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Quality Improvement Using the Six Sigma DMEDI Method for Hand Sterilizer Products

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ABSTRACT

XC Clenaindo Company is a manufacturing company that provides cleaning and sanitation services in Indonesia. However, defects that exceeded the company's tolerance limits were found in hand sterilizer products. This research aims to improve product quality so that it satisfies customer needs. Analysis was conducted to determine the leading causes of product defects using the Six Sigma Define, Measure, Explore, Design, and Implement (DMEDI) method. The DMEDI Six Sigma method is a quality improvement method with a creative approach so that the resulting solution can be a new work system design. The results of the defined process research found two problems, namely product defects because the Sterobac hand sterilizer bottle was convex and the length of the label installation process. At the measure stage, it was discovered that the problem was in the filling and labeling process, which was influenced by the increasing number of requests. At the exploration stage using the 5 why deep interview method, it was discovered that the problem was due to the lack of temperature during the liquid pouring process and the label design making the sticking process difficult. So, the work process was redesigned at the filling stage, and a new label design was created, which made it easier for workers to stick labels and apply the 5S concept. The final stage was implemented by designing the Poka-Yoke Form and Worker Operational Standards for the Filling. This research results in a reduction in the number of defective products.

Keywords:

Six Sigma DMEDI; Quality Improvement; Manufacturing Company.

Introduction

XC Cleanindo Company mainly called iCLEAN, produces various premium quality products to meet cleaning and sanitation needs. Founded in 2007 and increasing with a distribution network that has reached 29 cities in Indonesia and plans to add to several other large cities. Products produced by XC Cleanindo Company include Hand Sterilizer Sterobac, Toilet Seat Sanitizer, Clean Bright Xtra, and many more during the COVID-19 pandemic in Indonesia, XC Cleanindo Company is increasingly well known in Indonesia, especially the Sterobac Hand Sterilizer. However, with increasing demand, XC Cleanindo Company is increasingly having difficulty meeting market demand, resulting in frequent loss of customers (loss of orders). Some reasons for loss orders are the high number of defects in Sterobac Hand Sterilizer products after production. This condition harms companies and consumers because many products cannot be shipped.

This research focuses on process decomposition to improve product quality using the Six Sigma DMEDI method. The study case used is the Sterobac Hand Sterilizer product produced by XC Cleanindo Company to reduce the number of defective products. Figure 1 is an example of a defective Sterobac

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Hand Sterilizer product. Defects in the Sterobac Hand Sterilizer product include bulge bottles and labels that are not correctly installed.

Figure 1. Convex Sterobac Hand Sterilizer Packaging Bottle

DMEDI is one of the six-sigma methods for improving product or process quality, and it has five stages: Define, Measure, Explore, Design, and Improve [1]. Quality is a significant value when the digital world is developing [2], [3]. This is because the more the digital world develops, the broader the scope of marketing, resulting in increasingly tight market competition[4]. In tight market competition, products that can survive have superior quality[5]. Building sustainable quality is an essential goal for various companies[3]. The value of quality focus is presently focused on customer satisfaction, profit value, and cost reduction [6]. Multiple methods are used to assess product quality, including Six Sigma. Six Sigma is a management methodology that aims to improve quality by identifying and eliminating the causes of defects. [7], [8].

Six Sigma tools are commonly utilized within different performance improvement methodologies, including Design, Measure, Analyze, Improve, Control (DMAIC), Define, Measure, Analyze, Design, Verify (DMADV), and Define, Measure, Explore, Design, Implement (DMEDI)[9]. Typically, DMAIC is employed to enhance existing products, processes, and services, whereas DMADV and DMEDI are applied to design and develop new products, processes, and services. DMEDI has similar processes to DMAIC; the only difference is that in DMEDI, improvements are made by adding or replacing processes [10], [11]. Permedaan antara DMADV dengan DMEDI ada pada proses ketiga dan kelima, Dimana jika pada DMADV berhenti di tahap verify namun DMEDI berhenti pada tahap implement. DMADV is used when there is a need to redesign or develop a new product/process that relies heavily on data validation before implementation. This is in contrast to DMEDI, which is more suitable for innovations that require creative exploration and direct testing in implementation. The DMEDI method is expected to provide broader solutions because it is not limited by existing systems[12]. Some previous research regarding improving product quality using the DMEDI method is the Integration of the production process of the Xerox company [10] reduction of manual-handling strategies in the production process in a manufacturing company [1], designing a teabag product [12], [13].

This research focuses on improving the production quality of the Sterobac Hand Sterilizer by analyzing the production process using the Six Sigma DMEDI method. The defined process is carried out by collecting the Voice of the Customer (VOC) and creating a SIPOC diagram for the Sterobac Hand Sterilizer product[12], [13]. Meanwhile, in the Measure stage, process flow charts and trees of requirements are used to find key product performance indicators[14]. Next is the Explore stage, which uses the 5 Why method to find the root of the problem. This research hypothesizes the need to design new stages or equipment to improve product quality. Therefore, the design stage is carried out

by creating new stages or designing the equipment needed to improve quality. The final stage is implementing the Poka-Yoke technique and creating standard operational procedures (SOP).

Methods

This research was conducted by direct observation at XC Cleanindo Company and interviews with managers and operators in the filling, packaging, and labeling divisions. In addition, a literature study was conducted to enrich reference materials from sources relevant to the problems studied by understanding the theory to solve the issues. The method used in this study is Six Sigma, which has the stages of Define, Measure, Explore, Design, and Implement (DMEDI). DMEDI is one type of Six Sigma method. The most frequently used Six Sigma is DMAIC (Define, Measure, Analyze, Improve, and Control) [15], [16]. Unlike DMAIC, the DMEDI method focuses more on creativity in solving problems so that a solution is possible in the form of a new design for a system [13]. Figure 2 is the method used in this study.

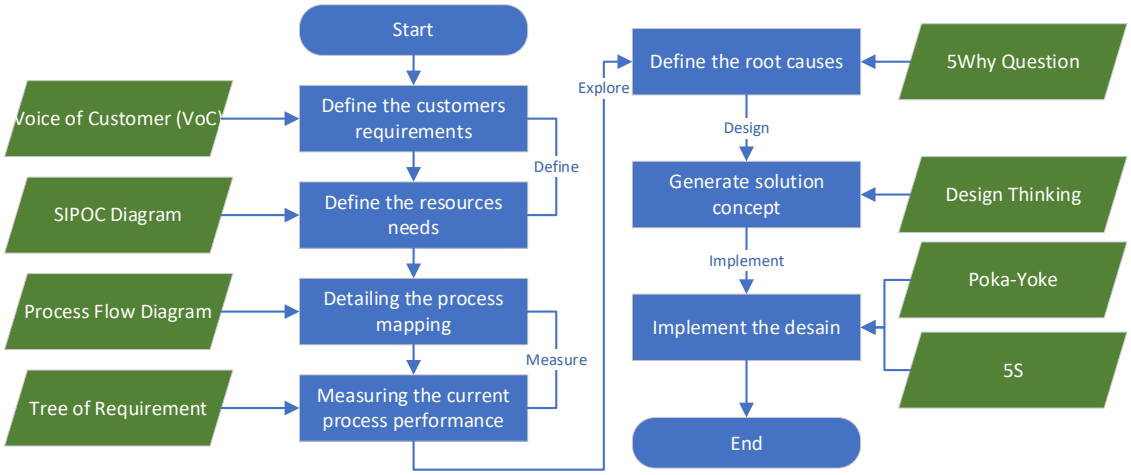


Figure 2. Reseach Method

In Figure 2, it can be seen that the stages of this research consist of five phases, namely: Define, Measure, Explore, Design, and Implement [17]. Each stage consists of several tools used. In the define phase, this is done by formally defining the target of improving the quality of the process to be consistent with customer demand or needs and company strategy. The Voice of Customer tools and the SIPOC diagram are used [10]. At the measure stage, data is collected on how quickly and effectively to find out what causes the problem, using a tree of requirements. At the explore stage, it is done to identify the underlying causes of a problem and focus on completing the next phase. In studying the 5 WHY tools used, the design stage confirms the design specifications to ensure the solution meets end-user requirements and improves and resolves problems identified through root cause analysis. The last stage is the implementation stage. The implementation stage aims to help employees implement the previously designed design. The Poka-Yoke Form and 5S tools are used [18], [19].

Results and Discussion

This research consists of 5 phases: Define, Measure, Explore, Design, and Implement (DMEDI). Each phase is a crucial stage to achieve quality improvement. The first phase starts with defining consumer needs and resources. Furthermore, the measure stage is carried out to find key performance indicators and measure current process performance. After getting the current process value, the exploration stage is continued to get to the root of the problem. The root of the issue found then becomes the basis

for the design stage so that the design is designed effectively and efficiently. The last stage is the implementation stage, which makes it easier for operators to apply new designs.

1. Define Phase
   At the define stage, all data about the company is collected to find problems in a process. Data can be primary or secondary data. Primary data is obtained by conducting in-depth interviews with workers at XC Cleanindo Company so that the Voice of Customer (VoC) of the company's problems can be found. Table 1 is the VoC from the operator's perspective as the end user who produces the Sterobac Hand Sterilizer.

Tabel 1 Voice of Customer

End user comment	Why are they saying ut?	What do they want?
average defective products are high up to more than 5%	*Defective bottle that bulges when filled with liquid*	*The bottle does not bulge when filled with liquid.*
	Stickers that are not in the right place and have been attached for a long time	*Addition of a machine for attaching stickers*

The interview results showed two causes of production defects in the Sterobac Hand Sterilizer: defective bottles that bulged when filled with liquid and stickers that were not in place and had been attached for a long time. The problem of bottles that bulge when filled with liquid must be identified as the leading cause of the problem. In contrast, the problem of workers' desire for a machine to help attach stickers to bottles needs to be considered in terms of importance and effectiveness. Therefore, the defined process is continued by elaborating with a SIPOC (Supplier Input Process Output Customer) diagram and creating a Product Breakdown Structure to determine the central location of the quality problem of the Sterobac Hand Sterilizer product.

Tabel 2 SIPOC (Supplier Input Process Output Customer)

Supplier	Input	Process	Output	Customer
Ingredients : 1. Ethyl alcohol 70% (Ajidharma Corp) 2. 1-proponal 10%, 3. polyethylene glycol - 400 (Ajidharma Corp) 4. polyhexamethylene biguanide 0.2% (Ajidharma Corp) 5. Fragrance (Wika Intinusa Company) 6. Glycerin (Wika Intinusa Company) 7. Aloevera (Wika Intinusa Company)	1. Ethyl alcohol 70% 2. 1-proponal 10%, 3. polyethylene glycol - 400 4. polyhexamethylene biguanide 0.2% 5. Fragrance 6. Glycerin 7. Aloevera	Raw Materials Sourcing Process	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Weightning Machine
Weightning Machine	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Goods Weighing Process	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Mixing Machine
Mixing Machine	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Liquid Raw Material Mixing Process	Liquid	Liquid Cooling Process
Liquid Cooling Process	Liquid	Temperature reduction liquid process	Liquid	Filling Station
Filling Station Packaging Bottles (Bisma Anugrah Plasindo Company)	Liquid and Packing Bottles	Filling Liquid into Packaging Bottles	Bottle Containing Liquid	Inspection of Packaging Bottles Containing Liquid
Inspection of Packaging Bottles Containing Liquid	Bottle Containing Liquid	Inspection Process of Liquid Bottles	Bottles containing liquid that have passed inspection	Filling Station

Tabel 2 SIPOC (Supplier Input Process Output Customer)

Supplier	Input	Process	Output	Customer
Filling Station bottle cap (Bisma Anugrah Plasindo Company)	Bottles containing liquid that have passed inspection bottle cap	Bottle Cap Installation	Product Hand Sterilizer Sterobac	Bottle cap inspection
Bottle cap inspection	Product Hand Sterilizer Sterobac	Bottle cap inspection process	Sterobac Hand Sterilizer Product that passed inspection	Labelling Machine
Labelling Machine Packaging Labels (Zezhiang Company)	Sterobac Hand Sterilizer Product that passed inspection	Process of Installing Packaging Labels on Hand Sterilizer Bottles	Products that are already labeled	Inspeksi Labelling
Inspeksi Labelling	Products that are already labeled	Inspeksi Labelling	Finished good product	Packaging Process
Packaging Process	Finished good product	Packing Process	Finished products that have been packed	Inspeksi Packaging
Inspeksi Packaging	Finished products that have been packed	Packing Inspection	Finished goods that pass inspection	Packaging
Shipping warehouse	Finished goods that pass inspection	Shipping	Products sold	Customers

Table 2 shows the Hand Sterilizer production process stages described using the SIPOC diagram (Supplier, Input, Process, Output, and Customer). The purpose of using the SIPOC diagram is to tell the complete production process from the leading supplier to the consumer so that the location of the process that is a production problem can be found [20]. In Table 3, the location of the problem in the process is marked in yellow. These are the Liquid Raw Material Mixing Process, Temperature reduction liquid process, Filling Liquid into Packaging Bottles, and the Inspection Process of Liquid Bottles. In addition, problems at the Labeling stage are seen during the label inspection process. After identifying the problem, the measurement process continues.

2. Measure Phase

The Measurement phase is carried out with two tools: creating a process flow diagram (PFD) and a Tree of Requirements to determine the set goals for process improvement. PFD can be a tool to help describe an actual process so that the location of the problem in a production process can be identified [21].

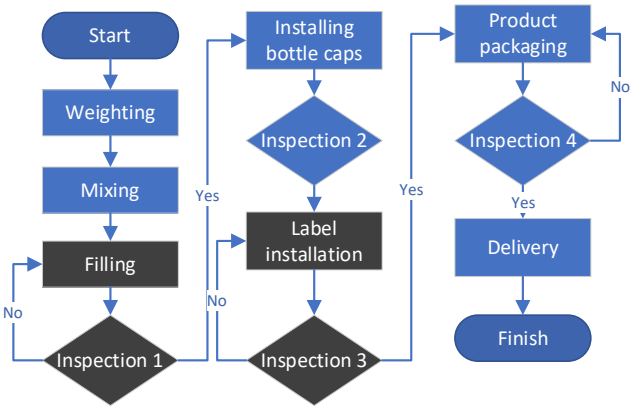
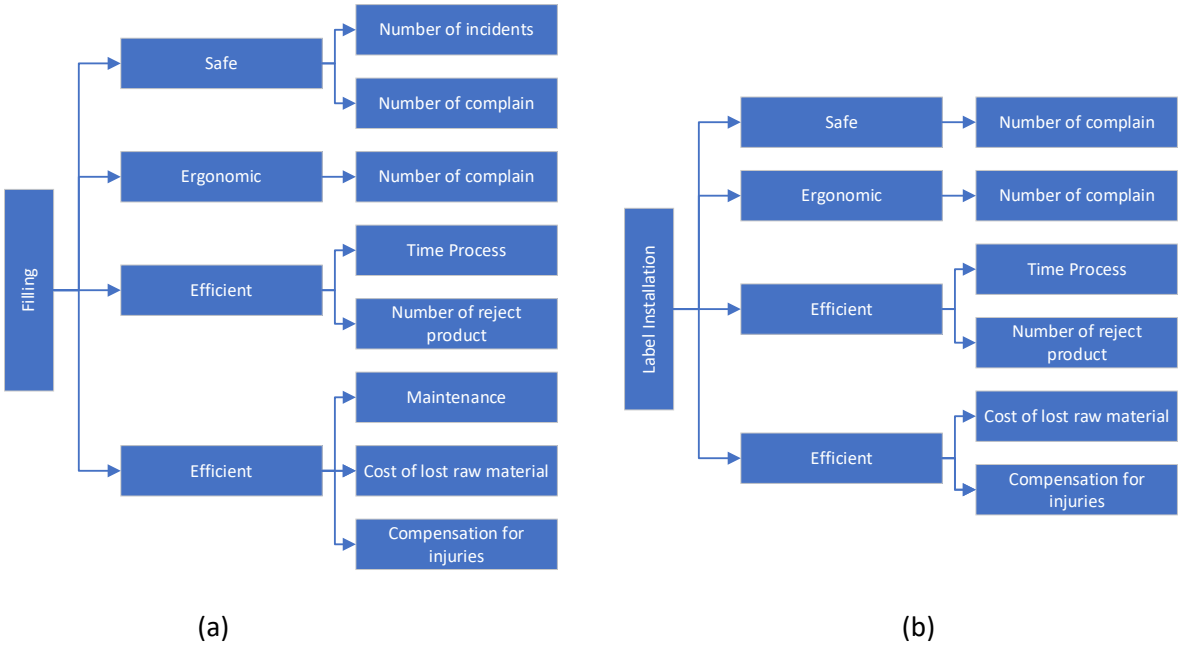


Figure 3. Hand Sterilizer Production Process Flow Chart

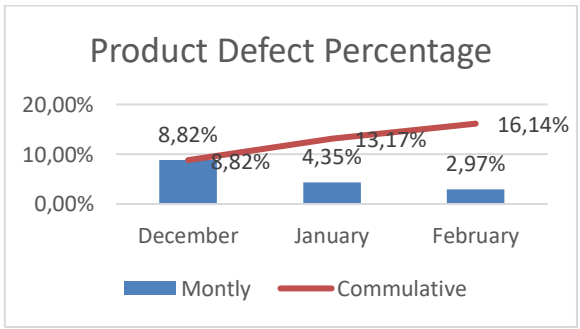
Figure 3 explains the hand sterilizer production process from weighing to product delivery. The process color gray is the problem point, where the process is the filling, as seen from the results of inspection 1, and at the label installation stage, as seen from the results of inspection 3. After the problem point is known, look for key performance indicators for the filling and label installation stages using the requirements tree. The Tree of Requirements can help describe the size of system requirements [22].



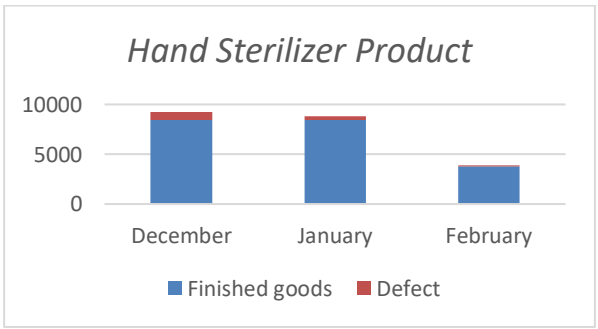
(a) (b)

Figure 4. Tree of Requirement: (a) Filling Process (b) Label Installation

Figure 4 is a tree of requirements for the hand sterilizer manufacturing process. The creation of a tree of requirements looks at four aspects: safety, ergonomics, efficiency, and low cost [1]. Each element is broken down into measurable indicators so that the level of importance of the problems faced can be assessed. After an analysis using a tree of requirements and measurable data collection, it was discovered that the central issue in the filling process was the large number of product defects reaching 16.14% in December-February and the increase in the number of defects was influenced by the number of orders (Figure 5).



Product Defect Percentage



Hand Sterilizer Product Proportion

Figure 5. Hand Sterilizer Product Defect

In the label installation process, the problem is indicated by many complaints from employees who have difficulty during the manual attachment process. In addition, there are also complaints from managers because the processing time is relatively high during the label installation process. So, the stages continued with the Explore stage to get to the root of the problem in the label installation process.

3. Explore Phase

The Explore phase uses the in-depth interview method with employees and managers. 5 Why is a tool used to help the team find the root of the problem. By asking with 5Why, the resource person will always look for reasons for each problem until the root of the problem is found [23]. Table 3 shows the in-depth interview results for problems in the Filling process.

Table 3. 5 Why Analysis for Filling Process

PROBLEM	
WHY 1	Why is there a convex Sterobac Hand Sterilizer bottle?
WHY 2	Why does hot liquid enter the Sterobac Hand Sterilizer bottle?
WHY 3	Why are operators in a hurry to pour liquid?
WHY 4	Why does not the operator know the degree of hotness of the liquid to be poured?
WHY 5	Why is there no liquid temperature indicator?

The in-depth interview results shown in Table 3 show that the main problem of bottle defects during the filling process is the absence of a temperature indicator for the liquid when it is poured into the bottle. When the number of orders is high, the operator is in a hurry to pour the liquid without considering the temperature of the fluid to be entered. So, it is necessary to design a workplace for the filling process using a temperature indicator.

Table 4. 5 Why Analysis for Labeling Process

PROBLEM	
WHY 1	Why are there so many labels that do not match when labeling?
WHY 2	Why do workers have difficulty labeling?
WHY 3	Why is not the label placed in the correct position?
WHY 4	Why do operators have difficulty removing adhesive labels?
WHY 5	Why are the labels made close to each other?

Table 4 is the result of an in-depth interview to find problems in the label installation process. The analysis showed that the label defects were due to the label design, making it difficult for operators to remove and install labels. This problem was then followed up in the design phase.

4. Design Phase

4.1 Desain Proses Filling

At the design stage, the first problem is in the filling process; a new filling process design is given with a liquid temperature indicator so that when the liquid enters the packaging at the right temperature, it does not cause product rejection. This temperature sensor is placed on the lid of the Sterobac liquid hand sterilizer container, which helps detect and control the temperature so that it is optimal. This sensor will sound if the Sterobac liquid hand sterilizer is between 36°C and 37°C. Figure 6 shows the temperature sensor's placement on the product liquid tube. The sensor is resistant to heat and liquids and can detect temperatures up to 120°C according to the company's needs. Figure 6 is a picture of the filling process design with the addition of a thermometer as a

temperature indicator. The company owner has validated the design for adding a temperature indicator device to the filling process for implementation.

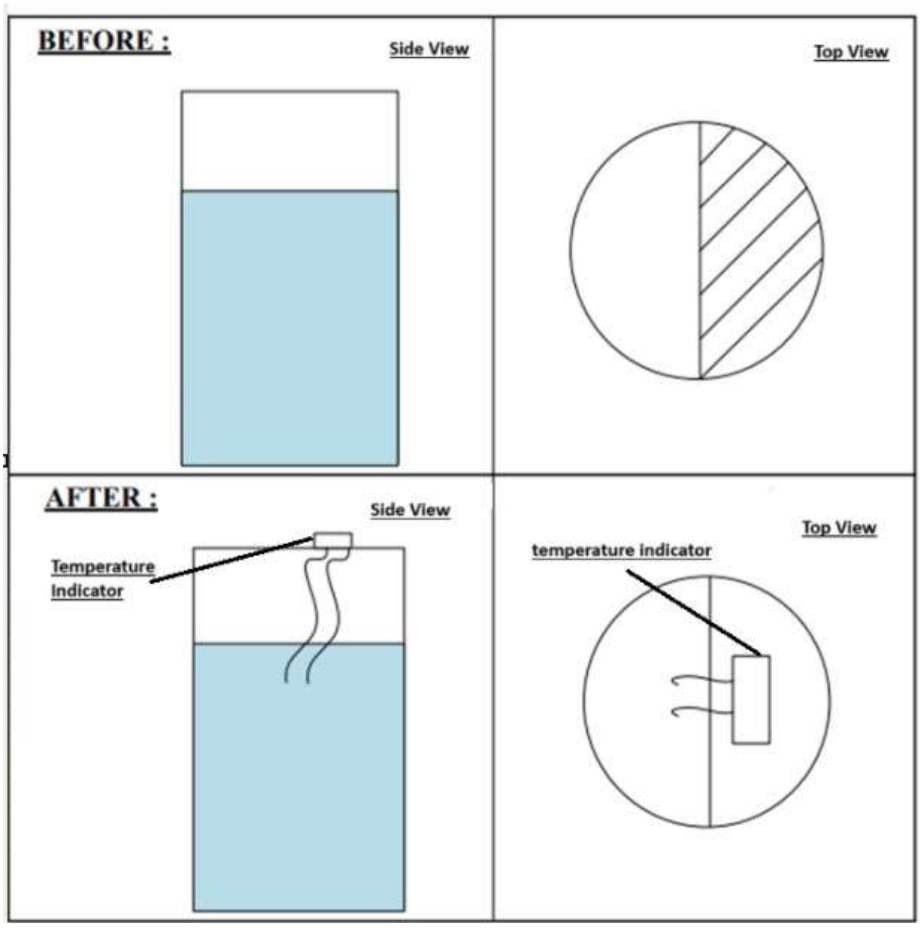


Figure 6. Desain Proses Filling

4.2 Label Design

The root of the second problem was the label design, which needed to be closer, making it difficult for operators to remove and attach the label. So, a unique label design was made with a distance between images to make it easier for workers to remove and attach the label, and the size was designed precisely according to the size of the hand sterilizer bottle[24]. Figure 7 is an illustration of the new label design. The new label design has a distance between images and a size more suitable for the bottle. Humans still carry out the label installation process to avoid reducing the number of workers because it is one of the requirements for labor-intensive companies in Indonesia.

Gambar 7. Desain Label Hand Stelizer

4.3 Work Culture Design 5S

Work culture is one of the things that influences employee performance. Therefore, it is necessary to design a good culture for a company to create optimal performance. The concept of Seiri, Seiton,

Seiso, Seiketsu, and Shitsuke (5S) from Japan is one method that can build good company habits. This concept was first introduced by Takasi Osada (1994), and it refers to maintenance, arrangement, cleaning, strengthening, and habitat. This concept is suitable for this labor-intensive company, so good habits need to be built in the company [25], [26]. The implementation of the 5S Concept is carried out by making 5S posters and placing them in strategic locations so that employees can easily read them. Figure 8. This is one example of putting a 5S poster on the glass of the labeling workstation.

Figure 8. 5S Poster in the Labeling Work Area

5. Implement Phase

The last stage is to carry out the Implementation. This stage is carried out to ensure that all processes that have been designed are carried out correctly. The method used in the implementation stage is creating a check sheet, Standard Operating Procedure (SOP), and the Poka-yoke method. The Poka-yoke method is used to avoid simple human errors in the workplace [27], [28]. Poka-Yoke was implemented in this study by creating a Poka-Yoke Form on the filling machine.

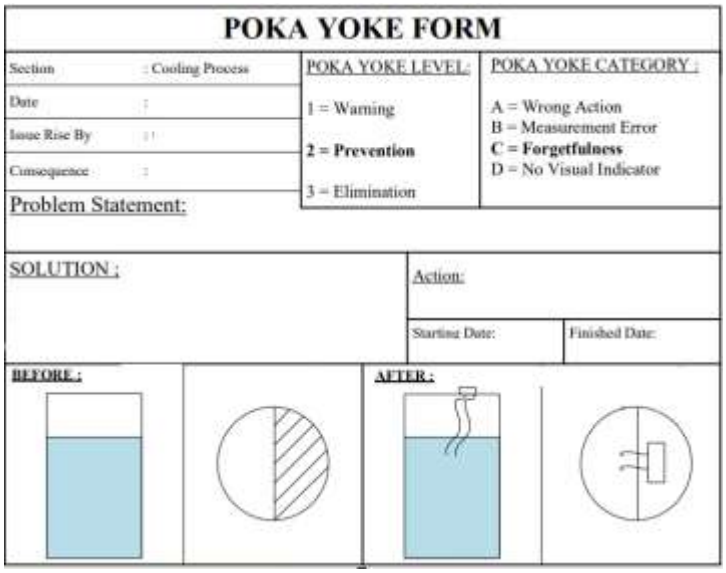


Figure 9. Poka-Yoke Form

Figure 9 is a Poka-Yoke Form for the filling process. Later, every time a problem occurs, the operator will fill out the Poka-Yoke Form. The Poka-Yoke Form is used to record issues with the system along with their solutions. Using the Poka Yoke Form makes it easier for workers to prevent problems in the future [27], [29]. In addition to creating the Poka-Yoke Form, Implementation is carried out by creating SOPs in the Filling process (Figure 10).

PT. XC CLEANINDO

Standard Operating Procedure for Sterobac Hand Sterilizer Liquid Filling

A. Objective

Provides directions for using the Sterobac Hand Sterilizer liquid cooling checklist

B. Tools and Materials

Checklist Form “Filling Process”

C.

Implementation procedures

1. Using a mask (PPE)
2. Using gloves (PPE)
3. Make sure the temperature sensor is on before the raw material mixing process is carried out
4. Make sure the temperature sensor is in good condition when you want to use it
5. Turn on the temperature sensor when you want to use it
6. Set the temperature to 36 degrees Celsius
7. Add liquid to the tube only after the sensor beeps.
8. The operator writes the name in the "Operator on Duty" column
9. The operator provides initials in the "Operator Initials" column
10. Berikan keterangan apabila diperlukan

Made by	Approved by
Chynthia Clarresta	Supervisor Produksi

Figure 10. Standard Operational Filling Process Procedure

Figure 10 is a Standard Operational Procedure (SOP) for the filling process. SOP is made as a work guide for operators after creating a new work design in the filling process. The purpose of making SOP is as a work guide for operators to avoid errors or work accidents [30].
The result of the implementation of this research is a decrease in the percentage of defects in the Company. Initially, the percentage of defects reached 8.82%. After implementing the research results, defects decreased to 2.97%. This value is expected to continue to decrease after workers get used to the new implementation implemented by the Company.

Limitation

The limitation of this research is that in-depth statistical calculations have not been carried out regarding the impact of improving the quality of implementation results, so further research can be carried out using sigma-level calculations or similar. On the other hand, cost considerations have not been added to this research.

Conclusion

This research concludes by discovering the cause of the most significant product defects from XC Clenindo Company is pouring Sterobac hand sterilizer liquid in hot conditions, and operators have difficulty installing labels. The proposed improvement for the problem of pouring hot hand sterilizer liquid is to redesign the filling process and add a tool as a thermometer to the liquid tube to indicate the correct temperature when pouring. Meanwhile, the proposed improvement for label installation problems is redesigning the labels at a distance to make it easier for operators to remove and install labels in the right conditions. A work pattern design was also created with the 5S concept to improve employee performance. At the implementation stage, a Poka-Yoke Form was created to make it easier for operators to record every problem that occurs so that it can be used as an evaluation material and prevent issues in the future. The implementation stage is also carried out by creating an SOP for the filling process to ensure operators work according to work safety standards.

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Quality Improvement Using the Six Sigma DMEDI Method for Hand Sterilizer Products

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ABSTRACT

XC Clenaindo Company is a manufacturing company that provides cleaning and sanitation services in Indonesia. However, defects that exceeded the company's tolerance limits were found in hand sterilizer products. This research aims to improve product quality so that it satisfies customer needs. Analysis was conducted to determine the leading causes of product defects using the Six Sigma Define, Measure, Explore, Design, and Implement (DMEDI) method. The DMEDI Six Sigma method is a quality improvement method with a creative approach so that the resulting solution can be a new work system design. The results of the defined process research found two problems, namely product defects because the Sterobac hand sterilizer bottle was convex and the length of the label installation process. At the measure stage, it was discovered that the problem was in the filling and labeling process, which was influenced by the increasing number of requests. At the exploration stage using the 5 why deep interview method, it was discovered that the problem was due to the lack of temperature during the liquid pouring process and the label design making the sticking process difficult. So, the work process was redesigned at the filling stage, and a new label design was created, which made it easier for workers to stick labels and apply the 5S concept. The final stage was implemented by designing the Poka-Yoke Form and Worker Operational Standards for the Filling. This research results in a reduction in the number of defective products.

Keywords:

Six Sigma DMEDI; Quality Improvement; Manufacturing Company.

Introduction

XC Cleanindo Company mainly called iCLEAN, produces various premium quality products to meet cleaning and sanitation needs. Founded in 2007 and increasing with a distribution network that has reached 29 cities in Indonesia and plans to add to several other large cities. Products produced by XC Cleanindo Company include Hand Sterilizer Sterobac, Toilet Seat Sanitizer, Clean Bright Xtra, and many more during the COVID-19 pandemic in Indonesia, XC Cleanindo Company is increasingly well known in Indonesia, especially the Sterobac Hand Sterilizer. However, with increasing demand, XC Cleanindo Company is increasingly having difficulty meeting market demand, resulting in frequent loss of customers (loss of orders). Some reasons for loss orders are the high number of defects in Sterobac Hand Sterilizer products after production. This condition harms companies and consumers because many products cannot be shipped.

This research focuses on process decomposition to improve product quality using the Six Sigma DMEDI method. The study case used is the Sterobac Hand Sterilizer product produced by XC Cleanindo Company to reduce the number of defective products. Figure 1 is an example of a defective Sterobac

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Hand Sterilizer product. Defects in the Sterobac Hand Sterilizer product include bulge bottles and labels that are not correctly installed.

Figure 1. Convex Sterobac Hand Sterilizer Packaging Bottle

DMEDI is one of the six-sigma methods for improving product or process quality, and it has five stages: Define, Measure, Explore, Design, and Improve [1]. Quality is a significant value when the digital world is developing [2], [3]. This is because the more the digital world develops, the broader the scope of marketing, resulting in increasingly tight market competition[4]. In tight market competition, products that can survive have superior quality[5]. Building sustainable quality is an essential goal for various companies[3]. The value of quality focus is presently focused on customer satisfaction, profit value, and cost reduction [6]. Multiple methods are used to assess product quality, including Six Sigma. Six Sigma is a management methodology that aims to improve quality by identifying and eliminating the causes of defects. [7], [8].

Six Sigma tools are commonly utilized within different performance improvement methodologies, including Design, Measure, Analyze, Improve, Control (DMAIC), Define, Measure, Analyze, Design, Verify (DMADV), and Define, Measure, Explore, Design, Implement (DMEDI)[9]. Typically, DMAIC is employed to enhance existing products, processes, and services, whereas DMADV and DMEDI are applied to design and develop new products, processes, and services. DMEDI has similar processes to DMAIC; the only difference is that in DMEDI, improvements are made by adding or replacing processes [10], [11]. Permedaan antara DMADV dengan DMEDI ada pada proses ketiga dan kelima, Dimana jika pada DMADV berhenti di tahap verify namun DMEDI berhenti pada tahap implement. DMADV is used when there is a need to redesign or develop a new product/process that relies heavily on data validation before implementation. This is in contrast to DMEDI, which is more suitable for innovations that require creative exploration and direct testing in implementation. The DMEDI method is expected to provide broader solutions because it is not limited by existing systems[12]. Some previous research regarding improving product quality using the DMEDI method is the Integration of the production process of the Xerox company [10] reduction of manual-handling strategies in the production process in a manufacturing company [1], designing a teabag product [12], [13].

This research focuses on improving the production quality of the Sterobac Hand Sterilizer by analyzing the production process using the Six Sigma DMEDI method. The defined process is carried out by collecting the Voice of the Customer (VOC) and creating a SIPOC diagram for the Sterobac Hand Sterilizer product[12], [13]. Meanwhile, in the Measure stage, process flow charts and trees of requirements are used to find key product performance indicators[14]. Next is the Explore stage, which uses the 5 Why method to find the root of the problem. This research hypothesizes the need to design new stages or equipment to improve product quality. Therefore, the design stage is carried out

by creating new stages or designing the equipment needed to improve quality. The final stage is implementing the Poka-Yoke technique and creating standard operational procedures (SOP).

Methods

This research was conducted by direct observation at XC Cleanindo Company and interviews with managers and operators in the filling, packaging, and labeling divisions. In addition, a literature study was conducted to enrich reference materials from sources relevant to the problems studied by understanding the theory to solve the issues. The method used in this study is Six Sigma, which has the stages of Define, Measure, Explore, Design, and Implement (DMEDI). DMEDI is one type of Six Sigma method. The most frequently used Six Sigma is DMAIC (Define, Measure, Analyze, Improve, and Control) [15], [16]. Unlike DMAIC, the DMEDI method focuses more on creativity in solving problems so that a solution is possible in the form of a new design for a system [13]. Figure 2 is the method used in this study.

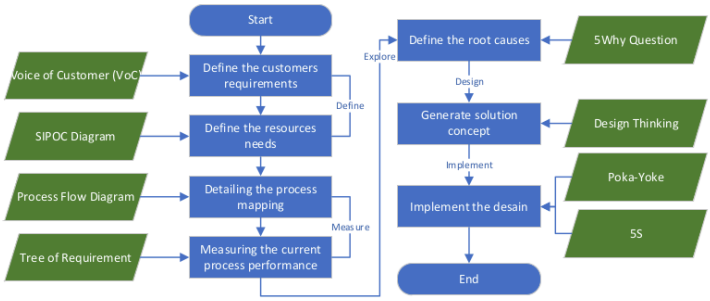


Figure 2. Reseach Method

In Figure 2, it can be seen that the stages of this research consist of five phases, namely: Define, Measure, Explore, Design, and Implement [17]. Each stage consists of several tools used. In the define phase, this is done by formally defining the target of improving the quality of the process to be consistent with customer demand or needs and company strategy. The Voice of Customer tools and the SIPOC diagram are used [10]. At the measure stage, data is collected on how quickly and effectively to find out what causes the problem, using a tree of requirements. At the explore stage, it is done to identify the underlying causes of a problem and focus on completing the next phase. In studying the 5 WHY tools used, the design stage confirms the design specifications to ensure the solution meets end-user requirements and improves and resolves problems identified through root cause analysis. The last stage is the implementation stage. The implementation stage aims to help employees implement the previously designed design. The Poka-Yoke Form and 5S tools are used [18], [19].

Results and Discussion

This research consists of 5 phases: Define, Measure, Explore, Design, and Implement (DMEDI). Each phase is a crucial stage to achieve quality improvement. The first phase starts with defining consumer needs and resources. Furthermore, the measure stage is carried out to find key performance indicators and measure current process performance. After getting the current process value, the exploration stage is continued to get to the root of the problem. The root of the issue found then becomes the basis

for the design stage so that the design is designed effectively and efficiently. The last stage is the implementation stage, which makes it easier for operators to apply new designs.

1. Define Phase
   At the define stage, all data about the company is collected to find problems in a process. Data can be primary or secondary data. Primary data is obtained by conducting in-depth interviews with workers at XC Cleanindo Company so that the Voice of Customer (VoC) of the company's problems can be found. Table 1 is the VoC from the operator's perspective as the end user who produces the Sterobac Hand Sterilizer.

Tabel 1 Voice of Customer

End user comment	Why are they saying ut?	What do they want?
average defective products are high up to more than 5%	*Defective bottle that bulges when filled with liquid*	*The bottle does not bulge when filled with liquid.*
	Stickers that are not in the right place and have been attached for a long time	*Addition of a machine for attaching stickers*

The interview results showed two causes of production defects in the Sterobac Hand Sterilizer: defective bottles that bulged when filled with liquid and stickers that were not in place and had been attached for a long time. The problem of bottles that bulge when filled with liquid must be identified as the leading cause of the problem. In contrast, the problem of workers' desire for a machine to help attach stickers to bottles needs to be considered in terms of importance and effectiveness. Therefore, the defined process is continued by elaborating with a SIPOC (Supplier Input Process Output Customer) diagram and creating a Product Breakdown Structure to determine the central location of the quality problem of the Sterobac Hand Sterilizer product.

Tabel 2 SIPOC (Supplier Input Process Output Customer)

Supplier	Input	Process	Output	Customer
Ingredients : 1. Ethyl alcohol 70% (Ajidharma Corp) 2. 1-proponal 10%, 3. polyethylene glycol - 400 (Ajidharma Corp) 4. polyhexamethylene biguanide 0.2% (Ajidharma Corp) 5. Fragrance (Wika Intinusa Company) 6. Glycerin (Wika Intinusa Company) 7. Aloevera (Wika Intinusa Company)	1. Ethyl alcohol 70% 2. 1-proponal 10%, 3. polyethylene glycol - 400 4. polyhexamethylene biguanide 0.2% 5. Fragrance 6. Glycerin 7. Aloevera	Raw Materials Sourcing Process	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Weightning Machine
Weightning Machine	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Goods Weighing Process	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Mixing Machine
Mixing Machine	1. Ethyl alcohol 70% 2. 1-proponal 10%, polyethylene glycol - 400 3. polyhexamethylene biguanide 0.2% 4. Fragrance 5. Glycerin 6. Aloevera	Liquid Raw Material Mixing Process	Liquid	Liquid Cooling Process
Liquid Cooling Process	Liquid	Temperature reduction liquid process	Liquid	Filling Station
Filling Station Packaging Bottles (Bisma Anugrah Plasindo Company)	Liquid and Packing Bottles	Filling Liquid into Packaging Bottles	Bottle Containing Liquid	Inspection of Packaging Bottles Containing Liquid
Inspection of Packaging Bottles Containing Liquid	Bottle Containing Liquid	Inspection Process of Liquid Bottles	Bottles containing liquid that have passed inspection	Filling Station

Tabel 2 SIPOC (Supplier Input Process Output Customer)

Supplier	Input	Process	Output	Customer
Filling Station bottle cap (Bisma Anugrah Plasindo Company)	Bottles containing liquid that have passed inspection bottle cap	Bottle Cap Installation	Product Hand Sterilizer Sterobac	Bottle cap inspection
Bottle cap inspection	Product Hand Sterilizer Sterobac	Bottle cap inspection process	Sterobac Hand Sterilizer Product that passed inspection	Labelling Machine
Labelling Machine Packaging Labels (Zezhiang Company)	Sterobac Hand Sterilizer Product that passed inspection	Process of Installing Packaging Labels on Hand Sterilizer Bottles	Products that are already labeled	Inspeksi Labelling
Inspeksi Labelling	Products that are already labeled	Inspeksi Labelling	Finished good product	Packaging Process
Packaging Process	Finished good product	Packing Process	Finished products that have been packed	Inspeksi Packaging
Inspeksi Packaging	Finished products that have been packed	Packing Inspection	Finished goods that pass inspection	Packaging
Shipping warehouse	Finished goods that pass inspection	Shipping	Products sold	Customers

Table 2 shows the Hand Sterilizer production process stages described using the SIPOC diagram (Supplier, Input, Process, Output, and Customer). The purpose of using the SIPOC diagram is to tell the complete production process from the leading supplier to the consumer so that the location of the process that is a production problem can be found [20]. In Table 3, the location of the problem in the process is marked in yellow. These are the Liquid Raw Material Mixing Process, Temperature reduction liquid process, Filling Liquid into Packaging Bottles, and the Inspection Process of Liquid Bottles. In addition, problems at the Labeling stage are seen during the label inspection process. After identifying the problem, the measurement process continues.

2. Measure Phase

   The Measurement phase is carried out with two tools: creating a process flow diagram (PFD) and a Tree of Requirements to determine the set goals for process improvement. PFD can be a tool to help describe an actual process so that the location of the problem in a production process can be identified [21].

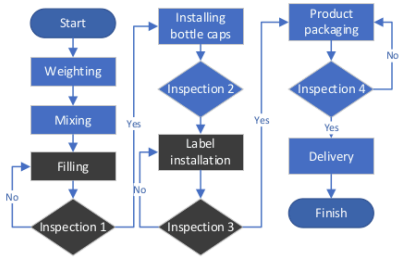
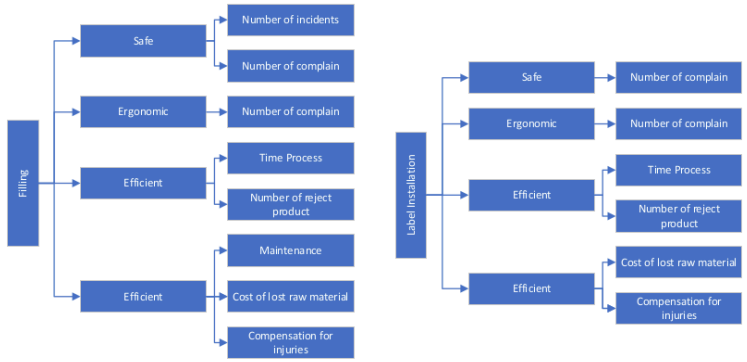


Figure 3. Hand Sterilizer Production Process Flow Chart

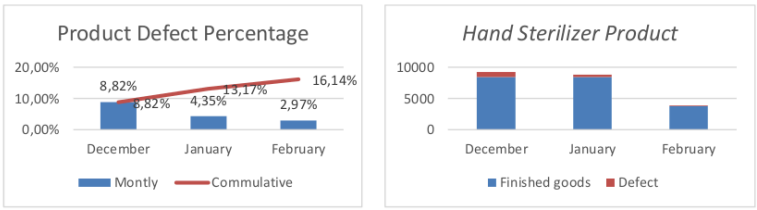
Figure 3 explains the hand sterilizer production process from weighing to product delivery. The process color gray is the problem point, where the process is the filling, as seen from the results of inspection 1, and at the label installation stage, as seen from the results of inspection 3. After the problem point is known, look for key performance indicators for the filling and label installation stages using the requirements tree. The Tree of Requirements can help describe the size of system requirements [22].



(a) (b)

Figure 4. Tree of Requirement: (a) Filling Process (b) Label Installation

Figure 4 is a tree of requirements for the hand sterilizer manufacturing process. The creation of a tree of requirements looks at four aspects: safety, ergonomics, efficiency, and low cost [1]. Each element is broken down into measurable indicators so that the level of importance of the problems faced can be assessed. After an analysis using a tree of requirements and measurable data collection, it was discovered that the central issue in the filling process was the large number of product defects reaching 16.14% in December-February and the increase in the number of defects was influenced by the number of orders (Figure 5).



Product Defect Percentage Hand Sterilizer Product Proportion

Figure 5. Hand Sterilizer Product Defect

In the label installation process, the problem is indicated by many complaints from employees who have difficulty during the manual attachment process. In addition, there are also complaints from managers because the processing time is relatively high during the label installation process. So, the stages continued with the Explore stage to get to the root of the problem in the label installation process.

3. Explore Phase

The Explore phase uses the in-depth interview method with employees and managers. 5 Why is a tool used to help the team find the root of the problem. By asking with 5Why, the resource person will always look for reasons for each problem until the root of the problem is found [23]. Table 3 shows the in-depth interview results for problems in the Filling process.

Table 3. 5 Why Analysis for Filling Process

PROBLEM	
WHY 1	Why is there a convex Sterobac Hand Sterilizer bottle?
WHY 2	Why does hot liquid enter the Sterobac Hand Sterilizer bottle?
WHY 3	Why are operators in a hurry to pour liquid?
WHY 4	Why does not the operator know the degree of hotness of the liquid to be poured?
WHY 5	Why is there no liquid temperature indicator?

The in-depth interview results shown in Table 3 show that the main problem of bottle defects during the filling process is the absence of a temperature indicator for the liquid when it is poured into the bottle. When the number of orders is high, the operator is in a hurry to pour the liquid without considering the temperature of the fluid to be entered. So, it is necessary to design a workplace for the filling process using a temperature indicator.

Table 4. 5 Why Analysis for Labeling Process

PROBLEM	
WHY 1	Why are there so many labels that do not match when labeling?
WHY 2	Why do workers have difficulty labeling?
WHY 3	Why is not the label placed in the correct position?
WHY 4	Why do operators have difficulty removing adhesive labels?
WHY 5	Why are the labels made close to each other?

Table 4 is the result of an in-depth interview to find problems in the label installation process. The analysis showed that the label defects were due to the label design, making it difficult for operators to remove and install labels. This problem was then followed up in the design phase.

4. Design Phase

4.1 Desain Proses Filling

At the design stage, the first problem is in the filling process; a new filling process design is given with a liquid temperature indicator so that when the liquid enters the packaging at the right temperature, it does not cause product rejection. This temperature sensor is placed on the lid of the Sterobac liquid hand sterilizer container, which helps detect and control the temperature so that it is optimal. This sensor will sound if the Sterobac liquid hand sterilizer is between 36°C and 37°C. Figure 6 shows the temperature sensor's placement on the product liquid tube. The sensor is resistant to heat and liquids and can detect temperatures up to 120°C according to the company's needs. Figure 6 is a picture of the filling process design with the addition of a thermometer as a

temperature indicator. The company owner has validated the design for adding a temperature indicator device to the filling process for implementation.

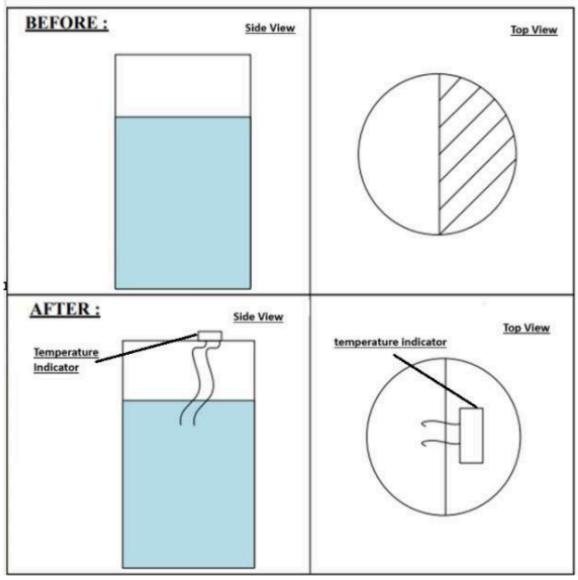


Figure 6. Desain Proses Filling

4.2 Label Design

The root of the second problem was the label design, which needed to be closer, making it difficult for operators to remove and attach the label. So, a unique label design was made with a distance between images to make it easier for workers to remove and attach the label, and the size was designed precisely according to the size of the hand sterilizer bottle[24]. Figure 7 is an illustration of the new label design. The new label design has a distance between images and a size more suitable for the bottle. Humans still carry out the label installation process to avoid reducing the number of workers because it is one of the requirements for labor-intensive companies in Indonesia.

Gambar 7. Desain Label Hand Stelizer

4.3 Work Culture Design 5S

Work culture is one of the things that influences employee performance. Therefore, it is necessary to design a good culture for a company to create optimal performance. The concept of Seiri, Seiton,

Seiso, Seiketsu, and Shitsuke (5S) from Japan is one method that can build good company habits. This concept was first introduced by Takasi Osada (1994), and it refers to maintenance, arrangement, cleaning, strengthening, and habitat. This concept is suitable for this labor-intensive company, so good habits need to be built in the company [25], [26]. The implementation of the 5S Concept is carried out by making 5S posters and placing them in strategic locations so that employees can easily read them. Figure 8. This is one example of putting a 5S poster on the glass of the labeling workstation.

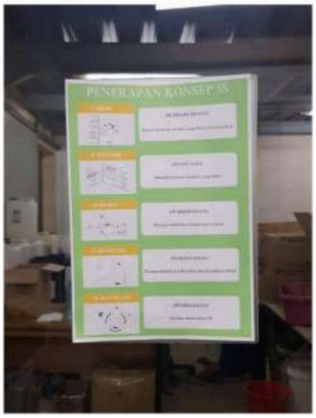


Figure 8. 5S Poster in the Labeling Work Area

5. Implement Phase

The last stage is to carry out the Implementation. This stage is carried out to ensure that all processes that have been designed are carried out correctly. The method used in the implementation stage is creating a check sheet, Standard Operating Procedure (SOP), and the Poka-yoke method. The Poka-yoke method is used to avoid simple human errors in the workplace [27], [28]. Poka-Yoke was implemented in this study by creating a Poka-Yoke Form on the filling machine.

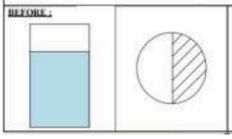
POKA YOKE FORM

Section	: Cooling Process	POKA YOKE LEVEL:	POKA YOKE CATEGORY :
Date	:	1 = Warning	A = Wrong Action
Issue Rise By	:	**2 = Prevention**	B = Measurement Error
Consequence	:	3 = Elimination	**C = Forgetfulness**
			D = No Visual Indicator

Problem Statement:

SOLUTION :	Action:	
	Starting Date:	Finished Date:

BEFORE :



AFTER :

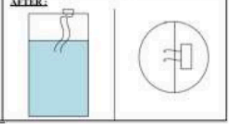


Figure 9. Poka-Yoke Form

Figure 9 is a Poka-Yoke Form for the filling process. Later, every time a problem occurs, the operator will fill out the Poka-Yoke Form. The Poka-Yoke Form is used to record issues with the system along with their solutions. Using the Poka Yoke Form makes it easier for workers to prevent problems in the future [27], [29]. In addition to creating the Poka-Yoke Form, Implementation is carried out by creating SOPs in the Filling process (Figure 10).

PT. XC CLEANINDO

Standard Operating Procedure for Sterobac Hand Sterilizer Liquid Filling

A. Objective
Provides directions for using the Sterobac Hand Sterilizer liquid cooling checklist

B. Tools and Materials
Checklist Form "Filling Process"

C.
Implementation procedures
1. Using a mask (PPE)
2. Using gloves (PPE)
3. Make sure the temperature sensor is on before the raw material mixing process is carried out
4. Make sure the temperature sensor is in good condition when you want to use it
5. Turn on the temperature sensor when you want to use it
6. Set the temperature to 36 degrees Celsius
7. Add liquid to the tube only after the sensor beeps.
8. The operator writes the name in the "Operator on Duty" column
9. The operator provides initials in the "Operator Initials" column
10. Berikan keterangan apabila diperlukan

Made by	Approved by
Chynthia Clarresta	Supervisor Produksi

Figure 10. Standard Operational Filling Process Procedure

Figure 10 is a Standard Operational Procedure (SOP) for the filling process. SOP is made as a work guide for operators after creating a new work design in the filling process. The purpose of making SOP is as a work guide for operators to avoid errors or work accidents [30].
The result of the implementation of this research is a decrease in the percentage of defects in the Company. Initially, the percentage of defects reached 8.82%. After implementing the research results, defects decreased to 2.97%. This value is expected to continue to decrease after workers get used to the new implementation implemented by the Company.

Limitation

The limitation of this research is that in-depth statistical calculations have not been carried out regarding the impact of improving the quality of implementation results, so further research can be carried out using sigma-level calculations or similar. On the other hand, cost considerations have not been added to this research.

Conclusion

This research concludes by discovering the cause of the most significant product defects from XC Clenindo Company is pouring Sterobac hand sterilizer liquid in hot conditions, and operators have difficulty installing labels. The proposed improvement for the problem of pouring hot hand sterilizer liquid is to redesign the filling process and add a tool as a thermometer to the liquid tube to indicate the correct temperature when pouring. Meanwhile, the proposed improvement for label installation problems is redesigning the labels at a distance to make it easier for operators to remove and install labels in the right conditions. A work pattern design was also created with the 5S concept to improve employee performance. At the implementation stage, a Poka-Yoke Form was created to make it easier for operators to record every problem that occurs so that it can be used as an evaluation material and prevent issues in the future. The implementation stage is also carried out by creating an SOP for the filling process to ensure operators work according to work safety standards.

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