



A DMAIC-BASED SIX SIGMA ANALYSIS IN CULINARY MSMEs: A CASE STUDY OF REFRESH SEAFOOD

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ABSTRACT

Micro, Small, and Medium Enterprises (MSMEs) in the culinary sector frequently face operational quality challenges, particularly service time variability, raw material waste, and limited capacity during demand surges. These problems are largely driven by process variation rather than defects in final products, especially in micro-scale enterprises with limited quantitative data. This study aims to analyze operational quality issues at Refresh Seafood, a micro-scale culinary MSME, using the Six Sigma method with the DMAIC (Define, Measure, Analyze, Improve, and Control) approach, and to formulate practical improvement strategies aligned with MSME characteristics. A descriptive qualitative approach was employed through semi-structured interviews and direct observation. Data were analyzed using the DMAIC framework supported by qualitative indicators and fishbone analysis. The findings reveal that service time instability between dine-in and delivery orders, suboptimal raw material utilization, and reactive capacity management are the main quality issues. Proposed improvements include developing mini standard operating procedures (SOPs), optimizing order flow, implementing batch preparation during peak periods, and utilizing leftover raw materials. This study demonstrates that Six Sigma can be flexibly applied in micro-scale culinary MSMEs to improve process stability and service efficiency

1. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are one of the main pillars of the Indonesian economy due to their significant contribution to employment generation and gross domestic product (GDP), particularly in the culinary sector, which exhibits relatively stable demand. Nevertheless, culinary MSMEs face complex operational challenges, including the management of perishable raw materials, fluctuations in customer demand, and limitations in human resources and equipment. These conditions make MSMEs vulnerable to process variations that may affect the consistency of product and service quality (Fitria & Novita, 2020).

In the culinary industry, quality is determined not only by food quality but also by service quality, which includes service speed, order accuracy, and the consistency of the customer experience. Previous studies have shown that both food quality and service quality have a significant influence on customer satisfaction and repurchase intention (Ekowati et al., 2018; Ruth et al., 2024). Inconsistencies in service time, non-standardized workflows, and raw material waste are common issues among culinary MSMEs and may negatively affect perceived quality and business competitiveness (Siaputra, 2024). Therefore, a quality management approach is required that can identify sources of process variation and provide practical improvement solutions aligned with the characteristics of MSMEs.

Six Sigma is a quality management methodology that focuses on reducing process variation and enhancing quality stability through data-driven and systematic analysis. This method employs the Define, Measure, Analyze, Improve, and Control (DMAIC) cycle as its primary framework for continuous improvement (Besterfield, 2013). Several studies have demonstrated that Six Sigma implementation is effective in improving process quality and efficiency while reducing waste across various sectors, including

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small and medium-sized enterprises (Ahmad et al., 2019; Parianti et al., 2020). However, the application of Six Sigma in micro-scale culinary MSMEs remains relatively limited, particularly studies that adopt qualitative approaches to capture contextual operational conditions. Limited numerical records and resource constraints are often the main barriers to implementing structured quality control methods in such enterprises (Rochamah & Pristiana, 2024).

This study focuses on Refresh Seafood, a culinary MSME that adopts a fresh seafood service concept. Refresh Seafood faces several operational quality issues, including variability in service time between dine-in and delivery orders, waste of specific raw materials, and process sensitivity to demand surges on certain days. These conditions indicate the presence of process variation that may adversely affect overall service quality. Therefore, this study aims to analyze operational quality problems at Refresh Seafood using the Six Sigma method with the DMAIC approach and to formulate practical improvement recommendations that are realistic and aligned with the characteristics of MSMEs. The findings are expected to provide practical contributions for culinary MSME practitioners in improving process efficiency and service quality, as well as academic contributions by enriching the literature on the application of Six Sigma in micro-scale, service-based enterprises.

Literature Review

Six Sigma and the DMAIC Approach

Six Sigma is a quality management method that focuses on reducing process variation and enhancing performance stability through data-driven continuous improvement. The core concept of Six Sigma emphasizes that quality is determined not only by final outputs but also by a process's capability to consistently produce results that meet customer requirements (Besterfield, 2013). By controlling variation, Six Sigma aims to reduce nonconformities and waste, thereby improving process efficiency and control.

The primary framework of Six Sigma is the Define, Measure, Analyze, Improve, and Control (DMAIC) cycle. The Define stage focuses on identifying priority problems and customer needs, while the Measure stage aims to assess process performance as a basis for improvement. The Analyze stage is used to identify root causes through cause-effect analysis, whereas the Improve stage is directed toward designing practical improvement solutions. The Control stage ensures that implemented improvements are sustained over time through simple control mechanisms (Besterfield, 2013).

Numerous studies have demonstrated that the implementation of Six Sigma using the DMAIC approach is effective in improving process quality and efficiency, including within small and medium-sized enterprise contexts. Ahmad et al. (2019) and Parianti et al. (2020) found that DMAIC helps business practitioners systematically identify sources of waste and process variation. Other studies have also highlighted that Six Sigma can be flexibly applied in MSMEs by adapting the method to resource constraints, particularly through the use of qualitative approaches and process observation (Fitria & Novita, 2020; Rochamah & Pristiana, 2024).

Quality Concepts in the Culinary Industry

Quality in the culinary industry is multidimensional, encompassing both food quality and service quality experienced by customers. Food quality relates to taste, freshness, hygiene, and product consistency, while service quality includes service speed, order accuracy, and employee-customer interactions. Previous studies indicate that these two dimensions of quality simultaneously influence customer satisfaction and repurchase intention (Ekowati et al., 2018; Ruth et al., 2024).

In the context of culinary MSMEs, quality problems are often not caused solely by product failures but rather by operational process variations, such as inconsistent service time, non-standardized kitchen workflows, and limited capacity during demand surges. Siaputra (2024) emphasizes that service speed and consistency play a crucial role in shaping restaurant quality perceptions, particularly for small-scale businesses that rely heavily on direct customer experience. Therefore, quality management approaches in the culinary industry should focus on process control rather than solely on final product outcomes. The integration of quality concepts in the culinary industry with the Six Sigma approach is particularly relevant, as DMAIC enables business practitioners to systematically identify process variation and formulate improvement actions based on actual operational conditions. Accordingly, the application of Six Sigma in

culinary MSMEs functions not only as a quality control tool but also as an analytical framework for enhancing process efficiency and service stability in a sustainable manner.

2. METHODS

This study employs a descriptive qualitative approach aimed at gaining an in-depth understanding of operational conditions and quality-related issues at Refresh Seafood, a culinary MSME. The qualitative approach was selected because the study focuses on process analysis, operational variation, and the business owner's experiences in managing production and service activities, rather than on testing statistical relationships among variables. This approach is considered appropriate for examining the implementation of Six Sigma in micro-scale culinary MSMEs, which generally face limitations in quantitative data recording (Fitria & Novita, 2020). The object of the study is the operational processes of Refresh Seafood, particularly raw material management, order flow, service time, and resource utilization. The subject of the study is the business owner, who is directly involved in operational decision-making and possesses comprehensive knowledge of the enterprise's daily activities. The research was conducted at the Refresh Seafood business location in Sumedang Regency, West Java, with data collection carried out in December 2025.

Data were collected through semi-structured interviews and direct observation. The interviews were conducted to obtain in-depth information on operational process flows, work practices, recurring quality issues, and strategies for managing raw materials and labor. Direct observation was carried out to capture a realistic depiction of preparation and cooking processes, service workflows, and differences in service time between dine-in and delivery orders. Secondary data were obtained through a literature review of academic journals and textbooks related to Six Sigma, DMAIC, and quality management in the culinary industry, which served as a conceptual foundation and a benchmark for field findings.

Data analysis was conducted using the Six Sigma framework through the DMAIC stages: Define, Measure, Analyze, Improve, and Control. In the Define stage, key quality issues were identified based on interview and observation results, including service time variability, raw material waste, and operational capacity constraints. The Measure stage involved organizing field findings into qualitative indicators, such as service duration, purchasing and storage patterns of raw materials, types of waste generated, and the condition of human resources and equipment.

The Analyze stage aimed to identify the root causes of quality problems by categorizing causal factors into human, method, material, equipment, and environmental aspects. A fishbone diagram was used as the main analytical tool to examine the relationship between process variation and the operational conditions of the MSME. Subsequently, the Improve stage focused on developing practical and feasible improvement proposals that could be implemented without substantial investment, including work process standardization, optimization of order flow, and more effective utilization of raw materials previously considered waste. The Control stage emphasized the design of simple control mechanisms, such as daily check sheets and periodic evaluations, to ensure the sustainability of the proposed improvements.

3. RESULTS AND DISCUSSIONS

The analysis of operational quality at Refresh Seafood was conducted using the Six Sigma approach through the DMAIC stages to identify process variation, root causes of quality problems, and improvement opportunities aligned with the characteristics of micro-scale enterprises. The results indicate that the main quality issues are related to instability in service time, waste of specific raw materials, and the sensitivity of operational processes to demand surges.

Define

Quality problems were identified based on the results of interviews and direct observations. Variability in service time emerged as the primary issue, particularly the difference between dine-in orders and orders placed through delivery applications. Under normal conditions, service time tended to be relatively stable; however, on days with high demand, service duration increased and became inconsistent. This condition indicates the presence of uncontrolled process variation, which, from a Six Sigma perspective, reflects low service process stability (Besterfield, 2013). In addition, material waste in the form of unused squid heads was identified, along with limited kitchen capacity when order volumes increased.

Measure

This stage provides a more structured depiction of the operational conditions. Measurement was conducted qualitatively by organizing field findings related to service duration, raw material purchasing patterns, levels of waste, and resource capacity. The measurement results show that dine-in orders have relatively more stable service times compared to delivery orders, which tend to experience delays during peak hours. Daily and bi-daily raw material purchasing patterns are effective in maintaining product freshness; however, they also make the business vulnerable to sudden increases in demand due to the absence of buffer stock. These findings are consistent with previous studies indicating that limited capacity and planning in MSMEs can increase process variation and reduce operational efficiency (Fitria & Novita, 2020).

To summarize the measurement results at the Measure stage, the field findings are presented in tabular form to facilitate the identification of differences in operational conditions across the analyzed aspects. The table presents a summary of the measured aspects, key findings based on interviews and observations, and preliminary interpretations used as the basis for analysis in the subsequent stage.

Table 1 Key Findings

Measured Aspect	Field Findings	Interpretation
Dine-In Service Time	20-25 minutes	Stable and relatively fast
Delivery Service Time	25-30+ minutes, particularly during peak hours	High variability, potential delays
Raw Material Purchasing Pattern	Seafood purchased every two days; vegetables purchased daily	Maintains quality, minimal waste
Raw Material Waste	Squid heads discarded	Opportunity for menu innovation
Human Resource Capacity	Adjusted to daily operational needs	Sensitive to demand surges
Seasonal Demand Pattern	Higher demand on weekends	Requires stock anticipation and operational preparedness

Analyze

At this stage, a fishbone diagram was used to analyze the root causes of the problems identified in the research object. The root causes were examined by grouping contributing factors into human, method, material, equipment, and environmental aspects.

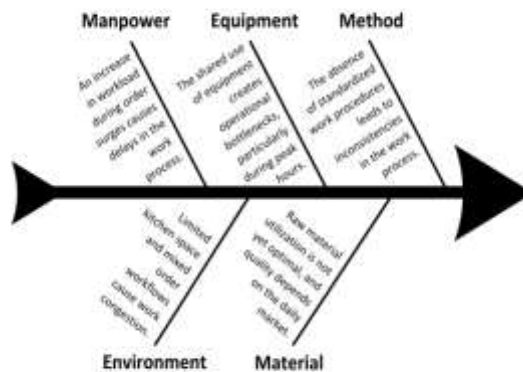


Figure 1 Fishbone Diagram

From the human aspect, the number of workers adjusted to daily operational needs was considered sufficient under normal conditions but became less optimal during demand surges. From the method aspect,

the absence of standardized operating procedures caused preparation and cooking times to be flexible and highly dependent on individual work habits, thereby increasing process variation. From the material aspect, the disposal of squid heads indicated suboptimal utilization of raw materials. From the equipment and environmental aspects, the shared use of equipment and limited kitchen space were likely to create bottlenecks during peak hours. These findings reinforce the view that quality problems in culinary MSMEs are more frequently driven by process variation rather than defects in final products (Ahmad et al., 2019).

Improve

The Improve stage focused on developing realistic and applicable improvement proposals. The main proposed improvements include the development of mini standard operating procedures (SOPs) for preparation and cooking processes to reduce service time variability, optimization of the delivery order processing flow, and the utilization of squid heads as additional menu items to reduce raw material waste. In addition, batch preparation of ingredients on high-demand days was proposed to enhance kitchen readiness without requiring additional resources. This simple and contextual improvement approach is consistent with the findings of Rochamah and Pristiana (2024), which emphasize that the effectiveness of Six Sigma implementation in MSMEs largely depends on the adaptability of the method to enterprise constraints. Based on the identified improvement proposals, the improvement actions were formulated into standard operating procedures (SOPs) for the main operational processes. These SOPs are presented in tabular form to facilitate understanding and practical implementation at Refresh Seafood, as shown in the table below.

Table 2 Proposed Standard Operating Procedures (SOPs) for Refresh Seafood

No.	Process Stage	Description of Activities (SOP)	Responsible Party	Implementation Standard	Expected Output
1	Order Receipt	Receive and record customer orders for both dine-in and delivery accurately and completely, based on the available menu	Cashier	Order recording is completed within a maximum of 2 minutes after the order is received	Order data recorded clearly and ready to be processed
2	Order Classification	Classify orders based on service type (dine-in or delivery) to facilitate kitchen workflow arrangement	Cashier	Classification is performed immediately after the order is recorded	More structured order processing flow
3	Raw Material Preparation	Prepare raw materials according to order type, including washing, cutting, and storing ingredients	Kitchen Staff	Maximum preparation time of 5 minutes per order	Raw materials ready to be cooked according to standards
4	Batch Preparation	Prepare semi-processed ingredients in advance on high-demand days to anticipate order surges	Kitchen Staff	Conducted before peak operational hours	Improved kitchen readiness without additional resources

5	Cooking Process	Perform cooking according to the established order sequence and standardized recipes	Kitchen Staff	Cooking time ranges from 10–15 minutes per order	Cooked food with consistent quality
6	Utilization of Leftover Materials	Process squid heads into additional menu items or other consumable products	Kitchen Staff	Conducted in accordance with food hygiene and safety standards	Reduction of raw material waste
7	Order Serving	Serve orders to dine-in customers or hand over orders to delivery service providers	Kitchen Staff	Orders served within a maximum of 3 minutes after cooking is completed	Orders delivered to customers on time
8	Daily Operational Evaluation	Conduct daily evaluations of service time and operational constraints encountered during service processes	Business Owner	Performed at the end of operational hours	Identification of process variation and basis for improvement evaluation

Control

This stage emphasizes the importance of continuous control to ensure that the proposed improvements can be sustained. The use of daily check sheets to record service time, raw material stock conditions, and levels of waste serves as a simple control mechanism that can be readily adopted by MSME practitioners. In addition, periodic operational evaluations enable the business owner to identify recurring delay patterns and adjust raw material preparation strategies during specific periods. These control mechanisms not only help maintain process consistency but also encourage data-driven decision-making at the MSME level.

Overall, the findings indicate that the implementation of Six Sigma using the DMAIC approach can assist Refresh Seafood in identifying sources of process variation and formulating improvement actions that are relevant to actual operational conditions. This study reinforces the existing literature suggesting that Six Sigma can be flexibly applied in culinary MSMEs to enhance service stability and process efficiency, even in the absence of complex quantitative data (Parianti et al., 2020; Rochamah & Pristiana, 2024).

4. CONCLUSION

This study demonstrates that operational quality issues at Refresh Seafood primarily stem from service process variation, particularly unstable service time, suboptimal utilization of raw materials, and the sensitivity of operational capacity to demand surges. The application of the Six Sigma method using the DMAIC approach proved effective in systematically identifying sources of process variation, even within the context of a micro-scale enterprise facing limitations in quantitative data and resources. Through the DMAIC stages, this study confirms that quality problems in culinary MSMEs are more strongly influenced by process-related factors than by final product quality. Non-standardized workflows, the absence of formal operating procedures, and reactive capacity management emerged as the main drivers of service inconsistency. These findings support previous studies highlighting that Six Sigma can be flexibly adapted for MSMEs by emphasizing process variation control and improvements grounded in real operational conditions.

From a practical perspective, the results indicate that culinary MSME practitioners can apply Six Sigma principles without adopting complex measurement systems. The development of mini SOPs for preparation and cooking processes, more structured order flow management, and the utilization of leftover raw materials as menu innovations represent simple yet effective steps to improve service time stability and operational efficiency. Furthermore, the implementation of basic control mechanisms—such as service time recording and periodic evaluations can help MSMEs cultivate data-driven decision-making practices at an appropriate scale. Academically, this study contributes to the enrichment of the literature on Six Sigma implementation in the culinary MSME sector, particularly through a qualitative approach that emphasizes process understanding. Practically, the findings are expected to serve as a reference for MSME practitioners and business development facilitators in designing realistic, sustainable, and contextual service quality improvement strategies. Future research is recommended to combine qualitative and quantitative approaches to more precisely measure the impact of improvement implementation, as well as to expand the research scope to various types of culinary MSMEs to enhance the generalizability of the findings.

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