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The Proposed Quality Improvement of Incense Products Using the Six Sigma Method at UD. Dupa Karya Mandiri

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A B S T R A C T

In 2023, Indonesia's Hindu population accounted for approximately 1.7% of the total population, equating to roughly four million individuals within a populace of 250 million. UD. Dupa Karya Mandiri being a prominent producer of incense products in high demand. However, during the 2023 Chinese New Year (Imlek) and Nyepi celebrations, expected to spur increased demand, the market witnessed a downturn due to a surge in defective product rejection. This study aims to describe the factors that cause product defects, measure the level of sigma level in incense production, then proceed with efforts to improve product quality. Six Sigma methodology is used to handle this problem, this study employs the Six Sigma methodology. The analysis yielded a sigma value of 2.1 and a DPMO (Defects Per Million Opportunities) value of 289,228.10, signifying the necessity of further enhancement in quality to reduce the number of defective products and elevate the sigma value. Therefore, this research gives recommendations for improvement to UD. Dupa Karya Mandiri includes SOPs for Drying, Understanding the Production Process, Machine Maintenance, Bamboo Encek Replacement and Monthly Production Reports.

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1. INTRODUCTION

In the year 2023, according to the 2023 population census, Indonesia's population stood at approximately 237,641,326 people. Within this diverse populace, the Hindu community comprised about 1.68%, equating to roughly 4,012,116 individuals (Trisna Dewi et al., 2023). Notably, a significant majority of Indonesia's Hindu population, accounting for around 80%, found their home on the enchanting island of Bali (Trisna Dewi et al., 2023). The incense industry has been witnessing a swift surge in demand, with Java and Bali, known for their diverse traditional ceremonies and celebrations like Nyepi, Chinese New Year, and Vesak Day, at its epicenter(Eka Sura Adnyana et al., 2021). These traditions are intrinsically linked to the use of incense, an indispensable element in various cultural and religious rituals. In 2023, the demand for incense during Chinese New Year and Nyepi celebrations experienced a remarkable upswing, increasing by up to 20% (Suharto, 2023). The growing consumer base paralleling the increasing number of incenses producers, both in the realm of Micro, Small, and Medium Enterprises (MSMEs) and large-scale enterprises, product quality has emerged as the paramount focus(Pratiwi et al., 2020). In this competitive landscape, consumers no longer base their decisions solely on price but also place significant emphasis on product quality. As such, manufacturers are engaged in a fierce competition to produce high-quality products that meet specific standards.

Quality in the incense industry is a critical aspect, and achieving it necessitates the manufacturer's dedicated effort to satisfy customer desires, needs, and expectations through quantifiable methods(Fitria & Novita, 2020). An enterprise can be deemed to possess high quality if its production system is robust and well-controlled, thereby aligning with customer expectations (Wicaksono & Yuamita, 2022). This paper examines the case of UD. Dupa Karya Mandiri, a Micro, Small, and Medium Enterprise (UMKM) specializing in incense production, situated in the region of Trenggalek, East Java, on the island of Java, Indonesia. UD. Dupa Karya Mandiri caters to a high demand for incense products. UD. Dupa Karya Mandiri identified issues related to the quality of their incense products, leading to a substantial number of rejections due to damage or non-compliance with product specifications. UD. Dupa Karya Mandiri experienced a downturn in demand, mainly due to the rejection of a significant number of their products. reveals an increase in the rate of product failure during the first quarter of 2023, highlighting the pressing need to improve product quality and minimize rejections attributed to defective products. Quality control measures, such as Six Sigma methodology, can be effective in mitigating product defects (Tarigan & Luhur, 2021). Notably, UD. Dupa Karya Mandiri operates with a business-to-business (B2B) system, where both suppliers and buyers originate from a single company.

Prior research success has demonstrated that the Six Sigma methodology effectively identifies the factors causing product failures, uncovers wastage in the production process, and formulates improvement strategies to elevate product quality (Pratiwi et al., 2020) (Tarigan & Luhur, 2021). Six Sigma is an established approach to address issues arising from product defects and subpar production quality (Tarigan & Luhur, 2021). Previous research has affirmed that Six Sigma is proficient in reducing the defect rate through quality control measures, particularly during the DMAIC (Define, Measure, Analyze, Improve, Control) phase. The problem faced by UD. Dupa Karya Mandiri can be effectively addressed through the implementation of the Six Sigma methodology, focusing on reducing product defects in the incense production process. This approach is particularly suitable as it does not necessitate a significant alteration of the production process itself, in contrast to Lean methodologies that primarily target process speed and waste reduction (Hafizh et al., 2023). Therefore, this research is dedicated to proposing strategies for enhancing incense product quality using the Six Sigma methodology at UD. Dupa Karya Mandiri. Although this study aims to provide recommendations and proposals for efforts to improve the quality of incense products without directly implementing them. incense product quality improvement without implementing it directly, data processing is still carried out to understand the failure rate of incense products, types of defects, as well as factors causing defects, and to develop recommendations for improving the quality of incense products. recommendations for improving the quality of incense products. There is no calculation of cost analysis in the incense production process at UD. Dupa Karya Mandiri

2. LITERATURE REVIEW

The incense industry is a manufacturing industry that produces or processes semi-finished raw materials derived from sawdust, sticky materials, stick bits, and others (W & M, 2018). Quality includes various characteristics of products and services, including marketing, design, manufacturing, and maintenance processes, so that the product, when used, can meet customer expectations (Luthfini Lubis & Suhaeri, 2020). Quality is a key factor that greatly influences consumer decisions in choosing products and services. The quality factor is the foundation for business success and competitive growth (Manan et al., 2018). The concept of quality involves aspects of results, human quality traits, and the overall quality process (Silalahi et al., 2022).

The quality of a good or service is indirectly influenced by raw materials, people, machines, work methods, management, markets, money. (Wicaksono & Yuamita, 2022). Six Sigma was created in 1980 by Bob Galvin and Votorola's team of engineers in gadget manufacturing (Council f Certification, 2018). Sigma (σ) is a letter of the Greek alphabet that indicates the degree of variability (Council f Certification, 2018). Six Sigma is divided into two words, "six" which refers to the number six, and "sigma" which is a symbol of standard deviation or used as a statistical measure that reflects the capability of a process and how large or small the sigma value is measured as DPU (Defect Per Unit) or PPM (Part Per Million). (Council f Certification, 2018). The implementation of Six Sigma quality improvement consists of five steps using the DMAIC method (Define, Measure, Analyze, Improve, Control) (Tarigan & Luhur, 2021).

1. Define, this stage aims to identify problems in the company and define the problem as the object of research.
2. Measure, the Measure stage is the stage to determine the level of sigma level achieved by a company, Six Sigma is known as a measurement system using Defect Per Million Opportunities (DPMO) as a measurement. The following is a way to determine DPMO is as follows:
    - Unit (U) is the amount of production.
    - Opportunities (OP) is a defect characteristic that is critical to product quality (Critical To Quality)
    - Defect (D) is a defect that is obtained.
    - Calculate Defect Per Unit (DPU) is a defect per unit obtained from the division between total defects and the number of units produced, namely

      DPU = Defect/Unit
    - Total Opportunities (TOP) is the total occurrence of defects in the unit, obtained through the multiplication of the number of units with opportunities, namely:

      TOP = U x OP
    - Defect Per Opportunities (DPO) is the opportunity to have defects obtained from the division between total defects and Total Opportunities (TOP) so that the DPO value is:

      DPO = D/TOP
    - Defect Per Million Opportunities (DPMO) is how many defects occur if there are one million opportunities, obtained from the multiplication of defects per opportunities multiplied by 1,000,000 or in other words looking for opportunities for failure in one million opportunities. The result of DPMO

      DPMO = DPO x 1,000,000
3. Analyze, In the analysis stage, factors affecting product quality degradation or product defects are analyzed (Nasution et al., 2021). Pareto diagrams can be used to identify the most common types of failures, while cause-and-effect diagrams or fishbone diagrams are used to identify problems and uncover causal factors of product failure. Failure Mode and Effect Analysis (FMEA) is a systematic approach to identify potential failures or defects in a product and their effects so that the product can meet the standards desired by the company. The FMEA setup process is done before starting the mass production processoil(Sitompul et al., 2023). *RPN=Saverity (S)x Occurrence (O)x Detection (D)*

   RPN (Risk Priority Number) generates a number that helps the team prioritize more appropriate corrective actions. For example, getting a Severity Score of 10 (frequently affected), Occurrence Score of 10 (happens all the time), and Detection Score of 10 (not noticed), the RPN is 1000 (Sitompul et al., 2023).
4. Improve, the improve stage is the stage where the company receives feedback and improvement suggestions related to product defects that occur. It involves developing an action plan to improve Six Sigma quality (Sinambela et al., 2023).
5. Control, control stage. The goal is to ensure that the new system operates in a stable condition and still maintains the Six Sigma level

3. RESEARCH METHOD

Research methods refer to the systematic approaches and techniques used to conduct research and gather information in a structured and organized manner. These methods are designed to answer specific research questions, test hypotheses, or investigate particular phenomena. Researchers choose research methods based on the nature of their study and the type of data they need to collect.

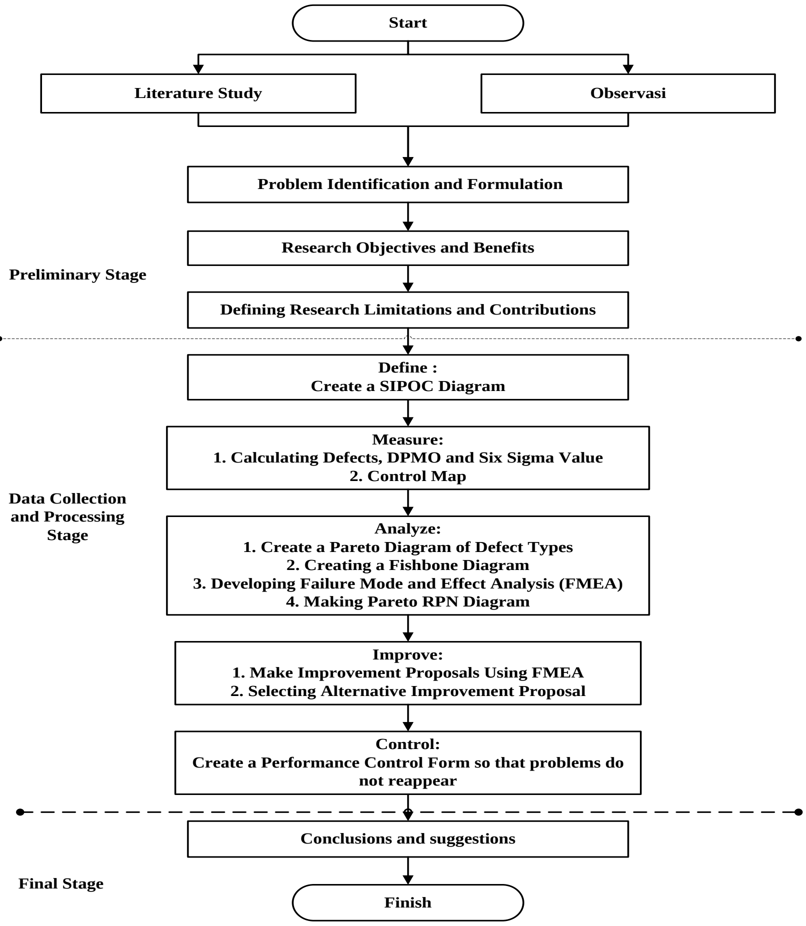

Figure 1. Research flowchart

3.1 Literature Review

Literature review is crucial to gather relevant information for the research. It involves studying various sources like books, essays, online materials, and theories related to Six Sigma. The goal is to build a strong knowledge base for addressing research issues.

3.2 Observation

The initial step involves field study and observations at the company being studied. Researchers aim to identify problems in the company for practical contributions. Data is gathered through direct interviews with employees and owners.

3.3 Problem Identification and Formulation

Identifying problems and formulating them is essential. The main problem is to enhance incense production quality by identifying defects' root causes and evaluating Six Sigma levels.

3.4 Research Objectives and Benefits

The stage of determining the research objectives and benefits is conducted after the problem has been formulated. The objectives of this research are to identify the factors causing defective incense products, determine the Six Sigma level, and quality control efforts in incense production by analyzing the quality control in incense production. The results of this research are expected to be useful for UD. Dupa Karya Mandiri.

3.5 Research Scope and Assumptions

Research constraints are established, focusing on production. The study assumes normal production processes and quality standards adherence during the research period. Data Collection and Data Processing Phase, this phase comprises data collection and processing, following the DMAIC approach.

3.6 Data Collection Stage

Quantitative data is collected on production quantities and defects. Primary data is obtained through observations and interviews. Secondary data comes from sources like sales records and monthly production quantities. Data Processing, Data processing includes using DMAIC to define, measure, analyze, improve, and control. It starts by defining the problem, followed by measuring defect rates. The analysis phase involves identifying root causes using tools like Pareto and fishbone diagrams. Prioritization of issues is done with the Failure Mode Effect Analysis (FMEA) method. Improvements are suggested based on FMEA results. Control involves implementing and monitoring these improvements.

3.7 Final Stage of Research

In the final stage, conclusions and recommendations are drawn. Conclusions and Recommendations, Researchers conclude the study and provide recommendations for improving incense production quality. The results aim to benefit the company by comparing conditions before and after the improvements.

4. RESULT AND DISCUSSION

In the early stages of data collection, researchers carried out the process by conducting direct observations in the field and extracting information from employees as a source of supporting data for the success of this study. After collecting data for 30 days, the data will then be processed using appropriate and predetermined tools to be used as a guide in analyzing and evaluating the problems that occur at UD. Dupa Karya Mandiri. The data collected during the incense production process includes the total amount of incense production and the types of incense defects and their details, which were observed for 30 observations. Data collection took place from August 7, 2023 to September 5, 2023.

Table 1. Defect product data UD. Dupa Karya Mandiri

Number of Product Defects							
No	Total Production	Defects type				Total Defect	Percentage Defect
		Broken	Crack	Peeled off	Mold		
1	76.750	4065	6133	6312	4940	21450	27,95%
2	76.627	5155	6165	6263	4794	22377	29,20%
3	75.745	4775	6960	6165	4615	22515	29,72%
4	55.528	4103	4769	4550	3553	16975	30,57%
5	57.536	4050	4365	4256	3950	16621	28,89%
6	69.235	4286	5982	5615	4527	20410	29,48%
7	70.359	4023	5964	5680	4127	19794	28,13%
8	72.560	4752	5571	5175	4973	20471	28,21%
9	72.655	4710	5898	5816	4476	20900	28,77%
10	70.250	4305	5953	5655	4061	19974	28,43%
11	68.950	4295	5875	5792	4098	20060	29,09%
12	68.880	4674	6515	5247	4070	20506	29,77%
13	69.790	4198	5990	5467	4738	20393	29,22%
14	71.535	4454	5420	5269	4606	19749	27,61%

Number of Product Defects							
No	Total Production	Defects type				Total Defect	Percentage Defect
		Broken	Crack	Peeled off	Mold		
15	71.480	4273	5674	5593	4251	19791	27,69%
16	71.765	4262	6085	5909	4011	20267	28,24%
17	52.455	2960	4559	4261	2890	14670	27,97%
18	53.695	3530	4770	4687	3474	16461	30,66%
19	50.120	3129	4540	4408	3070	15147	30,22%
20	67.110	4295	5287	5307	4174	19063	28,41%
21	73.070	4288	6679	6430	4197	21594	29,55%
22	75.835	5917	6758	6109	4133	22917	30,22%
23	74.370	4630	5904	5900	4970	21404	28,78%
24	75.865	5095	6580	6490	4186	22351	29,46%
25	78.590	4755	6505	6290	4875	22425	28,53%
26	76.695	4432	6438	6267	4253	21390	27,89%
27	75.580	4975	6400	6170	4724	22269	29,46%
28	77.435	4730	6580	6395	4933	22638	29,23%
29	76.780	4175	6370	6920	4450	21915	28,54%
30	78.125	4970	6121	6110	4500	21701	27,78%

4.1 Define

The Define stage is the first step in the process of improvement efforts using Six Sigma which begins by identifying potential problems in the UD production process. Raw material suppliers in the form of imported bamboo stick biting, wood flour, sticky flour, calcium flour at UD. Dupa Karya Mandiri is Tanu Jaya Importers. Dupa Karya Mandiri involves four types of raw materials, namely wood flour, sticky flour, calcium flour, incense biting, rubber, and packing cardboard. Dupa Karya Mandiri is Tanu Jaya Importer, who receives the incense products. Potential failures in the incense production process often arise, starting from the stirring stage of the raw materials to the completion of the production stage. The ingredient mixing stage is a key element in the incense production process, as errors in this stage can negatively impact productivity and incense quality. The impact is particularly noticeable on productivity, where poorly mixed materials can cause the incense machine to have glitches. Potential failures in the incense molding stage occur when operators do not check the machine settings and conditions before starting the production process. As a result, the molding process does not run properly, resulting in products that do not meet the characteristics of quality incense. Another cause is the mishandling of wet incense sticks that come out of the machine due to workers being too forceful when picking them up. In the sorting process, the dried incense is then sorted by the workers with the aim of separating defective products that do not meet the standards.

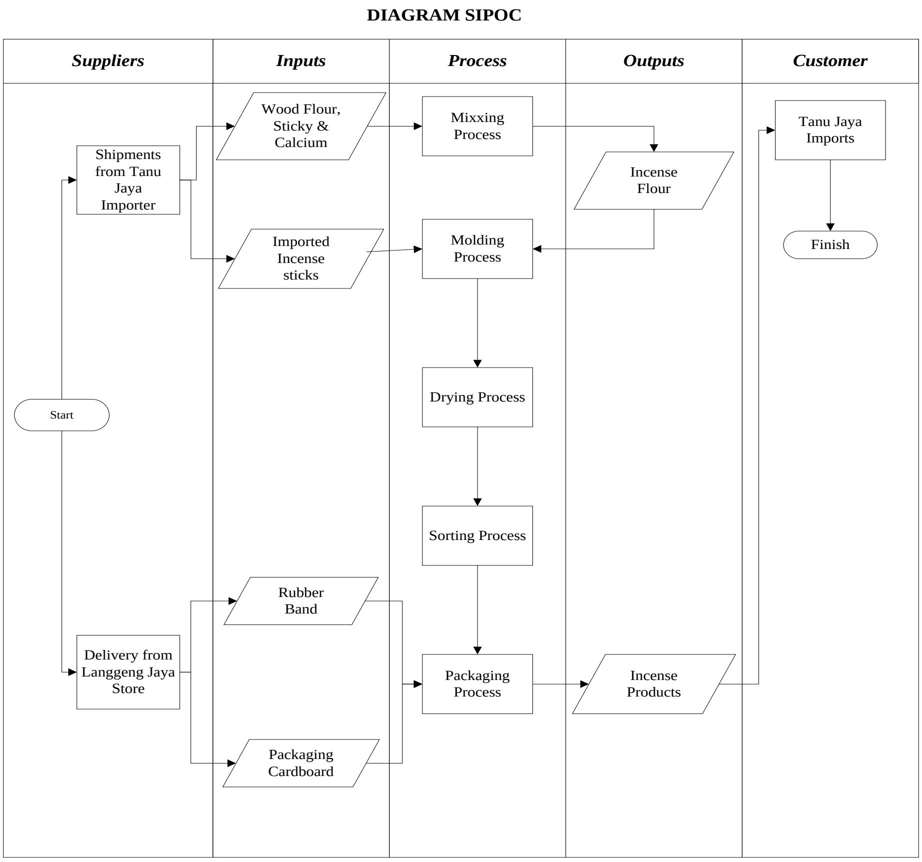

Figure 2. SIPOC Diagram

Figure 3. Product incense

4.2 Measure

The Measure stage involves a series of calculations to evaluate the level of capability of the production process, which involves analyzing the control map (P-Chart) as well as measuring the sigma value and DPMO (Defects Per Million Opportunities). In the control map analysis stage, measurements are made by calculating the CL (Center Line), UCL (Upper Control Limit), and LCL (Lower Control Limit) of the incense production process at UD.

Formula:

- Proportion

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

- Center Line = CL

$$CL = \acute{P} = \frac{\sum np}{\sum n}$$

- Upper Center Line = UCL

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

- Lower Center Line = LCL

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

The P-Chart control map is used to determine whether the number of defects that occur in the production process is within the upper and lower control limits. Based on the results of data processing, there are some data that are outside the lower control limit (LCL) of 0.284, the center line (CL) of 0.289, and the upper control limit (UCL) of 0.294

There are 19 data that are outside the control limits. Based on discussions with the company owner, this occurred because the quality of the powdery incense material could not stick to the bamboo sticks properly. This requires workers to re-produce, causing variations in product quality. In addition, a machine breakdown that resulted in one machine not operating had a negative impact on the productivity and quality of incense production. In such a situation, incense production experienced a decrease in production quantity.

These issues can result in variations in product quality, increase defect rates, and also lead to machine breakdowns. This has a negative impact on the productivity and quality of incense production, especially as a single non-operating machine can disrupt the overall production flow. Measurement through DPMO (Defects Per Million Opportunities) and sigma level calculation results in DPMO values. In this process, each production day is measured to obtain the DPMO value and sigma level respectively. Furthermore, the DPMO valueand sigma level of each production are calculated on average, which results in a DPMO value of 289,228.10. Dupa Karya Mandiri is still relatively low and requires improvement efforts in the production process, so that the sigma value can increase a higher sigma level indicates better quality in production and fewer defects in the final product. Dupa Karya Mandiri improve the quality of their incense products and reduce the defect rate.

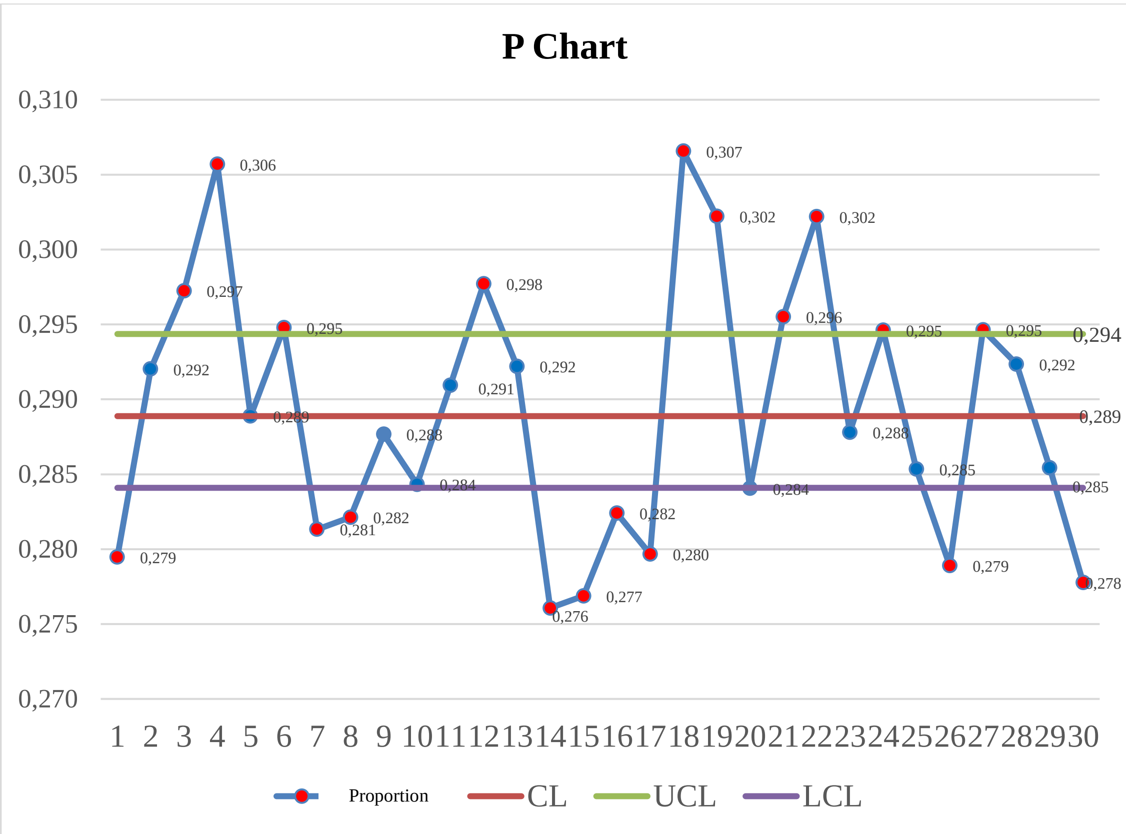

Figure 4. P-chart diagram

Table 2. Calculation of DPMO and sigma value

Number of Incense Product Defects											
Day	Production Total	Number of Product Defects				Total Defect	Finish Product	CTQ (OP)	DPU	DPMO	Sigma
		Broken	Crack	Peeled off	Moldy						
1	76.750	4065	6133	6312	4940	21450	55.300	4	0,279	279478,83	2,1
2	76.627	5155	6165	6263	4794	22377	54.250	4	0,292	292025,00	2,1
3	75.745	4775	6960	6165	4615	22515	53.230	4	0,297	297247,34	2,0
4	55.528	4103	4769	4550	3553	16975	38.553	4	0,306	305701,63	2,0
5	57.536	4050	4365	4256	3950	16621	40.915	4	0,289	288880,01	2,1
6	69.235	4286	5982	5615	4527	20410	48.825	4	0,295	294793,10	2,0
7	70.359	4023	5964	5680	4127	19794	50.565	4	0,281	281328,61	2,1
8	72.560	4752	5571	5175	4973	20471	52.089	4	0,282	282125,14	2,1
9	72.655	4710	5898	5816	4476	20900	51.755	4	0,288	287660,86	2,1
10	70.250	4305	5953	5655	4061	19974	50.276	4	0,284	284327,40	2,1
11	68.950	4295	5875	5792	4098	20060	48.890	4	0,291	290935,46	2,1
12	68.880	4674	6515	5247	4070	20506	48.374	4	0,298	297706,16	2,0
13	69.790	4198	5990	5467	4738	20393	49.397	4	0,292	292205,19	2,1
14	71.535	4454	5420	5269	4606	19749	51.786	4	0,276	276074,65	2,1
15	71.480	4273	5674	5593	4251	19791	51.689	4	0,277	276874,65	2,1
16	71.765	4262	6085	5909	4011	20267	51.498	4	0,282	282407,86	2,1
17	52.455	2960	4559	4261	2890	14670	37.785	4	0,280	279668,29	2,1
18	53.695	3530	4770	4687	3474	16461	37.234	4	0,307	306564,86	2,0
19	50.120	3129	4540	4408	3070	15147	34.973	4	0,302	302214,68	2,0
20	67.110	4295	5287	5307	4174	19063	48.047	4	0,284	284056,03	2,1
21	73.070	4288	6679	6430	4197	21594	51.476	4	0,296	295524,84	2,0
22	75.835	5917	6758	6109	4133	22917	52.918	4	0,302	302195,56	2,0
23	74.370	4630	5904	5900	4970	21404	52.966	4	0,288	287804,22	2,1
24	75.865	5095	6580	6490	4186	22351	53.514	4	0,295	294615,44	2,0
25	78.590	4755	6505	6290	4875	22425	56.165	4	0,285	285341,65	2,1
26	76.695	4432	6438	6267	4253	21390	55.305	4	0,279	278896,93	2,1
27	75.580	4975	6400	6170	4724	22269	53.311	4	0,295	294641,44	2,0
28	77.435	4730	6580	6395	4933	22638	54.797	4	0,292	292348,42	2,1
29	76.780	4175	6370	6920	4450	21915	54.865	4	0,285	285425,89	2,1
30	78.125	4970	6121	6110	4500	21701	56.424	4	0,278	277772,80	2,0
Total	**2.105.370**	**132.261**	**176.810**	**170.508**	**128.619**	**608.198**	**1.497.172**	**Average**		**289228,10**	**2,1**

4.3 Analyze

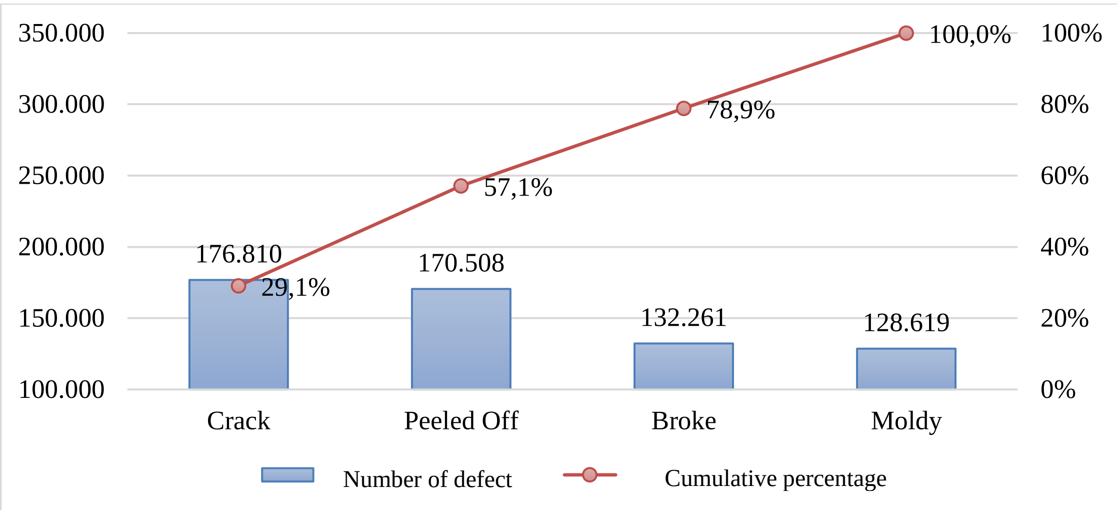

Figure 5. Pareto diagram

Six Sigma will use these tools to explore the causes of defects, assess their impact and identify improvement steps that can be taken. The use of Pareto diagrams at the Analyze stage aims to identify the most dominant types of defects in incense production at UD. Dupa Karya Mandiri. Pareto diagrams help in identifying the most dominant failures and should be addressed first.

Based on data from Figure 4, it shows that the most dominant defect is cracks in incense products, reaching 29.07% (29.1%) or equivalent to 176,810 units of incense products.

The second significant defect is peeled off, with a percentage of 28.03% or around 170,508 units of incense products. Meanwhile, other defects include broken at 21.75% (around 132,261 units of incense products) and moldy at 21.15% (around 128,619 units of incense products. Factors causing cracking and peeled off defects are identified through the 6M concept (Man, Machine, Method, Motivation, Media, Material). Cracking defects are mainly attributed to workers' rude behavior and a lack of understanding in handling wet incense, along with excessive force during sorting. Worker fatigue due to a lack of job division and excessive joking in the workplace also contributes to the issue. Machine-related factors include a lack of machine maintenance, especially cleaning, which can lead to dirt or foreign objects affecting incense flour production. Shift changes without breaks and errors in machine settings are also culprits. Method-related errors occur in incense production stages due to non-compliance with Standard Operating Procedures (SOPs) for handling wet and dry incense. Inadequate stirring contributes to peeled off defects. Motivation is influenced by a piece-rate payment system that may reduce workers' focus on product quality. Inadequate mechanical training affects motivation. Rough bamboo crackers and inadequate storage locations also contribute to defects. Cracking defects are linked to an incorrect composition ratio of incense flour and dirty or mixed raw materials during the stirring proces

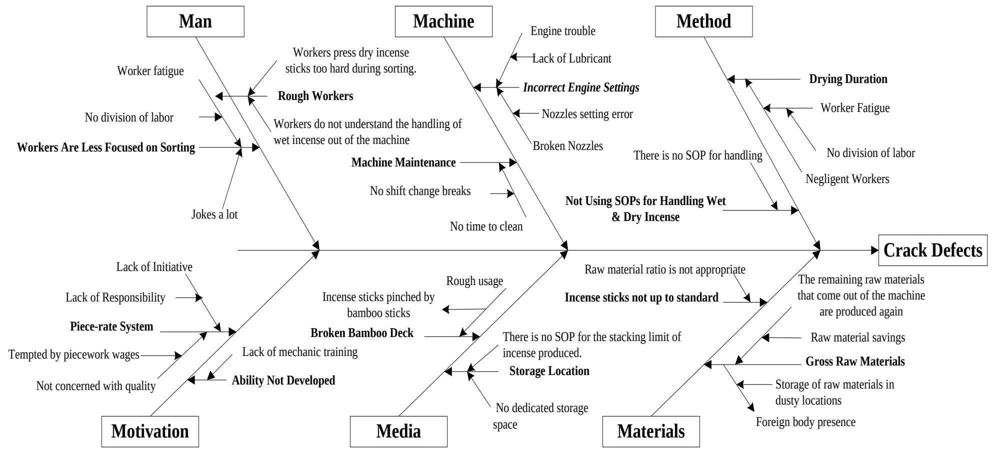

Figure 5. Fishbone diagram peeled off defects

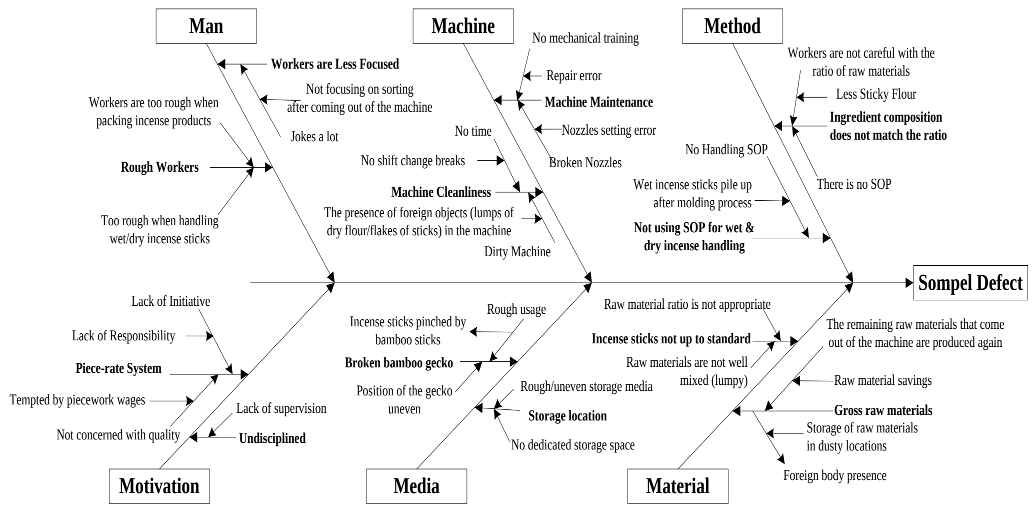

Figure 6. Fishbone diagram peeled off defects

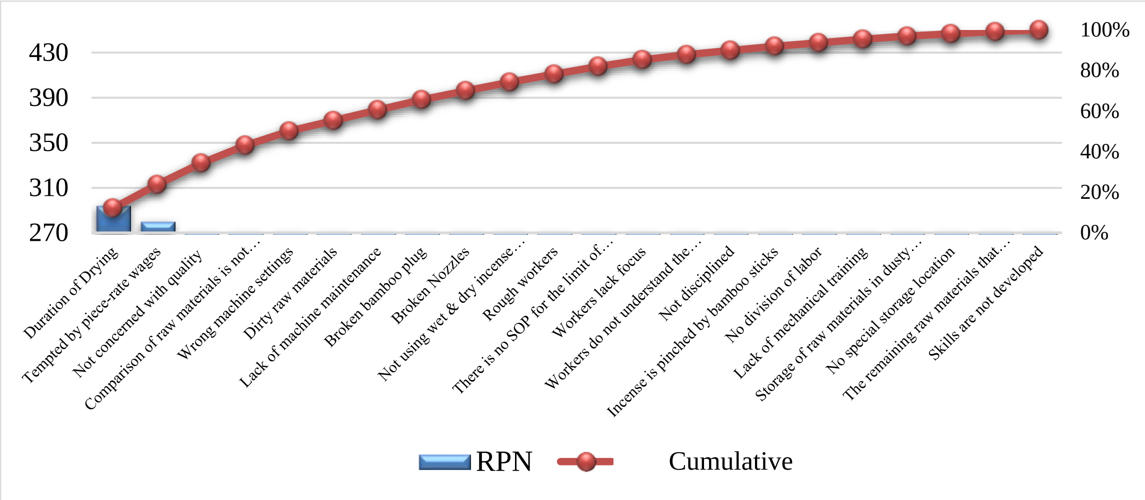

Figure 7. Pareto diagram of crack defect RPN

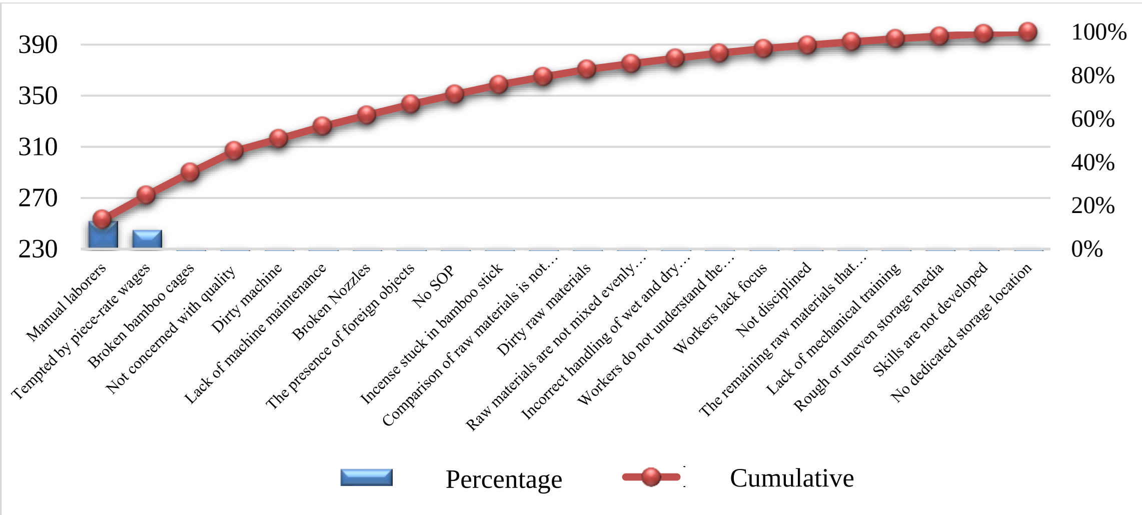

Figure 8. Pareto diagram of peeled off defect RPN

The Risk Priority Number (RPN) for cracking defects reveals that drying duration is the highest contributor, followed by the piece-rate payment system and a lack of attention to quality. Other factors include inappropriate raw material ratios and machine setting errors. For peeled off defects, workers' rude behavior has the highest RPN, followed by the piece-rate payment system and damage to bamboo skewers. Other factors include a lack of attention to quality and issues with dirty machinery and settings. The Improve stage aims to propose improvements, including creating specific SOPs for incense drying, changing the payment system to daily work with clear targets, and addressing issues related to machine maintenance and settings.

4.4 Improve

At this stage, the improvement of the incense production process is carried out by compiling proposed quality improvement efforts through production improvement using FMEA and selecting the most suitable improvement solution. The RPN assessment is carried out together with the owner of the Company.

Table 3. Proposed alternatives for repairing crack defects

Defect	Highest RPN	Alternative Improvements
Crack Defect	Duration of Drying	Pay more attention to the weather and the duration of drying and the condition of the product that has been dried. Also, establish an SOP for incense drying.
	Tempted by piece-rate wages	Change the piece-rate system to a daily work system with clear production targets.
	Not concerned with quality	Provide continuous evaluation and supervision of workers
	Comparison of raw materials not appropriate	Make an SOP for the comparison of the use of raw materials
	Wrong machine settings	Workers must pay attention to maintenance and machine settings every time they start and finish the printing process.

The highest RPN for the "crack" defect type provides a basis for formulating improvement proposals to reduce the level of defective products at UD. Dupa Karya Mandiri. One alternative for improvement is to focus more intensely on factors such as weather, drying duration, and product conditions after the drying process. The primary step in this improvement alternative is the creation of specific Standard Operating Procedures (SOP) for the incense drying process. The second-highest RPN failure cause is attributed to workers being influenced by a piece-rate payment system. Hence, it is essential to enhance worker motivation(Windiarti, 2022). However, this issue can be addressed by shifting from a piece-rate payment system to a daily work system with clear production targets, which can make workers more responsible. The third-highest RPN failure cause is workers' lack of attention to product quality in pursuit of personal wage targets. Therefore, the owner of UD. Dupa Karya Mandiri should provide assessments and ongoing supervision of worker performance (Windiarti, 2022).

Another cause of failure is the inappropriate comparison of raw materials, which can disrupt subsequent production processes. An improvement alternative for the owner of UD. Dupa Karya Mandiri is to establish SOPs governing the use of raw material comparisons. The fifth-highest failure cause is errors in machine settings. To address this issue, workers should pay attention to machine maintenance and settings when starting and completing the printing process (Pambudi, 2019).

Table 4. Proposed alternatives for repairing peeled off defects

Defect	Highest RPN	Alternative Improvements
Peeled off defect	Manual laborers	Conduct training and supervision to workers
	Tempted by piecework wages	Change the piecework system to a daily work system with clear production targets.
	Broken bamboo cages	Repairing and maintaining bamboo enclosures that are no longer suitable for use once a week.
	Not concerned with quality	Provide continuous evaluation and supervision of workers
	Dirty machine	Make an SOP for handling incense machines before and after the production process, and maintain the cleanliness and maintenance of incense machines.

The highest RPN value for the "crumbled" defect type suggests an improvement proposal to minimize the level of defective products, ensuring that UD. Dupa Karya Mandiri does not incur losses in terms of material and time. One alternative for improvement is addressing the failure cause due to rough worker behavior through training and supervision. The second-highest RPN failure cause is attributed to workers being enticed by the piece-rate payment system, indicating the need to enhance motivation among the workers. However, this issue can be resolved by transitioning from a piece-rate payment system to a daily work system with clear production targets. This change can encourage workers to be more responsible.

The third-highest RPN failure cause is bamboo splints damage. The improvement alternative involves performing repairs and maintenance on damaged bamboo splints that are no longer usable once a week. The fourth-highest RPN failure cause is workers' lack of attention to product quality in pursuit of personal wage targets. Therefore, the owner of UD. Dupa Karya Mandiri should provide evaluations and continuous supervision of worker performance. The fifth-highest failure cause is dirty machines. An improvement alternative for the company is to establish Standard Operating Procedures (SOP) for the handling of incense machines before and after production processes and to regularly maintain the cleanliness and upkeep of incense machines.

4.5 Control

The Control stage involves implementing the proposed improvements and quality control measures to prevent future failures. These include evaluating previous production processes within control limits, establishing clear SOPs for all stages of incense production, providing worker training, and ensuring regular machinery maintenance(Tambunan et al., 2018). By improving the production process and product quality, it is expected that costs can be reduced while maintaining the quality of incense products. Previous research on incense products and tablet medicine products has also highlighted the importance of training, maintenance, and the creation of SOPs to enhance product quality and process capabilities.

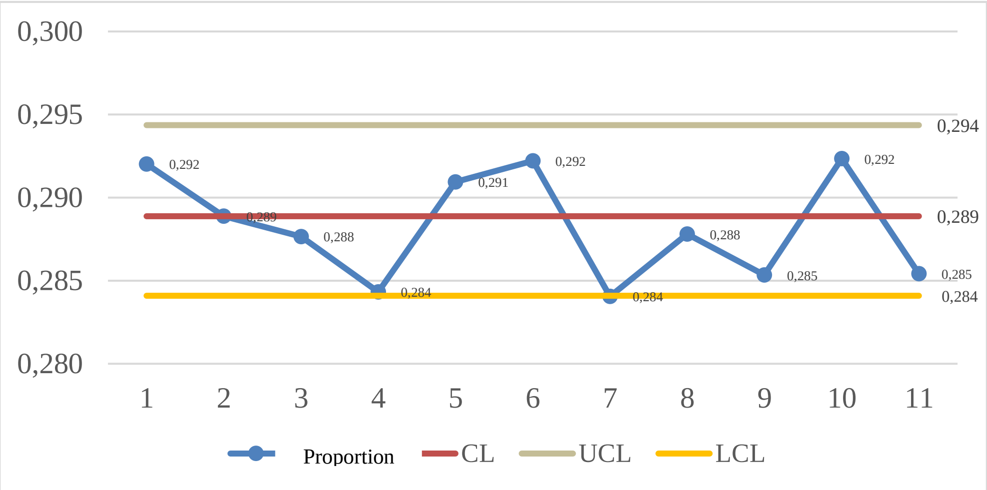

Figure 9. Graph of production process within control limits

Table 5. Improvement plan and control proposal

No	Improvement Plan	Proposed Control
1	Create and establish clear SOPs so that workers can understand the incense production process.	Establish an SOP for incense production so that workers can understand the handling of the production process properly so that the production process can run well.
2	Change the piece-rate system so that workers are not tempted by piece-rate wages	Using a clear production target system so that workers will have a sense of responsibility for their work. Incense productivity will also stabilize.
3	Scheduling production machine maintenance	Perform scheduled machine maintenance and pay more attention to machine cleanliness every day.
4	Repairing and maintaining damaged bamboo incense sticks	Routinely check the use of bamboo encek media and replace damaged bamboo encek.
5	Evaluate and supervise workers who do not pay attention to quality	Checking the incense production process from the stirring stage to the packaging stage regularly.

Improvement plans aimed at ensuring efficient production processes, high-quality products, and the achievement of desired quantity targets. Standard Operating Procedures (SOP) provide standardized operational guidelines within the organization, ensuring effective, consistent, standardized, and structured decision-making and facility usage. This process aids organizations in achieving high quality and efficiency (Andriansyah & Sulistyowati, 2021).

The first improvement proposal for UD. Dupa Karya Mandiri is to establish clear SOPs for the incense production process and provide adequate worker training to ensure that production meets the set targets. The second improvement plan involves transitioning from piece-rate to daily wage payment systems with clear production targets to prevent workers from being enticed by piece-rate wages and to encourage greater attention to product quality, thus stabilizing incense productivity. The third improvement plan includes scheduling routine maintenance for machines and production equipment. This aims to address issues like cracked product defects often caused by improper machine settings and machine dirt. Regular maintenance and daily machine cleanliness are necessary for resolution (Musa & Suseno, 2022). The fourth improvement plan targets the repair and maintenance of damaged bamboo splints. Damaged bamboo splints can result in crumbled incense, as the incense is often trapped by the damaged bamboo. To control this, regular inspections and replacement of damaged bamboo splints are necessary. The fifth improvement plan focuses on evaluating and supervising workers who may not prioritize product quality. Regular inspections throughout the incense production process, from mixing to packaging, are crucial for ensuring product quality.

The final improvement plan involves monthly reporting, simplifying evaluations and resolutions for subsequent production processes. By enhancing the production process through evaluating incense defects, it is expected to reduce costs while maintaining product quality and marketable incense quality (Musa & Suseno, 2022).

5. CONCLUSION

The study's data analysis yielded several key findings. Using the fishbone diagram, various factors causing product defects in incense production were identified, including Method Factor, Machine Factor, Human Factor, Motivation Factor, Media Factor, and Material Factor. The Six Sigma analysis revealed that the primary quality defects in incense products are cracking, peeled off, breakage, and mold. The Pareto diagram emphasized the significance of crack defects at 29.07% and peeled off defects at 28.03% as the most dominant issues in incense products.

Analyzing the data with DPMO (Defects Per Million Opportunities) values, the study found an average DPMO of 289,228.10, signifying that in one million opportunities, nearly 289,228.10 instances could result in defective incense products. The resulting sigma level was calculated at 2.1. Consequently, the study recommends several quality control and improvement measures, including the establishment of Standard Operating Procedures (SOPs) for drying, incense material usage, and machine maintenance. This aims to ensure that workers comprehend the correct production process, promoting smoother operations and increased worker responsibility. Additionally, implementing a clear production target system is suggested to enhance productivity. Scheduled machine maintenance and daily cleanliness are advised to prevent defects stemming from poorly maintained machinery. Regular checks on bamboo encek media and prompt replacement of damaged parts are also essential. Conducting routine inspections throughout the incense production process, from stirring to packaging, will help maintain product quality(H. Wicaksono, 2021). Monthly production reports, featuring comparisons between total production and daily defect counts, are recommended to facilitate process evaluation and improvement. This section provides answers to research questions and identifies opportunities for future research

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