



Implementation of the Six Sigma Method with the DMAIC Approach in Cemal - Cemil MSME Business in Butoh Village, Sumberrejo District, Bojonegoro Regency

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ABSTRACT

Today's society shows a tendency to be harmonious in choosing food products. In the Micro, Small and Medium Enterprises (MSMEs) business, especially in the Cemal - Cemil business that offers snack food products, the production section is a very crucial aspect, because that's where the quality of the food is determined by its success in meeting food quality standards. This cemal-snack business faces serious challenges that can result in losses if not handled properly, therefore improving quality is the main focus of snack entrepreneurs. Their long-term goal is to support programs to maintain and even expand market share. Snack entrepreneurs experience too many delays in production, resulting in delays in sending orders. Therefore, snack entrepreneurs need to improve the service process to match the expected service quality. This type of research is pure descriptive quantitative research that only describes the facts of what appears in the population. The implementation of this research, data collection was carried out directly at the production house "Cemal - Cemil" owner of one of the MSME businesses in Butoh village which already has many fans. samples were taken from interview data from the company and questionnaires.

INTRODUCTION

In the current industrial era, business competition is increasingly fierce, so that quality products and services are a requirement for competitive advantage and a necessity to ensure the improvement of a business's sustainability process. Therefore, optimizing the Cemal-Cemil MSME business with problems addressed by using the six sigma DMAIC method. Because it has become one of the techniques frequently used for product quality issues, with the aim of demonstrating the empirical application of DMAIC in minimizing the opportunity for product defects in the product production process. Judging from the current conditions of business competition in the global market, it is very volatile and unpredictable, and is characterized by various changes and consumer desires. Companies that are unable to adapt and adjust to existing changes will slowly but surely experience failure (Ahmad, 2019).

Today's society is showing a tendency to be selective in choosing food products. Consumers tend to compare the quality and price offered by sellers. In Micro, Small, and Medium Enterprises (MSMEs), especially in the Cemal-Cemil business, which offers snack products, the production department is a very crucial aspect, because it is there that food quality is determined by its success in meeting food quality standards. Success in meeting product quality standards is the main key to satisfying consumers. To ensure product quality remains in accordance with the desired standards, effective control of production quality is a must.

This snack business faces serious challenges that could result in losses if not addressed properly. Therefore, improving quality is a primary focus for snack entrepreneurs. Their long-term goal is to support programs to maintain and even expand market share. These improvement efforts are undertaken to reduce the number of customer complaints, thus positively impacting the business's reputation. In this context, understanding customer satisfaction levels is crucial for identifying service attributes that may not be fully satisfactory. One aspect of service that requires attention is order delivery. In this snack business, order delivery typically involves the Bojonegoro area. This delivery is tailored to customer preferences, such as order pickup at the production house, cash on delivery (COD) for remote locations, and direct delivery to the customer's location.

The steps to reduce defects are carried out systematically by defining (define), measuring (measure), analyzing (analyze), improving (improve), and controlling (control). These systematic steps are known as the 5 phases of DMAIC (Paul, 1999). DMAIC is carried out systematically based on science and facts towards the six sigma target of 3.4 DPMO (Defects per Million Opportunities) and of course increasing the company's profitability (Vanany et al., 2007).

Snack food entrepreneurs experience too many delays in production, resulting in delays in order delivery. Therefore, snack food entrepreneurs need to improve their service processes to meet the expected service quality. Perceived service quality refers to customer satisfaction with the service provided. To improve service delivery in the consumer order delivery section, the Six Sigma DMAIC method, namely Measure, is used in the control chart calculation.

LITERATURE REVIEW

Six Sigma

Six Sigma is a new management research tool used to replace Total Quality Management (TQM) (Daniels, 2009), which is highly focused on quality control by delving into the company's overall production system. It aims to eliminate production defects, reduce product manufacturing time, and eliminate costs (Daniels, 2009). Six Sigma is called a scientific discipline because it follows a formal model, namely DMAIC (Define, Measure, Analyze, Improve, Control) and the tool is used in conjunction with others, such as the Pareto Chart and Histogram (Heizer & Render, 2008). The success of improving quality and business performance depends on the ability to identify and solve problems (Evans & William, 2008). This ability is fundamental to the philosophy of Six Sigma (Evans & William, 2008).

DMAIC

It is an abbreviation of Define-Measure-Analyze-Improve-Control, or a structured step methodology for carrying out an improvement cycle based on data (performance data), which is used to improve, optimize and stabilize the design and processes in a company in accordance with the Lean Manufacturing concept (Eckes, 2001).

METHODOLOGY

This type of research is purely descriptive quantitative research, which only aims to describe facts about things that appear in the population. This research is applied research, which is a process. This research is conducted in a practical manner to provide solutions to the problems that occur in this MSME snack business. This research does not focus on ideas, concepts, theories but focuses on the application of this research to everyday life in running this MSME business. The implementation of this research, data collection was carried out directly at the "Cemal - Cemil" production house, the owner of one of the MSME businesses in Butoh village which has many enthusiasts. The "Cemal - Cemil" production house is located in Dukuh Mampir, Butoh Village, Sumberrejo District, Bojonegoro Regency. The research was conducted in March 2025. The population is a generalization area consisting of objects or subjects that have certain qualities and characteristics determined by the researcher to be studied and then drawn conclusions. The sample was taken using the Purposive Sampling Technique. The population in this study was taken from production data, shipping data, reports of defective products every day and other related production activity reports. Meanwhile, the sample was taken from interview data from the company and questionnaires. The questionnaire consisted of all employees and customers of "Cemal - Cemil".

RESEARCH RESULT AND DISCUSSION

Dafine Stages (Formulation)

The Dafine stage is the first step in implementing the Six Sigma DMAIC method. In this research phase, the first step is to identify the process and then determine the process objectives. The initial Dafine stage begins with a SIPOC

diagram, which illustrates the production process flow from the producer to the end consumer, starting with suppliers and inputs.

The process begins with the selection or grouping of raw materials, auxiliary materials, and complementary materials, the production process, the packaging process, and the transportation process. Finally, the output is the delivery of goods to the customer end user.

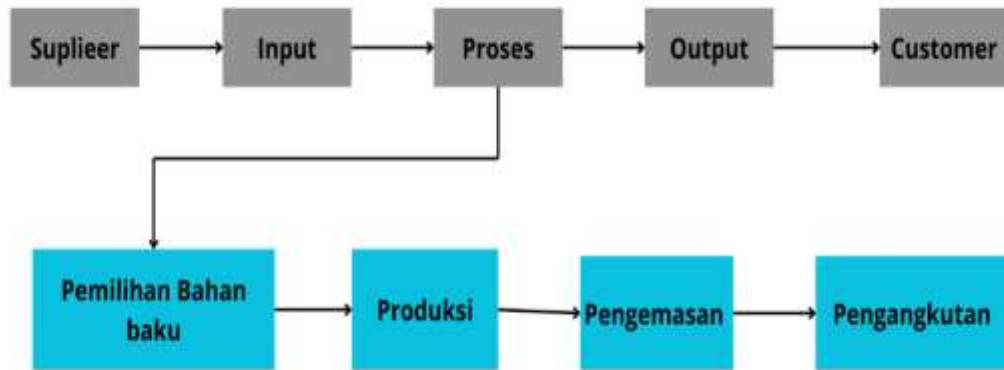


Figure 1. SIPOC Diagram

Data Stratification

The initial step in the measurement process is to group the error data based on characteristics. The data collected covered errors from June 2024 to March 2025.

Table 1. Data Stratification

No.	Month	Total Production	Product Defects	Good order	Percentage of Disabilities/Month
1	June	1300	150	1150	12%
2	July	1455	175	1280	12%
3	August	1358	200	1158	15%
4	September	1400	183	1217	13%
5	October	1560	173	1387	11%
6	November	1250	125	1125	10%
7	December	1675	157	1518	9%
8	January	1500	145	1355	10%
9	February	1450	135	1315	9%
10	March	1255	90	1165	7%

Source: Data processed 2025

Table 2. Data Specifications

No.	Month	Total Order Shipping	Delayed Delivery	Percentage Delayed Delivery
1	June	20	8	40%
2	July	37	12	32%
3	August	24	10	42%
4	September	16	7	44%
5	October	19	5	26%
6	November	25	7	28%
7	December	19	6	32%
8	January	24	14	58%
9	February	19	7	37%
10	March	12	5	42%

Source: Data processed 2025

DPMO Calculation and Sigma Capability

The table above shows that there were 215 shipments with a total of 81 delays. Based on this data, the DPMO value will be calculated. DPMO, or Defects Per Million Opportunities, is the number of defects per million opportunities. The calculation can be done as follows:

$$DPO = \frac{\text{Number of Disabilities}}{\text{Number of Shipments} \times \text{Chance}} = \frac{81}{215 \times 1} = 7,1302$$

$$DPMO = DPO \times 1.000.000$$

$$= 7,1302 \times 1.000.000 = 7.130.200$$

Next, the sigma value is calculated from the existing research data, as follows:

$$= \text{NORMSINV} (1 - DPMO/1,000,000) + 1.5$$

$$= (1 - 7,130,200/1,000,000) + 1.5$$

$$= 2.428698$$

$$= 2.42$$

Information:

The value of 1.5 is the variation shift value for the six sigma quality level. Based on the calculation above, it can be seen that the DPMO is 7,130,200 times per million opportunities with 81 delays in delivery of goods from a total of 215 deliveries. With a DPMO value of 2.428698, the six sigma value is 2.42 and the chance of being defect-free or in other words the error rate in shipping goods is 24.5% of the error rate, so improvements are needed to reduce the error rate that occurs.

Control Map

After calculating the critical to quality (CTQ), it was found that the highest percentage of delays was related to the delivery of goods. The next step involved using a control chart to assess whether the delays in delivery of goods were

within the statistical control limits. In this study, the control chart calculation was performed using a P control chart.

Delay Percentage Every Month:

- June P = 8 / 20 = 0.40
- P July = 12 / 37 = 0.32
- P August = 10 / 24 = 0.42
- P September = 7 / 16 = 0.44
- P October = 5 / 19 = 0.26
- P November = 7 / 25 = 0.28
- P December = 6 / 19 = 0.32
- P January = 14 / 24 = 0.58
- P February = 7 / 19 = 0.37
- P March = 5 / 12 = 0.42

The average or center (CL) delay percentage as the center line of the control chart:

$$CL = 81 / 215 = 0.3767$$

Upper control limit (UCL) and lower control limit (LCL):

$$UCL = \frac{0,3176 \pm 3 \sqrt{0,3176 (1 - 0,3176)}}{215} = 0,007973$$

$$LCL = \frac{0,3176 \pm 3 \sqrt{0,3176 (1 - 0,3176)}}{215} = 0,005019$$

Based on the calculations above, the calculation of the control limits for the number of shipments and the number of delays can be seen in the following table:

Table 3. Calculation of Control Limits P Delay

Month	Number of Shipments	Number of Delays	P	UCL	CL	LCL	Month
June	20	8	0.4000	0.007973	0.3767	0.005019	8
July	37	12	0.3243	0.007973	0.3767	0.005019	12
August	24	10	0.4167	0.007973	0.3767	0.005019	10
September	16	7	0.4375	0.007973	0.3767	0.005019	7
October	19	5	0.2632	0.007973	0.3767	0.005019	5
November	25	7	0.2800	0.007973	0.3767	0.005019	7
December	19	6	0.3158	0.007973	0.3767	0.005019	6
January	24	14	0.5833	0.007973	0.3767	0.005019	14
February	19	7	0.3684	0.007973	0.3767	0.005019	7
March	12	5	0.4167	0.007973	0.3767	0.005019	5

Source: Data processed 2025

Based on the table above, it can be seen that nothing is under control. This indicates that delay control is experiencing numerous problems. Therefore, further analysis is needed to determine the causes of the deviations seen on the P control chart. The factors causing the process to be out of control will be analyzed using a fishbone diagram.

Analyze Stage

In the analysis stage, the factors causing errors in the order delivery process will be explained using a fishbone diagram to identify the root of the problem.

Fishbone Diagram

A fishbone diagram is used to identify the root causes of a problem, both the root causes and the underlying causes. The results of the fishbone diagram analysis can be seen in the image below:

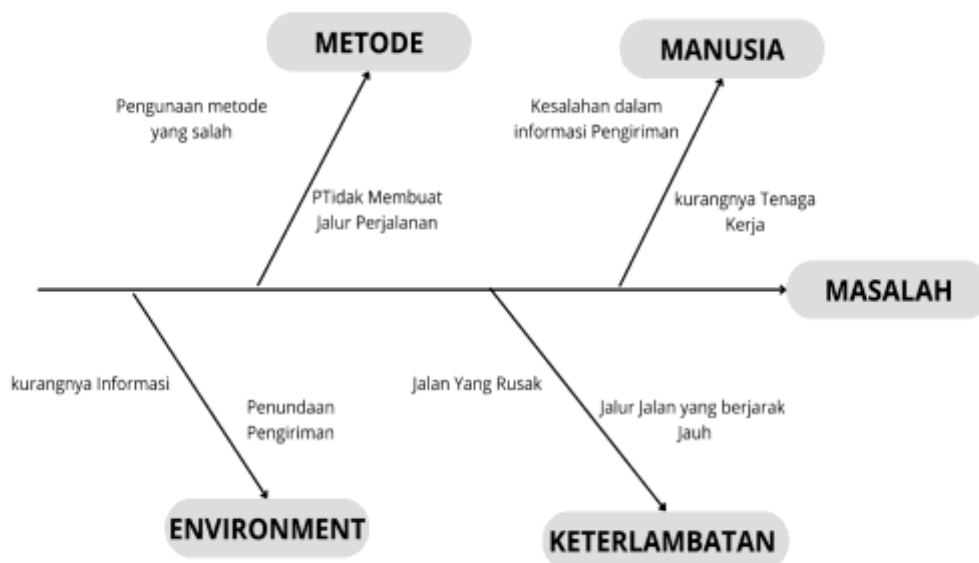


Figure 2: Fishbone Diagram
Source: Processed Data, 2025

Fishbone diagram analysis explains the root causes of late order deliveries, namely Method, Human, and Environment. In addition to these factors, there are also causes of late delivery influenced by other factors that have not been identified in this study but are instead the result of Questionnaires and interviews. The factors that contribute to late delivery of orders are influenced by the lack of employee involvement in creating order routes and the company's failure to conduct training aimed at honing skills and abilities. This Cemal-semi business also does not evaluate the quality of good use of work time for employees, resulting in slow inspection and equipment processes. There is still a shortage of workers in the operational section compared to the amount of work available, and employees feel that their wages are still insufficient. The cause of late delivery is also due to the limited number of operational fleets used to handle distribution. The entire order delivery process must use a transportation fleet and it is mandatory for drivers to know the route.

Improvement Stage

This stage is carried out after analyzing the fishbone diagram. This stage uses the 5W+1H analysis technique. The following is an explanation of the results of this study's analysis using the 5W+1H method based on the root cause of the problem in the fishbone diagram.

Table 4. 5W + 1H Table

Factor	Description	Explanation
Overwork and lack of labor	What	Overwork and lack of labor
	When	when orders are full and increasing
	Where	Butoh Village Snack Business House
	Why	To avoid the accumulation of order deliveries when orders are full, it causes overwork, so that employees become tired and ultimately the delivery plan has to be postponed.
	Who	Driver
	How	Adding workers to help lighten the workload during times of overwork.
Lack of Focus on Staff, resulting in errors in informing	What	Error in providing information
	When	When informing the order address
	Where	Butoh Village Snack Business House
	Why	So that there are no delays in sending orders
	Who	administrative staff
	How	Employee staff must remain focused even though many orders are sent
Damaged roads and long distance routes	What	the route taken is long and damaged
	When	distance traveled from one place to another
	Where	Butoh Village Snack Business House
	Why	to avoid delays in delivery
	Who	Driver
	How	Employees must create travel distances so that the distance covered is faster and can avoid damaged roads by choosing another route.
Lack of available fleet information	What	Not Informing the available fleet
	When	when the order is full
	Where	Butoh Village Snack Business House
	Why	The available fleet cannot cover existing orders.
	Who	Driver
	How	Employees must inform the fleet owner when the order is full so that the order is not delayed during delivery and does not experience delays.

Source: Data processed 2025

Control Stage

The final stage is control, which is the control of the analysis phase of this research. In this control stage, standard operating procedures (SOPs) will be used for all involved, especially the administration and drivers handling delivery. This will minimize delays in delivery. The following is the SOP used in the snack-selling MSME business.

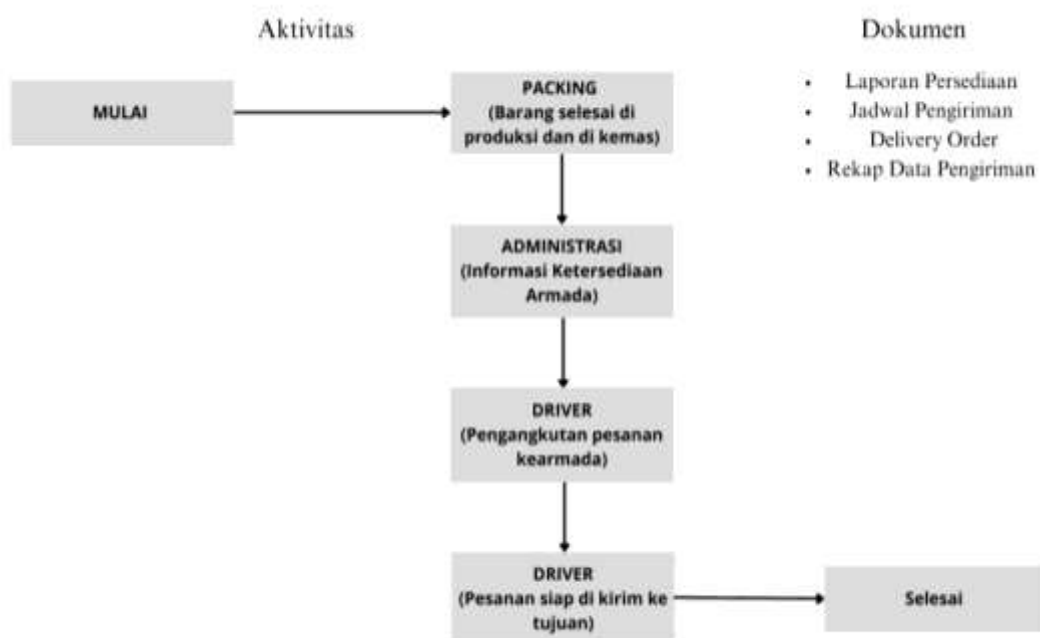


Figure 3: Standard Operating Procedure Diagram
 Source: Data processed 2025

Based on the table above, the shipping process and related documents can be seen. The marketing department ensures that the goods delivered match the order and that the driver carries the order. Meanwhile, the administration department books the fleet a week before delivery to ensure the delivery schedule.

CONCLUSIONS AND RECOMMENDATIONS

This research was conducted to optimize the Cemal-cemil MSME catering business in Butoh village, Sumberrejo District, Bojonegoro Regency, which has problems in delivery and defects. Supported by secondary data from the business, observations and interviews, it can be concluded with the results of the DPMO calculation that the problem of order delivery has a percentage of 2.42%. For the company, this research is expected to be a reference material for Cemal-Cemil owners to pay more attention, especially in the delivery section and improve competence so that they can create a delivery route.

ADVANCED RESEARCH

A potential avenue for advanced research stemming from this study is the application of the Six Sigma DMAIC method beyond the delivery aspect, extending it across the entire value chain of the Cemal-Cemil MSME from raw

material selection to after-sales service. This integrative approach allows for a systemic analysis of potential defects, time inefficiencies, and resource wastage that may have gone undetected with a narrower scope. Further studies could also explore the integration of digital technologies, such as IoT-based supply chain management systems and real-time delivery tracking, to reduce process variability and enhance service reliability. This direction is not only relevant to the local MSME context but also contributes significantly to the body of knowledge on Six Sigma implementation in small and medium-sized enterprises in developing countries.

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