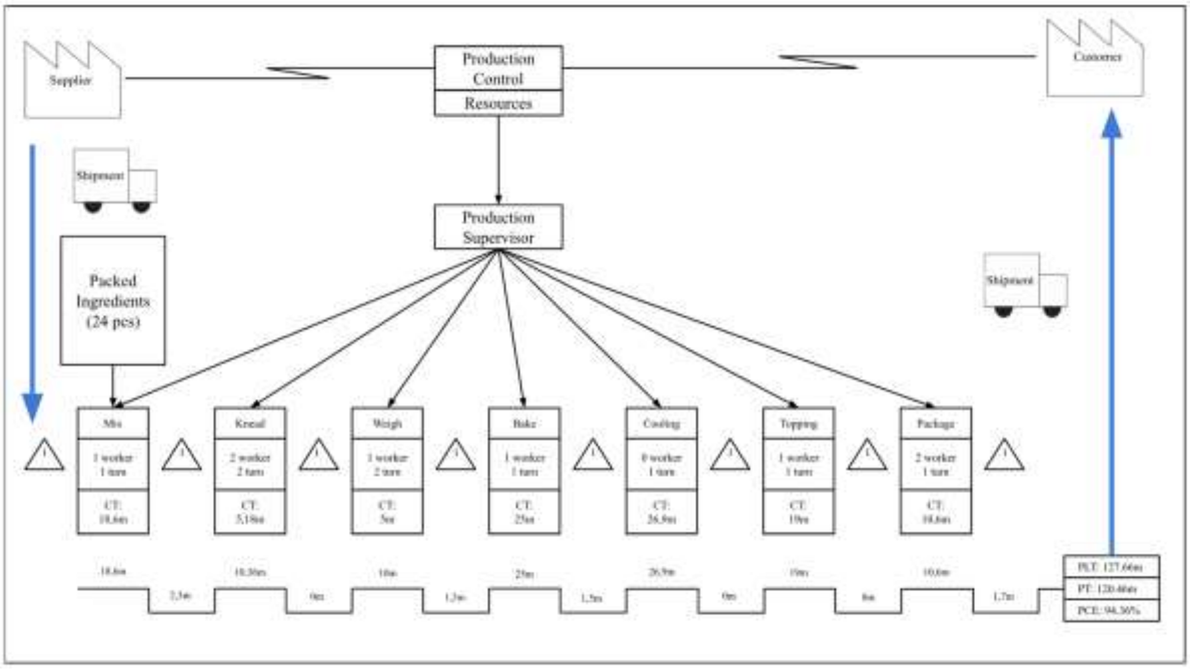
Figure 3. Fishbone Diagram Analysis for Unnecessary Motion

In the issue of unnecessary motion waste, the problem of employees slouching and sitting on the floor is caused by several factors: (1) Machine – large dough containers that cannot be placed on tables and non-compliant production tables that are too small to accommodate the kneading process, and (2) Mother Nature – inefficient table layout. On the other hand, the issue of weighing taking too long is caused by several factors: (1) Man – the lack of specialized training for employees and their unawareness of standard working time for the weighing process, (2) Method – the absence of standardized time, leading to inconsistent process completion times, and (3) Measurement – the lack of recorded time data, making it impossible to determine the average duration and implement improvements.

The various root causes mentioned above contribute to the occurrence of Non-Value-Added (NVA) activities in the production process, which must be eliminated as much as possible. Unnecessary motion waste is the primary cause of time inefficiency in production, particularly in the operational and transportation processes during the kneading stage. On the other hand, although overcooking waste does not impact production completion time as significantly as unnecessary motion waste, it plays a crucial role in determining product quality. Therefore, the time and temperature of the baking process must be standardized to ensure consistency.

Suggested improvements with Future State Mapping

After analyzing the waste in the production process of the layered cake at UMKM Lapis Tugu Kediri, the next step is to propose improvements to address the various causes of waste in the workflow. These suggested improvements are expected to serve as input and evaluation measures to eliminate waste, making the production process at UMKM Lapis Tugu Kediri more efficient.



Source: developed by authors.

Figure 4. Future State Mapping of Lapis Tugu Kediri Production Process

To address the issue of overcooking, several improvements can be implemented. One approach is to use an external timer or replace the steamer with one that has a built-in timer to ensure precise baking durations. Additionally, hiring more production staff and establishing a more structured shift system can help improve process supervision. Standardizing the baking temperature through research is also essential to ensure consistency in product quality. Another improvement is the development of a specialized tray system that allows products to be placed into and removed from the steamer in a single motion, ensuring uniform baking time for each batch. Lastly, regular recording of temperature and time during the baking process is crucial to monitor and refine the process for better control and consistency.

To resolve the issue of employees slouching and sitting on the floor, several improvements can be made. One solution is to replace the production table with a larger one or add additional tables specifically designated for the kneading process to provide better workspace efficiency. Another approach is to use dough containers with different dimensions but the same volume, allowing them to be placed on the table and reducing the need for employees to work in uncomfortable positions. If these solutions are not feasible, an alternative would be to reorganize the layout of items on the production table to create a more efficient and ergonomic workspace. On the other hand, training employees on efficient weighing techniques can help optimize their performance. Additionally, standardizing the working time at this production station and informing employees of the optimal time required to complete the task will ensure better time management. Furthermore, recording the weighing time is essential for evaluating and improving process efficiency.

As an illustration of the impact of implementing these improvements, Future State Mapping is created by adjusting the production timestamps to exclude Non-Value-Added (NVA) time. In this future state mapping, NVA activities resulting from overprocessing waste and unnecessary motion waste will be eliminated, leading to a more efficient production flow. Several aspects that will be adjusted include the transportation flow from weighing to baking, baking to cooling, mixing to kneading, and kneading to weighing, as well as the operational flow of the baking process.

In Figure 4, it can be observed that several time reductions occur after implementing the proposed improvements, resulting in a more efficient overall production time. As a result, the production lead time decreases to 127.66 minutes, with a process time of 120.46 minutes. With these changes, the process cycle efficiency (PCE) increases to 94.36%, indicating a significant improvement in production efficiency. Several key adjustments include reducing the transportation time from weighing to baking and baking to cooling to 1.5 minutes (1 minute and 30 seconds) per process, standardizing the baking operation to 25 minutes, reducing the transportation time from mixing to kneading from 4.1 minutes to 2.5 minutes, and eliminating the transportation time from kneading to weighing as the kneading process is now conducted directly on the production table.

5. Conclusion

This study analyzed the production process of Lapis Tugu Kediri using Value Stream Mapping (VSM) and the Fishbone Diagram to identify and eliminate waste. The findings revealed that overprocessing waste and unnecessary motion waste were the most significant contributors to inefficiencies. The root causes included the absence of standardized baking temperature, lack of proper equipment, inefficient workspace layout, and insufficient process supervision. To address these issues, several improvements were proposed, such as implementing timers in the baking process, optimizing workspace layout, standardizing baking parameters, and enhancing employee training. By applying these changes, the Future State Mapping showed a significant improvement in production efficiency, with the Process Cycle Efficiency (PCE) increasing to 94.36% and lead time reduced to 127.66 minutes. The results demonstrate that lean management tools, specifically VSM and the Fishbone Diagram, are effective in identifying and eliminating waste in SME production processes. Future research could explore additional lean methodologies or apply these findings to similar enterprises to validate their broader applicability.

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