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Quality Control Analysis at Citra Keramik Lombok MSME Using the Seven Basic Tools of Quality

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Abstract
This study analyzes quality control at the Citra Keramik Lombok MSME using three of the Seven Basic Tools: the histogram, Pareto chart, and cause-and-effect (fishbone) diagram. Defect data collected over five months reveal 54 occurrences, consisting of cracks (42), breakages (7), uneven coloration (2), shape nonconformity (2), and blistering (1). The histogram demonstrates a clear dominance of crack defects. Furthermore, Pareto analysis confirms that cracks account for 77.78% of total defects; when combined with breakages, this figure reaches 90.74%. The fishbone diagram maps plausible root causes using the 6M framework: material (composition and moisture variability), method (non-standard drying and inconsistent firing curves), machine/equipment (kiln calibration and mold wear), manpower (skills and handling practices), measurement (gauges and records), and environment (temperature-humidity and airflow). The PDCA-based improvement plan emphasizes standardized drying and firing practices, equipment calibration, operator training, and environmental control, supported by c-/u-charts and weekly run charts for continuous monitoring. This approach provides measurable, cost-efficient, and replicable improvements for similar ceramic MSMEs.

Keywords: Seven Basic Tools, Pareto chart, fishbone diagram, MSME, quality control

1. Introduction

Quality serves as a crucial factor for product differentiation in ceramic craft micro, small, and medium enterprises (MSMEs). This is particularly evident in markets defined by intense price competition and evolving consumer preferences (Setiarini *et al*., 2025; Mamuaya, 2024; Rajasa *et al*., 2023) [25, 18, 22]. Ceramic manufacturing processes are highly sensitive to variations in raw materials, environmental conditions, and operational discipline. Consequently, minor fluctuations in process parameters can increase the probability of product defects (Herzog *et al*., 2024; Haribaskar & Kumar, 2024) [7, 6]. Quality control analysis represents a vital component of the production process within the MSME sector, including Citra Keramik Lombok. High product quality enhances customer satisfaction, reduces production costs, and bolsters market competitiveness (Wicaksono & Syahrullah, 2020) [29].The application of the Seven Basic Tools of Quality provides an effective method for analyzing and resolving quality issues in ceramic products. These products frequently exhibit defects such as cracks, uneven coloration, disproportionate shapes, blistering, and breakage. By thoroughly understanding these defect patterns, MSMEs can effectively implement continuous improvement measures (Neyestani, 2017) [20]. Enhancing quality consistency mitigates costs associated with scrap and rework while positively contributing to local brand reputation and market expansion (Desai & Shaikh, 2018; Mahato *et al*., 2017) [3, 17].

To ensure consistent ceramic product quality, a methodological approach utilizing bar charts (histograms), Pareto charts, and cause-and-effect (fishbone) diagrams has proven effective in addressing operational challenges. Bar charts visually represent defect frequencies, while Pareto charts help identify primary causes that require immediate prioritization (Karnsarng *et al*., 2022; Sandhu *et al*., 2017) [13, 23]. Additionally, fishbone diagrams facilitate the structured mapping of root causes, an essential step for process improvement (Watcharaphassakorn & Yarlagadda, 2014) [28].

This approach is highly relevant for MSMEs because it delivers valuable insights for performance enhancement without necessitating expensive software investments (Kakaei-Lafdani *et al*., 2021) [12].

This study focuses on analyzing ceramic product defect data from the past five months. The objectives are to map the defect profile, determine improvement priorities based on the Pareto principle, and investigate potential root causes using the 6M approach within a fishbone diagram. The 6M framework encompasses Man, Machine, Method, Material, Measurement, and Environment. This targeted approach aims to formulate a measurable improvement plan applicable to MSMEs like Citra Keramik Lombok. The findings will enable the formulation of highly effective corrective actions. These actions are expected to minimize the risk of implementing low-impact improvements regarding quality performance and production costs (Imansuri *et al*., 2024) [8].

Table 1: Number of Product Defects Over a 5-Month Period

Defect Type	May	June	July	August	September
Cracks	8	9	10	7	8
Breakage	1	2	2	1	1
Uneven Coloration	1	0	1	0	0
Disproportionate Shapes	0	1	0	0	1
Blistering	0	0	0	1	0

The value added by this research lies in its integration of quantitative defect data visualization with qualitative root cause mapping. Defect frequencies and proportions provide an objective baseline for prioritization, while the fishbone diagram assists in identifying interconnected causes (Gijo *et al*., 2011) [5]. Further analysis utilizing Pareto and Ishikawa diagrams will offer profound insights into the root causes of these issues (Tyas & Giyanti, 2024; Kurniawan & Dahdah, 2023) [27, 14]. Through this combined approach, MSMEs can determine appropriate improvement measures more efficiently. This simultaneously mitigates the likelihood of implementing changes that yield insignificant impacts (Chavando *et al*., 2024) [2]. This study is anticipated to serve as a model for other MSMEs seeking to rapidly and cost-effectively reduce product defect rates. By identifying "cracks" as the primary issue based on the analyzed data, MSMEs can allocate resources toward improvements in areas most critical to their quality performance (Jamaluddin *et al*., 2011) [10].

2. Method

This study employs both qualitative and quantitative approaches through the application of the Seven Basic Tools of Quality, specifically Pareto charts, bar charts, and fishbone diagrams. Pareto charts are utilized to identify defect frequencies and establish improvement priorities. Bar charts illustrate the distribution of defects over the analysis period. The fishbone diagram systematically identifies the causal factors behind the defects (Jayanti & Pratiwi, 2021; Susendi *et al*., 2021) [11, 26].

The research utilizes observational data on ceramic product defects at the Citra Keramik Lombok MSME over the past five months. The recorded defect types and their frequencies total 54 occurrences, comprising cracks (42), breakage (7), uneven coloration (2), disproportionate shapes (2), and blistering (1). These data were extracted from daily final inspection logs and process quality audits. The analytical focus centers on frequency patterns across defect categories to direct the interpretation toward defect type prioritization.The accumulated defect data were systematically analyzed using statistical software to generate relevant charts (Mulyono & Apriyani, 2021) [19].

The first step involved data cleaning and classification to ensure consistency in defect type nomenclature. A summary table was then compiled to calculate the frequency, percentage, and cumulative percentage for each category. The second step entailed visual representation using bar charts. This illustrates the frequency distribution per defect category in a format easily comprehensible to shop-floor personnel.In the third step, a Pareto analysis was conducted by sorting defect categories from highest to lowest frequency and calculating cumulative percentages. The 80/20 principle served as a benchmark to identify the "vital few" defect types contributing to the majority of problems (Kwilinski & Kardas, 2024; Firdaus *et al*., 2025; Sarkar *et al*., 2012; Irfanto, 2022) [16, 4, 24, 9]. An 80% reference line was applied to establish the threshold for improvement priorities. The fourth step involved constructing an Ishikawa diagram to map suspected root causes based on the 6M framework. Potential root causes were identified by leveraging practical experience in ceramic processes. This encompassed clay and glaze material characteristics, drying and kiln firing disciplines, environmental conditions, operator competence, equipment readiness, and inspection practices.

3. Results and Discussion

The defect distribution exhibits a clear dominance of the crack category with 42 occurrences, representing 77.78% of the total. This is followed by breakage (7 occurrences, 12.96%), uneven coloration (2 occurrences, 3.70%), disproportionate shapes (2 occurrences, 3.70%), and blistering (1 occurrence, 1.85%). Total occurrences over the five months amounted to 54. These findings confirm that the most critical quality disturbances involve the structural integrity of the product, rather than aesthetic issues or form precision. Consequently, addressing cracks must become the primary focus for quality improvement efforts.Bar chart data corroborate these results, demonstrating an uneven distribution of defect frequencies. The majority of defects occurred during specific periods, which may correlate with suboptimal process parameters.

The bar chart (Figure 1) visually illustrates the significant frequency gap between cracks and other categories. This visualization is crucial for cross-functional communication, instantaneously conveying that cracks are overwhelmingly dominant. Thus, the bar chart serves as an awareness builder and a concrete foundation for problem-solving discussions.

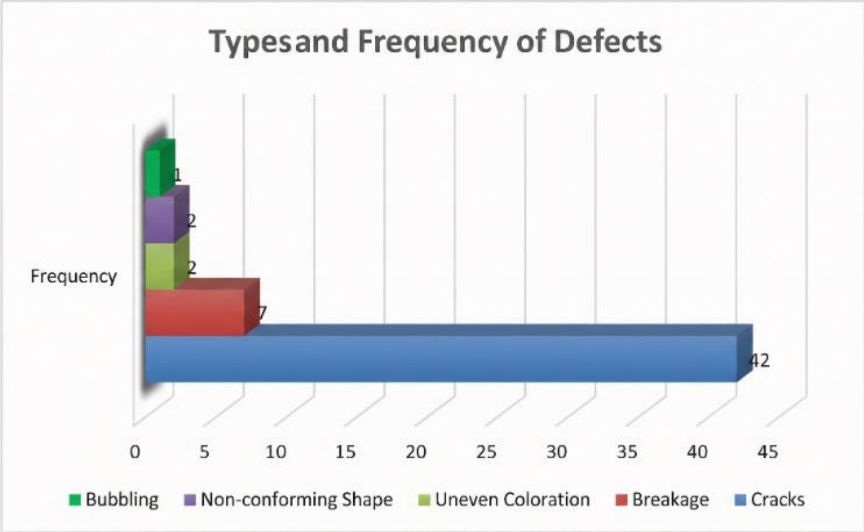

Fig 1: Bar Chart of Defect Types and Frequencies

Pareto analysis reaffirms the 80/20 principle. Cracks alone account for 77.78% of total defects, and when combined with breakage, the cumulative percentage reaches 90.74%. Focusing improvement efforts on these two categories presents the potential to reduce total defect occurrences by over 90%. Other categories have a proportionally minor impact on the overall problem and can be addressed in subsequent phases.

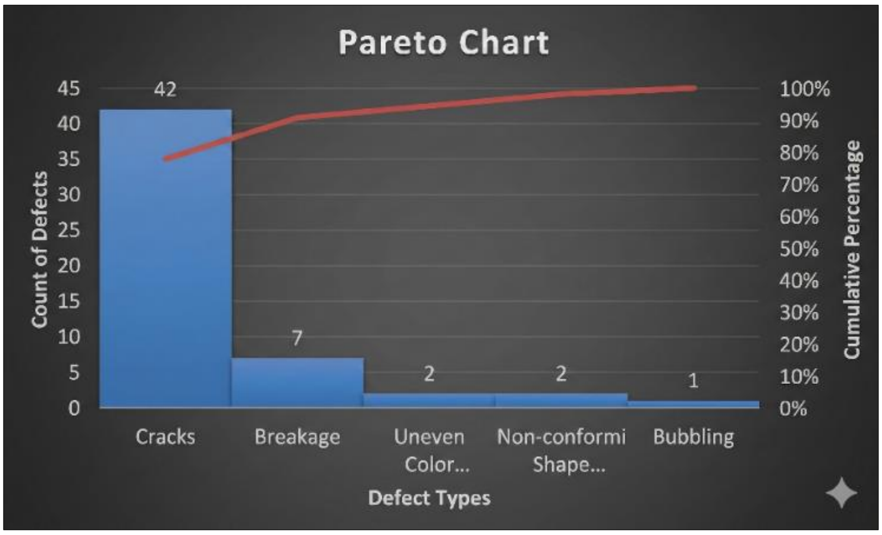

Fig 2: Pareto Chart of Defect Types and Frequencies

To investigate the root causes of cracks, a fishbone diagram was constructed using man, machine, material, method, and environment as the primary branches (Aristriyana & Fauzi, 2023; Kusuma *et al*., 2024) [1, 15]. Primary causes may include a lack of worker training in polishing and firing processes, the use of low-quality raw materials, and improper temperature settings during firing. This observation aligns with existing research literature (Susendi *et al*., 2021; Pratama & Suhartini, 2019) [26, 21]. Furthermore, dominant causal hypotheses requiring further verification include uncontrolled clay moisture content, inconsistent firing curves, inadequate kiln calibration, and unstandardized handling practices.

From an equipment perspective, potential causes involve suboptimal kiln conditions, uneven heat distribution, and unsuitable auxiliary equipment. Regarding materials, inconsistencies in clay composition, uncontrolled moisture, or varying raw material quality can render the product highly susceptible to cracking. Methodological issues contributing to the problem include poorly documented standard operating procedures (SOPs), the absence of standardized drying times, and a lack of detailed work instructions. Uncontrolled environmental factors, such as humidity and air circulation in the drying area, can also trigger cracking. The interaction among these factors amplifies the probability of crack defects in the final products.

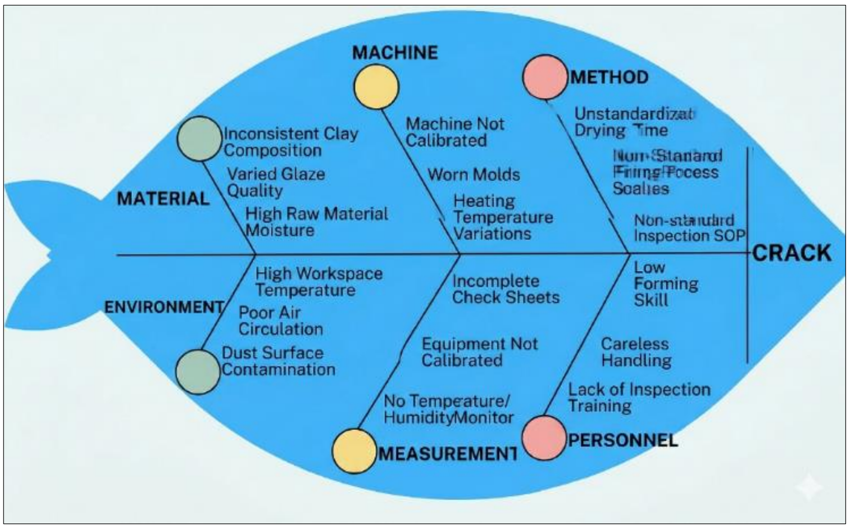

Fig 3: Fishbone Diagram of the Causes of Crack Defects

Based on this analysis, several improvement recommendations can be formulated.

1. The MSME needs to develop and implement written SOPs for the drying and firing stages, encompassing time management, temperature control, and product arrangement within the kiln.
2. Periodic technical training for operators regarding shaping techniques, product arrangement, and post-firing handling must be conducted to minimize operational variations that potentially cause defects.
3. Raw material control through supplier selection, moisture content inspections, and material homogenization prior to use can assist in reducing inconsistencies in the physical properties of the clay.
4. Reconfiguring the drying and firing areas to ensure better air circulation and more stable environmental conditions should also be considered

While focusing on cracks as the primary priority, the MSME must continuously monitor other defect types. Although their proportions are minor, defects like breakage and uneven coloration influence consumer perceptions of product quality consistency. The continuous use of check sheets enables the MSME to detect any increase in the frequency of these minor defects. Therefore, combining check sheets, Pareto charts, and fishbone diagrams creates a simple yet effective quality control system suitable for sustainable implementation at Citra Keramik Lombok.

5. Conclusion

This study demonstrates that quality control at the Citra Keramik Lombok MSME can be effectively analyzed using check sheets, Pareto charts, and fishbone diagrams. Data spanning five months reveal 54 total defects, predominantly characterized by cracks (42 occurrences, ±77.78%) and breakage (7 occurrences, ±12.96%). Other defect types constituted a negligible proportion. Pareto analysis confirms that addressing crack defects must be the primary priority for quality improvement initiatives.Fishbone analysis indicates the root causes of these cracks are multidimensional. Contributing factors include human elements (operator skills), machinery (kilns and racks), materials (composition and moisture consistency), methods (lack of standardized SOPs), and environmental conditions (humidity and air circulation).To reduce crack frequencies and enhance quality consistency, the MSME is advised to implement written SOPs for drying and firing stages, conduct technical training for operators, enforce raw material quality control, and establish a conducive working environment. This research is limited to a five-month observation period and the application of three basic quality tools. Future studies should extend the observation period, conduct detailed analyses of specific product types, incorporate tools like histograms and control charts, and evaluate defect rate reductions following the implementation of corrective actions.

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