Reducing the product defects using lean production perspective: a case study at CV Cita Nasional

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Abstract. This article discusses the issues of how to reduce pasteurized milk defects as part of waste in a lean production system. Product defects are the most important problem faced by the dairy enterprise daily. This problem makes production costs higher and decreases the profit. A set of seven tools and methods is used to identify and analyse the defect problem, and then make a solution plan. Value Stream Mapping is used to describe the current condition of the production system and make improvement planning. The lean production concept has been successfully used not only to find ways to reduce product defect, but also to plan and eliminate other wastes in the pasteurized-homogenized milk production process. Waste found and eliminated are production lead time, transportation, waiting time, defective products, and downtime machines. Overall, the research results in a reduction of overtime for 41 minutes, and make downtime on the packaging machine to become 0 minutes.

1 Introduction

Defective products are one of the problems faced by companies. The more defective products produced by the company, the more inefficient and effective the company is. Production that produces defects economically will lead to higher production costs. Defective products also cause the company's ability to sell products to decrease, resulting in reduced company revenues. Moreover, higher production costs and lower revenue from product sales resulting in lower profits for the company. In the end, the company's ability in earning lower profits will result in lower competitiveness. Company competitiveness is the key for companies to be able to compete in an increasingly competitive industry due to globalization.

Defective product from a lean production perspective is a waste that must be endeavored to be eliminated [1]. Lean production's ability to eliminate waste is seen by practitioners and researchers as one of the reliable methodologies used to improve company competitiveness. Lean production is a production philosophy that emphasizes minimizing the use of resources in various company activities. Lean production is also defined as a systematic approach to identify and eliminate waste (non-value-added activities) through continuous improvement by flowing products according to consumer needs to achieve perfection. The application of Lean production aims to increase product value by reducing the occurrence of waste. Waste is reduced by sorting out activities that generate value-added (VA) and do not produce added value (non-value-added / NVA) [2].

CV Cita Nasional is a privately owned company in Semarang, Central Java, which processes pure cow's milk into processed milk products. There are two products produced, namely pasteurized-homogenized milk and yogurt. Pasteurized-homogenized milk products are the main product of CV Cita Nasional, which is produced every day and in much higher quantities than yogurt that is not produced every day. Pasteurized-homogenized milk products are sold in five packages, namely 150 ml cup, 250 ml pure pack, 500 ml pure pack, and 125 ml minipack, and 180 ml minipack. The company has problems that occur in every production process carried out, namely there are defective products. CV Cita Nasional has a high commitment to implementing quality management.

The purpose of this study is to find the root cause of the occurrence of defective products and other potential waste and make an improvement plan. The products used as research objects are pasteurized-homogenized milk products packaged in 150 ml cups, 125 ml mini packs, and 180 ml mini packs. Lean production philosophy is used as the basis for achieving the objectives. Quality control tools in the seven tools method are used to help identify and analyze problems. The why-why analysis is used to find the root of the problem.

2 Literature Review

The principle of lean production system developed from Japan, exactly from Toyota. The term lean production came into prominence in the late 1980s when the Massachusetts Institute of Technology (MIT) researched the global automotive industry, focusing on the Japanese Toyota model to derive best-practice industry models. The concept of lean production itself has been implemented after the Second World War ended when Japanese industry began to think about changing its production model. The first industry to apply was the Toyota Company and the system used at that time was called the Toyota Production System [3].

Although lean production systems were originally used for the automotive industry, recently, many researchers have used lean production principles for other sectors, including agriculture and agro-industry. The benefits of lean production in the red meat industry value chain to respond to consumer needs [4]. The same research takes pork products in Catalan [5]. A framework for lean thinking for the agricultural sector [6]. Melin and Barth examined the application of lean thinking in 34 agricultural companies in Sweden and found that management commitment, training of managers and employees, corporate leadership, and the role of change agents are important factors for the success of lean implementation [7]. The use of lean production in the agribusiness sector to produce lean production that can facilitate the decision-making process, increase profits, market share, and customer evaluation [8]. Lean production is the key to the sustainable development of agricultural enterprises [9].

The concept of lean production is not whatever associated with the type of the manufactured products and therefore it applies in the energy sector to the same extent as in any other industry [10]. The lean production approach can be used to reduce waste in the enterprise [11].

The implementation of lean production can also be used in the industrial era 4.0. lean production supported by the use of technology 4.0 from the level of production planning to product distribution to consumers can increase flexibility and customer satisfaction [12].

The application of lean production which is supported by advanced technology (advanced tools) such as big data and smart technology will help companies to find their core competitiveness and achieve excellence [13].

3 Methodology

Data and information were collected in three ways, such as field observations, interviews, and discussions, as well as literature from company records and reports. Identification and analysis of data using checksheet tools, fishbone, root cause analysis using ask why 5 times, and value stream mapping techniques.

Checksheet is a basic tool for well-arranged data collection of quality in processes and simplifies post-processing of collected data [14]. Checksheet in this research is used to present the data, type, and value of defective products. Based on the checksheet, the highest type of defect is determined for further analysis. Fishbone diagrams are used to identify and show possible causes of problems and especially when a team tends to fall into thinking on a routine [15]. Fishbone diagrams are used to describe the causes of the highest types of defective products. The causes of problems are grouped into 4M, namely man, machine, materials, and method. Root cause analysis is used to find the root cause of the highest defective product, which is happening in the company. The simplest technique in finding the root of the problem uses the ask why 5 times technique [16]. Value Stream Mapping (VSM) is a visual method for mapping the production line of a product that includes material and information. VSM is used to describe the comparison of the current condition with the condition after the improvement plan has been carried out [17].

4 Results

4.1 Identification of Number and Type of Defective Product

Check Sheet is used to identify the number and type of defective products. Data collection using a checksheet for 4 months obtained the number of defective products presented in Table 1.

Table 1. Number of defective product

Month	Product		
	150 ml cup	125 ml minipack	180 ml minipack
Dec 2020	11,253	21,658	6,486
Jan 2021	9,888	20,686	6,064
Feb 2021	13,272	23,499	3,062
Mar 2021	10,173	21,114	6,132
Average/ month	11,146	21,739	4,702

Based on the results of the checksheet for the number of defective products, it was found that the 125 ml and 180 ml minipack product had the highest number of defects. Furthermore, a checksheet of the type of damage that occurred on the minipack product was carried out. The checksheet for the type and value of defective products of 125 ml and 180 ml minipack per month is presented in Table 2.

Table 2. Type and value of defective product 125 ml and 180 ml minipack per month

type	Number of defective product		Loss value
	125 ml	180 ml	
Leaky packaging	10,652	2,210	IDR 21,503,000
Lack volume	7,609	1,787	IDR 15,881,000
Expired date not printed	3,478	705	IDR 6,979,500
Total	21,739	4,702	IDR 44,363,500

There are three types of damage for minipack products such as leaky packaging, lack of volume, and expired date not printed. The highest type of damage as presented in Table 2 is leaky packaging. The value due to damage the minipack leaky packaging is IDR 21,503,000 per month. The second type of damage is lack of volume with a value of IDR 15,881,000 per month, and the smallest is an expired date not printed with a value of IDR 6,979,500 per month.

4.2 Analysis of the Causes of Defective Products

The cause of leaky packaging is illustrated using a fishbone diagram. There are 4 possible causes of leaky packaging based on the fishbone diagram, such as man, machine, material, and method. The results of the depiction of the leaky packaging fishbone diagram in 4M are presented in Figure 1.

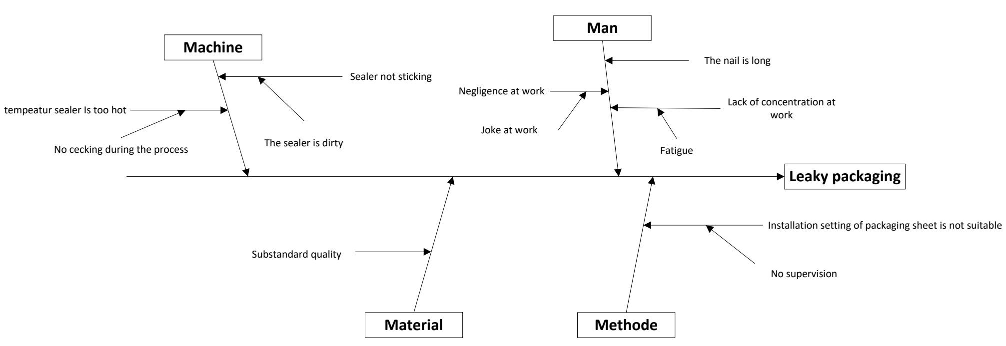

Fig. 1. Leaky packaging fishbone diagram

Root cause analysis by using why 5-time technique was used to find the root cause of the problem that causes the packaging to leak. The root of the problem in the leaky packaging occurs because there were no technical instructions for the use and maintenance of the sealer machine. Technical instructions specifically relate to two things, namely cleaning the sealer after use and replacing the sealer machine element within a certain period. The root cause analysis is presented in Figure 2.

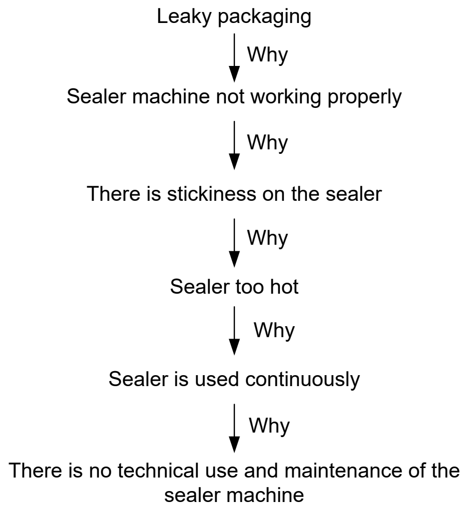

Fig. 2. Root cause analysis of leaky packaging

4.3 Waste Reduction Plan using VSM

The depiction of the VSM milk production process of the pasteurized-homogenized was begun with a description of the current state mapping. Current state mapping was needed as the first step in the process of identifying activities that may cause waste in the production process of pasteurized milk and homogenization of minipacks. There are 6 processes for making pasteurized milk minipacks, laboratory analysis, fresh milk cooling, mixing ingredients, pasteurization and homogenization, cooling and quality control, and packaging. The current state mapping is presented in Figure 3.

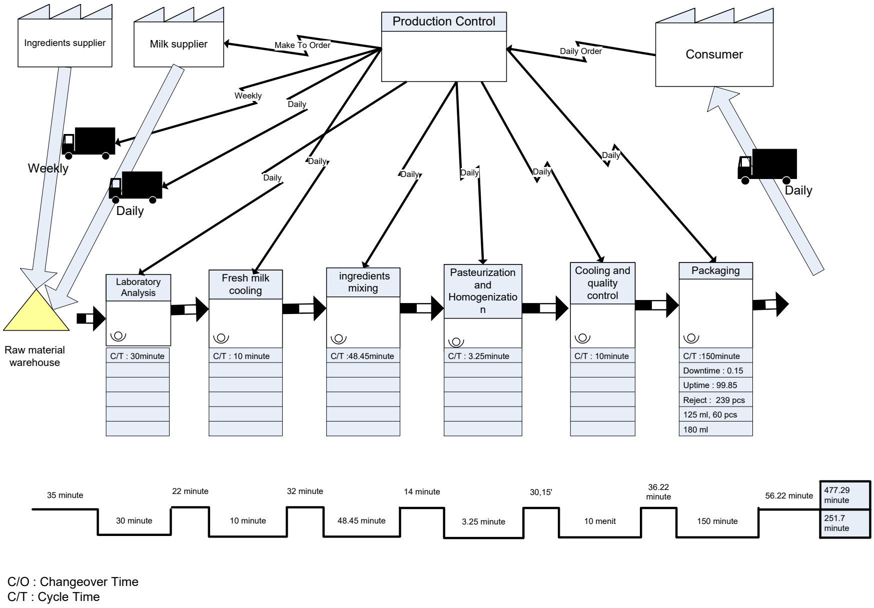

Fig. 3. Current state mapping of minipack product

After observing and analyzing, the VSM can identify the presence of waste other than defective products, such as production leadtime, transportation, waiting time, and downtime. production lead time and transportation waste occurs between the process of cooling fresh milk with the mixing ingredients. Waiting time occurs between the cooling process and mixing raw materials, also in the pasteurization process, cooling, QC, and the packaging process. Another waste found is downtime in the packaging process. The results of the current state mapping analysis are presented in Figure 4.

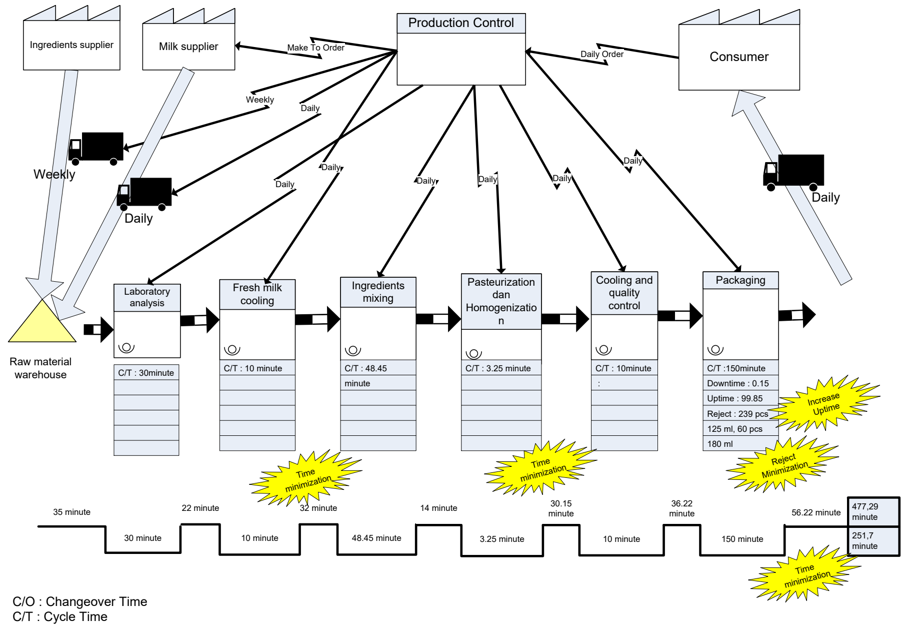

Fig. 4. Current state mapping analysis of minipack products

The way of handling waste based on the current state mapping is done by making improvement plans. The results of the waste analysis that may be improved are presented in Table 3.

Table 3. Improvement plan

Where	Waste	Cause	Improvement
Between the process of cooling fresh milk with the mixing ingredients	Production lead time	Weighing of ingredients the cooling process is complete	Place additional raw materials in the production room and weight them before the cooling process is complete thereby eliminating waiting time and transportation
	Transportation	1. Transport for additional raw materials from laboratory to dairy production room. 2. Transport for additional raw materials over the slippery floor.	
Between pasteurization process with cooling and quality control	Waiting time	controller walks from the QC laboratory room to the cooling room, after the homogenization process is complete	controller is ready in the cooling room, so that after the homogenization process is complete, samples can be taken immediately
Packaging process	Leaky packaging reject products	There is no sealer machine operating manual yet	1. Setting the temperature correctly and checking every 15 minutes. 2. Sealer is cleaned every 2.5 hours.

	Downtime	1. Cutter is not filed regularly and scheduled so that it is blunt 2. Replacement of the heater element wait until it is damaged	1. File cutter once a week. 2. Replace the cutter every 3 months so that it doesn't get dull. 3. Lubricate the machine on a scheduled basis every 30 minutes. 4. Set the sealer temperature properly and check every 1 hour. 5. Replace the heater element every 96 hours of use. 6. Socialization of autonomous maintenance to operators.
	Waiting time	1. The crates are not always ready to use because they are still being washed. 2. The product packaging arrangement works on the truck jokes a lot so it takes longer time. 3. Re-dismantling the packaging that is arranged in the truck because it looks like there is a leaking product.	1. Schedule for washing the crate, so that it is clean before the packaging process begins. 2. Packaging arrangement work on trucks must be more orderly. 3. Clear separation between product crates and reject product crates.

The improvement plan in addition to reducing waste can also reduce changeover time by 41 minutes and eliminate the downtime. The results of the improvement plan are depicted in the future state mapping presented in Figure 5.

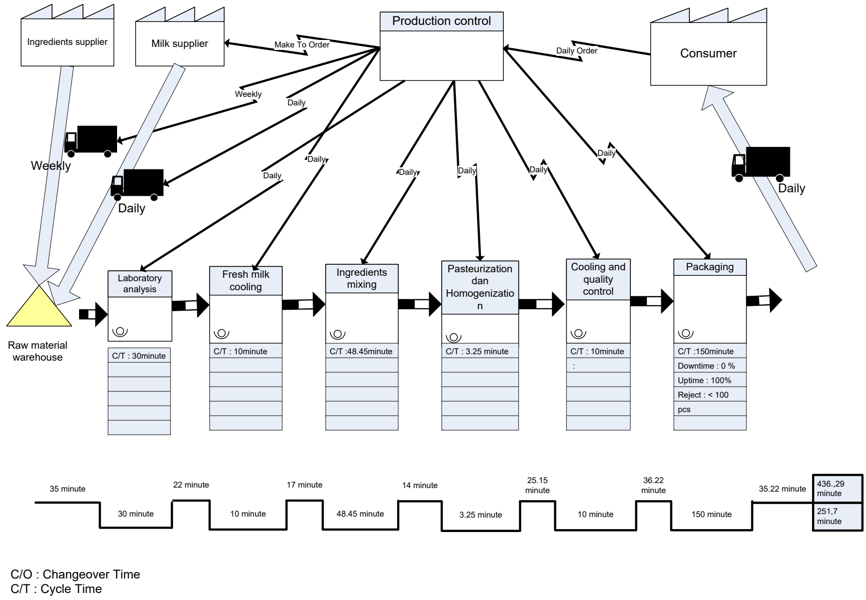

Fig. 5. Future state mapping of minipack product

Future state mapping shows the efficiency of change over time compared to current state mapping, after carrying out plant improvements. The change over time efficiency that occurs between the process of cooling fresh milk with the mixing ingredients is 15 minutes, from 32 minutes to 17 minutes. Efficiency of change over time between the pasteurization process with cooling and QC is 5 minutes, from 30.15 minutes to 25.15 minutes. Efficiency in the packaging process is 21 minutes, from 56.22 minutes to 35.22 minutes.

Efforts that need to be made to support the implementation of the improvement plan were to form a VSM team. The VSM team involves cross-functional members consisting of a combination of laboratory, production, purchasing, and maintenance service divisions. The task of the VSM team was to collect data, analyze, and make improvement plans to eliminate waste.

5 Conclusion

Lean production perspective can be used to make improvement plans to reduce product defects in dairy companies. The advantage of using lean production is that it can find other problems that become waste, such as production leadtime, transportation, waiting time, and downtime in this case. Sustainability of handling waste problems with the concept of lean production requires a team consisting of cross-functional people.

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