IJMR E-ISSN: 3109-9777
INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEACH

THE EFFECT OF PROCESS INNOVATION ON OPERATIONAL EFFICIENCY OF MSMES: SUPPLY CHAIN INTEGRATION AS A MODERATING VARIABLE

Agus Purnomo[1], Khairudin[2], Yanu Yanuarius Darmawan[3], Celia Fitriani[4], Zelfia Irfina[5], Adi Priyatna[6]
[1,2,3,4,5,6] Universitas Bandar Lampung, Indonesia
Email: agus.purnomo@ubl.ac.id

E-ISSN : 3109-9777		
Received: Februari 2026	Accepted: Februari 2026	Published: Februari 2026

Abstract : *Improving operational efficiency is a major challenge for Micro, Small, and Medium Enterprises (MSMEs) amidst business competition and limited resources. Process innovation is often viewed as an internal mechanism capable of increasing efficiency, but previous empirical findings show inconsistent results. This study aims to analyze the effect of process innovation on MSME operational efficiency and examine the role of supply chain integration as a moderating variable. This study uses a quantitative approach with an explanatory research design. Data were collected through a survey of 80 MSMEs in Bandar Lampung City and analyzed using Structural Equation Modeling based on Partial Least Squares (SEM-PLS). The results show that process innovation has a positive and significant effect on operational efficiency. Supply chain integration also has a significant positive effect on operational efficiency. Furthermore, the results of the moderation analysis confirm that supply chain integration significantly weakens the relationship between process innovation and operational efficiency. These findings indicate that the effectiveness of process innovation in improving MSME operational efficiency is highly dependent on the level of supply chain integration. This study makes an empirical contribution to the operations management and supply chain management literature by emphasizing the importance of synergy between internal capabilities and external integration in improving the operational performance of MSMEs in the context of developing countries.*

Keywords: *Process innovation; operational efficiency; supply chain integration; MSMEs; SEM-PLS*

INTRODUCTION

MSMEs are one of the main pillars of the Indonesian economy, including in Bandar Lampung City, which contributes significantly to job creation and local economic stability (Putri Salsabila Indrawan Lubis & Rofila Salsabila, 2024); (Aftitah et al., 2025). However, in recent years, the dynamics of an increasingly competitive business environment, market uncertainty, and pressure to increase productivity have encouraged MSMEs to adapt by strengthening operational capabilities (Hendayana, 2025). Amidst these conditions, process innovation has become an increasingly crucial internal strategy for increasing operational efficiency through improved workflows, reduced waste, and optimized resource utilization. Although recognized as a source of operational excellence, the adoption of process innovation is often insufficient to ensure consistent efficiency improvements, especially in MSMEs facing managerial and structural constraints. In this context, supply chain integration plays a strategic role as an external mechanism that can strengthen the effectiveness of process innovation through better coordination with suppliers, distributors, and other business

partners. Given the variation in innovation capabilities and levels of supply chain integration among MSMEs in Bandar Lampung, a more in-depth study is essential to understand how these two factors interact to influence operational efficiency (Hani'aturrofidha et al., 2025); (Yulianto Pudji Winarno, Koesharijadi, 2021).

Although process innovation is theoretically considered capable of strengthening operational efficiency, empirical findings in various studies of MSMEs show inconsistent results. Many MSMEs have adopted process improvements, such as standardization of procedures, simple digitization, or reduction of non-value-added activities, but the resulting improvements in operational efficiency are often insignificant or unsustainable. This inconsistency indicates that process innovation does not always have a direct impact on efficiency without supporting mechanisms that enable optimal utilization of these innovations. One mechanism suspected of influencing the success rate of process innovation is supply chain integration, which reflects the extent to which MSMEs are able to establish information flow, coordination, and collaboration with suppliers and distribution partners (Shamsudin et al., 2025). However, research specifically examining the role of supply chain integration as a moderating variable in the relationship between process innovation and operational efficiency is still limited, particularly in the context of MSMEs in developing regions like Bandar Lampung. This lack of clarity regarding how and to what extent supply chain integration can strengthen the effects of process innovation is the main issue and the basis for the need for this research.

In line with these issues, this study aims to empirically test the effect of process innovation on operational efficiency in MSMEs in Bandar Lampung City. This study also intends to analyze the role of supply chain integration as a moderating variable that has the potential to strengthen or weaken the relationship between process innovation and operational efficiency. By combining the perspectives of operations management and supply chain management, this study seeks to provide a more comprehensive understanding of the conditions that enable process innovation to produce optimal operational impacts. In addition, this study is expected to produce empirical findings relevant to MSMEs in formulating efficiency improvement strategies, while also contributing to the development of literature related to the mechanisms that influence the effectiveness of process innovation in the context of small and medium-sized organizations in developing countries.

Although the literature on process innovation and operational performance has grown significantly, several research gaps remain that hinder a comprehensive understanding of the mechanisms linking the two, particularly in the context of MSMEs. Most previous studies tend to focus on product innovation, while process innovation as a determinant of operational efficiency has been relatively underexplored, particularly in small-scale firms in developing countries. Furthermore, research highlighting the role of supply chain integration has predominantly been conducted in large manufacturing firms, making the findings not always generalizable to MSMEs with different structural,

operational, and resource characteristics. Furthermore, there is still a paucity of research examining supply chain integration as a moderating variable that could potentially clarify inconsistencies in empirical findings regarding the effect of process innovation on operational efficiency (Andika Yuwono et al., 2024). This literature gap indicates an urgent need to investigate how internal innovation and external integration interact in shaping the operational efficiency of MSMEs, particularly in a regional context such as Bandar Lampung which has not received much attention in international research.

This study offers a novel contribution by positioning supply chain integration as a moderating variable in the relationship between process innovation and operational efficiency, an approach that is still rarely used in the context of MSMEs, especially in developing countries. By combining an internal perspective through process innovation and an external perspective through supply chain integration, this study provides a more comprehensive conceptual foundation in explaining the conditions that enable innovation to produce optimal operational benefits. In addition to providing theoretical contributions to the development of SEM-based operations management models, this study also offers significant practical contributions for MSMEs in Bandar Lampung, which often face resource constraints and low levels of coordination in the supply chain. The findings of this study are expected to provide empirical justification for business actors and policymakers to encourage internal process improvements that align with increased external integration, so that operational efficiency can be achieved more consistently and sustainably. The novelty of the approach, the relevance of the context, and the potential practical implications make this study important for enriching the literature on operations management and supply chains in the MSME sector.

RESEARCH METHOD

This study uses a quantitative research design with an explanatory research approach that aims to test the causal relationship between process innovation, operational efficiency, and supply chain integration as moderating variables. The research model was analyzed using Structural Equation Modeling (SEM) based on Partial Least Squares (PLS), which was chosen because it is suitable for testing models with latent constructs, a relatively moderate sample size, and data distribution that does not have to be normal (Zulaeha & Priyono, 2017).

The study population consisted of all MSMEs operating in Bandar Lampung City and registered with the supervising agency such as the Cooperatives and MSMEs Office. A purposive sampling technique was used to select respondents who met the following criteria: (1) MSMEs have been operating for at least two years, (2) have a documented production or service process, and (3) are involved in supply chain interactions with suppliers or distributors. The unit of analysis is the MSME owner or manager who understands operational processes and innovation decisions. The minimum sample size was determined based on the SEM-PLS rule of thumb, which is 10

times the number of indicators for the variable with the most indicators; thus, a minimum sample size of 80 respondents is required to produce a stable model estimate (Fikriyah & Nuraeni, 2025).

The data collection instrument used a questionnaire compiled based on theoretical indicators that have been adapted to the characteristics of micro-retail businesses. The measurement scale used was a seven-point Likert scale (1 = strongly disagree to 5 = strongly agree) to minimize perceptual ambiguity and provide a wider range of answers. The validity and reliability of the instrument were analyzed through an evaluation of the measurement model (outer model), which included convergent validity, discriminant validity, and composite reliability tests. Convergent validity was conducted by assessing the factor loading and Average Variance Extracted (AVE) values for each construct, while discriminant validity was evaluated based on the Fornell-Larcker criteria and the HTMT ratio (Anggreni, 2016).

The data analysis process consisted of three main stages. The first stage was descriptive analysis to provide an overview of the respondent profile and the variables studied. The second stage included a measurement model assessment (MAM) to ensure that each construct had adequate reliability and validity. The third stage was a structural model assessment (SAM), which aimed to examine the causal relationships between latent variables in the conceptual model. Furthermore, a moderation analysis was conducted to determine whether supply chain capabilities strengthen the influence of integration on operational performance. This moderation test employed a two-way interaction approach (Dela Fahiran Pandiangan & Meyniar Albina, 2025).

This approach is not only methodologically sound, but also suits the complexity of the variables studied in the context of retail SMEs in developing countries, where market dynamics, resource constraints, and dependence on suppliers are often important determining factors (Barus et al., 2025). Thus, the design of this research method is expected to be able to produce valid, reliable, and relevant findings from both practical and theoretical perspectives in explaining the relationship between integration, capability, and operational performance in local retail businesses.

FINDINGS AND DISCUSSION

The 80 respondents to this study came from diverse backgrounds, both in terms of demographics and business characteristics. The majority of respondents were female (56%) and were in the productive age group of 25–44 years (72%), reflecting the dynamics of MSMEs in Bandar Lampung. In terms of education, 46% had a high school education, while 31% had a bachelor's degree, indicating variations in managerial capacity that can influence innovation capabilities. The length of operation of most businesses, with most having been in operation for more than five years (60%), indicates that respondents have sufficient operational experience to assess innovation processes. Meanwhile, 54% of MSMEs only have 1–4 employees, confirming that most are in the micro-enterprise category, which is highly sensitive to process changes and supply chain integration.

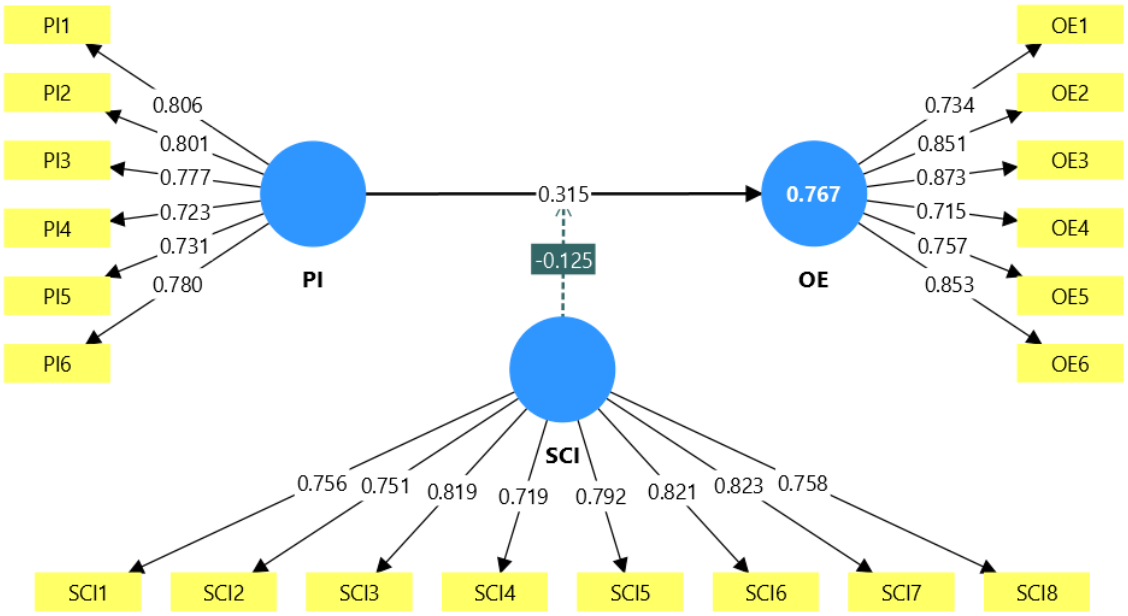

Figure 1. Measurement Model

The measurement model assessment is shown in Figure 1. This is done to ensure that the research constructs have an adequate level of validity and reliability before testing the structural model. The evaluation results show that all indicators in the process innovation, supply chain integration, and operational efficiency variables have a loading factor value of > 0.70, which indicates that each indicator is able to reflect the latent construct strongly and consistently with the results: Construct 1: Process Innovation is measured by: PI1 (0.806), PI2 (0.801), PI3 (0.777), PI4 (0.723), PI5 (0.731) and PI6 (0.780); Construct 2: Supply Chain Integration is measured by: SCI1 (0.756), SCI2 (0.751), SCI 3 (0.819), SCI4 (0.719), SCI5 (0.792), SCI6 (0.821), SCI7 (0.823) and SCI8 (0.758); Operational Efficiency is measured by: OE1 (0.734), OE2 (0.851), OE3 (0.873), OE4 (0.715), OE5 (0.757) and OE6 (0.853).

The Average Variance Extracted (AVE) values for each construct are PI (0.594), SCI (0.610), and OE (0.639), which are higher than the minimum limit of 0.50, thus meeting the convergent validity criteria. In addition, the construct reliability is strengthened by the Composite Reliability (CR) values of PI (0.862), SCI (0.915), and OE (0.891), as well as Cronbach's Alpha values of PI (0.863), SCI (0.909), and OE (0.885). Both reliability indicators are above 0.70, indicating excellent internal consistency of the instrument. Overall, the results of the measurement model assessment confirm that this research instrument is valid and reliable, so it can proceed to the structural model testing stage.

Discriminant validity was evaluated to ensure that each construct in the model has clear conceptual distinctions and does not measure the same concept excessively. Testing was conducted using the Heterotrait-Monotrait Ratio of Correlations (HTMT) approach recommended in modern PLS-SEM literature.

The analysis results showed that all HTMT values were well below the threshold of 0.85, which is a common acceptance criterion for ensuring separation between constructs. These low HTMT values indicate that the correlations between indicators of different constructs remain at acceptable levels, thus avoiding issues of conceptual multicollinearity. Thus, the measurement model meets the criteria of discriminant validity, ensuring that process innovation, supply chain integration, and operational efficiency truly represent distinct concepts and do not overlap empirically. Fulfillment of discriminant validity provides methodological confidence that the structural analysis conducted in the next stage has a strong measurement foundation and can be interpreted validly.

Structural model assessment was conducted to evaluate the strength and significance of the relationships between variables in the research model. The analysis results showed that the structural model has good predictive quality, indicated by an R^2 value of 0.767 for the operational efficiency construct, indicating that process innovation, supply chain integration, and interaction variables are able to explain 76.7% of the variance in operational efficiency. In addition, a Q^2 value of 0.35 confirms that the model has strong predictive relevance. All VIF values are below 2, indicating there is no indication of multicollinearity between constructs in the structural model. Hypothesis testing was conducted through path coefficient analysis using the bootstrapping method. The results showed that process innovation has a positive and significant effect on operational efficiency ($\beta = 0.315$; $t = 3.446$; $p < 0.001$), thus supporting the first hypothesis (H1). Supply chain integration also showed a positive and significant effect on operational efficiency ($\beta = 0.567$; $t = 6.396$; $p < 0.001$), supporting the second hypothesis (H2). Furthermore, the moderating effect of supply chain integration on the relationship between process innovation and operational efficiency was proven to be significant and negative ($\beta = -0.125$; $t = 2.284$; $p = 0.022$), so that the third hypothesis (H3) was accepted. This finding indicates that supply chain integration weakens the effect of process innovation on operational efficiency, so that MSMEs with a higher level of supply chain integration tend to obtain lower benefits from process innovation compared to MSMEs with a high level of integration.

The results of the study show a positive and significant correlation between process innovation and operational efficiency, indicating that the higher the level of process innovation undertaken by MSMEs, the better the operational performance they can achieve. This strong correlation reflects the role of process innovation as an internal mechanism capable of increasing productivity, reducing waste, and simplifying workflows. This finding aligns with the literature stating that process innovation is a fundamental element in creating responsive and efficient organizations (Syaputra et al., 2024). n the context of MSMEs which generally operate with limited resources, this correlation suggests that process innovation is an effective strategy, especially when directed at core activities that have a direct impact on productivity and output quality.

The positive correlation between supply chain integration and operational efficiency was also found to be significant, indicating that MSMEs' operational

effectiveness is influenced not only by internal capabilities but also by the strength of external relationships within the supply network. When MSMEs have better integration with suppliers and distributors through transparent information exchange, collaborative planning, and high responsiveness, supply stability, production accuracy, and speed of demand fulfillment can improve substantially. This finding supports previous research (Hani'aturrofidha et al., 2025) which emphasizes that supply chain integration is a critical catalyst for improving operational efficiency and flexibility. For MSMEs, this correlation is particularly relevant because dependence on suppliers is often high, making strengthening supply chain integration a potential source of sustainable competitive advantage.

Furthermore, the research findings indicate a moderating correlation between process innovation and supply chain integration in influencing operational efficiency. This correlation indicates that process innovation will have a smaller impact on operational efficiency when implemented in conjunction with strong supply chain integration. In other words, these two variables are non-complementary, not substitutive, so the effectiveness of process innovation depends on the extent to which MSMEs are able to establish efficient operational collaboration with external partners. This interactive correlation weakens the contingency theory in operations management, which states that the success of internal strategies is determined by their fit with external conditions. In the context of MSMEs, this moderating relationship has important implications: process innovation undertaken in isolation is insufficient to generate maximum efficiency without the support of adequate supply chain integration, such as demand synchronization, raw material procurement coordination, and clear logistics information.

The combination of these three correlations suggests that MSME operational efficiency results from the synergy between internal capabilities and external relationships. Process innovation provides the initial impetus for efficiency gains, but supply chain integration broadens the impact of these innovations through improved coordination. Therefore, the correlations between these variables provide a comprehensive picture that MSME efficiency depends not only on the quality of internal processes but also on the strength of external networks that support the flow of goods, information, and operational decisions.

CONCLUSION

This study confirms that process innovation is a key determinant that significantly improves the operational efficiency of MSMEs in Bandar Lampung. Process innovation enables MSMEs to improve workflows, increase productivity, and minimize non-value-added activities, resulting in faster, more precise, and more stable operational processes. The results also show that supply chain integration has a direct impact on operational efficiency, indicating that strengthening coordinative relationships with suppliers and distributors is a crucial factor in creating operational excellence. Furthermore, the moderating effect of supply chain integration on the relationship between process innovation

and operational efficiency proved significant. This emphasizes that process innovation by MSMEs will yield smaller benefits when supported by robust supply chain integration systems, such as transparent information exchange, joint planning, and effective logistics coordination.

Overall, this study strengthens the literature on operations management, dynamic capabilities, and supply chain management by demonstrating that MSME operational performance results from the synergy between innovation-based internal capabilities and external capabilities reflecting the quality of supply chain integration. The resulting model has strong explanatory power and provides new insights into the contingency mechanisms linking process innovation to operational efficiency in the context of emerging markets.

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