

Inventory Management Literacy, Information Technology Adoption and MSME Operational Efficiency: The Role of Inventory Control Mediation

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ABSTRACT

This study aims to examine the effect of inventory management literacy (LMP) and information technology adoption (ATI) on the operational efficiency (EO) of SMEs, with inventory control (PP) as a mediating variable. A quantitative approach with an explanatory survey design was employed, involving 120 SME owners/managers selected through purposive sampling and analyzed using PLS-SEM with SmartPLS 4.0. The results show that LMP and ATI each have a significant positive direct effect on both PP and EO, with ATI being the strongest predictor of PP. PP also has a significant positive effect on EO and partially mediates both the ATI-EO and LMP-EO relationships. The model demonstrates substantial predictive power in explaining variance in EO. These findings confirm that improving inventory management literacy and IT adoption are important strategies for SMEs to enhance operational efficiency, both directly and through strengthening their inventory control systems.

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) play a strategic role in the economies of developing countries, including Indonesia, due to their large contribution to the Gross Domestic Product (GDP) and the absorption of the national labor force (Kementrian Koperasi dan UKM, 2019). The MSME sector is the largest group in the national economic structure that involves the distribution of goods and services with a very high transaction intensity (BPS, 2023). The high intensity of these transactions poses complex operational challenges, especially in supply chain management and merchandise inventory control (Heizer et al., 2020). Failure to effectively control inventory can cause two equally detrimental conditions, namely stockout that results in loss of sales, and overstock that binds working capital unproductively (Kaya et al., 2024). The inability to manage inventory has a direct impact on increasing operational costs, declining customer satisfaction, and reduced business competitiveness in an increasingly competitive market (Grando et al., 2026). Various studies confirm that weak inventory control systems are one of the main causes of MSME failure,

where around 60% of MSMEs experience liquidity problems that are rooted in suboptimal stock management (Tadayonrad & Ndiaye, 2023). Therefore, effective inventory control is the most critical operational issue that must be solved so that MSMEs can grow sustainably (Yeboah & Zogli, 2025).

One of the fundamental factors that determine the quality of inventory control is the level of inventory management literacy possessed by business actors, namely the ability to understand and apply stock management principles systematically in daily business operations (Phan et al., 2019). This literacy includes mastering concepts such as Economic Order Quantity (EOQ), safety stock, reorder points, and inventory turnover analysis which are the basis for rational procurement decision-making (Jabbarzadeh et al., 2019). Research Haq et al (2026) found that the majority of MSME actors in Indonesia still rely solely on intuition and empirical experience in managing stocks, without being supported by an adequate conceptual understanding of inventory management. This condition causes reactive and unplanned procurement decisions, so business actors tend to overbuy when demand increases or vice versa to order late when stock is close to running out (Du et al., 2024). Studies Vikaliana et al (2021) revealed that MSMEs with managers who have better inventory management competencies are able to reduce storage costs by up to 30% compared to MSMEs who do not have this understanding. Thus, increasing inventory management literacy is an urgent need for MSME actors to be able to manage the supply chain more effectively and competitively (Yu et al., 2022).

In addition to literacy, the adoption of information technology is an increasingly crucial accelerator factor in supporting the effectiveness of inventory control in the era of digital transformation (Jamwal et al., 2021). The use of inventory management information systems, point-of-sale (POS) applications, and digital platforms allows businesses to monitor stock movements in real-time, automate transaction recording, and generate accurate inventory reports based on data (Dwivedi et al., 2021). Study Aditya et al (2025) showed that MSMEs that adopted a digital-based inventory information system experienced an increase in stock accuracy of up to 45% compared to those that still relied on manual recording. However, the level of information technology adoption among Indonesian MSMEs is still very low, with more than 70% of business actors not utilizing technology optimally due to limited knowledge, infrastructure, and financial resources (APJII, 2023).

Various previous studies have examined the factors that affect the inventory control and operational efficiency of MSMEs partially. Yeboah & Zogli (2025) found that human resource capabilities have a positive effect on the operational performance of MSMEs, but did not measure inventory management literacy as a separate construct. Jamwal et al (2021) confirming that the adoption of technology improves operational efficiency, but the study is limited to manufacturing companies in developed countries. Study Grando et al (2026) integrating lean supply chain with operational efficiency, but does not include the literacy dimension of business actors in the context of MSMEs in developing countries. From the

study, a significant research gap was identified, namely the absence of a study that comprehensively integrates inventory management literacy and information technology adoption in a single model that tests the role of inventory control as a mediating variable for the operational efficiency of MSMEs in Indonesia (Yu et al., 2022).

Based on the research gap, this study presents an integrated conceptual model that links inventory management literacy and information technology adoption to inventory control as a mediating variable and operational efficiency as a dependent variable in MSMEs (Du et al., 2024). Specifically, this study aims to: (1) test the influence of inventory management literacy on inventory control; (2) testing the influence of information technology adoption on inventory control; (3) test the direct influence of the two variables on operational efficiency; (4) testing the effect of inventory control on operational efficiency; and (5) examining the mediating role of inventory control in the model. Theoretically, this research contributes to the development of the literature on supply chain management and MSME operational management. Practically, these findings are expected to be a reference for MSME actors and policy makers in designing strategies to improve inventory management competency and adoption.

RESEARCH METHODS

This study uses a quantitative approach with a cross-sectional explanatory survey design, aiming to explain and test the causal relationship between variables in a measurable and generalizable manner (Creswell et al., 2009; Hair et al., 2022). The positivism paradigm is the philosophical foundation that views social reality as something that can be objectively measured through valid and reliable instruments. The analysis unit is the owner or active manager of MSMEs who are directly involved in operational decision-making, including procurement and inventory management (Phan et al., 2019).

The population is all active MSME actors who meet the criteria of Law No. 20 of 2008, namely assets of a maximum of Rp10 billion or a maximum annual turnover of Rp50 billion. The inclusion criteria include: (1) active owners/managers of MSMEs, (2) businesses operating for at least one year, and (3) willing to fill out a complete questionnaire, while MSMEs are inactive or in the process of liquidation are exclusion criteria (Sekaran & Bougie, 2016). The sampling technique uses purposive sampling with a sample number of 120 respondents, in line with the recommendations Hair et al (2022) for optimal estimation stability in medium complexity models.

This study involved four latent variables measured using reflective indicators with a Likert scale of 5 points (1 = Strongly Disagree to 5 = Strongly Agree), as presented in Table 1.

Table 1. Operationalization of research variables

Variabel	Indicator Code	Indicator Description
Inventory Management Literacy (Phan et al., 2019)	imp1	Understanding of basic concepts of inventory management
	imp2	Stock requirements planning capabilities
	imp3	Knowledge of inventory management techniques
Adoption of Information Technology (Jamwal et al., 2021)	ati1	Use of information systems for stock recording
	ati2	Utilization of technology in transaction processing
	ati3	Integration of technology in operational management
	ati4	Ease of access to data through technology
Availability of Working Capital (Chen, 2023)	KMK1	Sufficient capital for procurement of supplies
	KMK2	Smooth operating cash flow
	KMK3	Ability to meet short-term capital needs
	KMK4	Availability of reserve funds for urgent needs
Inventory Handling (Heizer et al., 2020; Kaya et al., 2024)	pp1	Accuracy of stock recording
	pp2	Rebooking accuracy
	pp3	Consistency of stock intake
	pp4	Ability to minimize <i>stockout</i> and <i>overstock</i>
Operational Efficiency (Grando et al., 2026)	eo1	Operational cost efficiency
	eo2	Speed of customer service
	eo3	Minimizing resource wastage
	eo4	Overall operational productivity

The instrument is a questionnaire structured in two parts: the first part includes the demographic characteristics of the respondents, and the second part contains 16 statements to measure the four variables. The instrument has gone through content validation by three operational/supply chain management experts and two MSME practitioners, as well as a pilot

study to 30 respondents outside the main sample (Hair et al., 2022). Data collection was carried out in parallel, offline and online through Google Form for approximately four weeks until 120 valid questionnaires were fulfilled (Hair et al., 2022).

Data analysis using PLS-SEM with SmartPLS version 4.0 (Ringle et al., 2020). The analysis was carried out in two stages. In the first stage, the evaluation of the outer model includes: (a) convergent validity with outer loading > 0.70 and AVE > 0.50 ; (b) discriminant validity with HTMT < 0.90 ; and (c) construct reliability with CR and Cronbach's Alpha > 0.70 . The second stage, internal evaluation of the model through bootstrapping 5,000 iterations to test seven hypotheses ($t > 1.96$; $p\text{-value} < 0.05$), equipped with R^2 and R^2 adjusted assessments to measure the predictive power of the model (Hair et al., 2022). The mediated effect of inventory control was tested through indirect effects with a bootstrapping procedure.

RESULTS AND DISCUSSION

Uji Measurement Model (Outer Model)

Convergent Validity Test

Convergent validity is assessed based on the value of outer loading and Average Variance Extracted (AVE). The indicator is declared valid if the outer loading ≥ 0.70 and AVE ≥ 0.50 (Hair et al., 2019). The test results are presented in Table 2.

Table 2. Outer Loadings Test Results

Indicator	Outer Loading	Remarks
ati1	0,930	Valid
ati2	0,831	Valid
ati3	0,898	Valid
ati4	0,872	Valid
eo1	0,736	Valid
eo2	0,928	Valid
eo3	0,882	Valid
eo4	0,872	Valid
eo5	0,832	Valid
lmp1	0,863	Valid
lmp2	0,742	Valid
lmp3	0,853	Valid
pp1	0,974	Valid
pp2	0,972	Valid
pp3	0,950	Valid
pp4	0,903	Valid

Based on Table 2, all indicators show an outer loading value above 0.70 with a value range between 0.736 to 0.974. This indicates that all indicators have qualified for convergent validity and are suitable for use in further testing.

Reliability and AVE Tests

Construct reliability was measured using Cronbach's Alpha, Composite Reliability (rho_a and rho_c), and AVE. Constructs were declared reliable when Cronbach's Alpha and CR were ≥ 0.70 and AVE ≥ 0.50 (Fornell & Larcker, 1981). The results are presented in Table 3.

Table 3. Construct Validity and Reliability Test Results

Construct	Cronbach's Alpha	CR (rho_a)	CR (rho_c)	AVE
Adoption of Information Technology	0,906	0,915	0,934	0,781
Operational Efficiency	0,905	0,913	0,930	0,727
Inventory Management Literacy	0,767	0,809	0,861	0,674
Inventory Handling	0,964	0,965	0,974	0,902

Based on Table 3, the entire construct has Cronbach's Alpha between 0.767–0.964, CR(rho_c) between 0.861–0.974, and AVE between 0.674–0.902. All values exceed the required minimum limit, so that the entire construct is declared valid and reliable.

Uji Structural Model (Inner Model)

Coefficient of Determination (R^2)

The coefficient of determination (R^2) measures the ability of independent variables to explain the variation of dependent variables. The test results are presented in Table 4.

Table 4. Determination Coefficient (R^2) Test Results

Variabel	R-Square	R-Square Adjusted
Operational Efficiency	0,787	0,773
Inventory Handling	0,587	0,569

Based on table 4, the R^2 value of 0.787 for Operational Efficiency indicates that 78.7% of the variation can be explained by variables in the model. The R^2 value of 0.587 for Inventory Control shows that 58.7% of the variation is explained by Inventory Management Literacy and Information Technology Adoption. According to Hair et al. (2019), the R^2 value ≥ 0.67 is categorized as substantial and ≥ 0.33 is categorized as moderate, so this model has good predictive power.

Direct Effects Hypothesis Testing

Testing of the direct effect hypothesis is carried out through a bootstrapping procedure. The hypothesis is accepted when the T-statistic > 1.96 and the P-value < 0.05 (Hair et al., 2019). The results are presented in Table 5.

Table 5. Direct Effects Test Results

No	Hipotesis	Original Sample	P-Value	Remarks
H1	Adoption of Information Technology → for Operational Efficiency	0,295	0,005	Signifikan
H2	Adoption of Inventory Control Information Technology →	0,485	0,000	Signifikan
H3	Inventory Management Literacy → Operational Efficiency	0,351	0,001	Signifikan
H4	Inventory Management Literacy →	0,394	0,000	Signifikan
H5	Inventory Control → Operational Efficiency	0,379	0,005	Signifikan

In table 5 the results of the hypothesis test show that the entire hypothesis is immediately accepted. The adoption of Information Technology has a positive and significant effect on Operational Efficiency (H1; $\beta=0.295$; $p=0.005$), in line with the Technology Acceptance Model (TAM) which states that the perception of technology usability has a direct impact on improving user performance (Davis, 1989); The adoption of Information Technology also has a positive and significant effect on Inventory Control (H2; $\beta=0.485$; $p=0.000$), as technologies such as ERP systems and IoT improve the accuracy of stock data and strengthen the overall inventory control system. Inventory Management Literacy has a positive and significant effect on Operational Efficiency (H3; $\beta=0.351$; $p=0.001$), considering that a good understanding of inventory management allows for more informed decision-making in stock management so that waste can be minimized; likewise for Inventory Control (H4; $\beta=0.394$; $p=0.000$), because an understanding of the concepts of EOQ, safety stock, and reorder points is the main foundation of an effective inventory control system. Finally, Inventory Control has a positive and significant effect on Operational Efficiency (H5; $\beta=0.379$; $p=0.005$), because good inventory control minimizes waste, avoids shortages or excess stocks, and optimizes the use of operational resources.

Indirect Effects Hypothesis Testing

Indirect effect testing was carried out to determine the mediating role of Inventory Control. The results are presented in Table 6.

Table 6. Indirect Effects Test Results

Yes	Hubungan	Original Sample	P-Value	Remarks
H6	Adoption of Information Technology → for Inventory Control → Operational Efficiency	0,184	0,025	Signifikan
H7	Inventory Management Literacy → Inventory Control → Operational Efficiency	0,149	0,023	Signifikan

The results of the indirect effects test showed that Inventory Control significantly mediated the relationship between Information Technology Adoption and Operational Efficiency (H6; $\beta=0.184$; $p=0.025$); because the direct influence of Information Technology Adoption on Operational Efficiency is also significant, Inventory Control acts as a partial mediation, which means that ATI increases EO both directly and through strengthening the inventory control system. Similarly, Inventory Control significantly mediated the relationship between Inventory Management Literacy and Operational Efficiency (H7; $\beta=0.149$; $p=0.023$); Because the direct influence of Inventory Management Literacy on Operational Efficiency is also significant, Inventory Control also acts as a partial mediation, so that LMP contributes to EO both directly and through improving the quality of inventory control.

Discussion

Adoption of Information Technology for Operational Efficiency

The structural path from Information Technology Adoption to Operational Efficiency was recorded significantly with a coefficient of 0.295 and p of 0.005, so that H1 was declared acceptable. The t -statistic number of 2.787 is well above the 1.96 threshold, which means the relationship does not arise due to sample chance. The question then is, what is the practical meaning of this number for business actors? Simply put, any improvement in the use of information systems, whether in the form of recording applications, transaction automation, or other digital devices, will contribute to promoting proportional operational efficiency. Interestingly, this influence is direct; This means that MSMEs do not need to wait for the improvement of the inventory control system first to feel the benefits. This condition is quite advantageous for small business actors who generally do not have much time to wait for the long-term results of an investment. Technology, in this context, works like an accelerator whose impact can be felt in a relatively short time once implemented.

This kind of relationship pattern is not new in the literature. Davis (1989) through the Technology Acceptance Model has long explained that the perception of the usability of a technology perceived usefulness is the main driver of how the technology is adopted and ultimately has an impact on the performance of its users. When MSME actors feel the concrete benefits of using technology, their motivation to make the most of it also increases, and it leads to better efficiency. Research Jamwal et al (2021) also reported similar findings in

manufacturing companies, albeit with a much larger business scale than MSMEs in this study. Interestingly, more recent research has shown that small companies tend to be more agile in adopting new technologies than large companies, with technology readiness and compatibility as the main driving factors. The relatively simpler organizational structure of MSMEs and lower resistance to change are also factors that support the successful adoption of this technology. This means that the scale of small businesses is not a barrier, but can actually be an advantage in the context of operational digitalization.

For MSME actors, this finding sends a pretty clear signal: information technology should not be positioned as a complement, but as a strategic priority. Businesses that still rely on manual recording can start with simple steps, such as switching to digital cash applications or low-cost point-of-sale systems. What needs to be underlined is that the benefits of new technology will be optimal when accompanied by an increase in the team's ability to use it for free to install sophisticated applications if the use is only half-hearted. For policymakers, these results could be an additional argument for designing technology subsidies or digital training targeting micro and small MSMEs, groups that are usually the most lagging behind in terms of digitalization. Support such as cheap internet access or device purchase incentives will go a long way in speeding up the adoption process. Ultimately, the adoption of information technology is proving to be one of the fastest ways for MSMEs to increase efficiency without having to wait for greater structural changes.

Adoption of Information Technology for Inventory Control

Among all the structural pathways tested in this study, the relationship between Information Technology Adoption and Inventory Control appeared the strongest. This position is interesting to observe, meaning that, of all the factors tested, information technology is the one that most determines the quality of MSME inventory control, not even managerial literacy. In practical terms, this shows that digital recording systems and operational data integration are not just administrative complements, but the backbone of the entire stock control system. With adequate technology, recording can be done automatically, so that errors due to human error in manual recording can be suppressed. The implications are also felt in the timeliness of reorders, because stock data can be monitored at any time without the need for repeated physical checks. H2 is thus accepted, and this path is an important marker that technology investment has the greatest impact on other factors in forming the foundation of good inventory control.

Such findings are in line with the results Aditya et al (2025), which recorded a significant spike in stock accuracy in MSMEs that switched from manual to digital systems. More recent research even mentions that artificial intelligence-based demand forecasting models have changed the way companies manage inventory, allowing for much more precise predictions without sacrificing customer satisfaction. This reinforces the argument that technology not only speeds up data recording, but also improves the quality of decision-making related to stocks. Another study on MSMEs also found that limited knowledge and

resources often hinder the implementation of an ideal decision support system in inventory management, conditions that can be overcome through the adoption of appropriate information technology. From a theoretical point of view, these results also fit into the contingency framework in inventory management. The theory emphasizes that managers need accurate information to manage inventory and reduce costs, because the right information allows for the purchase of goods as needed without stockpiling excessively. Technology, in this framework, plays the role of the "information provider" that managers need to make more rational decisions.

The implication for business actors is quite straightforward: investment in stock management technology should be a priority, even compared to other operational aspects whose impact is not this large. Even a simple inventory system, when implemented consistently, can have a significant impact on the overall quality of inventory control. It is also recommended that the selected system is directly integrated with sales activities, so that stock data is automatically updated without troublesome double recording. The training of the staff who handle the inventory should also not be ignored, no matter how advanced the technology will not be optimal if the user is not used to it. For technology service providers and MSME companion institutions, this finding opens up opportunities to develop inventory management solutions that are cheap and easy for small business actors to use. The government and MSME associations can also use this result as an argumentative basis to expand the inventory digitization program. In short, strengthening information technology seems to be the most effective way to build a resilient MSME inventory control system in the long term.

Inventory Management Literacy for Operational Efficiency

In addition to technology, inventory management literacy has also been proven to have an effect on operational efficiency directly, a value that is quite strong and consistent in this research sample. H3 was also declared accepted. What is interesting about these findings is that the influence of literacy on efficiency does not have to go through inventory control mechanisms first; it works directly. How can this happen? Conceptual understanding is apparently not just passive knowledge stored in the head of the business owner, but capabilities that are directly translated into daily operational actions. Business actors who understand the concept of inventory turnover or stock needs planning tend to make more measurable procurement decisions, not the origin of purchase or origin of stock. These kinds of more rational decisions in turn reduce the waste of resources and operational costs that usually arise from planning errors.

Vikaliana et al (2021) previously also reported similar findings, that MSMEs with competent managers in good inventory management were able to reduce storage costs much more than MSMEs with minimal understanding. Meanwhile, Haq et al (2026) in fact, it is found that the opposite condition in the majority of Indonesian MSMEs still rely on intuition alone in managing stocks, so that literacy is a crucial differentiating factor. Research on micro

and small enterprises in Ethiopia also confirms the same thing, that business actors need skills and knowledge about scientific inventory management techniques and decision models in order for their businesses to run optimally. From the Resource-Based View, this kind of managerial competence is seen as an intangible resource that has the potential to become a sustainable competitive advantage, especially for small-scale organizations with minimal physical capital. Recent research also notes that limited financial and managerial literacy is often the main internal obstacle that weakens MSMEs' cash flow and strategic planning. This pattern is quite consistent across contexts in Indonesia, Africa, and other developing countries that managerial literacy does have a real role, not just a normative recommendation.

From a practical point of view, the message for MSME actors is quite simple: improve a basic understanding of inventory management, even if you don't have to be an expert. Understanding the concept of EOQ, safety stock, or reorder point in general is enough to have a real impact on daily operational efficiency. Training from cooperative offices, campuses, or financial institutions that often offer business education can be an easily accessible entrance. Even small steps such as recording product demand patterns regularly are enough to help determine the right number of orders. For policymakers, these findings serve as a basis for designing more massive and affordable managerial literacy training programs, given their empirically significant impact. The training module should ideally focus on practical application, not just theories that are difficult for ordinary business actors to apply. With these simple steps, operational efficiency can actually be improved without having to be accompanied by a large financial investment.

Inventory Management Literacy to Inventory Control

In addition to having a direct impact on efficiency, inventory management literacy has also been shown to shape the quality of inventory control, making it the second strongest path after the influence of technology adoption on the same variable. H4 accepted. This finding is quite logical when examined further: conceptual understanding becomes the underlying foundation of how inventory control systems are built in the field. Business actors who understand stock needs planning and inventory management techniques tend to be more systematic in developing control procedures than those who rely solely on intuition. Managers who only have "taste" capital usually do inconsistent recording and control, sometimes neatly, sometimes messy, depending on mood or busyness. Adequate literacy helps businesses determine more precisely when to reorder and what is the ideal amount of safety stock for their product characteristics. In short, literacy serves as a cognitive prerequisite that underlies the formation of good inventory control practices.

Phan et al (2019) It has previously been emphasized that understanding "know-what," "know-when," "know-how," and "know-why" is an important foundation for managers in planning, monitoring, and controlling inventory levels effectively. Contingency theory in inventory management is also in line with this argument, stating that knowledge is the main tool that managers use to avoid mismatches in records, loss of goods, or excess inventory.

Research on other MSMEs also shows that limited knowledge often hinders the implementation of ideal decision support systems in inventory management, which confirms the importance of literacy as a prerequisite before control practices can run well. Other research even mentions that digital literacy allows inventory managers to complete the recording of goods movements and data analysis more quickly, thus supporting decision-making and reducing wasted time due to manual documentation. Jabbarzadeh et al (2019) He added that mastery of the concept of EOQ and reorder points is the basis for rational procurement decision-making. These findings, taken together, point to a common conclusion: literacy is not just a complement, but an inseparable foundation of the success of inventory control systems at the small and medium-sized enterprise level.

For MSME actors, these findings imply a sensible sequence of steps: first build a basic understanding of inventory control, and then or in parallel invest in the supporting technology. Without a sufficient conceptual understanding, even technology investments risk being wasted because users don't understand the logic behind the available features. Business owners are advised to start learning the basics, such as when to reorder and how much safety stock is in accordance with the characteristics of their respective products. This kind of literacy training should ideally be carried out in stages, from basic understanding to more complex techniques according to business needs. For MSME companion institutions, this result confirms that literacy improvement programs should precede or at least go hand in hand with digitalization programs, so that the benefits of technology can be felt to the maximum. The combination of both literacy and technology clearly results in a more robust inventory control system than relying on just one of them. In the end, inventory management literacy deserves to be seen as a long-term investment that is the basis for all aspects of MSME stock management.

Inventory Control for Operational Efficiency

As a mediator variable in this research model, Inventory Control has also been shown to have a direct and significant effect on Operational Efficiency. The standard deviation value is relatively higher than other paths, but the statistical significance is maintained. H5 is thus accepted. Recording accuracy, accuracy of reorders, and consistency of stock taking are apparently not just administrative routines, but core mechanisms that determine how efficiently a company's resources are utilized. Business actors who consistently minimize stockout and overstock tend to have smoother operational processes and more controlled costs than those who ignore this aspect. Considering that the R^2 value of Inventory Control in this model is also relatively high (0.587), this variable deserves to be called the most central path that bridges the determinants of literacy and technology towards the operational efficiency of MSMEs.

Heizer et al (2020) It has long placed inventory control as a central element in operations management to achieve cost efficiency and smooth business processes. These findings are also consistent with recent studies that suggest that inventory measurement and

control significantly affect profitability, while assessment and recording methods alone do not show the same effect, indicating that the quality of control is much more decisive than the completeness of documents. Another study on MSMEs confirms that inventory control theory highlights the importance of stock availability to meet customer needs in a timely manner, so any inventory-related decision needs to consider the accompanying consequences. The experience of MSMEs in Peru is also quite relevant to compare the lack of a digitized control system there, which gives rise to frequent stock imbalances, sudden purchases at high prices, and lower profitability. This consistent pattern, both in Indonesia and other developing countries, reinforces the argument that inventory control is indeed a key determinant of efficiency, not just a complementary variable in research models.

The implication is that MSME actors should build inventory control routines as part of daily operations, not activities that are carried out only occasionally. Daily and weekly periodic stock taking should ideally be a standard procedure that is carried out in a disciplined manner, not optional. Evaluation of reorder points also needs to be done regularly so that stock policies can adjust to changes in customer demand patterns over time. Setting standard operational standards related to stock recording is also important, considering that this helps maintain data consistency despite the change of staff handling inventory. For MSMEs with limited resources, inventory control can start from simple things, such as categorizing products based on their turnover rate to prioritize supervision of critical products. Policymakers can also use these findings as a basis to encourage training on inventory control practices that are applicable, not just theoretical. Ultimately, a strong inventory control culture will be an important capital for MSMEs to achieve sustainable operational efficiency.

Adoption of Information Technology through Inventory Control to Operational Efficiency

Indirect effects testing confirmed that Inventory Control significantly mediated the relationship between Information Technology Adoption and Operational Efficiency. H6 is accepted, although the magnitude of the effect is indeed smaller than the direct effect. Since ATI's direct influence on EO is also significant, the role of Inventory Control here is partial mediation, not full mediation. Interestingly, when direct and indirect effects are combined, the total influence of ATI on EO reaches 0.479 much greater than if we only look at the direct effects. This means that Information Technology Adoption actually works through two paths at once: directly driving efficiency, and simultaneously strengthening inventory control systems which in turn also drive efficiency. It can be said that the benefits of technology investment for MSMEs are greater than they seem at first glance, because some of the impact is "hidden" in improving the stock control process.

This kind of partial mediation pattern is quite common in the supply chain management framework, which views inventory control as an operational mechanism that bridges strategic inputs, in this case technology, with the company's performance output. Previous research has also reported that the adoption of data provision technology can improve operational

efficiency as well as customer satisfaction, in line with the logic that the benefits of technology can arise either directly or through improvements in certain operational processes. Another study mentions that the integration of artificial intelligence, predictive analytics, and efficient logistics is now a crucial component in modern inventory management, ultimately ensuring the resilience, cost efficiency, and adaptability of companies in the midst of a dynamic market. This argument reinforces the idea that technology not only has an instant impact, but also forms the foundation of processes that have a long-term impact. Research Jamwal et al (2021) about the adoption of Industry 4.0 technology also shows a similar pattern, where part of the impact of technology on operational performance is channeled through internal process improvements. The consistency of this pattern across studies is quite convincing to conclude that the role of operational process mediation, especially inventory control, cannot be ignored in understanding how technology impacts company performance.

For MSME actors, the practical lesson from these findings is the importance of looking at technology investment more holistically not only for instant benefits, but also as a means of strengthening inventory control systems in the long term. When new technologies are implemented, it's a good idea to integrate them directly into daily inventory control practices, such as minimum stock notifications or automatic reports of item turnover. By maximizing these two impact pathways, the efficiency benefits obtained by MSMEs can be much greater than relying on only one pathway. It's also important to realize that the optimal outcomes of technology adoption require a commitment to changing the way things work, not just installing apps without changing old habits. For technology solution providers, these findings actually open up the opportunity to design features that explicitly link operational data with inventory control action recommendations. The government, through the MSME digitalization program, should ideally also include assistance in inventory control practices, so that the benefits of technology do not stop at the recording level alone. With this kind of integrated strategy, the total efficiency impact of information technology investment can be maximized more fully.

Inventory Management Literacy through Inventory Control to Operational Efficiency

A similar pattern was also found in the mediation pathway of Inventory Management Literacy towards Operational Efficiency through Inventory Control. H7 is accepted, although the value is slightly lower than the mediation pathway in the ATI-EO relationship discussed earlier. Just like in H6, because the direct influence of LMP on EO is also significant, the role of Inventory Control here is also partial mediation. The total influence of LMP on EO, when the direct and indirect effects are combined, reaches 0.500, indicating that the literacy contribution to MSME efficiency is actually greater than what can be seen in the direct effect alone. Inventory management literacy, in other words, works in two ways: directly improving operational decision-making, and simultaneously strengthening inventory control systems that ultimately drive efficiency. The position of Inventory Control as a mediator here once again confirms its central role in the overall research model.

These findings are quite in line with the Resource-Based View perspective, which holds that intangible resources such as new managerial knowledge provide optimal benefits when translated into concrete operational capabilities in this case, inventory control systems. The contingency theory in inventory management also emphasizes the same thing, that knowledge is the main tool for managers to avoid mismatches in recording and overstocking, which ultimately has an impact on the company's overall performance. Research on micro and small enterprises in Ethiopia also shows that the owner or manager needs to have the skills and knowledge of scientific inventory management techniques and decision models in order for his or her organization's competitiveness and performance to improve comprehensively, a pattern that is in line with the logic of partial mediation in these findings. Another study added that limited financial and managerial literacy is often the main internal obstacle that weakens the strategic planning of MSMEs, emphasizing that literacy does need to be translated into concrete operational practices so that its impact is truly optimal. When compared to the pattern in H6, there are interesting similarities: both literacy and technology require strengthening inventory control practices to maximize their impact on efficiency.

The practical message is clear: inventory management knowledge alone will not be optimal without consistent control practices in the field. Literacy training programs should not stop at the delivery of theory alone, but are also equipped with assistance in the implementation of inventory control practices directly. Business owners are advised to immediately practice what they have learned, setting reorder points, for example, or getting used to regular stock taking so that the knowledge gained really has an impact on efficiency. MSME training and mentoring institutions should ideally design a curriculum that combines conceptual education with practical simulations, not just one-way lectures. Policymakers also need to realize the importance of a comprehensive MSME empowerment program, including both improving literacy and assisting in the implementation of sustainable operational practices. This combination of approaches will obviously have a greater impact than programs that focus solely on literacy or technology. In the end, the most effective MSME empowerment strategy seems to be one that is able to integrate increasing managerial literacy with strengthening inventory control practices simultaneously and continuously.

CONCLUSIONS AND SUGGESTIONS

This study successfully tested an integrated model that connects Inventory Management Literacy (LMP) and Information Technology Adoption (ATI) to the Operational Efficiency (EO) of MSMEs with Inventory Control (PP) as a mediator. All seven hypotheses proposed in this study were accepted.

Some of the main findings of this study are as follows. First, LMP and ATI have been proven to have a positive and significant effect on PP, with ATI as the most dominant predictor in shaping the quality of inventory control. Second, LMP, ATI, and PP each proved to have a positive and significant effect on EO directly, which shows that these three variables have their own contribution in encouraging the operational efficiency of MSMEs. Third, PP

has been proven to partially mediate the relationship between ATI and EO, as well as the relationship between LMP and EO, which means that both independent variables improve operational efficiency both directly and through strengthening the inventory control system. Overall, this research model has substantial predictive power in explaining variations in the operational efficiency of MSMEs.

Theoretically, this study contributes to the supply chain management literature by presenting an empirically tested mediation model in the context of Indonesian MSMEs. Practically, MSME actors are advised to improve inventory management literacy through training and gradually adopt information technology to strengthen inventory control systems which ultimately increase operational efficiency. For policymakers, these findings are the basis for designing targeted managerial literacy training programs and subsidies for technology adoption.

The limitations of this study include the use of cross-sectional designs that cannot capture dynamic changes between variables over time, as well as the scope of the sample that is still limited to MSMEs in one study area. Further research is suggested using longitudinal design, expanding the scope of the sample geographically, and considering moderation variables such as effort size or peak management support.

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