
PRODUCT QUALITY CONTROL OPTIMIZATION THROUGH THE SIX SIGMA METHOD APPROACH

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Abstract

The right quality of products and services in accordance with consumer preferences has a crucial role in determining the success of a company. Therefore, deep understanding of consumers, their needs and expectations that must be met is an important aspect for the organization. In order to maximize quality improvement efforts, the Six Sigma method is an integral key element. This method has been proven to be effective in optimizing product and process quality, with a positive impact on reducing the rate of defects that have a negative impact on company performance. Through a structured and measurable approach, Six Sigma is able to steer companies towards sustainable development. The Six Sigma method includes a series of steps known as DMAIC, namely Define – Measure – Analyze – Improve and Control. Through the Definition stage, the company explicitly identifies problems or opportunities for improvement and maps out the project framework. The Measurement step refers to collecting relevant data to analyze the initial situation, while the Analysis step is used to analyze the data in depth to identify the root cause of the problem. After that, the Improvement stage is carried out by designing and testing suitable solutions to overcome the identified problems. Lastly, the Control step ensures that the changes implemented are maintained and sustained over the long term. while the Analysis phase is used to analyze the data in depth to identify the root cause of the problem. After that, the Improvement stage is carried out by designing and testing suitable solutions to overcome the identified problems. Lastly, the Control step ensures that the changes implemented are maintained and sustained over the long term.

Keywords: Quality, Six Sigma Method, DMAIC.

Introduction

In the era of globalization and increasingly fierce competition, product quality is a critical factor affecting the competitiveness of a company in the market. Poor quality can result in decreased customer satisfaction, additional costs due to manufacturing defects, and a negative impact on the company's image. Therefore, companies must focus on quality control of their products to ensure that the resulting products meet or exceed customer expectations.

One method that has been proven effective in improving product quality and production processes is the Six Sigma method. Six Sigma is a quality management approach that focuses on reducing variations in the production process, thus minimizing defects and discrepancies with established specifications. This method uses a data-driven approach (data-based) and combines statistical concepts with management strategies (Evans and Lindsay, 2007).

In product quality control, the Six Sigma method can be used to identify the root causes of quality problems, measure the level of defects or discrepancies, and design continuous improvements. By implementing Six Sigma principles, companies can achieve high levels of quality, better efficiency, and reduced costs due to manufacturing defects (Douglas C, Montgomery, 2009).

However, although the great potential of Six Sigma in improving product quality has been widely recognized, not all companies have been able to implement this method successfully. The process of introducing Six Sigma requires commitment from various levels of the organization, proper training of personnel, and the use of sophisticated statistical analysis tools. Therefore, it is necessary to have a more in-depth study on how to optimize product quality

control through the Six Sigma method approach, especially in the context of a specific industry and business environment.

The characteristics of the current business environment describe an era filled with rapid developments in various fields, requiring excellent management capabilities in anticipating and adapting to any changes that occur in global economic activity. These changes form a dynamic and challenging business landscape, where companies must have adaptive and innovative strategies to remain competitive (Brue, 2002).

There are three main characteristics of change that are now being emphasized in the face of an increasingly complex business environment: temporality, diversity, and novelty. First, temporary refers to the temporary or impermanent nature of business situations and conditions. What is effective today may no longer be relevant tomorrow. Second, diversity refers to a wider variety of things, including consumer preferences, business models, and technology. Third, recency implies that new changes are constantly emerging, whether in the form of cutting-edge technologies, evolving consumer trends, or new management paradigms. (Bissell, 1990).

In dealing with these three characteristics, companies must have a high ability to maintain and improve the quality of their products. Consistent and superior quality is one of the key factors that can help companies retain customers, win in a competitive market, and adapt to the rapidly changing business environment. This is where the importance of product quality control becomes increasingly felt. The Six Sigma method is emerging as a very relevant approach. Six Sigma is not just an approach to reducing product defects, but also a philosophy that includes continuous improvement, accurate measurement, in-depth data analysis, and implementation of measurable and targeted changes. By adopting Six Sigma principles, companies can be better prepared to deal with transience, diversity, and novelty in today's business environment. However, the implementation of Six Sigma must also be understood as a complex and highly committed step. It requires an investment of time, resources and commitment from multiple levels of the organization. Therefore, there is a need for further research and development on how to optimize product quality control through the Six Sigma method approach in dealing with the characteristics of this dynamic business environment (Peter et al, 2000).

By acknowledging the urgency and relevance of changes taking place in the business world today and seeing the potential of the Six Sigma method in dealing with this challenge, research or implementation efforts aimed at optimizing product quality control through the Six Sigma method approach will have a solid foundation. It is hoped that these steps will help companies maintain superior product quality, increase competitiveness, and deal successfully with the continuous changes that occur in a dynamic global business environment (DOrothea, 2004).

By understanding this background, research or initiatives aimed at optimizing product quality control through the Six Sigma method approach will have a solid foundation. It is hoped that the successful implementation of this method will help companies improve the quality of their products, reduce production defects, and ultimately, increase customer satisfaction as well as competitiveness in the market.

Literature Review

The concept of quality in business has undergone various evolutions and approaches from various figures and experts in management. An understanding of quality does not only involve the technical and physical aspects of a product or service, but also involves the dimensions of customer satisfaction, fulfillment of needs and compatibility with business objectives. The following is a further development of opinions regarding the notion of quality from various perspectives:

Juran (1962) revealed that quality is "fitness for purpose or benefit." That is, the quality of a product or service can be measured based on the extent to which the product meets the stated objectives.

Crosby (1979) defines quality as "conformance to requirements which includes availability, delivery, reliability, maintainability, and cost effectiveness." This definition places more emphasis on meeting customer needs in various aspects, including availability, delivery, reliability, ease of maintenance, and cost effectiveness.

Deming (1982) argues that quality must meet current and future customer needs. This underscores the importance of considering the long-term needs of customers in the product and service development process.

Feigenbaum (1991) defines quality as "the totality of product and service characteristics which include marketing, engineering, manufacture, and maintenance, in which these products and services in use will conform to the needs and expectations of customers." This definition covers all aspects of the product or service life cycle, from development to maintenance, with the goal of meeting customer requirements.

Scherkenbach (1991) put forward the view that quality is determined by the customer, and that customers want products and services that match their needs and expectations at a certain price level that reflects the value of the product.

Elliot (1993) argues that quality is something that varies for each person, depending on the context of time and place, or can be adapted to the goals to be achieved.

Geoetch and Davis (1995) define quality as "a dynamic condition with regard to products, services, people, processes, and the environment that meet or exceed what is expected." This definition highlights the dynamic and relative aspects of quality, which can change over time and development. The definitions of ISO 8402 and the Indonesian National Standard (SNI 19-8402-1991) define quality as "the totality of features and characteristics of a product or service that bear on its ability to satisfy needs, whether stated expressly or implicitly." The term "requirement" is defined as the specifications written in the contract or criteria that must be explained in more detail beforehand.

Comprehensive understanding of the various opinions of these companies to form a holistic view of the quality of their products and services, considering technical aspects, customer satisfaction, and adaptation to changes in the dynamic business environment.

Quality control is an important approach in the industrial world that aims to ensure that the products or services produced meet the expected quality standards. In eras competition increasingly stringent, it is important for companies to have strong control over the quality of their products to maintain customer satisfaction and achieve efficiency in the production process. This article will develop the aims and benefits of quality control in the context of production, with reference to the views of several experts.

A. Quality Control Objectives

1. Purpose of Quality Control according to Assuari (1980):

a. Achieve Quality Standards

The main purpose of quality control is to ensure that the goods or products produced reach the quality standards that have been set. This helps ensure that the products put out by the company are of consistent quality and meet customer expectations.

b. Inspection Cost Reduction

By implementing good quality control, companies can reduce the costs associated with the inspection process. An effective inspection process can help identify defects or non-conformances earlier in the production process, reducing the need for repeated inspections.

c. Production Cost Reduction

Good quality control can also help in reducing the overall cost of production. By avoiding defects and optimizing production processes, companies can save on costs that may occur due to scrap or unfit products.

2. The purpose of Quality Control according to Reksohadiprojo and Sudarmo (1985):

a. Quality Improvement

Quality control aims to continuously improve product quality. By identifying problems and defects, companies can take the necessary corrective steps to improve the quality of their products over time.

b. Keep it Quality

In addition to improvement, quality control also aims to maintain the quality that has been achieved. This involves ensuring that the production process remains consistent and conforms to established quality standards.

c. Reduction of Damaged Materials

One of the main benefits of quality control is the reduction in the number of defective materials or products. By identifying defects early, companies can avoid wastage of materials and reduce costs associated with defective products.

3. The purpose of Quality Control according to Ahyari (1990):

a) Improved Consumer Decisions

By ensuring good quality, companies can increase consumer confidence in their products. Consumers are more likely to choose products that are guaranteed to have adequate quality.

b. Production Cost Efficiency

Effective quality control can help reduce production costs by avoiding wastage of resources due to production defects. This can help companies maintain their competitiveness in the market.

c. Selection of the Right Time

Through quality control, companies can ensure that the products produced meet predetermined deadlines. This is important in meeting customer demands and maintaining smooth operations.

In all, quality control is an integral part of the production process which aims to produce high quality products, meet customer expectations, and reduce wastage and production costs. By implementing an effective quality control approach, companies can build a good reputation, improve customer satisfaction, and maintain their competitiveness in a competitive market.

B. Six Sigma

There are many definitions of Six Sigma. Six Sigma is defined as a technologically advanced method used by engineers and statisticians in improving/developing processes or products. Six Sigma is interpreted that way because the main key to improving Six Sigma is using statistical methods, although not entirely talking about statistics. Another definition of Six Sigma is "the goal of approaching perfection in achieving customer needs". There are also those who define Six Sigma as "an attempt to change the corporate culture to achieve better customer satisfaction, profits and competition". The main key to the understanding above is measurement, goals or changes in corporate culture.

Complete and clear definition of Six Sigma is a comprehensive and flexible system for achieving, supporting and maximizing business processes that focuses on understanding customer needs using facts, data and statistical analysis and continuously pays attention to managing, improving and reviewing business processes. The advantages of implementing Six Sigma are different for each company concerned, depending on the business it is running.

Research Methods

A. Six Sigma Steps

Six Sigma has implementation steps, namely DMAIC, which stands for Define – Measure – Analyze – Improve and Control. The five stages are always repeated to form a cycle, as shown in Figure 1. The DMAIC improvement methodology is a very focused and continuous step, where the first step and the next step are interrelated.



Figure 1. DMAIC Six Sigma Method Cycle

For more details, the Define - Measure - Analyze - Improve and Control (DMAIC) steps can be described as follows:

1. Define (Definition)

The first step in DMAIC is to clearly and specifically define the problem or improvement opportunity. The purpose of this step is to understand the context, scope, and objectives of the improvement to be achieved. Common activities carried out in this stage include:

- a) **Defining Project**
Determine specific improvement projects, including what you want to achieve and why improvements are needed.
- b) **Setting the Scope**
Identify the project boundaries, what is included and what is not included in the analysis.
- c) **Identifying Parties Involved**
Identify the project team and stakeholders involved.
- d) **Formulating Goals**

Describe the improvement goals quantitatively, for example reducing production defects, increasing efficiency, or increasing customer satisfaction.

2. Measure

After the project and objectives have been defined, the next step is to measure data and information related to the problem to be solved. This involves gathering accurate and objective data to identify the root cause of the problem. The steps in the measurement stage include:

- a) **Defining Important Variables**
Identify the parameters or variables that are related to the problem and need to be measured.
- b) **Collecting data**
Collect relevant data according to predetermined variables.
- c) **Analyzing Data**
Analyze data to identify patterns or trends that may be contributing factors to problems.

3. Analyze

After the data is collected, the analysis phase aims to analyze the data in more depth to identify the root cause of the problem. Activities in the analysis phase include:

- a) **Deep Data Analytics**
Use statistical methods and other analytical tools to identify the factors that cause problems.
- b) **Identification of Root Causes**
Identify the main causes of the problem and look for relationships between the variables involved.

4. Improve (Repair)

Once the root cause of the problem has been identified, the next step is to develop solutions and make changes to the relevant processes or systems. The steps in the repair stage include:

- a) **Solution Development**
Build a solution that might address the root cause of the problem.
- b) **Trials**
Test the proposed solution on a small scale or in a controlled environment to measure its effectiveness.
- c) **Implementation**
Implement tested and proven solutions into daily operations.

5. Control

The last step in DMAIC is to ensure that the changes that have been made can be maintained and the results of improvements remain consistent over time. The steps in the control stage include:

a) Develop Control System

Create a control and measurement system to monitor process performance after improvements are implemented.

b) Performance Monitoring

Perform continuous monitoring of process performance and collect relevant data.

c) Make Corrections and Improvements

If there is deviation from the target or new problems arise, additional corrective steps can be taken.

DMAIC is a structural approach that helps companies improve and optimize their business processes with a data-driven and analytical approach. Each step has its own purpose and each stage supports the other to achieve perfection and high customer satisfaction.

Results and Discussion

In quality control with Six Sigma, there are many tools (tools) that are used and are quite extensive. The image below shows what methods and tools are used in Six Sigma but not in full. Some of the Six Sigma tools used in this study include:

1. In Pareto chart

In Pareto diagrams are used to find problems or causes that are key in solving problems and comparisons to the whole.

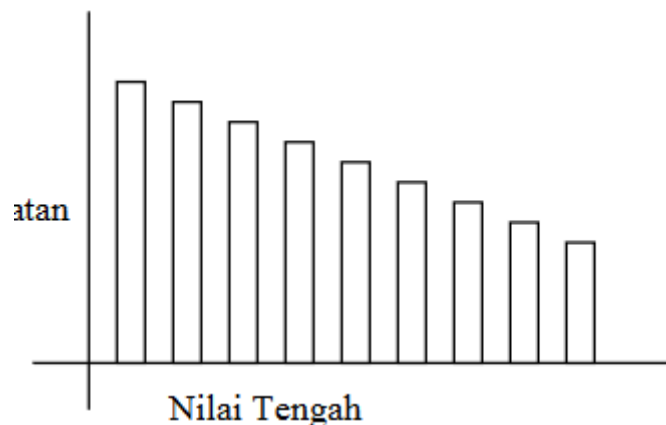


Figure 2. Pareto Diagram

2. In SIPOC diagram (Supplier, Input, Process, Output, Customer)

SIPOC used to show major activities or subprocesses in a business process together with the framework of the process presented in Supplier, Input, Process, Output, Customer. While input requirements must be directly related to process requirements (process requirements)

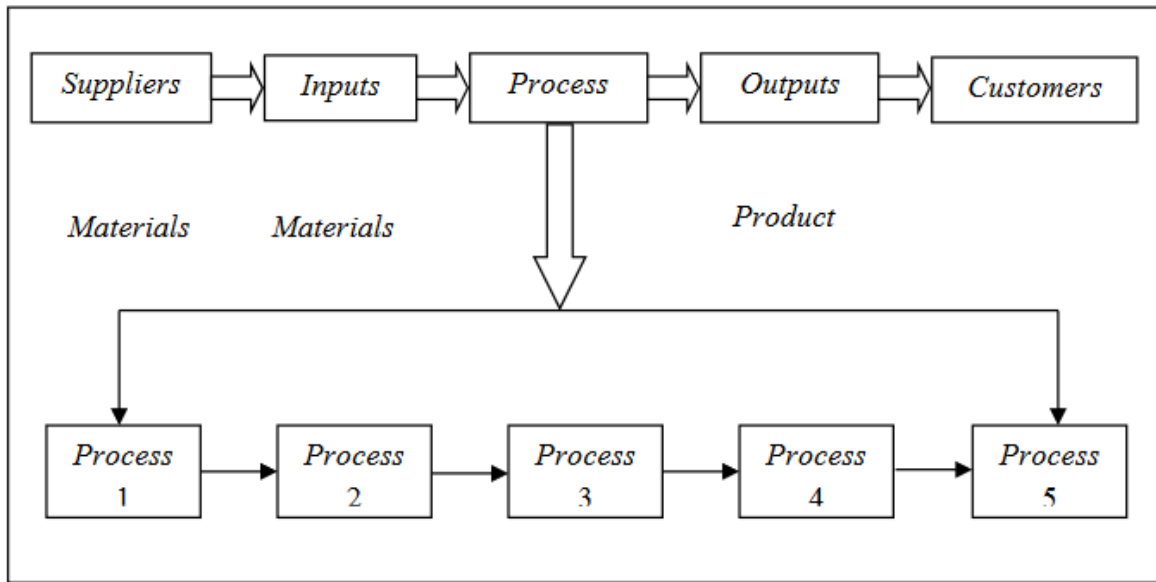


Figure 3. SIPOC diagram

3. Peta Control

In the production process, deviations in the resulting size can be found. The control chart is basically an analytical tool made following a statistical method, where data relating to product quality will be plotted in a control chart. Here we will use a control map for attribute data types (Attribute control chart), namely p-chart.

4. Control Chart

Control affect is a tool to describe in a precise way what is meant by statistical control. Control charts can also be used as a management control tool to achieve certain goals regarding process quality. The function of using the quality control chart is as follows:

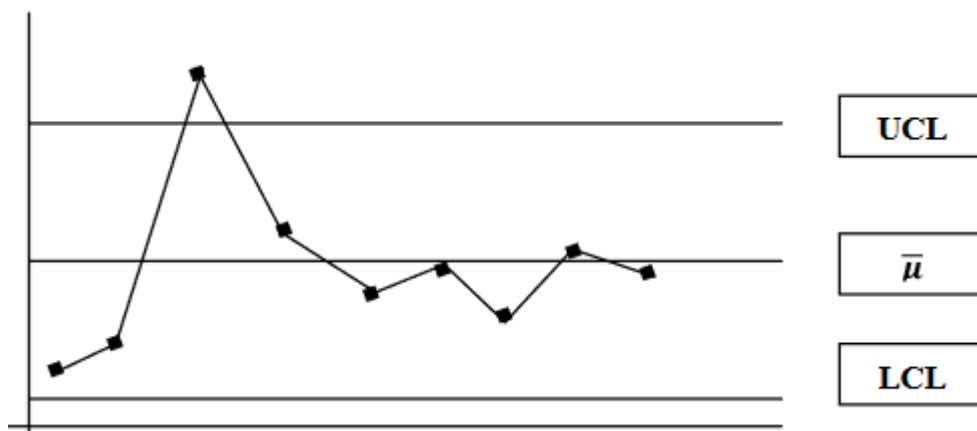


Figure 4. Control Chart

5. Brainstorming

Brainstorming is known as one of the tools/means that can be used to look for factors that cause work irregularities. Giving suggestions is a management bottom-up disclosure because it gives freedom to convey ideas and input. One problem with brainstorming is that everyone assumes that what they are coming up with is a good thing, or that they are giving ideas to appear good to other people.

6. Inagram Cause and effect (Fishbone Diagram)

In a causal diagram known as a fishbone diagram (fishbone diagram) was introduced by Prof. Kaoru Ishikawa in 1943. This diagram is useful for analyzing and finding factors that have a significant influence in determining the quality characteristics of work output. To find the factors that cause deviations in work results, there are five main causal factors that need to be considered, known as the 4 MIE, namely:

- a. Human
- b. Working method
- c. Machine
- d. Raw materials
- e. Work environment

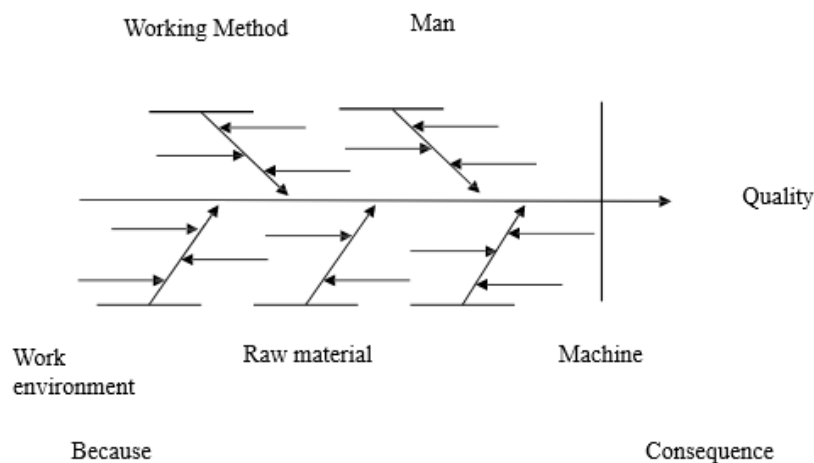


Figure 5. Cause-Effect Diagram

Conclusion

1. Six Sigmamhas implementation steps, namely DMAIC, which stands for Define – Measure – Analyze – Improve and Control.
2. BSome of the Six Sigma tools used in this study include:
 - a. Pareto Charts
In Pareto diagrams are used to find problems or causes that are key in solving problems and comparisons to the whole.
 - b. SIPOC Diagram (Supplier, Input, Process, Output, Customer)
SIPOC is used to indicate major activities or subprocesses in a business process together with the framework of the process presented in Supplier, Input, Process, Output, Customer.
 - c. Control Map

In the production process, deviations in the resulting size can be found. The control chart is basically an analytical tool made following a statistical method, where data relating to product quality will be plotted in a control chart.

d. Control Chart

Chartcontroller is a tool to describe in a precise way what is meant by statistical control. Control charts can also be used as a management control tool to achieve certain goals regarding process quality.

e. Brainstorming

Brainstorming is known as one of the tools/means that can be used to look for factors that cause work irregularities. Giving suggestions is a management bottom-up disclosure because it gives freedom to convey ideas and input.

f. Cause-and-effect Diagram (Fishbone Diagram)

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