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Article

QUALITY CONTROL ANALYSIS TO REDUCE BAG PRODUCT DEFECTS USING THE LEAN SIX SIGMA METHOD (Case Study: Alfajar Bag Convection MSMES, Jakarta)

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A B S T R A C T

The background of this research is to control the quality of bag production to reduce product defects and improve the quality of the resulting products. The purpose of this research is to identify the causes of product defects, determine the DPMO and sigma values, and propose improvements using the Lean Six Sigma method for bag production at Alfajar Bag convection. This research is both descriptive quantitative and qualitative, collecting production data over one year from May 2022 to April 2023. It was found that 11,940 Rempel Backpacks were produced, with 1,147 defective items, resulting in an average defect rate of 9.6%. The research analysis uses the Lean Six Sigma method to understand quality control through several stages. In the Define phase, four types of Critical To Quality (CTQ) attributes were identified for Rempel Backpack production. In the Measure phase, the calculations for DPMO and Sigma Level revealed an average DPMO of 24,015.913 and a Sigma Level of 3.477σ. In the Analyze phase, five main factors and seven types of waste affecting production were identified. In the Improve phase, several improvement suggestions were made to reduce product defects and waste in the bag production at Alfajar Bag. In the Control phase, the improvement suggestions analyzed in the Improve phase were implemented, and continuous monitoring and improvements were carried out.

Keywords

Lean Six Sigma;
Defect;
DMAIC;

1. BACKGROUND

1.1 Introduction

In a production business, defects or production failures are often found in products. This determines the quality of the products produced by a company which will influence consumers' views of a company. Companies must maintain quality control over their products. Variations must be kept to a minimum to produce high quality goods. Defect problems can reduce consumer happiness and confidence in product performance and results. Additionally, this can result in higher costs. Not all causes of product defects can be handled at once, therefore, to overcome these problems, business people must be able to prioritize which problems need to be fixed first (Kartini, 2015). Applying quality control measures can help minimize non-conformities in the production process when product errors occur (Rahayu & Bernik, 2020).

In a bag convection business, product defects and waste are often encountered which greatly affect profits in bag production itself. Common problems found in the production of these bags usually include uneven stitching, poorly sewn zippers, and incomplete or defective accessories. During the production process, issues such as material wastage, lengthy procedures, unnecessary processes, and other inefficiencies often occur. These problems impact the production outcomes and product marketing, reducing profits because the defective products are frequently returned by the stores to the manufacturer. These returns prevent the manufacturer from maximizing profits and can even lead to losses. This research was conducted at one of the Alfajar Bag convection MSMEs which produce women’s bag. This research was conducted to determine product defects in bag production by applying the Lean Six Sigma method which is expected to reduce product defects in production and is expected to be a solution to problems so that bag production is optimal and customer satisfaction can be met so that there are no losses and maximum profits.

1.2 Research Purpose

1. To find out what causes product defects in bag production at the Alfajar Bag convection.
2. To find out the DPMO value and Sigma value in bag production at Alfajar Bag.
3. To find out the prorposals produced by the Lean Six Sigma method in a effort to reduce product defects in bag production.

2. LITERATURE RIVIEW

The production system is one of the most important systems, business performance is substantially influenced by how well the system is operated. *Lean Manufacturing* is a strategy that can be applied to overcome inefficiencies or waste that arise in a business's production system. Anything that is not useful is generally *waste* . In contrast, waste in a production context refers to instances where resources or materials are used in a way that does not follow established protocols. In general, *waste* in the production process *includes excess inventory, waiting, excessive transportation, inappropriate processing, overproduction, and the movement of unnecessary and substandard goods*.(Najib, Choiri, Farela, & Tantrika, 2000).

A defect is an imperfection that results in the value or quality being lower than it should be. A defective product is defined as a good or service that has been produced but has flaws that make it less valuable or reduce its optimal quality. (Vicy M. Dasmasela, Jenny Morasa, 2020)

According to Vincent Gasperz (2005) in (Ahmad, 2019), *"The operational methods and procedures used to meet quality standards are known as quality control".* Management uses quality control as the main instrument to maintain the existing high level of quality in products, reduce the number of defective items, and improve them when necessary. *Total Quality Management* (TQM) is a method often used by businesses to methodically improve quality with the goal of improving performance metrics including quality, productivity, and profitability. According to (Tetteh & Uzochukwu, 2015) TQM is a process that allows management and staff to work together to continuously improve the way goods and services are produced.

Six Sigma (Ari Zaqi Al-Faritsy1, 2022) is a quality control strategy that aims to reduce waste during the production and delivery of goods and services to save costs and increase customer satisfaction. *Six Sigma* is a technique for improving and managing quality to achieve targets 3.4 DPMO . According to the idea of *Six Sigma* , there is a failure metric that displays the number of errors or failures per million opportunities.

The operational management model called *Lean*

Six Sigma combines the best aspects of *Lean and Six Sigma* . Businesses can achieve *Six Sigma "quality" and Lean* "speed" by using *Lean Six Sigma* . This approach helps businesses reduce the average number of defects per million opportunities (DPMO) to 3.4 by eliminating seven wastes that arise in manufacturing or service processes and producing high-quality output. The goal is to increase business revenue, ensure sustainability, and offer additional value to clients (Choirunnisa, W, Si, & Si, 2020). In implementing *Six Sigma* there are five steps called DMAIC (*Define, Measure, Analyze, Improve, and Control*).

a. Define
Six Sigma quality improvement program is definition. At this point, we should define a number of topics related to *Six Sigma* project selection criteria , the roles and responsibilities of those involved, training requirements for those involved, important processes in the project and its customers, specific customer needs, and the project goal statement (Vincent Gasperz) . Key processes, process flow and how they interact and the client involved in each process must all be determined for each selected Six Sigma project. The SIPOC process model must be understood before defining important processes and clients in Six Sigma projections. SIPOC (*Suppliers – Inputs – Processes – Outputs – Customers*) is the most popular and practical tool for process management and improvement.

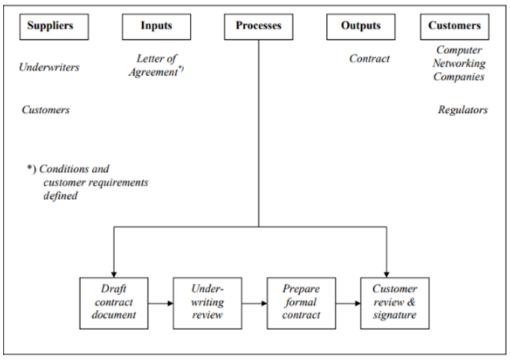

Figure 1 SIPOC Diagram

b. Measure
The second operational phase of the Six Sigma quality improvement methodology is called Measure. At this point, the process capability level is calculated using DPMO (*Defect Per Million Opportunity*), and the capacity level is measured. Seven wastes are displayed to identify the most impactful waste of each (Roby Rio Andiwibowo, Joko Susetyo, 2018). The way to determine the DPMO value and *Sigma value* is as follows. (Rinjani et al., 2021)

a. Calculating DPU (Defect Per Unit)

$$DPU = \frac{Number\ of\ Production\ Defects}{Production\ Quantity}$$

b. Calculating DPO (Defect Per Opportunities)

$$DPO = \frac{Defects\ Per\ Unit}{Defect\ Probability\ Per\ Unit}$$

c. Calculating DPMO (Defects Per Million Opportunities)

$$DPMO = DPO \times 1.000.000$$

d. To obtain sigma results, convert the DPMO calculation results using the Six Sigma table.

c. Analyze
The third operational phase in the *Six Sigma* quality improvement methodology is analysis. Analysis focuses on the causes of deficiencies, errors, or excessive variance. Currently, an analysis of the CTQ (*Critical To Quality*) obtained is being carried out. CTQ is classifying causal sources using the concepts show in the cause and effect diagram (Fishbone Diagram).

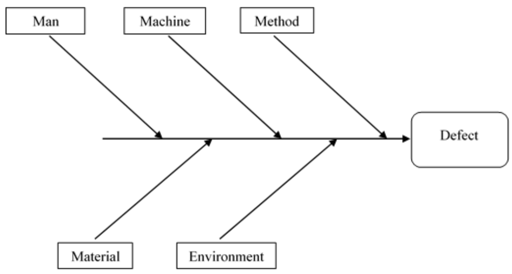

Figure 2 Fishbone Diagram

d. Improve (Repair)
The next step in implementing *Six Sigma* quality improvement is to identify an action plan, namely Improve. The goal of Improve is to gather ideas for problem solving or elimination, as well as to improve performance measurements detected during the Analysis phase.

e. Control
The final operational phase of a Six Sigma quality improvement project is called control. At this point, the *Six Sigma project* ends when ownership and responsibility are transferred

from the *Six Sigma Team* to the owner or person responsible for the process. Additionally, *Six Sigma initiatives* across business processes or other organizational domains are classified as new projects, thereby requiring adherence to the DMAIC (*Define, Measure, Analyze, Improve, and Control*) cycle. Increased learning, institutionalization, integration, and sharing or transfer of new information within a *Six Sigma organization* are the expected outcomes of this approach. (Gaspersz, 2002)

3. METHODOLOGY

This research was conducted to control the quality of bag production, ensuring smooth operations and high-quality products without defects. This study is both descriptive quantitative and qualitative, involving the collection of production data over one year, specifically from 2022, and direct field observations through interviews with the owner and workers at Alfajar Bag. The research was carried out at Alfajar Bag Convection, located on Jalan Cempaka Baru IX, Cempaka Baru, Kemayoran District, Central Jakarta, Special Capital Region of Jakarta.

This research began by identifying the problems that occurred at the Alfajar Bag Convection. After that, continue with literature study by looking for previous research journals that are useful as references in conducting research. Then data was collected by conducting direct observations and interviews with the company to look for problems related to the production process at the company. After the data is obtained, it continues with data processing using the Lean Six Sigma method which applies the (DMAIC) stage. The Define stage includes making actual observations in the field, namely data on the number of product errors in a particular year. To identify problems, the SIPOC diagram is also used which is useful in determining problems in production and CTQ (Critical to Quality). Measure Stage To ensure the lower and upper limits, this step involves data analysis using a control chart. Then the sum of the DPMO and sigma values is calculated to determine the characteristics of product quality. In the Analyze stage, data from Measure is analyzed to identify the root causes of defects in each critical waste for each identified *waste by utilizing Pareto Diagrams and Cause and Effect Diagrams (Fishbone Diagrams*). The Improve stage is described by a work method which includes problem analysis and proposals to determine which *waste* will be a priority for recommendations for improvement. Control Stage to reduce production errors by implementing improvement suggestions from the improve stage into practice. In addition, if there are deficiencies in the planned improvement program, continuous improvement will be implemented.

4. RESULTS AND DISCUSSION

This research focuses on one type of bag produced at Alfajar Bag, the Ransel Rempel backpack, which is highly popular among consumers but frequently experiences production defects. The production stages of the Ransel Rempel bag include pattern drawing and material cutting, gluing, stitching, zipper installation, assembling and stitching all components, accessory installation, and packaging.

The Lean Six Sigma methodology with the DMAIC approach (Define, Measure, Analyze, Improve, Control) is used to analyze the data. This method is straightforward and useful for quality control. The stages of the DMAIC approach are as follows: defining the problem (*Define*), measuring capabilities and setting goals (*Measure*), analyzing data to understand the issues (*Analyze*), improving performance and minimizing sources of problems (*Improve*), and implementing process controls for the future (*Control*).

4.1 Define Stage

Define stage is identifying problems that affect waste in the bag production process . At this stage the SIPOC diagram and CTQ determination will be explained.

a. SIPOC Diagram

The production process in convection in producing bags can be identified through the SIPOC diagram, which is as follows:

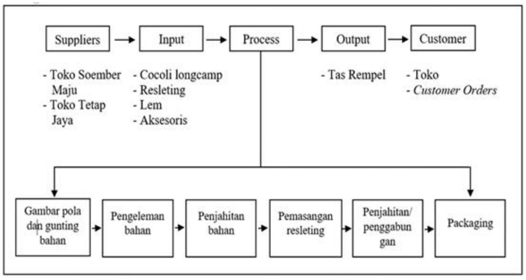

Figure 3 SIPOC Diagram

Based on the SIPOC diagram above, to produce bags using a sewing machine which plays a very important role in bag production at the Alfajar

Bag convection. The *output* is in the form of Rempel backpacks which will be distributed to shops and customer orders which are *customers* . To produce bags, the main raw materials are used, namely fabric as the main material and other bag components such as zippers, bag straps and accessories.

b. Identifying CTQ
The purpose of CTQ identification is to identify the type of product defect and the production process where the defect arises. Based on CTQ identification, in the production process carried out there are 4 types of defects, namely stitching, zipper, glue and accessories defects.

4.2 Measure Stage

Using the data that has been collected, the CTQ, DPMO, and Sigma values will be calculated at this measurement stage.

a. CTQ Determination
Data was obtained by conducting direct interviews with the owner and several workers at Alfajar Bag and the results were obtained in the following table:

Table 1 CTQ Determination

No	Type of Defect	Amount	Defects (%)	Cumulative (%)
1	Stitching	546	47.60%	47.60%
2	Zipper	266	23.19%	70.79%
3	Glue	186	16.22%	87.01%
4	Accessories	149	12.99%	100.00%
Total		**1,147**	**100%**	

Based on data processing from the table above, it can be seen that the number of product defects during production taken based on production data is 1,147 production defects or defects. The most production defects were stitching defects, 546 bags, and the fewest were accessories defects, namely 149 bags, based on 1 year of production data.

b. DPMO and Sigma Level Calculation
The DPMO and Sigma Level values are searched using the six sigma formula and the results can be seen in the table below:

Table 2 DPMO and Sigma Level Calculation

No.	Month	Production	Defective Products	DPU	DPO	DPMO	*Sigma Level*
1	May	480	32	0.067	1,667	16,666,667	3,628
2	June	924	38	0.041	1,208	10,281,385	3,816
3	July	888	35	0.039	0.985	9,853,604	3,832
4	August	852	54	0.063	1,585	15,845.07	3,648
5	September	960	72	0.075	1,875	18,750	3.58
6	October	1,128	81	0.072	1,795	17,952.128	3,598
7	November	1,224	96	0.078	1,961	19,607,843	3.56
8	December	1,296	274	0.211	5,285	52,854,938	3.11
9	January	816	77	0.094	2,359	23,590,686	3.48
10	February	1,248	175	0.14	3,506	35,056.09	3,311
11	March	1,128	127	0.113	2,815	28,147,163	3,409
12	April	996	86	0.086	2,159	21,586,345	3,522
Amount		**11,940**	**1,147**	**0.096**	**2,402**	**24,015,913**	**3,477**

Based on the DPMO and Sigma Level calculation table above, the overall value can be seen, namely with a DPMO value of 2,2515.99 while the *Sigma value* obtained was 3.5 . Thus, it can be described that if the Alfajar Bag convection produces one million bag products , it will produce *a defect* of 2,2515.99 bag unit. And *Sigma's results* from Alfajar Bag bag production are at level 3.5, which has reached the national industry average level.

Thus, bag production at Alfajar Bag still has to make improvements and develop systems related to the production process in stages to reach sigma level 5 to sigma level 6 which is the highest level of the international class so that the profits obtained are greater and to make it easier to compete with SMEs who produce the same product.

4.3 Analyze Stage

The analysis stage will be carried out using Pareto Diagrams and Cause-Effect Diagrams

(Fishbone Diagrams), to analyze the causes of waste generation in the bag production process based on important waste at the Analysis stage.

a. Pareto Chart

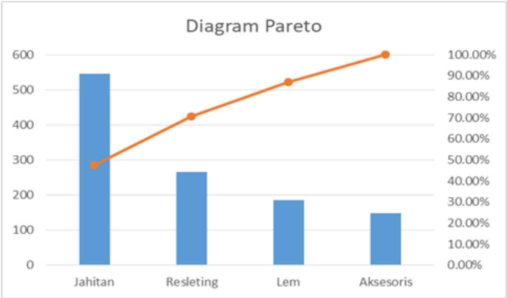

Figure 4 Pareto Chart

From the Pareto Diagram above, it can be seen that there is a defect that is most influential and prioritized for improvement in the production of Rempel Backpacks, namely stitching defects with a total of 546 bags amounting to 47.60%.

b. Cause-Effect Diagram (Fishbone Diagram)

The Fishbone Diagram functions to determine the Cause and Effect in a production and to describe the indicators that cause defects and waste in the production of Rempel Bags at Alfajar Bag.

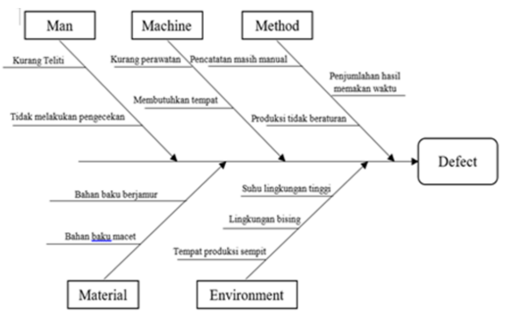

Figure 5 Fishbone Diagram

4.4 Improve Stage

In the Improve stage, improvements are made to the results of the Analyze Stage by using 5W+1H, namely (*What*, *Why*, *Where*, *When*, *Who*, *How*) to identify action plans and make Improvement Proposals based on the analysis process in the *Fishbone Diagram* which focuses on 5 key factors that in the production process, namely (*Man*, *Machine*, *Method*, *Material*, *Environment*) as well as indicators and *waste* that occurs, then there are several suggestions for improvements that will be made.

4.5 Control Stage

In DMAIC, the Control stage is last. To at least help companies carry out quality control, it is now explained in the form of input for companies in accordance with the proposed changes at the Improve stage as outlined in the 4M+1E and 5W+1H Analysis tables. After improvements have been made, the business must continue to monitor employees and carry out quality control in accordance with the suggestions for improvements made in the Improve stage.

The aim of carrying out control on proposed improvements is to reduce waste in the production process, reduce costs, maintain profits, maintain consumer confidence . To support the success of production and reduce product defects in bag production by carrying out a checklist for implementing SOP (Standard Operating Procedure), namely rules and guidelines that serve as a reference in carrying out the production process with their respective duties in each production. After the SOP is implemented, continue with making a checklist for workers so they can re-check the production bags before packaging the bags. It is hoped that implementing the checklist can help control product quality before distribution to customers so that production is maintained and consumer satisfaction is achieved

5. CONCLUSION

Based on the results of research conducted by researchers, several conclusions can be drawn as follows:

1) The causes of product defects in the production of Rempel backpacks at Alfajar Bag are stitching defects, zipper defects, glue defects and accessory defects.
2) The results of the DPMO and Sigma Level calculations show that the average DPMO value is 24,015.913 and Sigma Level 3.477σ.
3) Proposed improvements to reduce product defects and waste in bag production at Alfajar Bag include carrying out supervision, carrying out maintenance, improving production records, improving raw material storage and other suggestions contained in the Improve stage . After providing the proposal, continue with carrying out Control and adding the implementation of SOP (Standard Operating Procedure) and creating a production checklist which is carried out *continuously*.

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