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The Mediating Role of Process Stability in the Relationship Between Supply Performance and Product Quality Consistency Among SMES in Japing

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Abstract

Product quality inconsistency is still a major challenge for food MSMEs due to high dependence on raw material supply and semi-manual production processes. This study aims to analyze the mediating role of process stability in the relationship between supply performance and product quality consistency in JAPA MSMEs. The research uses a quantitative approach supported by production operational data. Initial research used 120 production batches; after data screening for outliers, 90 observations were used in the final analysis. Data were analyzed using linear regression, path analysis, and Sobel tests. The results show that supply performance has a significant effect on process stability, but the direction of the influence is negative, so H1 is not supported. Process stability has a positive effect on product quality consistency, while supply performance does not directly affect product quality consistency. The Sobel test shows that process stability mediates the relationship between supply performance and product quality consistency. These findings confirm that improving the quality of food MSME products cannot be achieved solely through improving supply but requires strengthening the stability of the production process.

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) have a strategic role in the Indonesian economy, especially in the food and beverage sector, which is one of the main contributors to the Gross Domestic Product and the absorption of the national workforce. Data from the Central Statistics Agency shows that MSMEs account for more than 60% of Indonesia's GDP, with the food and beverage subsector being a relatively stable and growing sector (Central Statistics Agency, 2023). This condition confirms that strengthening the operational competitiveness of food MSMEs is a strategic issue for the sustainability of the national economy.

As market demand increases, many food MSMEs face challenges in maintaining product quality consistency. Unlike large-scale manufacturing companies that already have standardized operating systems and supply chains, MSMEs generally still rely on semi-manual production systems with a high level of dependence on raw material suppliers. As a result, small variations in supply often have a significant impact on the smooth production and quality of the final product. JAPING, as a producer of basreng tuna snacks since 2016, is facing this situation. Increasing production from a small scale to a larger capacity raises potential inconsistencies in product quality. One of the key factors that affects the quality of MSME products is supply performance, which reflects the ability of suppliers to provide raw materials according to the quality, quantity, and timeliness of delivery needed. The supply chain management literature confirms that low supply performance increases operational uncertainty, triggers production disruptions, and has the potential to degrade product quality, especially in the food industry, which is sensitive to input quality and timeliness (Parwani & Raut, 2021; Burgess et al., 2023).

The timeliness and accuracy of raw material delivery is very crucial for JAPING MSMEs because raw materials cannot be stored for a long time at the production site. This approach is in line with the principle of Just in Time (JIT), where JIT itself is an operations management concept that emphasizes the procurement and use of materials in a timely manner, in the right quantity, and according to the needs of the production process, with the main goal of minimizing inventory, reducing waste, and improving the efficiency of process flow (Ohno, 1988; Gupta & Brennan, 2020). In a JIT system, materials are delivered by suppliers as close as possible to the time of their use in the production process, so that reliance on safety stock can be reduced and process variations become more controlled. This approach demands a high level of supply performance, particularly in terms of quality, quantity, and timeliness of delivery, as minor disruptions to supply can have a direct impact on production smoothness (Parwani & Raut, 2021; Chen, 2023).

For Micro, Small, and Medium Enterprises (MSMEs), the application of the Just in Time principle is increasingly relevant considering the limited capital, storage space, and inventory control capacity they have. Research shows that MSMEs that adopt the JIT principle tend to be able to reduce inventory costs, minimize the risk of raw material waste, and increase the stability of the production process through better synchronization between supply and production activities (Oluyisola & Rahmani, 2022; Costa et al., 2021). In the context of the food industry, the implementation of JIT also helps MSMEs reduce the risk of degrading raw material quality due to prolonged storage, thereby contributing to increased consistency of final product quality (Burgess et al., 2023). Therefore, JIT is not only seen as an operational efficiency strategy but also as an important approach to increasing the competitiveness and operational sustainability of MSMEs (Burawat, 2025).

Instability in supply performance has a direct impact on the stability of the production process. Production process stability refers to the ability of a production system to operate consistently with low variation in cycle time, material flow, and resource utilization. Quality management theory emphasizes that a stable process is the main prerequisite for achieving a reliable and predictable production system (Juran, 1998). In the food industry, small disruptions to the process can quickly develop into bottlenecks, idle time, and rework that reduce efficiency and production quality. The stability of the production process has a central role in maintaining the consistency of product quality. The quality management literature views quality not as a result of final inspection but as a consequence of a controlled process with minimal variation (Juran, 1998; Costa et al., 2021). In food MSMEs, quality consistency is reflected in the uniformity of product characteristics, such as weight, texture, taste, and low defect rates, which have a direct effect on consumer satisfaction and trust (Wibisono & Sari, 2021; Yunita et al., 2023).

A number of previous studies have shown that the relationship between supply performance and product quality consistency has not yielded consistent results. Several studies have found that good supply performance, especially in the quality dimension of raw materials, can directly improve the quality of the final product (Burgess et al., 2023). However, other research shows that the influence of supply performance on product quality is not always directly significant but depends on the ability of the production system to control internal process variations (Renna, 2022; Samouilidou et al., 2023). The gap in this study lies in the limitations of quantitative studies that specifically test the role of process stability as a mediating variable in the relationship between supply performance and product quality consistency in food MSMEs. Previous research has placed supply performance and product quality in direct relationships, while internal mechanisms through process stability are still rarely empirically tested, especially in food MSMEs with semi-manual production processes.

The inconsistency of these findings indicates that the relationship between supply performance and product quality consistency is contextual and does not stand alone. In the context of food MSMEs, where production systems tend to be semi-manual, labor-dependent, and have limited formal operational standards, supply variations have the potential to increase the instability of the production process. This condition shows that the stability of the production process acts as an internal mechanism that explains how supply performance translates into consistent product quality. Without adequate process stability, even good supply performance does not necessarily result in consistent product quality. Therefore, this study views the stability of the production process as a mediating variable that is theoretically and empirically needed to explain the inconsistency of previous research findings, especially in the context of food MSMEs such as JAPING.

In addition, most supply chain theories and operations management models were developed based on studies of large-scale manufacturing companies in developed countries. Research on food MSMEs in developing countries is still relatively limited and often descriptive or case study-based, so it has not provided strong quantitative evidence regarding the relationship between operational variables (Tambunan, 2019; Ali et al., 2021). This condition opens up research opportunities to retest established theories in the context of MSMEs with different operational characteristics.

The novelty of this research lies in five key aspects. First, it introduces process stability as a mediating variable in the relationship between supply performance and product quality consistency—a novel approach in the Indonesian food MSME literature. Second, it uses actual operational data (production batches) rather than perceptual survey data, providing objective measurement of variables and reducing common method bias. Third, it focuses on the specific context of semi-manual food production in MSMEs, which differs fundamentally from automated large-scale manufacturing where most operations management theories were developed. Fourth, it employs path analysis with the Sobel test to rigorously test the mediation hypothesis, moving beyond simple direct effect analysis. Fifth, it addresses the specific practical problem at JAPING MSME—maintaining quality during production scaling—while generating findings generalizable to other food MSMEs facing similar challenges.

Based on the problems found in the literature and phenomena at JAPING MSMEs, this study will answer the following questions: 1) Does supply performance affect process stability? 2) Does supply performance affect product quality consistency? 3) Does process stability affect product quality consistency? 4) Does process stability mediate the influence of supply performance on product quality consistency?

Based on the above background, this research is important to conduct because it not only fills the gap in empirical findings related to the relationship between increasing production quantity and product quality consistency in MSMEs but also addresses the practical needs of

JAPING MSMEs in ensuring that production capacity growth can be achieved without sacrificing product quality. This study uses a correlational quantitative approach. By using actual operational data and the entire available observation population, this study is expected to make an empirical contribution to the MSME operations management literature while providing practical implications for improving the competitiveness of food MSMEs.

This research is expected to make contributions both theoretically and practically. Theoretically, this study enriches the literature on operations management and supply chain management by providing empirical evidence on the relationship between supply performance, production process stability, and product quality consistency in the context of MSMEs, which until now remains relatively limited and shows diverse findings. This research also examines the role of production process stability as a mediation mechanism, thereby expanding understanding of how supply performance affects product quality through internal production processes. Practically, this study provides implications for food MSMEs, especially JAPING, in designing supply management strategies and production processes so that an increase in production quantity can be achieved without sacrificing product quality consistency. The results of this study are expected to serve as the basis for data-driven operational decision-making in response to demand growth and sustainable production capacity increases.

METHOD

This study uses a correlational quantitative approach with the aim of examining the relationship between supply performance, production process stability, and product quality consistency. This approach was chosen because the research does not aim to provide a treatment or experiment but rather to test the strength and direction of the relationship between variables that have been theoretically formulated in the supply chain management and operations management literature. A correlational quantitative approach is commonly used in supply chain and operations research to test causal relationships based on empirical data (Hair et al., 2019).

The unit of analysis in this study is all observations of the production process during the observation period at the MSMEs that are the object of this research. The study used the full population, so no sampling was carried out. The initial research used 120 production batches as observation units. After screening data using the Z-score method with a limit of ±1.96, 30 extreme observations were removed, so that the total number of final data used in the analysis was 90 observations. The use of the full population aims to minimize sampling bias, while the screening process is carried out to ensure that the analyzed data is not dominated by extreme values.

The research variables consist of three main constructs. Supply performance acts as an independent variable that reflects the performance of suppliers in providing raw materials according to production needs. The stability of the production process is positioned as a mediating variable that explains the internal mechanisms of how supply performance affects the production process. Product quality consistency is a dependent variable that represents the final result of the production system in operation.

Supply performance is measured through three main indicators: supply quality, supply quantity, and delivery timeliness. The supply quality indicator is represented by the level of conformity of raw materials to production specifications as well as the defect level of raw materials. The supply quantity indicator is measured through the accuracy rate of the supply quantity and the supplier's order fulfillment ratio. The delivery timeliness indicator is represented by the percentage of on-time deliveries as well as the supplier's lead time variation. These indicators are in line with supply performance measurements that are widely used in the supply chain and food industry literature (Parwani & Raut, 2021; Burgess et al., 2023). The stability of the production process is measured through process variation and regularity. Process variation is represented by variations in production cycle time and actual time deviations from the process standard. Process regularity is measured through the level of idle time and the frequency of production flow disruptions, such as bottlenecks. This measurement approach is consistent with the operations and quality management literature that emphasizes the importance of controlling process variability (Costa et al., 2021; Renna, 2022).

Product quality consistency is measured through output uniformity, product defect rate, and compliance with quality specifications. The uniformity of output is represented by variations in product characteristics, such as weight or size. The level of product defects is measured through the defect rate and product yield. Compliance with quality specifications is represented by the percentage of products that pass final inspection. These parameters are commonly used in quality research in the food industry and MSMEs (Juran, 1998; McDermott & Antony, 2024; Yunita et al., 2023). The research data were obtained from actual operational sources including daily production records, quality control reports, and raw material delivery documents during the observation period. The use of actual operational data allows for objective measurement of variables and reduces the potential for perception bias. The following is the flow of the production process at JAPING:

Table 1. JAPING MSME Production Process Flow

Yes	Process Stages	Main Activities	Results/Actions	Research Measurement Points
1	Dough Reception	Acceptance of dough for the production process	–	*Supply Performance* (quantity & quality of supply)
2	Check the Quality of the Dough	Dough quality inspection	If it does not pass the dough is returned	Quality of supply
3	Steam	Dough steaming	–	Process stability (runtime)
4	Cool	Steam cooling	–	Variation of the process time
5	Insert the Freezer	Storage of dough in the freezer	–	Process flow stability
6	Iris	Dough cutting	–	Consistency of size
7	Fryer	Frying sliced dough	–	Process stability (temperature & time)
8	Oil Drying	Oil drizzling after frying	–	Process variations
9	Cooling	Cooling of the product after frying	–	Flow regularity
10	Seasoning	Mixing of products with spices	–	Process consistency
11	*Product Quality Check*	Quality inspection of seasoned products	If it doesn't pass it will be thrown away	Product quality consistency
12	Packing	Product packaging	–	Stability of the packaging process

Yes	Process Stages	Main Activities	Results/Actions	Research Measurement Points
13	*Quality Check Packing*	Packaging inspection	If it does not pass the dismantling	Consistency of packaging quality
14	Storage	Storage of finished products	–	Flow regularity
15	Distribution	Product distribution to outlets/resellers	–	Quality outcomes

Data analysis was carried out using inferential statistical techniques to test the relationships between variables. Model testing will be carried out using path analysis, so that it can test both direct and indirect influences. This approach is appropriate for research models that involve mediated relationships and has been widely used in operations and supply chain management research (Hair et al., 2019). The indicators and parameters used in this study are based on the following table:

Table 2. Research Indicators and Parameters

Variable	Indicator	Parameters	Scale	Source
Supply Performance (X)	Quality of supply	Percentage of raw materials according to specifications	Ratio (%)	Parwani & Raut (2021); Burgess et al. (2023)
		Percentage of raw materials defective	Ratio (%)	Burgess et al. (2023)
	Supply quantity	Difference in quantity ordered and received	Ratio (%)	Oluyisola & Rahmani (2022)
		Supplier order fulfillment percentage	Ratio (%)	Parwani & Raut (2021)
	Delivery timeliness	On-time delivery percentage	Ratio (%)	Chen (2023)
		Delivery lead time variations	Ratio	Chen (2023)
Production Process Stability (M)	Cycle time variations	Standard deviation / coefficient of cycle time variation	Ratio	Costa et al. (2021); Renna (2022)
	Idle time	Average idle time of production	Ratio	Chen (2023)
		Percentage of idle time to production time	Ratio (%)	Costa et al. (2021)
	Process flow regularity	The percentage of the process runs according to the SOP	Ratio (%)	Oluyisola & Rahmani (2022)
		Production bottleneck frequency	Ratio	Costa et al. (2021)
Product Quality Consistency (Y)	Output uniformity	Variations in product weight or size	Ratio	Juran (1998); Costa et al. (2021)
	Product defect level	Percentage of defective products	Ratio (%)	McDermott & Antony (2024)
		Percentage of products that pass quality inspection	Ratio (%)	Yunita et al. (2023)

In this study, the delivery delay was calculated based on the difference between the actual time of arrival of raw materials and the standard cut-off time of 08.00. If the raw materials arrive at 08.35, then the delay value is recorded at 35 minutes. On the other hand, if the raw materials arrive at 07.50, then the value is recorded at -10 minutes, which indicates a 10-minute faster delivery. The cycle time deviation is calculated based on the difference between the actual cycle time and the standard production cycle time of 420 minutes. A positive value indicates a process that takes longer than the standard, while a negative value indicates a faster process than the standard. The data analysis in this study was carried out using IBM SPSS Statistics software. SPSS was chosen because it is suitable for regression analysis and operational quantitative data-driven pathways and is commonly used in operations and supply chain management research (Hair et al., 2019). Data testing is carried out through several statistical stages. The classical assumption test is performed before the hypothesis test, which includes the normality test (Kolmogorov–Smirnov), the multicollinearity test (*Variance Inflation Factor* (VIF < 10), and the heteroscedasticity test (Glejser test). Testing for the direct influence between variables was carried out using linear regression analysis with a significance level of 5% ($\alpha = 0.05$).

Testing of the mediating role of the stability of the production process was carried out using *regression-based* path analysis with *a causal steps* approach. This study uses the approach of Baron and Kenny (1986) because the method is still relevant as a conceptual basis in mediation analysis, especially to identify direct relationships, indirect relationships, and the role of mediator variables through systematic regression stages. Although the *bootstrap* method and PROCESS Hayes have now evolved, Baron and Kenny's approach remains widely used in management, operational, and applied social science research because it provides an intuitive mediation testing flow. Therefore, in this study, Baron and Kenny's approach was strengthened by the Sobel test to test the significance of indirect influences. In addition, Zhao et al. (2010) explain that the direct relationship between independent and dependent variables does not have to be significant as long as the indirect influence is proven to be statistically significant.

The significance of indirect influences was tested using the Sobel test to ascertain whether the stability of the production process plays a significant mediator in the relationship between *supply performance* and product quality consistency. The model is declared feasible if the significant regression coefficient ($p < 0.05$) and the value of the determination coefficient (R^2) show sufficient clarity of the model. Hypothesis testing in this study was carried out using linear regression analysis and *path analysis* with a significance level of 5% ($\alpha = 0.05$). The decision to accept or reject a hypothesis is based on the significance value (*p-value*) and the direction of the regression coefficient resulting from statistical testing.

Operationally, the criteria for hypothesis testing are set as follows:

1. **The H1 hypothesis is accepted** if the regression coefficient between *supply performance* and the stability of the production process is positive and statistically significant (*p-value* < 0.05). On the other hand, H1 is rejected if the significance value is ≥ 0.05.
2. **The H2 hypothesis is accepted** if the regression coefficient between the stability of the production process and the consistency of product quality is positive and significant (*p-value* < 0.05). If the coefficient is not significant, then H2 is rejected.
3. **The H3 hypothesis is accepted** if *supply performance* has a direct positive and significant influence on product quality consistency (*p-value* < 0.05). If it is not significant, then H3 is rejected.
4. **The H4 hypothesis (mediation) is accepted** if the indirect influence of *supply performance* on product quality consistency through the stability of the production process is proven to be significant. The significance of indirect influence was tested using the Sobel

test. The stability variable of the production process is expressed as a mediator if the Sobel statistical value is significant (*p-value* < 0.05).

Furthermore, the type of mediation is determined based on the significance of direct *effect*. If the direct influence of *supply performance* on product quality consistency remains significant after the mediation variables are included in the model, then the stability of the production process is categorized as *partial mediation*. On the other hand, if the direct influence becomes insignificant, then the stability of the production process is categorized as *full mediation*.

RESULTS AND DISCUSSION

Table 3. Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
X	90	-0.80	1.44	0.0102	0.46865
M	90	-1.82	1.79	-0.1082	0.71288
Y	90	-0.92	1.08	-0.0306	0.45706
Valid N (listwise)					

This study initially used 120 observations. After the data screening process through outlier detection using the Z-score method with a limit of ±1.96, as many as 30 extreme observations were issued, so that the number of final data used in the analysis became 90 observations with no missing value. Based on Table 1, the Supply Performance (X) variable has a minimum value of -0.80, a maximum of 1.44, a mean of 0.0102, and a standard deviation of 0.46865, which shows a moderate relative variation between observations. The Process Stability (M) variable has a minimum value of -1.82, a maximum of 1.79, a mean of -0.1082, and a standard deviation of 0.71288, making it the variable with the highest dispersion rate. This indicates the heterogeneity of production process conditions between batches. Meanwhile, the Product Quality Consistency (Y) variable has a minimum value of -0.92, a maximum of 1.08, a mean of -0.0306, and a standard deviation of 0.45706, which shows that the variation in product quality is relatively lower than the process variable. In general, the mean values of the three variables that are close to zero reflect that the data has been in the form of standardization.

Table 4. Classic Assumption Test

Yes	Classic Assumptions	Prob
1	**Normality Test**	
	Kolmogorov-Smirnov	
	Supply Performance (X)	0,146
	Process Stability (M)	0,005
	Product Quality Consistency (Y)	0,200
	Shapiro-Wilk	
	Supply Performance (X)	0,018
	Process Stability (M)	0,006
	Product Quality Consistency (Y)	0,465
2	**Multicollinearity Test**	
	Tollerance	>0.10
	Variance Inflation Factor	<10

Yes	Classic Assumptions	Prob
3	**Heteroscedasticity Test**	
	Glejser	All Variables >0.05

Based on Table 4, the results of the normality test showed that the variable Product Quality Consistency (Y) was normally distributed with significance values in the Kolmogorov-Smirnov test of (0.200>0.05) and Shapiro-Wilk of (0.465>0.05). The Supply Performance (X) variable shows a normal distribution based on Kolmogorov-Smirnov (Sig. = 0.146 > 0.05), but abnormal based on Shapiro-Wilk (Sig. = 0.018 < 0.05). Meanwhile, the Process Stability (M) variable did not meet the normality assumption because the significance values on Kolmogorov-Smirnov were 0.005 and Shapiro-Wilk were 0.006, both smaller than 0.05. However, with a sample size of 90 observations, the data distribution is still tolerable based on the *central limit theorem* approach (Hair et al., 2019). In addition, in the context of research based on actual production data, abnormal data distribution is common due to variations in production processes (Costa et al., 2021). The normality results show that the process stability variable is not completely distributed normally. Therefore, the results of mediation testing need to be read taking into account the limitations of data distribution. Not normally some variables do not necessarily invalidate the analysis, but indicate the need to strengthen the method, for example through *bootstrapping* on indirect effects testing.

The results of the multicollinearity test showed that all independent variables had a Tolerance value of > 0.10 and a Variance Inflation Factor (VIF) of < 10, so it can be concluded that the regression model is free from the symptoms of multicollinearity. Furthermore, the results of the heteroscedasticity test using the Glejser method showed that all variables had a significance value greater than 0.05, so that the residual variance was homogeneous (*homoscedasticity*) and the model did not experience symptoms of heteroscedasticity.

Table 5. Mediation Regression Test Results

Hypothesis	Variable Relationships	Coefficients	t- statistk	Significance
H1	Supply Performance (X) → Process Stability (M)	-0.395	-2.519	0.014*
H2	Process Stability (M) → Product Quality Consistency (Y)	0.173	2.547	0.013*
H3	Supply Performance (X) → Product Quality Consistency (Y)	-0.069	-0.667	0.507

Model 1:

$$M = a + Bx + e$$

$$M = -0.104 - 0.395X$$

Based on Table 4, the estimated regression model shows that the value of the constant is -0.104, meaning that when the *Supply Performance* variable is considered constant or zero, the value of Process Stability is estimated at -0.104. The value of *the Supply Performance* regression coefficient of -0.395 indicates that every 1 unit increase *in Supply Performance* will decrease Process Stability by 0.395 units, assuming other variables are constant.

Model 2 :

$$Y = a + bX + bM + e$$

$$Y = - 0.11 – 0.069X + 0.173M$$

A constant value of -0.011 indicates that when the *variables Supply Performance* and Process Stability are zero, then the product quality consistency value is estimated to be -0.011. The *supply performance* coefficient of -0.069 indicates that every 1 unit increase in *supply performance* will reduce product quality consistency by 0.069 units. Meanwhile, the process stability coefficient of 0.173 indicates that every 1 unit increase in process stability will increase product quality consistency by 0.173 units.

Table 6. Goodness of Fit Test Results

Models	Relationships	R Square	Adj R Square	F Statistics	Prob.
Model 1	*Supply Performance* (X) → Process Stability (M)	0.067	0.057	6.348	0.014
Model 2	*Supply Performance* (X) → Process Stability (M) → Product Quality Consistency (Y)	0.088	0.067	4.188	0.018

Coefficient of Determination

Based on Table 5, Model 1 has an R-Square value of 0.067, which shows that supply performance is able to explain the 6.7% variation in process stability. Meanwhile, the Model 2 has an R Square value of 0.088, which means that supply performance and process stability are simultaneously able to explain 8.8% variation in product quality consistency. This value indicates that the model has low clear power, so most of the variation in process stability and consistency of product quality is affected by other factors outside of the research model. The low R^2 value in food MSMEs can be explained because process stability and consistency of product quality are not only determined by supply performance, but also by internal operational factors such as labor skills, compliance with SOPs, frying temperature, oil quality, seasoning standards, freezer capacity, humidity control, and the effectiveness of quality control inspections. Banerjee et al. (2021) explain that the consistency of the quality of manufactured products is influenced by various production attributes that interact with each other, making it difficult to explain by just a few independent variables. In addition, Ozili (2023) stated that a low R^2 value does not necessarily indicate a bad model, especially if the purpose of the study is to test the relationship between statistically significant explanatory variables and variables.

Thus, the low R^2 value in this study is not only a limitation of the model, but also shows that the production process of food MSMEs is complex. The next study is suggested to integrate additional variables such as labor skills, SOP compliance, frying temperature, oil quality, seasoning standards, freezer capacity, humidity control, and the effectiveness of quality control inspections so that the model can explain product quality variations more comprehensively.

Statistical F test

The F-statistical value of Model 1 of 6.348 with a probability of $0.014 < 0.05$ indicates that the regression model is significant, so that *the supply performance* variables together with the constant are able to explain the variation in process stability. In Model 2, the F-statistical value of 4.188 with a probability of $0.018 < 0.05$ shows that *the variables of supply performance* and process stability simultaneously have a significant effect on the consistency of product quality.

Statistical t-test

Based on Table 4, it can be found that the statistical t-value of each variable is:

a. H1: Supply Performance → Process Stability

The variable supply performance on process stability has a significance value of 0.014 < 0.05. Therefore, supply performance has a significant effect on process stability.

b. H2: Process Stability → Product Quality Consistency

The variable of process stability to product quality consistency has a significance value of 0.013 < 0.05. Therefore, process stability has a significant effect on the consistency of product quality.

c. H3: Supply Performance → Product Quality Consistency

The variable supply performance on product quality consistency has a significance value of 0.507 > 0.05. Therefore, supply performance does not have a significant effect on the consistency of product quality.

Sobel Test (H4)

The calculation of the Sobel test uses the regression coefficient of two equations, namely the regression equation of *supply performance* to process stability (X → M) and the regression equation of process stability to quality consistency (M → Y).

The coefficients used in the Sobel calculation are as follows:

- Path coefficient X → M (a) = -0.395
- Error standard X → M (Sa) = 0.157
- Path coefficient M → Y (b) = 0.173
- Standard error M → Y (Sb) = 0.068

The Sobel test formula used is as follows:

$$Z = \frac{axb}{\sqrt{(a^2 S_b^2) + (b^2 S_a^2)}}$$

The calculation of the Sobel test is carried out as follows:

a × b = (-0.395) × (0.173) = -0.068335

Denominators:

$$\sqrt{(a^2 S_b^2) + (b^2 S_a^2)}$$

$$\sqrt{(-0{,}395^2 \text{x } 0.068^2) + (0.173^2 x\ 0.157^2)}$$

= 0.02846

So that it is obtained:

Z = -0.068335/ 0.02846 = - 2.40

|Z| = 2.40

The results of the Sobel test show a statistical value of Z = -2.40 with an absolute value |Z| = 2.40. Because the value exceeded the critical limit of 1.96, the mediation effect was declared significant. This shows that process stability plays a role as an intervening variable in the relationship between *supply performance* and product quality consistency.

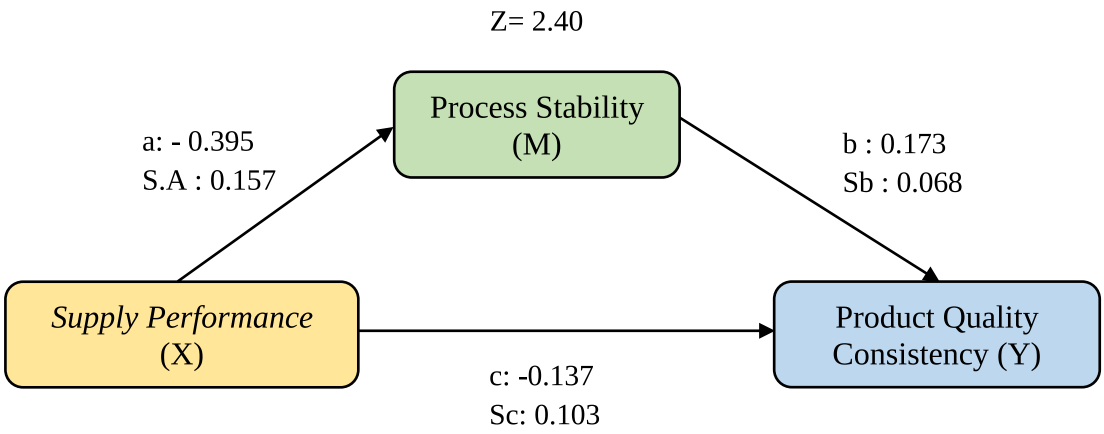

Figure 3. Supply Performance Mediation Test Results Chart on Product Quality Consistency through Process Stability

The Effect of *Supply Performance* on Process Stability (H1)

Based on the results of the regression test in Table 4, the *variable supply performance* on process stability has a calculated t-value of -2.519 and a probability of 0.014 < 0.05. These results show that *supply performance* has a negative and significant effect on process stability. Thus, H1 is not supported because the direction of the influence is negative, contrary to the hypothesis that supply *performance* has a positive effect on process stability.

Theoretically, good *supply performance* should smooth the flow of raw materials, reduce delays, and reduce production disruptions so that the process becomes more stable. However, in JAPING MSMEs that still involve a semi-manual production process, improving supply performance has not automatically increased process stability. When supplies arrive faster, more consistently, or in larger quantities, unprepared labor capacity, machinery, and workflow arrangements can create new pressures in the form of *bottlenecks*, process queues, *idle times*, and irregularities in production rhythms.

This result is in line with the view of Heizer et al. (2020) that improving input performance does not always result in better process output if the company's internal capacity is not balanced. In addition, Renna (2022) explained that process stability is greatly influenced by the synchronization between *material flow* and *production capacity*. If one component increases faster than the other, the process variation can actually increase. Thus, improving *supply performance* in JAPING MSMEs must be accompanied by improving internal process capabilities, such as production scheduling, workforce readiness, SOP standardization, and production flow control.

The results of this study also show that there are limitations of the model because process stability is not only influenced by *supply performance*, but also by other internal variables such as workflow, human resource skills, machine capacity, SOP discipline, and production supervision. Semi-manual processes such as slicing, frying, seasoning, packaging, and quality inspection make process stability sensitive to operator capabilities, work discipline, and SOP compliance. Therefore, supply improvements need to be followed by standardization of workflows and upskilling of the workforce.

Effect of Process Stability on Quality Consistency (H2)

Based on the results of the regression test in Table 4, it is known that the process stability variable on product quality consistency has a calculated t-value of 2.547 > table t of 1.987 and a probability value of 0.013 < 0.05, then H0 is rejected and H2 is accepted. This means that the process stability variable has a positive and significant effect on the consistency of product quality.

These results show that the more stable the production process carried out by JAPA MSMEs, the more consistent the quality of the products produced. Process stability reflects regular operating conditions, minimal disruption, uniform workflow, and controlled production parameters. In the food industry, process stability is very important because small variations in production stages can cause changes in taste, texture, size, hygiene, and durability of the product. Therefore, a process that runs consistently will produce output with a more uniform quality over time.

This research is in line with the concept *of Statistical Process Control* (SPC) which states that the best product quality is achieved when process variations are within the control limits and process deviations can be minimized. Montgomery (2019) explained that the quality of the output is a direct reflection of the quality of the process, so that increasing process stability will have an impact on improving product consistency. In addition, Banerjee et al. (2021) stated that the consistency of the quality of manufactured products is greatly influenced by the company's ability to maintain the stability of production process parameters in a sustainable manner. Thus, the results of this study indicate that in JAPA MSMEs, improving product quality does not only depend on raw materials or supply, but is highly determined by the ability to keep the production process stable. Therefore, business actors need to strengthen SOPs standardization, production time control, consistency of material dosage, workforce training, and process monitoring so that product quality remains uniform and in accordance with consumer expectations.

The Effect of *Supply Performance* on Quality Consistency (H3)

Based on the results of the regression test in Table 4, it is known that the *supply performance variable* on product quality consistency has a calculated t-value of -0.667 < table t of 1.987 and a probability value of 0.507 > 0.05, then H0 is accepted and H3 is rejected. This means that the supply performance variable does not have a significant effect on the consistency of product quality. Changes in *supply performance* have not been directly proven to be able to improve or decrease the consistency of product quality in JAPA MSMEs. The significance of direct *effect* is not a mandatory requirement for mediation, because independent variables can affect dependent variables completely through indirect channels through mediators (Preacher & Hayes, 2008). In other words, an X-to-Y relationship can become insignificant once the mediator is incorporated into the model, because the main influence has been channeled through the mediation variable. In addition, Zhao, et al (2010) refer to this condition as *indirect-only mediation*, i.e. when the direct path X to Y is insignificant, but the indirect path through the mediator is significant. This condition is in accordance with the results of this study, where supply performance does not have a direct effect on product quality consistency, but through the Sobel test it is proven to have a significant effect through process stability.

This study shows that the quality of products in JAPING MSMEs is not automatically determined by the smooth supply. Even if raw materials are available on time, sufficient quantities, or suppliers are responsive, the quality of the final product remains highly dependent on how the raw materials are processed in the production process. In MSME-scale food businesses, quality variations often appear at internal stages such as mixing ingredients, production doses, processing time, cooking temperatures, labor skills, and packaging, rather than in the supply aspect alone. The insignificance of this direct effect can be explained because the relationship between *supply performance* and consistency of product quality is indirect through the process stability variable as a mediator. This shows that in the production of food MSMEs, raw materials that arrive on time, in appropriate quantities, or good supply quality do not automatically produce consistent products if the internal process has not run stable.

This study is in line with Bakhtiar et al. (2023) who found that several quality management variables do not have a direct effect on operational performance, but become significant through quality culture as a mediating variable. Onofrei and Fynes (2019) also found that *lean practices* do not have a direct effect on *production swiftness*, but this influence becomes significant through *quality practices* as a mediating variable. Thus, for JAPA MSMEs, the focus on improvement is not enough only on suppliers and raw materials, but also needs to be directed at strengthening the internal production system, such as standardizing work processes, controlling production variations, improving labor skills, and operational discipline.

The effect of *supply performance* on product quality consistency through the stability of the production process (H4)

Based on the results of the Sobel test in Table 4, it is known that the effect *of supply performance* on product quality consistency through process stability produces a calculated Z value of 2.40. At a significance level of 5%, the Z value of the table is 1.96. Since the value of the Z calculation = 2.40 > the Z table = 1.96, then H0 is rejected and H4 is accepted. This means that the process stability variable has been proven to significantly mediate the influence of *supply performance* on product quality consistency. Thus, the effect of *supply performance* on product quality does not occur directly, but through increasing the stability of the production process first.

These results show that supply *performance* improvements such as supply timeliness, raw material availability, supplier reliability, and smooth delivery do not necessarily directly improve product quality consistency. However, when the supply performance is able to create a more orderly production process, minimal disruption, and run according to operational standards, the impact will be seen on more uniform and consistent product quality.

This research is in line with the concept *of mediation mechanism* proposed by Baron & Kenny (1986), that an independent variable can influence a dependent variable through an intermediate variable that explains the mechanism of the relationship. In this study, process stability plays a role as a transformation mechanism from the quality of supply inputs to the quality of product output. In addition, Preacher & Hayes (2008) explained that mediation testing is used to prove the existence of indirect effects between independent and dependent variables through mediators. The results of the significant Sobel test show that the indirect pathway in this study actually occurs statistically.

A good supply system will only produce quality excellence if it is supported by stable internal processes. In other words, timely and quality raw materials do not automatically produce consistent products if the production process still experiences frequent delays, dosage variations, operator errors, or workflow irregularities. For JAPA MSMEs, the results of this study imply that the strategy to improve product quality should be focused on the integration between supply management and production process control. *Supply performance* must be directed to strengthen production rhythms, maintain operational continuity, and reduce process variations in order to produce consistent product quality and meet consumer expectations in a sustainable manner. The relationship between operational input factors and output quality is not always straightforward. In a production system, product quality is the result of an internal process mechanism that converts inputs into outputs. Therefore, the mediation process needs to be taken into account to explain how *supply performance* can be translated into product quality consistency. Process stability in JAPING MSMEs is an important mechanism that bridges supply performance and final product quality. Although the results of the Sobel test show a significant mediating effect, these results need to be interpreted with caution because the Sobel test assumes a normal distribution of indirect effects. Given that the mediating variables in this study are not fully distributed normally, further research is recommended to use a *bootstrapping* approach, such as the PROCESS Hayes Model 4, to obtain *a more robust* estimate of indirect effect *and* confidence interval.

Implications of Research Results

The results of this study show that improving product quality in MSMEs is not enough only through improving *supply chains* and process stability, but also requires strengthening the quality control system and standardizing the production process.

CONCLUSION

Based on the results of the data analysis and discussions that have been carried out, it can be concluded that several things are as follows: 1) *Supply performance* has a significant effect on the stability of the production process. The results of the study show that *supply performance* has a significant influence on the stability of the production process. This shows that supply performance, which includes the quality, quantity, and timeliness of raw material delivery, is an important factor in determining the level of stability of the production process. However, the negative direction of the relationship indicates that the improvement *in supply performance* has not been fully offset by the readiness of the internal production system. 2) The stability of the production process has a significant effect on the consistency of product quality. The results of the study show that the stability of the production process has been proven to have a positive and significant influence on the consistency of product quality. This shows that the more stable the production process is carried out, the more consistent the quality of the products produced. 3) *Supply performance* has no significant effect on product quality consistency. The results of the study show that *supply performance* does not have a direct influence on the consistency of product quality. This shows that the quality of raw materials does not automatically determine the quality of the final product, especially in the context of MSMEs with a semi-manual production system. 4) The stability of the production process mediates the relationship between *supply performance* and product quality consistency. The results of the mediation test showed that the stability of the production process played a role as a mediating variable in the relationship between *supply performance* and product quality consistency. This indicates that the influence of *supply performance* on product quality occurs through increasing the stability of the production process first.

Overall, this study shows that the consistency of product quality in JAPING MSMEs is not only influenced by supply factors, but is highly determined by the company's ability to maintain the stability of the production process. Thus, improving product quality needs to be focused on the integration between supply management and internal process control on an ongoing basis.

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