ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

Quality Control of Ceramic Wall Products Six Sigma Method with Dmaic Tools and Failure Mode and Effect Analysis (FMEA)

Muhammad Rizki[1]; Tri Ngudi Wiyatno[2]; Retno Fitri Astuti[3]
Industrial Engineering Study Program, Faculty of Engineering, Pelita Bangsa University
Jl. Kalimalan g Inspection No. 9 Cibatu, Bekasi 17530

Abstract:- Considering the importance of increasingly rapid industrial development, business people must be aware of the orientation towards product quality. The manufacturing industry has an important role in industrial development. It is hoped that it will be able to grow and have advantages in industrial development, therefore it is necessary to improve and increase product quality. The company continues to strive to maintain and improve product quality and increase productivity so that customers are satisfied with the products produced. One way that needs to be done is to reduce the number of defective products in the production process. This effort is one way of continuous improvement carried out by PT. ABC and companies operating in the same field. The ceramic wall production process has relatively high demand but still has a high level of defects. Based on information on production data and data on the number of defects for the period January – September 2023, wall ceramic production has a defect rate of 3.86%. Companies must reduce the number of defects to achieve company targets. This research aims to improve the production process of wall ceramics by minimizing the number of defective products. This research uses the six sigma method with the DMAIC (Define, Measure, Analyze, Improve, Control) tool assisted by the FMEA (Failure Mode and Analysis) method. Corrective action to reduce defects based on the 5 Why analysis is to find out what the problem is and ask "why" and "what is the root of the problem". The research results show that there are 4 types of defects which have a large number of defects, namely Rupture Defects, Application Defects, Peeling Defects and Hole Defects. From the research results, solutions were obtained for the emergence of several types of defects in the wall ceramic production process, namely by providing planning suggestions and corrective actions which are discussed this time. At the defect calculation stage, Broken produces a DPMO value of 29.362 with a sigma level of 3.39 with a sigma level of 3.48, Defect Peeled produces a DPMO value of 28.044 with a sigma level of 3.38, and holes are defective. resulting in a DPMO value of 26,020 with a sigma value of 3.45 from the data calculation results, it is still not enough to meet the company's target at the sigma level, therefore the company must make quality improvements to achieve the main target at the sigma level.

Keywords:- *Component; Six Sigma, Fmea, Quality Control, Product Quality.*

I. INTRODUCTION

PT ABC is a company operating in the building sector. PT ABC's main products are floor ceramics and wall ceramics which are produced for domestic market needs. The industrial world brings big changes to all parties involved in it. Consumer needs and knowledge always increase all the time [1] .

Business actors are required to have their own advantages that other competitors do not have [2] . One of the advantages that a company can have is better product quality compared to competing companies [3] . Quality control is an activity that is closely related to production, where quality control is a system of verification and maintenance of the desired level/degree of product quality through good planning, appropriate equipment, continuous inspection, and corrective action if necessary. [4] . In order to achieve several aspects required by industry, you must have a production line that supports the process. To obtain optimal production process performance and obtain products that have good quality, improvements are needed that can increase efficiency in the production process. Quality [5] .

One thing that can be used to improve and increase quality is to use the DMAIC method [6] . Initially developed the DMAIC method as part of the Six Sigma framework, which was proven to eliminate defects and improve quality related to business metrics [7] . Before the Six Sigma process is carried out, the level of performance is first measured, namely the DPMO level (Defects Per Million Opportunities) and the achievement of the Sigma level (Sigma Level). Six Sigma implementation involves several integrated tools to obtain increased sigma values. The tools used in the six sigma DMAIC method include the fishbone diagram. [8] .

In its application, six sigma has 5 (five) steps to improve business performance, namely define, measure, analyze, improve and control so that problems or opportunities, processes and customer requirements must be verified and updated in each step [9] . The application of the Six Sigma DMAIC method can reduce the level of damage and increase the sigma level [10] . The company's advantage in implementing this method can be to reduce costs

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

significantly [11] . The Six Sigma DMAIC method focuses on reducing process variability to produce high quality products and creating efficient processes that are obtained without waste, thereby generating added value for customers [12] . Referring to the successful application of the DMAIC method in manufacturing companies. This research aims to improve quality by bringing products to the lowest level of defects to near perfection in the resulting production process. The application of DMAIC at PT ABC is expected to reduce the number of defects in wall ceramic products.

II. RESEARCH METHODOLOGY

A. Research Flowchart

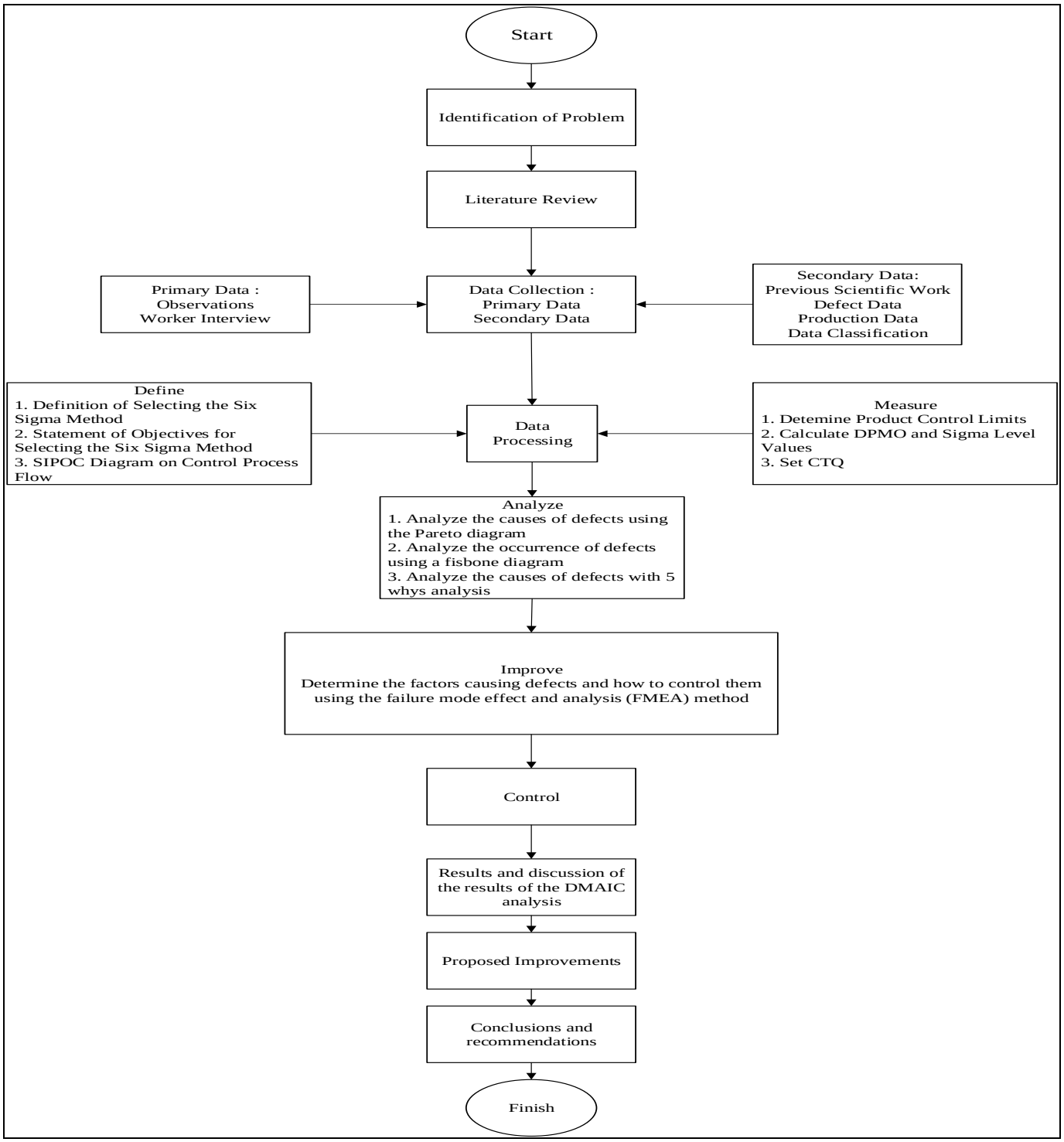


Fig 1: Research Design Scheme

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

This research was conducted on ceramic wall products in the production process at PT. ABC to reduce the number of defects produced. This research uses the six sigma method assisted by the DMAIC (Define, Measure, Analyze, Improve, Control) tools. This research uses secondary data, which is production data from January to September 2023 and data on the number of products produced and the number of defective products. DMAIC is often used to improve product quality and reduce the number of defects in products. DMAIC is a continuous improvement process to achieve PT's six sigma targets. ABC wants.

B. Define Stage

The define stage is the initial stage which is the application of DMAIC in improving product quality. At this stage, choose and determine steps in determining problems and goals. One way to solve problems is by using the SIPOC (Suppler, Input, Process, Output, Customer) diagram. And the define stage aims to improve the quality of the wall ceramic production process.

C. Measure Stage

The measure stage is included in the second stage. Before taking measurements, it is important to determine the main criteria for the type of product defects using CTQ (Critical To Quality) and the Pareto Diagram before calculating the percentage of defects and sigma level. The following is the calculation to determine the CTQ value:

- *Defects Per Million Opportunities*

DPMO = DPO x10^6

- *Calculation of Upper and Lower Control Limits*

$$p = \frac{\sum np}{\sum n}$$

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

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

- *Defects Per Unit*

$$DPU = \frac{Total\ Defect}{Total\ Unit\ Produksi}$$

- *Total Opportunities (TOP)*

TOP = U × OP = 2,207,245 x 1

- *Defects Per Opportunities*

$$DPO = \frac{Total\ Defect}{Total\ Opportunitiesi}$$

Sigma Level Conversion Table

Yield	DPMO	Sigma	Yield	DPMO	Sigma	Yield	DPMO	Sigma
6.6%	**934,000**	**0**	**69.2%**	**308,000**	**2**	**99.4%**	**6,210**	**4**
8.0%	920,000	0.1	72.6%	274,000	2.1	99.5%	4,660	4.1
10.0%	900,000	0.2	75.8%	242,000	2.2	99.7%	3,460	4.2
12.0%	880,000	0.3	78.8%	212,000	2.3	99.75%	2,550	4.3
14.0%	860,000	0.4	81.6%	184,000	2.4	99.81%	1,860	4.4
16.0%	840,000	0.5	84.2%	158,000	2.5	99.87%	1,350	4.5
19.0%	810,000	0.6	86.5%	135,000	2.6	99.90%	960	4.6
22.0%	780,000	0.7	88.5%	115,000	2.7	99.93%	680	4.7
25.0%	750,000	0.8	90.3%	96,800	2.8	99.95%	480	4.8
28.0%	720,000	0.9	91.9%	80,800	2.9	99.97%	330	4.9
31.0%	**690,000**	**1**	**93.3%**	**66,800**	**3**	**99.977%**	**230**	**5**
35.0%	650,000	1.1	94.5%	54,800	3.1	99.985%	150	5.1
39.0%	610,000	1.2	95.5%	44,600	3.2	99.990%	100	5.2
43.0%	570,000	1.3	96.4%	35,900	3.3	99.993%	70	5.3
46.0%	540,000	1.4	97.1%	28,700	3.4	99.996%	40	5.4
50.0%	500,000	1.5	97.7%	22,700	3.5	99.997%	30	5.5
54.0%	460,000	1.6	98.2%	17,800	3.6	99.9980%	20	5.6
58.0%	420,000	1.7	98.6%	13,900	3.7	99.9990%	10	5.7
61.8%	382,000	1.8	98.9%	10,700	3.8	99.9992%	8	5.8
65.6%	344,000	1.9	99.2%	8,190	3.9	99.9995%	5	5.9
						99.99966%	**3.4**	**6**

Fig 2: Sigma Level

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

D. Analyze Stage

This stage requires identifying the source and root cause of product defects that are problems in the wall ceramic production process based on product defects that often appear or the most dominant defects. Then create an improvement plan to overcome the problems that are occurring. By making a fishbone diagram, it functions to analyze and find factors that influence the quality characteristics resulting from the wall ceramic production process.

E. Improve Stage

Once the source and root cause of the quality problem is known, a plan will be implemented to eliminate the known causes of nonconformity. To implement six sima and improve quality. In this research, steps were taken at the improve stage, namely proposing improvements using the 5 why analysis method.

F. Control Stage

The control stage is the final stage in the six sigma method using DMAIC. During the planning process and corrective actions, management must control and monitor the production process of ceramic wall products. And assess the Company's capabilities so that problems do not occur in the future.

III. RESULTS AND DISCUSSION

A. Define

Initial operational steps in the product quality improvement program using six sigma. The steps that need to be taken are defining several criteria related to the selection of defective products that will be examined. In this research, the selection of criteria was carried out by prioritizing defects that frequently appear. The author's aim in choosing this research was because when conducting observations, a defect in the wall ceramic product was found which was caused by the production process. The following is defect data from the results of the production process for making ceramic wall products at PT. ABC during January to September 2023.

Table 1: Data on Defects in the Ceramic Wall Production Process

No	Month	Type Of Defect								Total production (n)	Total Defect (np)
		Application Defect	Broken	Crack	Decoration Defect	Holes	Peeled	Planarity	Uneven Edge		
1	Januari	6211	4803	193	1350	6424	7215	1370	2296	193249	29862
2	Februari	8116	6995	209	1350	1749	9029	2794	2072	243147	32314
3	Maret	6894	6590	87	1127	4314	7891	5289	2298	197232	34490
4	April	5993	7288	0	1953	1083	7307	1489	4620	203879	29733
5	Mei	5881	9242	0	2614	16960	8340	2794	10643	210199	56474
6	Juni	10420	10589	63	3740	10568	8278	5289	6933	365560	55880
7	Juli	6886	6772	33	1595	5600	3939	1489	3239	245232	29553
8	Agustus	5888	7452	92	2300	7688	6098	1587	2300	302903	33405
9	September	4887	5079	11	2359	4774	3803	2143	632	245844	23688
Total		**61176**	**64810**	**688**	**18388**	**59160**	**61900**	**24244**	**35033**	**2207245**	**325399**

Based on table 1, it can be seen that several output results from wall ceramics at PT. ABC has 8 defects. Therefore, using quality control using the six sigma method to find the causes of product defects and improve the quality of wall ceramic products. Therefore, this quality control is expected to meet the product standards desired by customers and company partners. So that the products produced by the company do not suffer losses, benefit people and benefit the company. Then the SIPOC diagram shows the factors that influence the wall ceramic production process by identifying the production process from suppliers to raw material processing until it is received into the hands of customers.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

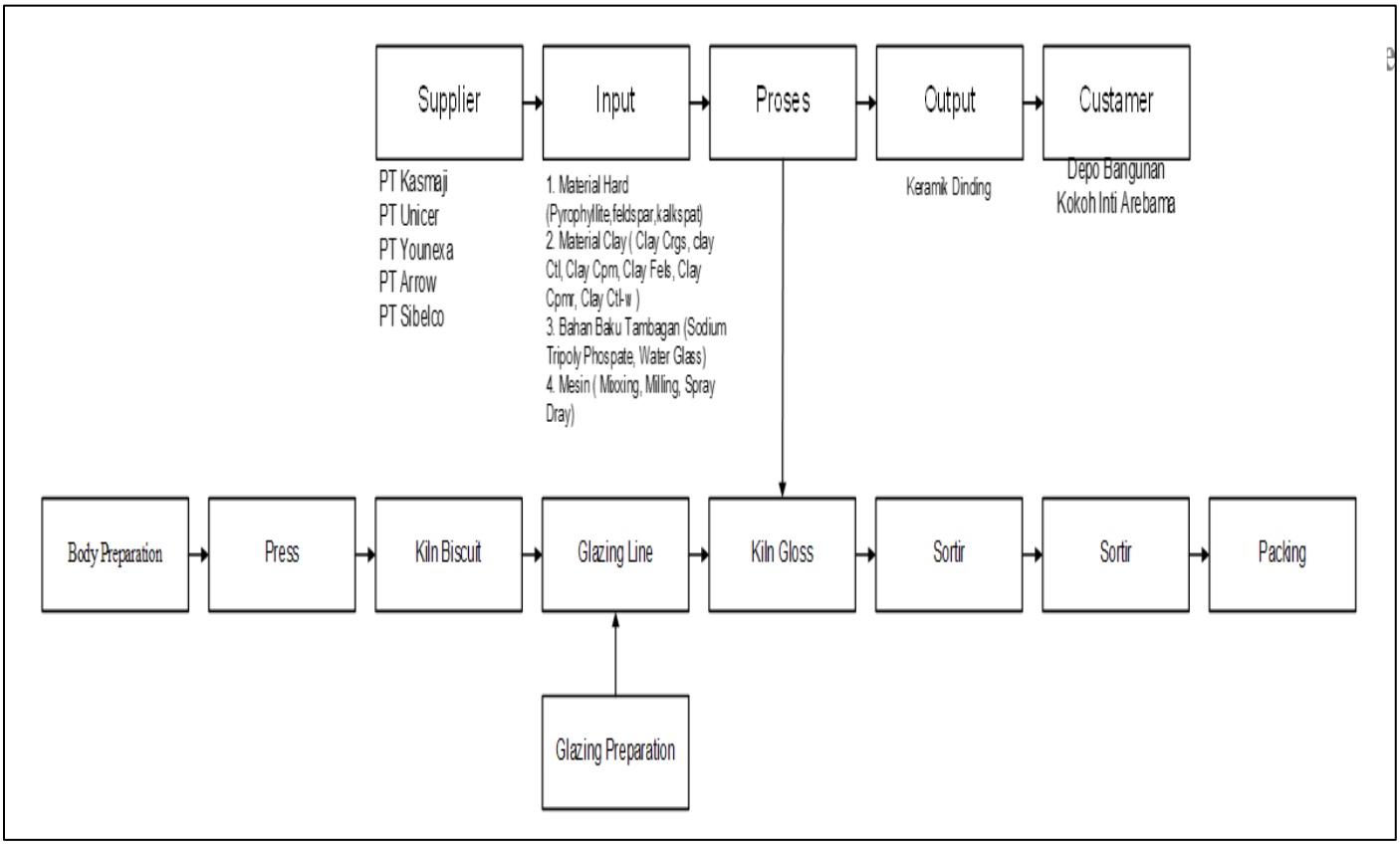


Fig 3: SIPOC Flow Diagram

B. Measure

At this stage, measurements are taken of the types of defects that have been identified. When carrying out measurements, it is important to determine the main criteria that are important for critical to quality (CTQ) quality and calculate the sigma level from the level of damage per million opportunities to defects per millions of opportunities (DPMO). Therefore, to determine the value of CTQ, you must determine the defect percentage value from the reject data that has been obtained. To calculate the defect percentage as follows:

Table 2: Cumulative Percentage of Wall Ceramic Defects

Process	Jenis Defect	Number of Ceramic Production Defects (Unit)	Presentation Defect %	Cumulative Percentage (%)
Wall Ceramic Production Process	**Application Defect**	61176	19,92	19,92
	Broken	64810	19,02	38,94
	Crack	688	18,8	57,74
	Decoration Defect	18388	18,18	75,92
	Holes	59160	10,77	86,69
	Peeled	61900	7,45	94,14
	Planarity	24244	5,65	99,79
	Uneven Edge	35033	0,21	100
Total		325399	100	

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

The next calculation sorts the defect percentage values from largest to smallest and calculates the cumulative percentage value that will be obtained. The results of the cumulative percentage calculation can be seen in table 2.

Once the defect percentage calculation results are known, they are depicted in the form of a Pareto diagram. The function of the Pareto diagram is to make the selection of defect types more targeted and valid. The Pareto diagram can be seen in Figure 3.

➢ *Pareto Chart*

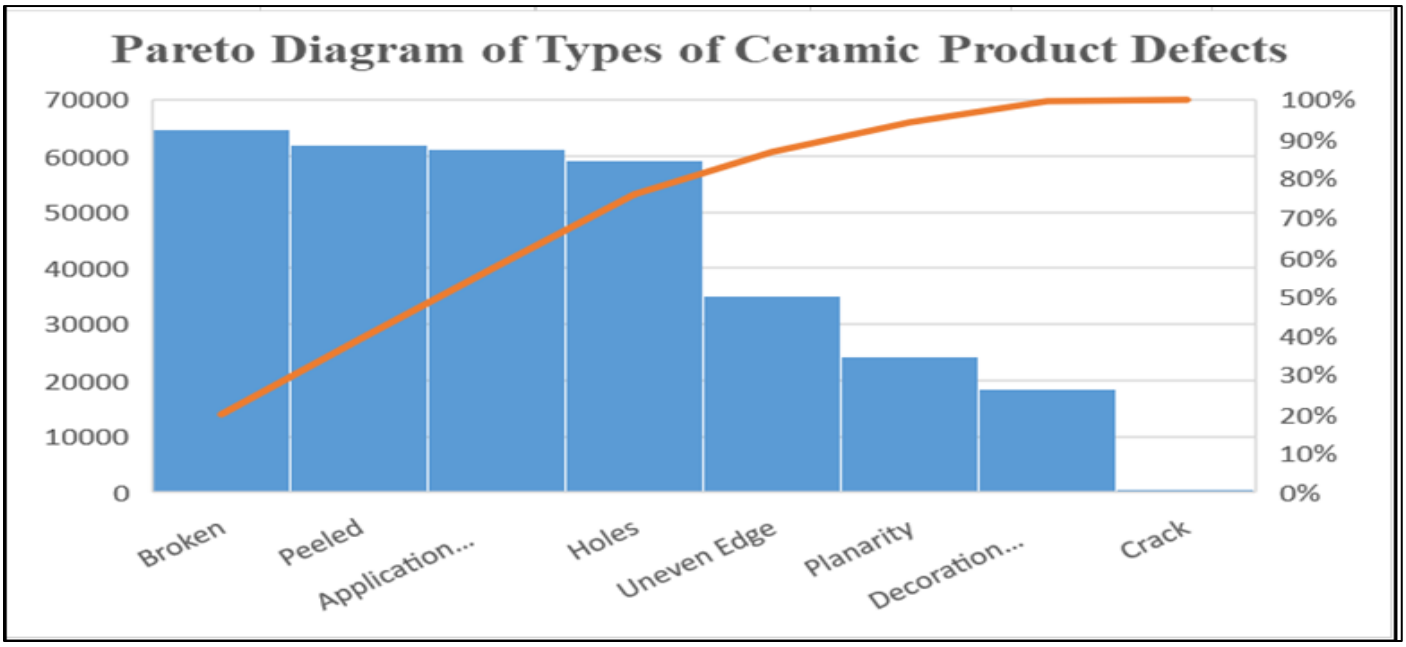


Fig 4: Pareto Chart for Ceramic Wall Products

➢ *Control Map*

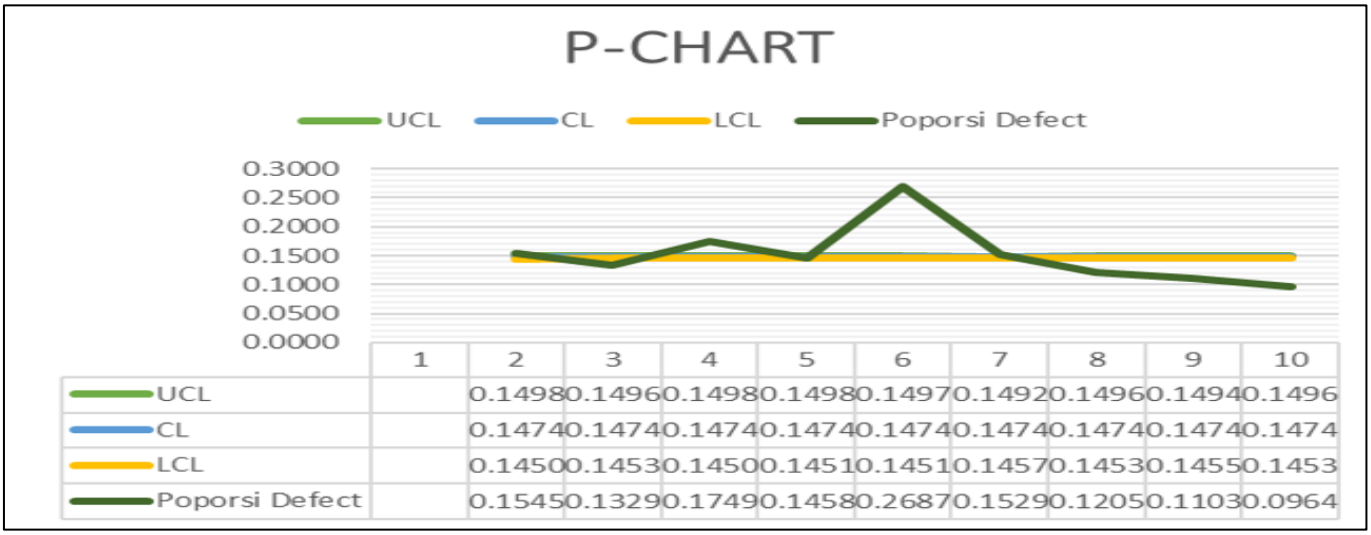
In this study, a P control chart is used, because the P control chart is used if the defect size is the proportion of defective products in each sample taken. making a control chart P using data on production quantities and the number of defects that have the most dominant numbers in the ceramic production process in the period January – September 2023.

Table 3: Control Map P

Control chart p											
No	Month	Type Of Defect				Total production (n)	Total Defect (np)	UCL	CL	LCL	Proportion of Defects
		Application Defect	Broken	Holes	Peeled						
1	Januari	6211	4803	6424	7215	193249	29862	0.1498	0.1474	0.1450	0.1545
2	Februari	8116	6995	1749	9029	243147	32314	0.1496	0.1474	0.1453	0.1329
3	Maret	6894	6590	4314	7891	197232	34490	0.1498	0.1474	0.1450	0.1749
4	April	5993	7288	1083	7307	203879	29733	0.1498	0.1474	0.1451	0.1458
5	Mei	5881	9242	16960	8340	210199	56474	0.1497	0.1474	0.1451	0.2687
6	Juni	10420	10589	10568	8278	365560	55880	0.1492	0.1474	0.1457	0.1529
7	Juli	6886	6772	5600	3939	245232	29553	0.1496	0.1474	0.1453	0.1205
8	Agustus	5888	7452	7688	6098	302903	33405	0.1494	0.1474	0.1455	0.1103
9	September	4887	5079	4774	3803	245844	23688	0.1496	0.1474	0.1453	0.0964
Total		**61176**	**64810**	**59160**	**61900**	**2207245**	**325399**				

After the control limit calculations are obtained, the next step is to create a control chart graphic which functions to map the data limits. The purpose of making this control chart graph is to find out whether the data is within control limits or not.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035



	1	2	3	4	5	6	7	8	9	10
UCL		0.1498	0.1496	0.1498	0.1498	0.1497	0.1492	0.1496	0.1494	0.1496
CL		0.1474	0.1474	0.1474	0.1474	0.1474	0.1474	0.1474	0.1474	0.1474
LCL		0.1450	0.1453	0.1450	0.1451	0.1451	0.1457	0.1453	0.1455	0.1453
Poporsi Defect		0.1545	0.1329	0.1749	0.1458	0.2687	0.1529	0.1205	0.1103	0.0964

Fig 5: P Chart Graph

This shows that the wall ceramic production process is still unstable. And several types of defects occur that must be prioritized and quality improved so that these problems do not occur again.

- *DPMO (Defects Per Millions Opportunities) and Sigma Level*

  The DPMO calculation can be seen below:

  DPMO = DPO x10^6

  Example of DPMO and Sigma level calculations

- *Defect Broken*

  DPMO = 0.029362 x 10^6= 29.362

- Sigma Levels

$$\frac{DPMO_a - DPMO_x}{DPMO_x - DPMO_b} = \frac{Level_a - Level_x}{Level_x - Level_b}$$

$$\frac{35.900 - 29.362}{29.362 - 28.700} = \frac{3.3 - x}{x - 3.4}$$

$$\frac{6.538}{662} = \frac{3.3 - x}{x - 3.4}$$

6,538 (x – 3.4) = 662 (3.3 – x)
6,538x + 662x = 6,538 (3.4) + 662 (3.3)
7,200 x= 24,413.8
X = 3.39

To calculate the sigma level of the defect type, use the same method. The results of sigma level calculations for other types of defects can be seen in table 5.

Table 4: Dominant Defect Sigma Level

Defect Type	DPMO	Sigma Levels
Broken	29,362	3.39
Application Defect	27,715	3.48
Peeled	28,044	3.38
Holes	26,020	3.45

The results obtained from the sigma level calculation for the wall ceramic production process are currently at level 3.48 (taken from a large sigma level). Based on the results of the data processing that has been carried out, the average DPMO value for wall ceramic production in January - September 2023 is 27,785, meaning that there are still a large number of defects produced in the wall ceramic production process.

After going through the measurement stage, the next step will be to carry out the analysis stage. Basically, this stage is the stage of identification and analysis regarding the main causes of problems and in the end you will find out how to anticipate the causes of the main problems in this research. By making Pareto diagrams and P control chart graphs, it can

C. Analyze

be seen that there are four types of defects that greatly influence CTQ, namely Broken Defects, Application Defects, Peeled Defects, Holes Defects in wall ceramic production. The next step will be to carry out an analysis of the root causes of known defect problems using a fishbone diagram.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

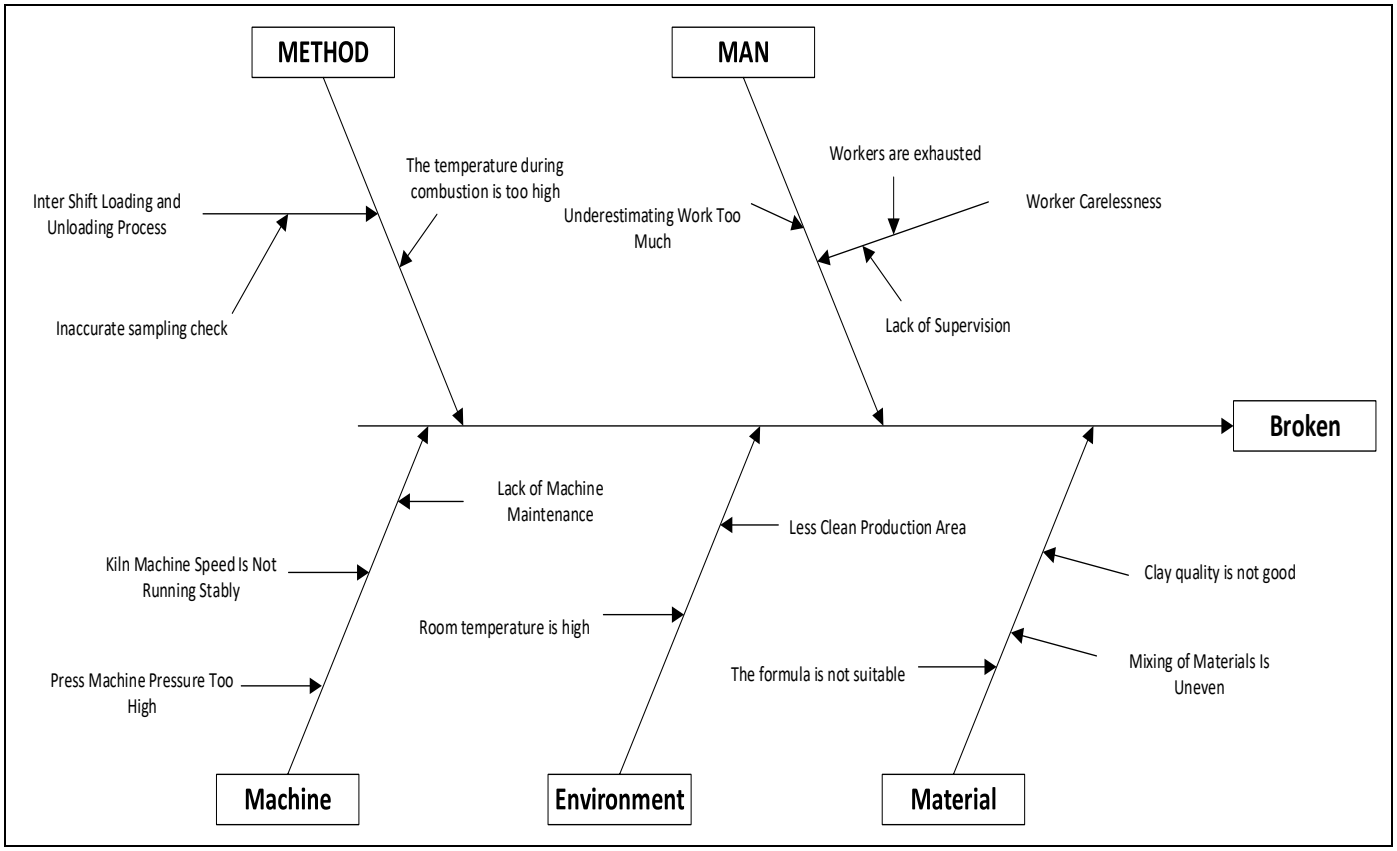


Fig 6: Fishbone Diagram of Broken Defect

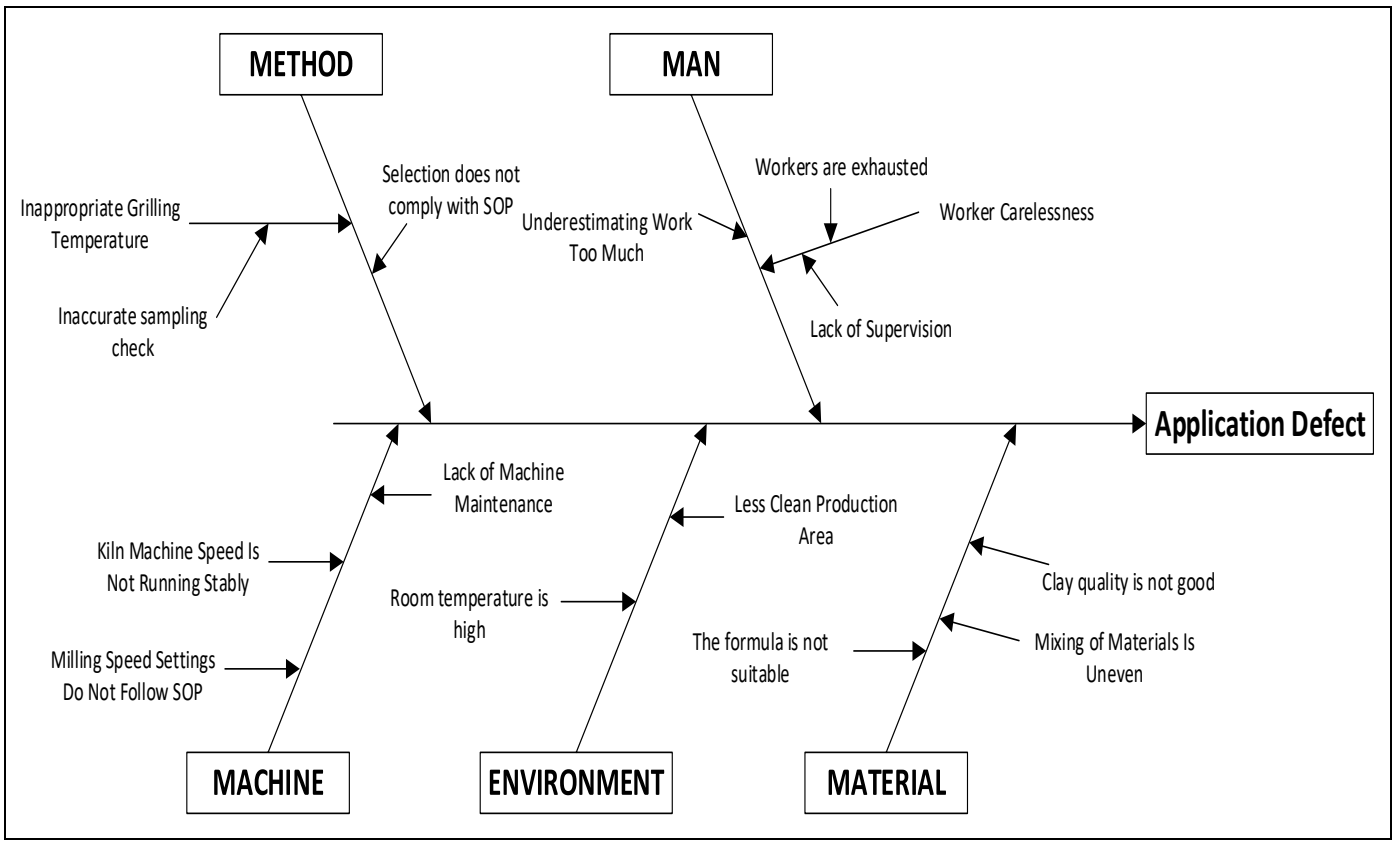


Fig 7: Fishbone Diagram Defect Application Defect

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

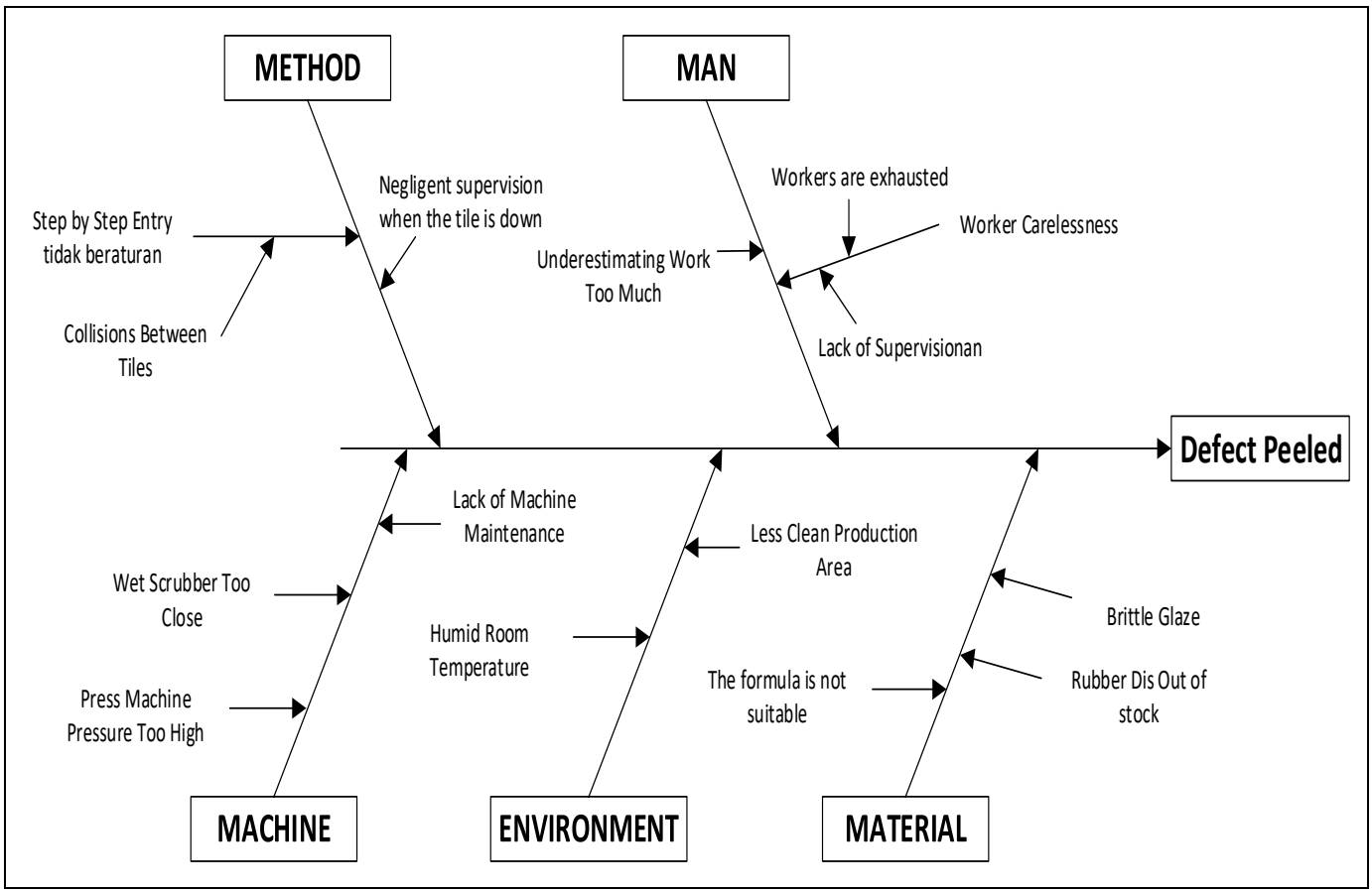


Fig 8: Fishbone Diagram of Peeled Defect

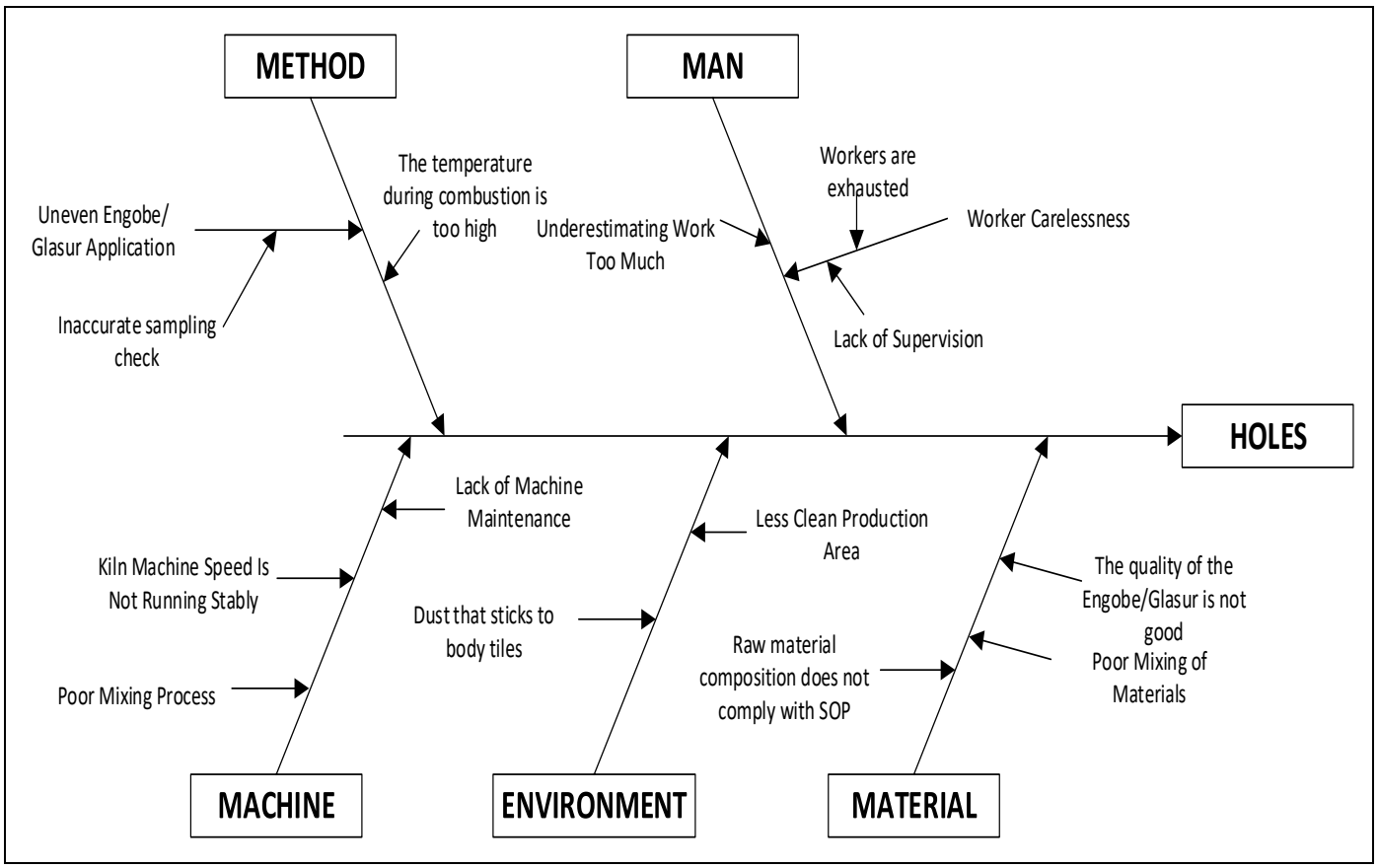


Fig 9: Fishbone Diagram of Defect Holes

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

The 5 why analysis tool is usually used to find errors and failures in the production process. 5 why analysis is a tool that functions to connect cause and effect between existing or emerging problems. Using the 5 why analysis tool also functions to solve a problem by knowing the root cause. Table 5 why analysis as follows:

Table 5: Why Analysis of the Causes of Problems in the Wall Ceramic Production Process

Question	Answer
Why are broken defects, peeled application defects and holes the most dominant and cause defects in wall ceramic products?	Because it is caused by machines with settings that do not apply the predetermined SOPs, and production machines that are not properly maintained.
Why can mechanical factors cause defects in a ceramic wall product?	Because wall ceramics are made from soil and several mixtures, if the pressure exceeds the SOP during pressing, it will cause defects during firing in the kiln machine. And the kiln machine must have a stable temperature.
Why is the method of mixing the main raw materials the basic basis for ceramic wall products?	Because if you process and mix the raw materials incorrectly, it will have an impact on the ceramic wall product and will cause defects in the product
Why do human factors influence the occurrence of ceramic wall defects?	Because humans are very influential in the process of producing wall ceramics. Therefore, if people are not responsible for their work and underestimate their work, the production process will be inefficient and cause defects to increase
Why can environmental factors cause defects in a ceramic wall product?	Because ceramic wall or ceramic products that are still half-finished if placed in an area that is not clean, dusty and too humid, these three things are included in environmental factors.

In analyzing the causes of defects using the fishbone diagram, it can be seen that problems occur in several types of defects which are caused by several factors, namely machine factors, method factors, human factors, material factors and environmental factors.

D. Improve

Based on the results of the previous stages, the next process is to improve the types of wall ceramic production defects using the FMEA (Failure Mode And Effect Analysis) method which provides an overview of sources and priorities in implementing the plan. As well as developing plans for improvement and quality improvement.

FMEA produces a Risk Priority Numper (RPN) which will be used as a priority scale for improvements to ceramic wall products.

The RPN calculation results aim to find the saverity rating, occurrence rating and detection values.

➢ *Severity Value*

The saverity value is a calculation that estimates how serious the impact of failure on the product is. Failure will result in disruption to the system as a whole. The saverity value uses a scale of 1 to 5.

Table 6: Severity Value

Scale	Information
1	No effect
2	Not Too Serious
3	Serious enough
4	Are you serious
5	Very serious

➢ *Occurrence Value*

The occurrence value is an analysis of failures that often occur. The occurrence value is the same as severity using a scale of 1 to 5.

Table 7: Occurance Value

Scale	Information
1	Definitely Detected
2	Most Likely to Detect
3	Maybe Detected
4	Small Chance of Detection
5	Not detected

➢ *Detection Value*

Detection value is an assessment of the amount of current control detected or the result of a failure. The detection value is a measurement to control failures that can occur. The Detection value is the same as the initial value on a scale of 1 to 5.

Table 8: Detection Value

Scale	Information
1	Very Rare
2	Rarely happening
3	Sometimes Happens
4	Often occur
5	Happens Very Often

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

Table 9: Risk Priority Number Defect Broken

No	Potential Failure	Severity	Occurance	Detection	RPN	Priority
1	Press Pressure Exceeds	5	3	2	30	2
2	Kiln Machine Temperature is too Hot	5	3	2	30	2
3	Shrinkage of Ceramics	5	4	1	20	3
4	Uneven Glazing	4	2	2	16	5
5	Lack of Machine Maintenance	5	4	2	40	1

Table 10: Risk Priority Number Application Defect

No	Potential Failure	Severity	Occurance	Detection	RPN	Priority
1	Less Than Optimal Glaze Grinding	5	3	1	15	5
2	High Humidity	5	4	2	40	1
3	The Conveyor is Running too Fast	3	3	2	18	4
4	Glaze too Dry	5	3	2	30	2
5	The First Burn Was too Fast	5	3	1	15	5

Table 11: Risk Priority Number Defect Peeled

No	Potential Failure	Severity	Occurance	Detection	RPN	Priority
1	Wet Scrubber is too Tight	5	4	1	20	3
2	Row pormer (Collision Between Ceramics)	4	5	1	20	3
3	The Distance Between th Ceramics is too Close	3	5	1	15	5
4	Guides Often Wear Out	3	4	3	36	1
5	Machine Settings Are Not Correct	5	3	1	15	5

Table 12: Risk Priority Number Defect Holes

No	Potential Failure	Severity	Occurance	Detection	RPN	Priority
1	The Glaze Burned too Quickly	4	3	2	24	4
2	Air Bubbles Appear In the Glaze	5	2	2	20	3
3	The Ceramic Biscuit Firing Temperature is too High	5	3	1	15	5
4	The Glazing Mixture Contains Plastic Clay	5	3	2	30	1
5	The Glaze Mixture is too Thick	5	3	1	15	5

Based on the results of the Risk Priority Number table above, it can be seen that the potential for failure in broken defects is mainly found in the lack of machine maintenance with an RPN value of 40. In application defects, the potential for failure occurs at high ceramic humidity with an RPN value of 40. Then there is the potential for failure that occurs in Peeled defects occur on the US guide guide with an RPN value of 36. Then hole defects have the potential for failure to occur in glaze mixtures containing plastic clay with an RPN value of 30.

Tabel 13: Usulan Perbaikan Tindakan terhadap Defect Broken dan Defect Peeled

Component	Causative Faktor	Proposed Corrective Action
Machine	Wet Scrubber too Tight	1. Checking Conveyor Speed Seetings
		2. Cheecking Distance From Wet Scrubber Machine to Tile Size
	Press Pressure too High	1. Adjust the Pressure of the press Machine According to the Size of the Ceramic
		2. Continuos Inspection of Press Machine Setting
	Unstable Line Speed	1. Teflon Gate Support Must Be Stretched According to the Ceramic Size
		2. Checking and Controlling Teplon Gate Support
	Machine Setting Incorrect	Employees Must Continuosly Check Minimum Machine Setting When Changing Shifts
	Guide Often Wears Out	1. Replacing Worn Guides
		2. Employees Responsible for the Area Must Check the Guide
	Lack of Maintenance on the Machine	1. Inspection and maintenance of Machine in the Glazing line Area, Input or Output of machine Kiln and Sorting Machine
		2. Clean Dirty Panels Regularly
		3. Create a Panel Cleaning Schedule

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

Table 14: Proposed Improvements to Defect Application Defects and Defect Holes

Component	Causative Faktor	Proposed Corrective Action
Material	Formula Concoctions Are Not SOP	1.The Responsible Departement Must Check And Control The formula
		2. Trying the Formula Wit the Lab Scale
	Clay Grinding Result Are Less Fine	1. Reset Grinding Duration
		2. Inspection and Maintenance of Mixer Machines
	The Quality of the soil Raw Materials is Not Good	1. Checking Soil Raw Materils Properly and Correctly
		2. Charrying Out Checks When Filtering Clay
	Engobe too Dry	Checking Engobe Materials
	Glaze too Rough	1. Checking the Cleanliness of the Glaze Solution 2. Charrying Out Checks With a Lab Scale
	Uneven Smelting of Raw Materials	1. Employees Check Mixer Settings When Changing Shifts 2. Checking the Clay Slip
Manusia	Lack of Responsibility for Work	1.Leaders must exercise Control Over Their Subordinates 2. Giving Motivation
	Intruction From Above Are Not Clear	1. Supervisors Must Provide Clear Work Instructions
		2. Superios Must Provide Accurate Information
	Lack of Discipline	Supervisors Must Reprimand When Operators Lack Discipline
	Lazy Operators	Company Officials Must Give Awards to Outstanding Employees

➢ *Controls*

The final process of the six sigma method in improving quality is the control stage. The control stage aims to control the wall ceramic production process so that the quality of the product produced is much better than before and the production process runs well from the beginning to the end of the process.

Table 15: Table of Suggested Actions During Implementation

NO	FACTOR	SUGGESTION
1	Create Incoming and Outgoing Product Inspection Reports and Create Maintenance Checksheets for Kiln Machines	The resulting data can later be seen when the ceramic wall product enters and exits the kiln. When the ceramic wall product enters it looks good, then when the ceramic product comes out of the kiln, the ceramic wall product appears to have defects and needs to be repaired on the kiln machine. With this checksheet report form, companies can see developments in the condition of incoming and outgoing products produced by the kiln machine every day. And the company can evaluate the condition of the kiln machine which is monitored every day
2	Setting the pressure on the press machine according to the size of the ceramic, and carrying out inspection and maintenance of the press machine	The press machine has the main function of the production process for making ceramic wall products, because initially the material is still in powder form, then it is pressed by the press machine and results in the formation of a solid body so that the shape of the ceramic wall is not disturbed by mechanical, chemical and physical impact. Therefore, if the press pressure is not in accordance with the SOP, it will cause the surface of the ceramic wall product to become less solid and too dense, so that when it is burned in the kiln machine it will cause defects in the product.
3	Create a Report Form on Guide Changes and Set the Guide According to Its Position	By creating a guide replacement report form, the company will know when to replace a worn guide
4	Create Information Boards in Each Area	The information board is useful for information between shifts. With the information board, other shifts can see the machine settings so that there are no misunderstandings between shifts and checking the machine so that the machine does not experience changes to the initial settings that have been seen by the previous operator.
5	Eliminating Unnecessary Variables	Eliminating variables that are not important is the first step. Especially on variables related to dangerous machine factors and raw materials
6	Enter the raw material formula according to the company's SOP with predetermined sizes	If the operator makes a mistake in mixing the formula, defects will occur in the ceramic product, because the formula is the basis for the product, especially ceramic wall products.
7	Resetting the grinding duration on the mixer machine and checking	Adding or resetting the duration during the grinding process aims to make the resulting clay softer and smoother. Operators must carry out checks and

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

	and carrying out maintenance on the machine	maintenance on the machine so that the machine's performance does not decrease and runs smoothly
8	The clay raw materials used are not good	The department responsible for the arrival of raw materials must check and record newly arrived materials. Because the raw materials that come are not all of good quality
9	Poor Glazing Quality	Glazing liquid is one of the most important components in ceramic wall products because the presence of ceramic glazing liquid on walls can withstand water, is fireproof and is easy to clean because the material is very dense and non-porous. So the Operator Responsible for the Glazing Liquid Must Really Pay Attention to the Grinding Duration and Mixture of Raw Materials
10	Mixing of Materials Is Uneven	When mixing in the mixer machine, the responsible operator must check the duration of the mixer again. If the results are still uneven, the operator must increase the duration of the mixer machine.
11	Less than Perfect Melting	After mixing the materials in the mixer machine, the raw material for the product then enters the continuous milling machine, where in the machine the raw material experiences melting of the material to create clay slip, so the operator must check the results of the melting in the continuous milling process on the rotary whether the clay produced is suitable or not. Not yet, if not, the operator must increase the duration of the process
12	Operators Lose Work Motivation	The role of the company is very influential on employee motivation because without operators the production process will not run smoothly, therefore the company must give awards to employees who have achievements.
13	Lack of discipline and laziness	Companies Must Be More Strict in Implementing the 5S System

IV. CONCLUSION

Based on the research description that has been explained in the previous stages, it can be concluded that quality control in the wall ceramic production process is as follows:

- There are 4 types of defects included in CTQ (Critical to Quality) in wall ceramic production, namely: Broken Defects with a DPMO value of 29,362 units with a sigma level of 3.39, Application Defects with a DPMO value of 27,715 units with a sigma level of 3.48, Peeled Defects with The DPMO value is 28,044 with a sigma level of 3.38, Defect Holes with a DPMO value of 26,020 with a sigma level of 3.45. The sigma level for ceramic wall product data is in accordance with industry standards in Indonesia, however control and quality improvement of ceramic products must continue to be improved.
- The causes of defects are caused by machine, material and human factors. For machine factors, there is a lack of care and maintenance for production machines, material factors include main raw materials that are of low quality and mixing materials that do not follow SOPs (standard operating procedures), while for human factors this occurs due to a lack of responsibility for the work and operators not having motivation. high work.
- Improvement plans and proposals to reduce defects in wall ceramic products can be carried out by maintaining, checking and controlling the machine. Carry out supervision while the production process is in progress by inspecting each machine that is being used. Check and inspect raw materials and other materials before entering the machine and make SOPs in accordance with company work standards so that they are carried out well by operators and apply the 5s (seiri, seiton, seiso, seiketsu, shitsuke).

REFERENCES

[1]. M. Arifin and HH Supriyanto, "Application of the Lean Six Sigma Method for Proposing Production Line Improvisation Taking into Account Environmental Factors," *J. Tek. ITS* , vol. 1, no. ISSN: 2301-9271, pp. A477–A481, 2012.

[2]. RC Lestari, KF Handayani, GG Firmansyah, and M. Fauzi, "Efforts to Minimize Product Defects by Implementing the Lean Six Sigma Method (Case Study of PT. XYZ Company)," *J. Ilm. Stat. and Econ.* , vol. 2, no. 1, pp. 82–93, 2022.

[3]. WA Prasetyo Kusnandar and AJ Nugroho, "Improving the Quality of Granulated Sugar Production by Implementing Lean Six Sigma," *J. Teknol. and Manaj. Ind. Apply.* , vol. 2, no. 4, pp. 242–249, 2023, doi: 10.55826/tmit.v2i4.142.

[4]. Y. Nurfauzi *et al.* , "Literature Review: Analysis of Factors Influencing Purchasing Decisions, Product Quality and Competitive Pricing Literature Review: Analysis of Factors Influencing Purchasing Decisions, Product Quality and Competitive Pricing," *Manag. Stud. Entrep. J.* , vol. 4, no. 1, pp. 183–188, 2023, [Online]. Available: http://journal.yrpipku.com/index.php/msej

[5]. C. Cesariana, F. Juliansyah, and R. Fitriyani, "Purchasing Decision Model Through Consumer Satisfaction in the Marketplace," *J. Manaj. Educator. And Social Sciences.* , vol. 3, no. 1, pp. 211–224, 2022.

[6]. I. Setiawan and S. Setiawan, "Defect reduction of roof panel parts in the export delivery process using the DMAIC method: a case study," *J. Sist. and Manaj. Ind.* , vol. 4, no. 2, pp. 108–116, 2020, doi: 10.30656/jsmi.v4i2.2775.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1035

[7]. S. Dan, K. Di, and PT Xyz, "Improving Quality Using the Six Method," vol. 01, no. 02, pp. 152–161, 2020.
[8]. F. Romadhani, N. Mahbubah, and MD Kurniawan, "Implementation of the Lean Six Sigma Method to Eliminate Defects in the Purified Gypsum Production Process at Pt. Aaa," *RADIAL J. Perad. Science, Engineering and Technology.* , vol. 9, no. 2, pp. 89–103, 2021, doi: 10.37971/radial.v9i2.224.
[9]. H. Sirine, EP Kurniawati, S. Pengajar, F. Ekonomika, D. Bisnis, and U. Salatiga, "QUALITY CONTROL USING THE SIX SIGMA METHOD (Case Study at PT Diras Concept Sukoharjo)," *AJIE-Asian J. Innov. Entrep.* , vol. 02, no. 03, pp. 2477–3824, 2017, [Online]. Available: http://www.dirasfurniture.com
[10]. H. Supriyanto, "Empowerment and Strengthening Business Competitiveness by Implementing the Lean Six-Sigma Concept, Case Study," *J. Manaj. Competitiveness* , vol. 20, no. 1, 2018, doi: 10.23917/dayasaing.v20i1.5997.
[11]. V. Brama Kumbara, "Determination of Customer Value and Purchasing Decisions: Analysis of Product Quality, Product Design and Endorsement," *J. Ilmu Manaj. Apply.* , vol. 2, no. 5, pp. 604–630, 2021, doi: 10.31933/jimt.v2i5.568.
[12]. MA Lutfianto and R. Prabowo, "Integration of Six Sigma and FMEA (Failure Mode And Effect Analysis) to Improve Newspaper Product Quality (Case Study: PT. ABC Manufacturing - Sidoarjo, East Java - Indonesia)," *JIEMS (Ind Journal . Eng. Syst.* , vol. 15i1.3599.