

IMPLEMENTATION OF THE LEAN SIX SIGMA METHOD TO IMPROVE PRODUCT QUALITY IN THE FOOD AND BEVERAGE INDUSTRY



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Abstract

This study aims to analyze problems in the food and beverage industry and describe an action plan to improve product quality through the implementation of Lean Six Sigma. This approach is expected to provide an effective solution to reduce waste, increase efficiency, and minimize defective products. This study uses a qualitative method with a case study approach. Data were collected through observation, interviews, and document analysis from the companies studied. The main focus is on analyzing the problems faced by the company and designing a plan to overcome the problems with the implementation of Lean Six Sigma. The results of the study show that Lean Six Sigma analyzes the problems faced by the company and designs solutions through the DMAIC (Define, Measure, Analyze, Improve, Control) approach. In the Define stage, the company identifies the main problems and sets improvement goals. Measure is used to collect current related data and measure the extent to which the problem has an impact. Analyze focuses on identifying the root cause of the problem using data analysis tools. Once the cause is known, the Improve stage designs and implements a solution to overcome the problem. Finally, Control ensures that the implemented solution remains effective in the long term by monitoring and controlling the process continuously. Through this DMAIC cycle, companies can systematically identify and address problems to improve product quality and process efficiency.

Keywords: Product Quality, Lean Six Sigma, DMAIC, Food and Beverage Industry

INTRODUCTION

The food and beverage manufacturing industry in Banten Province is facing serious challenges related to the amount of waste produced during production. Banten Province is in the top 5 provinces producing the largest B3 manufacturing waste from 2020 - 2023 (BPS Indonesian Environmental Statistics, 2023). The high volume of waste indicates the low quality of the products produced, the large number of defective products, and the inefficiency in using raw materials and resources (Fadwa et al, 2022; Isbahi, 2023). This has a significant negative impact on the environment. Solid and liquid waste from the production process often requires special handling, and the greenhouse gas emissions produced by these factories contribute to the increasingly worrying problem of air pollution (Muqarrabin et al, 2022).

Indonesia is the largest greenhouse gas emitter in Southeast Asia and is among the world's top 10 largest greenhouse gas emitters (Ahdiat, 2023). Based on the Indonesia Research Institute for Decarbonization (IRID) in 2022, Indonesia itself has submitted its long-term low-carbon plan to the UNFCCC, called the Long-term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) which states that Indonesia will achieve NZE conditions in 2060 or earlier. To achieve this target, the Indonesian government must involve all related parties and also involve and contribute to implementing climate change actions from both government and non-government actors.

According to data from the Central Statistics Agency in 2021, there were 325 companies included in the food and beverage industry in Banten Province. With a large number of companies in an era where awareness of the importance of environmental sustainability is increasing, the food industry in Banten Province, out of 325 food and beverage sector companies, only 30 companies are registered in the PROPER program (the number of PROPER registered companies is less than 10%). The low number of companies registered with PROPER in Banten Province shows that companies in the food and beverage industry sector are still carrying out their production processes using old (conventional) methods and concepts and have not implemented the green product concept.

One of the efforts to improve product quality is to use the Lean Six Sigma method approach. The Lean Six Sigma method can be an effective instrument in achieving the goal of achieving green products. The implementation of Lean Six Sigma can be widely applied

to types of industrial sectors, both manufacturing and non-manufacturing. In the manufacturing sector, Lean Six Sigma is widely explored in small and medium enterprises (SMEs), the automotive industry to the heavy equipment industry (Singh, M. and Rathi, A., 2018).

According to (Pushug et al., 2024) Manufacturing industries that use the Six Sigma approach show that unproductive times can be reduced. Energy consumption is reduced, and machine efficiency and availability are increased resulting in significant monthly savings. This is also in line with the implementation of Lean Six Sigma in the Egyptian manufacturing industry, Lean Six Sigma is able to reduce the ratio of product damage, reduce product variation, reduce cycle time, increase added value, reduce non-value-added time, increase labor productivity, and increase overall equipment effectiveness (Gomaa A., 2024). then in the food industry, through the Lean Six Sigma approach, it can minimize waste identified in production and reduce the number of lost products while improving the performance of the production process in the food industry (Widyawati T., 2024).

The Lean Six Sigma method is renowned for its ability to identify and eliminate waste in the production process, thus helping the food and beverage industry in Banten Province to improve its product quality and operational efficiency. By improving product quality, reducing defects, and reducing waste, companies can not only save production costs but also reduce the environmental impact of their operations. In addition, the implementation of Lean Six Sigma can also improve product quality and customer satisfaction. By reducing variation in the production process, companies can ensure consistency in their products, which in turn will improve their brand reputation and strengthen their position in the market. This is also in line with the increasing consumer demand for high-quality and sustainable products. To achieve optimal results, the food and beverage industry in Banten Province needs to adopt a Lean Six Sigma approach in a holistic and integrated manner. Thus, in production planning efforts, especially in the food and beverage industry, it is necessary to implement a green product-based production process, with its commitment to all internal stakeholders.

REVIEW OF LITERATURE

Conceptual Product Quality

According to Deming (1982), quality is defined as conformity to market or consumer needs. Companies must truly be able to understand what consumers need for a product to be produced. Deming explains the importance of focusing on continuous improvement, eliminating variability, cooperation between management and employees, and fact-based and data-based decision-making. Deming also developed the principles of quality management known as The Deming 14 Points for Management to achieve quality improvement in an organization.

Conceptual Lean Six Sigma Method

Lean Six Sigma is a management methodology that combines Lean and Six Sigma principles to improve efficiency and quality in business processes. Lean focuses on reducing waste and increasing the flow of value, while Six Sigma aims to reduce variation and defects in processes. The combination of these two approaches results in a highly effective methodology for improving operational performance and achieving competitive advantage. Waste in the context of Lean is identified in seven main categories often referred to as the "7 wastes" namely Overproduction producing more than is needed, waiting for materials, information, or equipment., Extra Processing additional processes that do not add value, Excessive inventory, Inefficient worker motion, and Defects defective products that require rework or become scrap.

RESEARCH METHOD

This research was conducted using a qualitative case study approach, namely with subjects of companies included in the food and beverage industry category in Banten Province. The qualitative approach was chosen because it allows for in-depth exploration of the processes, experiences, and views of various parties involved in the implementation of Lean Six Sigma. This approach is suitable for understanding the complexity and dynamics of the application of this method in the context of the food and beverage industry in Banten. The case study method is used to obtain a detailed and comprehensive picture of how Lean Six Sigma is applied in several food and beverage companies in Banten. This method allows

researchers to identify best practices and challenges in implementing Lean Six Sigma, analyze the impact of implementing Lean Six Sigma on product quality and operational efficiency, and understand the specific context of each company that influences the success or failure of implementation. The study produces descriptive data in the form of written words. Specifically, the stages of the research also apply qualitative methods, techniques and tools. According to Sugiyono (2013), case study method research is research when researchers conduct detailed and in-depth exploration of a process and activity. This research will use a qualitative research approach so that in this research the data produced is in the form of numerical data and also explanations obtained from informants who are researched and can be trusted.

RESULTS AND DISCUSSION

Improve

The 5W1H method is used in the improve stage *Lean Six Sigma* because it provides a systematic and comprehensive framework to analyze and understand the problem in depth. By answering the questions of what, why, where, when, who, and how, the team can identify the important details of the problem and the solutions needed. This method helps in gaining a deep understanding of the root causes of the problem, ensuring appropriate and strategic decision-making, and facilitating effective communication among team members and stakeholders. In addition, the 5W1H method also supports clear and structured planning of improvement steps, so that implementation can be carried out more efficiently and effectively, which ultimately helps the food and beverage industry achieve improved product quality and operational efficiency.

Control

In the Control stage, the improvements that have been implemented are then measured with the aim of ensuring that the improvements remain effective and provide consistent results.

Table 1.
Table of Control Stages for Improvement Planning Stages

The Problem	Repair	Control Stages	
B3 Solid Waste	Machine	Condition and time-based maintenance schedules and reports.	
		Machine calibration schedule and report.	
		Machine performance monitoring system data	
	Material	Environmentally friendly material specifications	
		Checklist material quality inspection	
		Checklist use of materials for efficiency	
	Man	Employee training schedule	
		Employee performance measurement	
	Method	Production SOP	
		Data on the amount of waste and its identification	
Defective Product	Machine	Condition and time-based maintenance schedules and reports.	
		Machine calibration schedule and report.	
		Machine performance monitoring system data	
	Method	Statistical Process Control (SPC) reports, results, and corrective actions.	
		Reports & Specifications of materials according to standards	
	Material	Storage and Usage Procedures	
		Employee training schedule	
		Employee performance measurement	
	Water Consumption Inefficiency	Method	Creation of a water recycling system.
			Water usage report.
Audit and reporting of production processes			
CIP system monitoring report			
Material		Water quality reports and specifications	
		Water management audit	
Man		Employee training schedule	
		Employee performance measurement	

	Environment	Water Resources Management report
Customer Complaints	Method	Audit and reporting of production processes.
		Customer satisfaction survey
	Material	Reports & Specifications of materials according to standards
		Storage and Usage Procedures
	Machine	Condition and time-based maintenance schedules and reports.
		Machine calibration schedule and report.
		Sensor Accuracy and Automation Report.
	Man	Employee training schedule
		Employee performance measurement
		Quality campaign schedule
Greenhouse Gas Emissions	Machine	Condition and time-based maintenance schedules and reports.
		Machine calibration schedule and report.
		Machine performance monitoring system data
		Machine efficiency report
	Method	Energy management audit.
		Energy efficiency report.
	Material	Reports & specifications of materials that comply with standards and are environmentally friendly
		Local supplier usage report
	Man	Employee training schedule
		Employee performance measurement report
Environmentally friendly campaign schedule		

The application of Lean Six Sigma methods in the food and beverage industry shows significant potential to improve product quality and operational efficiency. Through 5W1H analysis, several key issues have been identified, including solid waste, defective products, inefficient water consumption, greenhouse gas emissions, and customer complaints. The

company can identify the root causes of the problems faced and design appropriate improvement steps.

Research conducted in the food and beverage industry reveals the benefits of implementing Lean Six Sigma methods in addressing issues such as solid waste, product quality, water consumption inefficiencies, greenhouse gas emissions, and customer complaints. These findings reinforce the theory discussed in the book "Lean Six Sigma for Manufacturing and Service Industries" by Vincent Gaspersz and Avanti Fontana, which emphasizes that Lean Six Sigma can integrate waste reduction with continuous quality improvement.

Solid Waste Management

Solid waste is a major challenge in the food and beverage industry, which can be leftover raw materials, packaging, or defective products. Through the implementation of Lean Six Sigma and implementing 5S techniques to maintain cleanliness and orderliness of the workplace. This process not only helps in reducing waste but also increases efficiency and productivity. For example, optimizing the layout of the factory and using materials more efficiently reduces the amount of waste generated.

In his book, Gaspersz explains that waste reduction is a core component of Lean, where the main focus is on eliminating all forms of waste (muda) in the production process. This includes waste of time, materials, and labor. The 5S and Kanban techniques are effective tools for creating a more efficient and clean work environment, which in turn helps reduce costs and improve product quality.

Product Quality Improvement

Product quality is a critical aspect in the food and beverage industry, as it is directly related to customer satisfaction. The application of Six Sigma methodology, specifically tools such as DMAIC (Define, Measure, Analyze, Improve, Control), allows companies to systematically identify and eliminate variations in the production process that can lead to product defects. Through data analysis and statistical process control (SPC), companies can ensure that every product produced meets stringent quality standards.

The book highlights that Six Sigma aims to achieve quality improvement by reducing variability and defects in the production process. With tools such as SPC, companies can

monitor and control quality in real time, ensuring that the products produced are consistent and meet the specifications set. This is important for maintaining brand reputation and consumer trust.

Water Consumption Inefficiency

The food and beverage industry often faces challenges in managing water consumption, which is used in various stages of production, including cleaning and chilling. By implementing Lean Six Sigma, companies can identify areas where water is being used inefficiently and implement measures to reduce consumption. For example, water-saving technologies and improvements in cleaning processes can significantly reduce water use, without compromising product quality or food safety.

Gaspersz and Fontana explain that Lean focuses on optimizing the use of resources, including water. This is done by analyzing each step in the production process and looking for ways to reduce waste. This approach not only saves costs but also contributes to environmental sustainability, which is a major concern in modern industry.

Greenhouse Gas Emission Reduction

Food and beverage production can also produce significant greenhouse gas emissions, primarily from the energy used in the production process. Research shows that by adopting renewable energy and energy efficiency technologies, companies can reduce their carbon footprint. Additionally, optimizing production processes with Lean can reduce overall energy requirements, which also contributes to reduced emissions.

This book emphasizes that Lean Six Sigma focuses not only on economic efficiency but also on environmental sustainability. By reducing energy waste and adopting environmentally friendly practices, companies can reduce greenhouse gas emissions and meet increasingly stringent regulatory demands for environmental protection.

Customer Complaint Management

Customer feedback is a critical element in continuous improvement. Using Six Sigma, companies can analyze customer complaint data to identify problem patterns and root causes. This approach allows companies to take appropriate corrective actions and improve their products and services.

According to Gaspersz, Six Sigma is a data-driven approach that helps companies better understand and respond to customer needs. With in-depth data analysis, companies can find the root of problems and make necessary improvements, thereby increasing customer satisfaction and loyalty to their products.

CONCLUSION

Based on the findings and discussion, using the kaizen blitz method (5W1H), the following conclusions can be drawn:

1. Solid Waste

To reduce the impact on overall operating costs, companies can plan corrective measures to increase efficiency and reduce waste in the production area by conducting routine maintenance and calibration to prevent failure and ensure optimal and stable operation. Employee training is conducted to improve knowledge, and skills, and prevent errors, with employee performance documentation. Standard specifications and quality control are implemented to ensure the use of quality materials. Clear and detailed SOPs, as well as appropriate methods, are then implemented to optimize machine operations and minimize waste, with consistent monitoring and documentation.

2. Defective Product

To reduce the impact on overall operational costs, companies can plan improvement steps in the production area by means of routine maintenance and calibration of production machines to prevent failure and instability of production machines.

Employee training to prevent human error and ensure competence in machine operation. Implemented specification standards and quality control to ensure the use of high-quality materials. Optimized SOPs and Statistical Process Control (SPC) systems are implemented to identify defective products more accurately and implement corrective actions.

3. Water Consumption Efficiency

To reduce the impact of future water supply disruptions, companies can plan efficiency measures in water use by implementing water quality control and specification standards to ensure effective and efficient water use, including in the cleaning process.

Implementation of SOPs and water use policies to avoid water waste. Exploration of new water source search programs as future reserves, with periodic evaluations to ensure water availability. Employee training to improve knowledge and skills in water use, and prevent mistakes that can lead to water waste.

4. Greenhouse Gas Emissions

To reduce the impact on overall operating costs, companies can plan steps to reduce greenhouse gas emissions by conducting routine maintenance and calibration to ensure energy efficiency and optimization of machine operations. Employee training is enhanced to prevent errors that can lead to energy waste. Environmentally friendly material specification standards and quality control are implemented to reduce emissions from material use. Clear and detailed SOPs, as well as optimal energy management, are implemented to reduce energy waste and ensure efficient machine operations.

5. Customer Complaints

To reduce the impact of the decline in the company's reputation and the overall decline in sales, the company can plan corrective measures to improve product quality and reduce customer complaints by conducting routine maintenance and calibration to maintain product quality according to standards. Employee training is increased to strengthen knowledge and skills in dealing with customers. Standard specifications and quality control are implemented to ensure the use of high-quality materials. Optimal methods and SOPs are implemented to ensure the production process produces high-quality products, with periodic evaluations to maintain product quality.

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