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Product Quality Improvement Of Stainless Steel Round Trash Bin With Six Sigma And Fuzzy Analytical Hierarchy Process Method At PTXYZ

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ABSTRACT
PT. XYZ is a manufacturing industry that produces various cleaning equipment. One of the products that has a high level of defects are trash bins made of stainless steel. The purpose of this research is to improve the quality of stainless steel waste products. The method used is Six Sigma and Fuzzy Analytical Hierarchy Process. In the Define stage, the types of defects found were body dents, scratches, spots, and rough lids. In the Measure stage, the initial DPMO value obtained is 3.422. In the Analyze stage, the results of the analysis process are defects with the highest Risk Priority Number of 280. The next stage is Improve, where defects with the highest RPN value are prioritized for proposed improvements using Fuzzy AHP. Based on the results of the Fuzzy AHP assessment, it was found that the highest weight was alternative 3, namely the machine must be cleaned regularly after being used at 0.4322, alternative 2, namely the addition of material handling to facilitate product transfer of 0.2048, and alternative 4, namely the establishment of SOPs for product handling. of 0.2041. After the Improve stage, the final stage in the form of Control is carried out to see whether the implementation of the proposed improvements has a positive impact on the company. The DPMO results obtained after implementation were 3.6061.

INTRODUCTION

PT. XYZ is a manufacturing industry that produces cleaning equipment. PT. XYZ was founded in 2010 and has been present providing superior products to consumers and establishing cooperative relationships with national scale business partners in Indonesia. In this research, it is conducted on the production process of stainless steel trash bin from PT. XYZ because it is a product with the highest defect value and exceeds the company's tolerance limits. The company's defect tolerance limit is 5%. The historical data on the production results of stainless steel round trash bin used is data for the period January to June 2022 (Table 1). The highest percentage of defects seen in Table 1 was in February at 10.86%. Apart from that, in March, May and June, the number of defects obtained still exceeded the company's tolerance limits.

Table 1. Historical Data on Production of Round Stainless Trash

Period	Round Stainless Trash Bin		
	Production Quantity	NG Product	Defect Percentage
January	550	23	4,18%
February	700	76	10,86%
March	300	17	5,67%
April	450	19	4,22%
May	600	44	7,33%
June	650	63	9,69%

Source : Primary Data of PT XYZ, 2022

The company has implemented a quality control process by carrying out regular inspections of the production process and checking raw materials before use to ensure that the final product has no defects. However, defective products were found in the company hence the quality improvements are needed. Improvements to the quality of this stainless steel round trash bin product refer to the quality dimensions in the form of durability, aesthetics, and conformance to standards. These three quality dimensions become a reference for good product quality to be accepted by costumers of round stainless steel trash bin at PT. XYZ. The method used in this research to improve the quality of stainless steel trash bin products are the Six Sigma and Fuzzy AHP methods. Using the six sigma method can help understand and identify the causes of problems to improve product quality. The use of the six sigma method focuses on reducing variance to minimize the opportunity for defects to occur (Subana et al., 2021). Then the Fuzzy AHP method is used which is an improve level of AHP, because the AHP method as shortcomings in the form of a lack of ability to overcome uncertainty and vague decisions in decision making (Doaly et al., 2019). Therefore, by using the fuzzy AHP method, aspects of uncertainty and vague decisions can be handled well so that the resulting decisions are more accurate and in line with the company's needs.

LITERATURE REVIEW

Six Sigma

The Six Sigma method is a method or way to achieve operational performance, only finding 3.4 defects in every one million activities or opportunities. Six Sigma is driven by an understanding of facts, data, and statistical analysis. Six Sigma also provides benefits including cost reduction, increased productivity, market share growth, defect reduction, and production or service development. In its application, Six Sigma has five steps to improve performance, namely Define, Measure, Analyze, Improve and Control, which is then abbreviated as DMAIC, so that problems or opportunities, processes and customer needs must be verified and updated at each step(Hernadewita et al., 2019).

Six Sigma creates a reliable process that eliminates waste, reduces variation and improves process flow. Internal changes that can occur using the Six Sigma method include organizational culture, perception of methodology, reduction of losses, and transfer of knowledge from projects to company knowledge. External changes, namely benchmarking with Six Sigma organizations, market competition, and customer satisfaction (Yadav et al., 2019). DMAIC is a structured problem solving procedure and is widely used in quality and process improvement. DMAIC is often associated with Six Sigma activities and almost all Six Sigma implementations use the DMAIC process for project management and completion. However, DMAIC does not have to be formally related to Six Sigma, and can be used independently of organizational use of Six Sigma (Montgomery, 2013).

Fuzzy Analytical Hierarchy Process (Fuzzy-AHP)

Fuzzy-AHP is a development methodology for AHP. The Fuzzy-AHP method is basically the same as the AHP method, but the Fuzzy-AHP method sets the AHP scale into a fuzzy triangular scale for priority access (Septiani et al., 2021). Analytical Hierarchy Process (AHP) is a decision-making methodology developed in 1980 by Saaty. AHP is used to simplify the decision-making process by using quantitative and qualitative techniques to decompose complex problems into several sub-problems. The Fuzzy method is used in AHP to cover AHP errors such as problems with criteria that have a more subjective nature (Khoiriah et al., 2020)

METHODS

The method that will be used in this research is DMAIC in Six Sigma. In the initial stage, the Define process is carried out to define the problems that occur. Next, the Measure process is carried out for data measurement. Then proceed with the Analyze process to analyze the data to identify the root of the existing problem. At the analyze stage, the Failure Mode Effect Analysis (FMEA) method is used to define the product process, collect data on problems that may occur, assess problems in terms of impact, probability and detection, calculate the Risk Priority Number (RPN), and take action to reduce risk (Lutfianto & Prabowo, 2022). The results of FMEA are dominant problems which are corrected subject at the next stage. At the Improve stage, the results from the previous stages need to be followed up with proposals for improvement. Decision making in the Improve stage is carried out using the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method. The Fuzzy AHP method in six sigma is used to select the best alternative. The creation of the hierarchical structure contained in the initial step of Fuzzy AHP is based on the FMEA results at the Six Sigma stage obtained in the Analyze step (Kurniawan et al., 2022)

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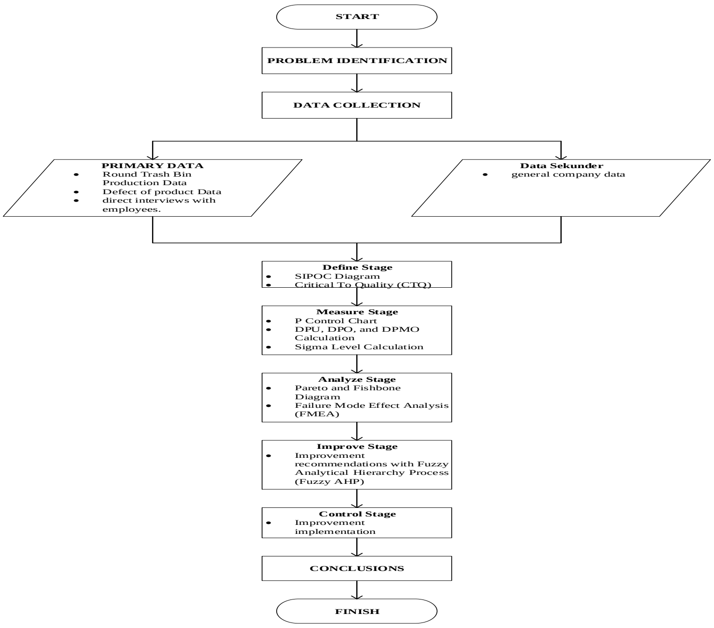
Figure 1. Methods *Flowchart*



Source : Data Processing, Microsoft Visio, 2022

RESULTS

Define

At the Define stage, the SIPOC (Supplier-Input-Process-Output-Customer) diagram is used, which is a diagram to map all processes and elements involved in the product manufacturing process (Montgomery, 2013). Defects can be defined as any deviation in performance from Critical To Quality (CTQ) (Singh & Lal, 2016)

Table 2. SIPOC Diagram

Supplier	Input	Process	Output	Customer
Raw Material Warehouse	Stainless Steel Sheet	Transfer of Raw Materials	Stainless Steel Sheet	Shearing Machine
Shearing Machine	Stainless Steel Sheet	Raw Material Measurement	Stainless Steel Sheet with sizes according to cutting	Shearing Machine
Shearing Machine	Stainless Steel Sheet with sizes according to cutting	Raw Material Cutting	Trash Bin Body, Trash Bin Lid, Trash Bin Base	Pond Machine
Pond Machine	Trash Bin Lid, Trash Bin Base	Base and Lid shape printing	Trash Bin Lid, Trash Bin Base	Stamping Press Machine, Assembly Area
Pond Machine	Trash Bin Body	Punching on the body side	Trash Bin Body	Plate Roll Machine
Stamping Press Machine	Trash Bin Lid, Trash Bin Base	Pressing Process	Trash Bin Lid, Trash Bin Base	Argon Welding Machine
Plate Roll Machine	Trash Bin Body	Bending Process	Trash Bin Body	Argon Welding Machine
Argon Welding Machine	Trash Bin Body, Trash Bin Base	Joining and Welding	Trash Bin	Assembly Area
Assembly Area	Trash Bin, Trash Bin Lid	Assembly	Trash Bin	Assembly Area
Assembly Area	Trash Bin	Finished Product Inspection	Trash Bin	Assembly Area
Packaging Area	Trash Bin	Product Packaging	Trash Bin	Finished Goods Warehouse

Source : Observation and interview results, 2022

The supplier describes the initial material or goods that will be worked on in the production process, the input is the material that is available and will be used, the process is the work steps, the output is the product produced in the process, and the customer is the next step that will be carried out. After identifying the SIPOC Diagram, the next step is identifying Critical To Quality (CTQ) or the main characteristics that will influence customer satisfaction (Primahesa & Ngatilah, 2022)

Table 3. Critical To Quality (CTQ)

No	Type of Defect	Image of Defect	Defect Description
1	Body Dent		The surface of the trash bin body is dented, reducing the appearance and durability of the trash bin
2	Scratches		Scratches on the body, lid and base of the trash bin make the product quality less good and the appearance less attractive
3	Spots on the body		Spots that make the body dirty are caused by the production floor in the packaging area being less than clean
4	Rough lid		The surface of the lid is rough so it cannot be used or is dangerous for customers, caused by a lack of pressure during the pressing process

Source : Observation and interview results, 2022

In Table 3 Critical To Quality (CTQ), 4 types of defects were obtained based on direct observations and interviews with production section operators. The types of defects found in round trash bin products made from stainless steel are attributes.

Measure

At the measure stage, the P control chart is used to determine whether defects in the product are within the control limits or not. The following are the calculation results for the P control chart graph:

Table 4. P Control Chart Calculation

No	Observation Date	Total Product (Units/day)	Defect Total	Defect Percentage	CL	UCL	LCL
1	01/09/22	50	6	0.12	0.109	0.2412	0
2	05/09/22	75	12	0.16	0.109	0.217	0.001
3	07/09/22	100	11	0.11	0.109	0.2025	0.0155

No	Observation Date	Total Product (Units/day)	Defect Total	Defect Percentage	CL	UCL	LCL
4	13/09/22	80	4	0.05	0.109	0.2135	0.0045
5	15/09/22	30	5	0.1667	0.109	0.2797	0
6	19/09/22	25	4	0.16	0.109	0.296	0
7	20/09/22	65	10	0.1538	0.109	0.225	0
8	23/09/22	75	8	0.1067	0.109	0.217	0.001
9	26/09/22	25	2	0.08	0.109	0.296	0
10	27/09/22	70	9	0.1286	0.109	0.2207	0
11	28/09/22	40	4	0.1	0.109	0.2568	0
12	29/09/22	35	1	0.0286	0.109	0.267	0
13	03/10/22	75	8	0.1067	0.109	0.217	0.001
14	07/10/22	50	7	0.14	0.109	0.2412	0
15	12/10/22	40	4	0.1	0.109	0.2568	0
16	14/10/22	70	3	0.0429	0.109	0.2207	0
17	19/10/22	95	6	0.0632	0.109	0.2049	0.0131
18	21/10/22	40	2	0.05	0.109	0.2568	0
19	25/10/22	50	7	0.14	0.109	0.2412	0
20	26/10/22	30	7	0.2333	0.109	0.2797	0
21	27/10/22	25	5	0.2	0.109	0.296	0
22	07/11/22	50	4	0.08	0.109	0.2412	0
23	08/11/22	30	5	0.1667	0.109	0.2797	0
24	11/11/22	100	12	0.12	0.109	0.2025	0.0155
25	14/11/22	75	7	0.0933	0.109	0.217	0.001
26	16/11/22	50	4	0.08	0.109	0.2412	0
27	22/11/22	90	9	0.1	0.109	0.2075	0.0105
28	25/11/22	100	8	0.08	0.109	0.2025	0.0155
29	29/11/22	40	5	0.125	0.109	0.2568	0
30	30/11/22	45	9	0.2	0.109	0.2484	0
Total		1725	188				

Source : Processed Data from Observation, 2022

In table 4, first the results of the center line calculation are obtained, namely the division of total defects by the total production quantity. Next, the upper control limit and lower control limit are calculated to determine the highest and lowest limits of the defect data(ANDRIANI et al., 2021). The following is one of the UCL and LCL calculations for the observation date 01/09/2022:

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$= 0{,}109 + 3\sqrt{\frac{0{,}109(1-0{,}109)}{50}}$$

$$= 0{,}2412$$

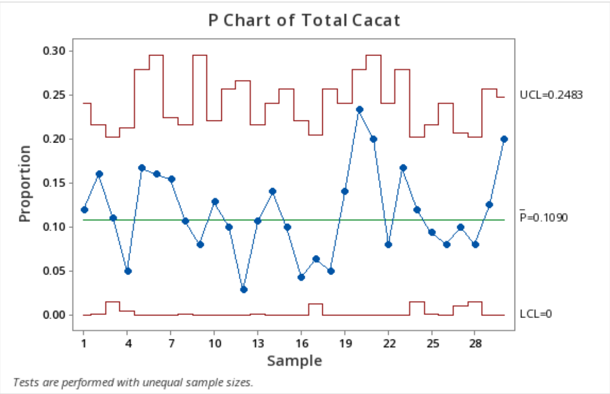
LCL $= \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$= 0{,}109 - 3\sqrt{\frac{0{,}109(1-0{,}109)}{50}}$

$= -0{,}0232$

Based on the calculation results in table 4, a P control chart graph was obtained using Minitab software. The control chart graph P is presented in Figure 2 :

Figure 2. P Control Chart Graph



Source : Control P Chart from Minitab Processing, 2022

The results of the graph show that the defect data for the production of round stainless steel trash bins is still within the control limits, so there is no out of control data. Next, the DPMO calculation is carried out to determine the sigma level of the production process for round trash bins made from stainless steel (Setiawan et al., 2021). Based on production data from September to November 2022, data on total units produced, total defects and types of defects were obtained as follows:

Total units produced = 1725

Total defects = 188

Types of defects = 4

DPO = (Total Unit of Defect)/(Total unit x CTQ Opportunity)

= 188/(1725 x 4)

= 0,0273

DPMO = 0,0273 x 1.000.000 = 27.300

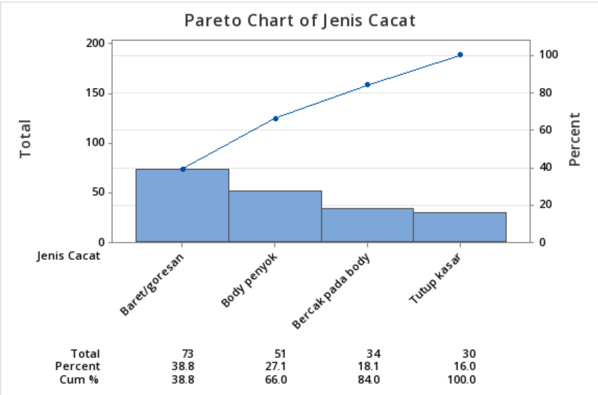
Sigma Level = normsinv ((1000000 – DPMO) / 1000000) + 1.5 = 3,422

Based on the calculation results above, a DPMO value of 27300 is obtained, where these results indicate that there are 27300 opportunities for defects out of 1,000,000 opportunities in the process of stainless steel round trash bin products. With this DPMO value, a sigma level of 3.422 is obtained.

Analyze

The tools used at the analyze stage are Pareto diagrams, fishbone diagrams, and Failure Mode Effect Analysis (FMEA)(Patyal et al., 2021). The Pareto diagram is used to obtain values for the types of defects based on largest to smallest (Wulandari et al., 2022). The following are the results of the Pareto diagram obtained using the Minitab software :

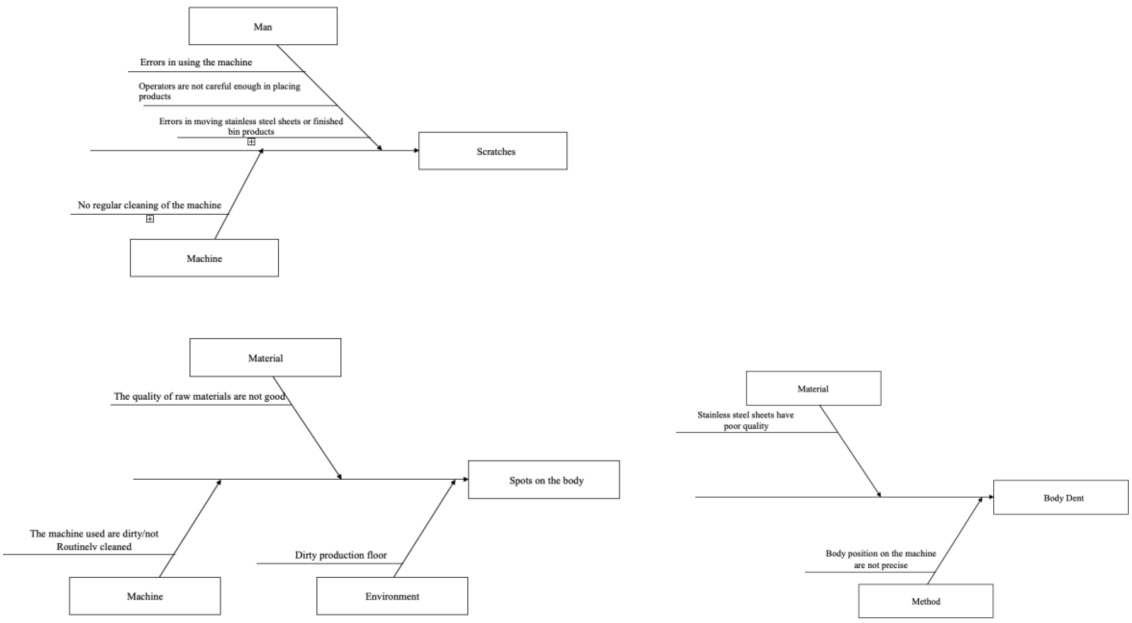
Figure 3. Pareto Diagram



Source : Pareto Chart from Minitab Processing, 2022

It was found that scratches had the largest total, followed by body dents, spots on the body, and rough lid. At the analyze stage there is a fishbone diagram that will be used to determine the causes of existing problems based on the categories that are Men, Method, Machine, Materials, and Environment (Hisprastin & Musfiroh, 2020)

Figure 4. Fishbone Diagram



Source : Observations and Interview Results on Defects, 2022

After obtaining the causes of defects through a fishbone diagram, further analysis is carried out using failure mode effect analysis (FMEA) to define the product process, collect data on problems that may occur, assess problems in terms of impact, possibility and detection, calculate Risk Priority Number (RPN), as well as taking action to reduce risk (Lutfianto & Prabowo, 2022). The Risk Priority Number value is obtained from the product of each identified severity, occurrence and detection scale (Meykasari et al., 2022). Below are the FMEA results :

Table 5. Failure Mode Effect Analysis of trash bin stainless steel product

Process	*Potential Failure*	*Cause of Failure*	*Effect of Failure*	*Severity*	*Occurrence*	*Current Control*	*Detection*	*RPN*	Rank
Bending	Scratches	No regular cleaning of the machine	Reducing product quality and the product must be reworked	7	8	Routine maintenance of the machines used	5	280	1
		Errors in using the machine			6	Supervision of the production process carried out by the operator		210	4
		Operators are not careful enough in placing products			7		5	245	3
		Errors in moving stainless steel sheets or finished bin products			5	Operators are to be more careful in moving raw materials or products from one machine to the other	4	140	7
	Body Dent	Body position on the machine are not precise	Product is not suitable for use	7	6	Checking the body position by the operator before the bending process is carried out	5	210	4
		Stainless steel sheets have poor quality			6	Checking stainless steel sheets before use	6	252	2
Shearing	Spots on the body	Dirty production floor	Reducing product quality	5	8	Regular cleaning is carried out on the production floor	3	120	8
		The quality of raw materials are not good			6	Checking stainless steel sheets before use	6	180	6
		The machine used are dirty/not routinely cleaned			7	Routine maintenance of the machines used	3	105	9

Source : FMEA observation and Interview Analysis, 2022

Based on the FMEA results in table 5, the highest Risk Priority Number (RPN) value was obtained at 280 for the type of scratches defect in the cause of failure in the form of not carrying out regular cleaning of the machine.

DISCUSSION

Improve

At the Improve stage, changes will be made to improve process performance and solutions will be developed to problems so that improvements can be made (Batuta, 2023). In the previous stage that is FMEA, defects with the highest RPN were found in the form of scratches. Therefore, scratches will be prioritized to provide recommendations for improvement using the fuzzy analytical hierarchy process (Fuzzy AHP). Proposed improvements or recommendations for types of scratches are presented in table 6.

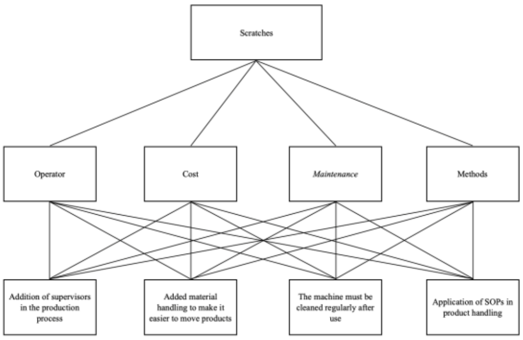
Table 6. Improvement recommendations

Type of defect	Improvement recommendations
Scratches	Addition of supervisors in the production process
	Added material handling to make it easier to move products
	The machine must be cleaned regularly after use
	Application of SOPs in product handling

Source : Interview and Brainstorming Results, 2023

The initial stage in solving problems with Fuzzy AHP is creating a hierarchical structure. In the hierarchical structure, there are criteria in the form of operators, costs, maintenance, and methods. There are alternatives to these criteria.

Figure 5. Hierarchical Structure of scratches defect



Source : Improvement Recommendations, Microsoft Visio, 2023

The next stage of the Fuzzy AHP method is to determine priority weights based on the criteria that have previously been obtained. The weights are obtained from the results of preparing a pairwise comparison matrix with each AHP and TFN scales. The following is the Triangular Fuzzy Number Scale used.

Table 7. TFN Scale

AHP Scale	Description	Fuzzy Triangular Value
1	Equally important	(1,1,1)
3	A little more important	(1,3,5)
5	More important	(3,5,7)
7	Definite importance	(5,7,9)
9	Absolute importance	(7,9,9)

Source : Questionnaire results of 2 Experts, 2023

The next stage of the Fuzzy AHP method is to determine priority weights based on the criteria that have previously been obtained. The weights are obtained from the results of preparing a pairwise comparison matrix with each AHP and TFN scales. In this Fuzzy AHP calculation, 2 experts were used, namely the head of production and the production operator from PT XYZ.

Table 8. Pairwise Comparison Matrix of Expert 1

Expert 1				
Criteria	Operator	Cost	Maintenance	Methods
Operator	1			Equally important
Cost	A little more important	1		Equally important
Maintenance	More important	A little more important	1	A little more important
Methods				1

Source : Questionnaire results of 2 Experts, 2023

Table 8 showed the assessment results by expert 1 with the related criteria. Based on the result on table 8, the assessment will then be converted to numerical value according to the AHP scale. These results are presented in table 9.

Table 9. Numerical Pairwise Comparison Matrix of Expert 1

Expert 1				
Criteria	Operator	Cost	Maintenance	Methods
Operator	1	1/3	1/5	1
Cost	3	1	1/3	1
Maintenance	5	3	1	3
Methods	1	1	1/3	1

Source : Questionnaire results of 2 Experts, 2023

Consistency test for expert 1 was carried out next. The value of the consistency ratio (CR) obtained was 0.0431, this result states that the pairwise matrix between the criteria for expert 1 is consistent due to the CR value being <0.1. After the result obtained showed expert 1 to be consistent, calculations are carried out for expert 2.

Table 10. Pairwise Comparison Matrix of Expert 2

Expert 2				
Criteria	Operator	Cost	Maintenance	Methods
Operator	1	A little more important		
Cost		1		
Maintenance	More important	More important	1	More important
Methods	Equally important	A little more important		1

Source : Questionnaire results of 2 Experts, 2023

Based on the result obtained in table 10, the assessment will be converted to numerical value according to the AHP scale. These results are presented and can be seen in table 11.

Table 11. Numerical Pairwise Comparison Matrix of Expert 2

Expert 2				
Criteria	Operator	Cost	Maintenance	Methods
Operator	1	3	1/5	1
Cost	1/3	1	1/2	1/3
Maintenance	5	5	1	5
Methods	1	3	1/2	1

Source : Questionnaire results of 2 Experts, 2023

Consistency test calculation for expert 2 was carried out. The value of the consistency ratio (CR) obtained was 0.0577, this result states that the pairwise matrix between the criteria in expert 2 is consistent. The next step to be carried out was the combination of the pairwise comparison matrix by expert 1 and expert 2.

Table 12. Pairwise Comparison Combination Matrix of expert 1 and expert 2

Combination Matrix of Expert 1 and Expert 2				
Criteria	Operator	Cost	Maintenance	Methods
Operator	1	0.9999	0.2	1
Cost	0.9999	1	0.2582	0.5773
Maintenance	5	3.873	1	3.873
Methods	1	1.7321	0.2582	1
Total	7.9999	7.605	1.7164	6.4503

Source : Questionnaire results of 2 Experts, 2023

The consistency ratio (CS) obtained was 0.0172, this result states that the pairwise matrix between the criteria in the combination of expert 1 and expert 2 is consistent due to the CR value being <0.1. After the CR result obtained showed that expert 1 and expert 2 are both consistent, a defuzzification process was carried out.

Table 13. Defuzzification Criteria of Expert 1 and Expert 2

Criteria	Importance Fuzzy Number			Norm. Fuzzy Number			Defuzzification	
	l	m	u	l	m	u	Weight	Normalization
Operator	0.5028	0.6687	0.9291	0.0717	0.1324	0.2811	0.1617	0.135
Cost	0.4288	0.6213	1.0659	0.0611	0.123	0.3225	0.1689	0.141
Maintenance	1.7321	2.9428	3.9563	0.2468	0.5827	1.1971	0.6755	0.5639
Methods	0.6412	0.8178	1.0659	0.0914	0.1619	0.3225	0.1919	0.1602
Total	3.3049	5.0506	7.0172	0.471	1	2.1232	1.198	1

Source : Questionnaire results of 2 Experts, 2023

The normalization results in defuzzification process will be used as the weights in determining the best alternative. After calculating the criteria and each existing alternative, the final result was obtained in the form of the weight of each alternative from the existing criteria. The weight result is presented and can be seen in table 14.

Table 14. Improvement Alternative Weight Results

Criteria	Criteria Weight	Alternative Weight				Repair Alternatives (Criteria Weight x Alternative Weight)			
		1	2	3	4	1	2	3	4
Operator	0.135	0.148	0.2422	0.4971	0.1128	0.02	0.0327	0.0671	0.0152
Cost	0.141	0.1098	0.122	0.4599	0.3084	0.0155	0.0172	0.0648	0.0435
Maintenance	0.5639	0.1739	0.2404	0.4629	0.1227	0.0981	0.1356	0.261	0.0692
Methods	0.1602	0.1587	0.1203	0.2453	0.4758	0.0254	0.0193	0.0393	0.0762
Total						0.159	0.2048	0.4322	0.2041
Rank						4	2	1	3

Source : Questionnaire results of 2 Experts, 2023

Based on the calculation results obtained in table 14, it was found that the repair alternative with the highest total weight was alternative 3 (the machine must be cleaned regularly after use) with a total of 0.4322, alternative 2 (Added material handling to make it easier to move products) with a total of 0.2048. and alternative 4 (application of SOPs in product handling) with a total of 0.2041.

Control

In the next stage, namely Control, implementation is carried out based on the results of proposed improvements that have previously been determined using the Fuzzy Analytical Hierarchy Process (Fuzzy AHP). The Control stage is carried out to check whether there is a positive impact resulting from implementation of proposed improvements to the company (Smętkowska & Mrugalska, 2018). Based on the results on the discussions and outreach with the company regarding the proposed improvements that will be implemented, the selected improvement proposal is the establishment of a Standard Operating Procedure (SOP) for operators in handling products. The implementation carried out will be observed to ensure whether the improvement can provide results or changes in quality (Sajjad et al., 2021). The Sigma level obtained after implementation was an increase that was not too high, namely from 3.422 to 3.6061.

CONCLUSIONS

Based on data processing related to stainless steel round trash bin products at PT XYZ, the following conclusions were obtained:

1. Based on Critical To Quality (CTQ) identification, 4 types of defects were found, namely body dents, scratches, spots on the product body, and rough lid surfaces.
2. The DPMO value obtained from the production process of round stainless steel trash bins for the period of September – November 2022 was 27,300, so the sigma level obtained is 3.422.
3. The results of the Pareto diagram show that the dominant defects found on the product are scratches with a percentage of 38.8%, body dents with a percentage of 27.1%, and spots on the product body with a percentage of 18.1%. The results of the Failure Mode Effect Analysis (FMEA) were obtained, namely scratches caused by not carrying out regular cleaning on the machine, which had the highest RPN value of 280.
4. Based on the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) assessment regarding 4 criteria in the form of operators, costs, maintenance and methods for the 4 alternatives given, the highest improvement alternative weight was obtained, namely alternative 3 (the machine must be cleaned regularly after use) with a total of 0.4322, alternative 2 (Added material handling to make it easier to move products) with a total of 0.2048, and alternative 4 (application of SOPs in product handling) with a total of 0.2041.
5. Implementation and observations were carried out on 18 April 2023 – 02 May 2023 with a total of 5 days of data obtained. There was an increase in the Sigma level obtained after implementation, but it was not significant enough, namely from 3.422 to 3.6061.

LIMITATION

In the process of implementing proposed improvements, there are several limitations, namely as follows:

1. The implementation time is limited due to public holidays so the production process stops, so the length of implementation time obtained is 5 working days.
2. Limited implementation time means that the increase in sigma level obtained is not yet significant
3. The proposed improvement of added material handling to make it easier to move products cannot yet be implemented due to limited implementation time and requires coordination regarding the costs incurred.

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