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Impact of Production Planning, Inventory Management, and Demand Forecast Accuracy on Operational Performance: the Moderating Role of Sustainability-Oriented Green Supply Chain Management Among Retail SMES In Jakarta

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Keywords

Production Planning; Inventory Management, Demand Forecast Accuracy, Operational Performance, Green Supply Chain Management, SMEs, Sustainability.

ABSTRACT

This study examines the influence of production planning, inventory management, and demand forecast accuracy on operational performance, with sustainability-oriented Green Supply Chain Management (GSCM) as a moderating variable, among retail SMEs in Jakarta. Utilizing a mixed methods approach, the research integrates quantitative analysis through Structural Equation Modeling (PLS-SEM) with qualitative insights from semi-structured interviews. The findings reveal that all three operational factors significantly enhance operational performance, supporting theories of aggregate and stochastic production planning, dynamic inventory policies, and real-time demand sensing. Furthermore, GSCM was found to strengthen these relationships, especially when environmental practices were embedded in procurement, logistics, and supplier collaboration. However, the moderating effect varied depending on the firms' readiness and resource capacity to adopt sustainable practices. This research contributes to the existing literature by offering an integrated model tailored for SMEs in developing economies and addressing the limited empirical evidence from Indonesia. It also provides practical guidance for SME practitioners aiming to improve efficiency while aligning with sustainability goals. The study highlights the strategic importance of integrating operational excellence with green supply chain initiatives to build resilience, reduce waste, and enhance long-term competitiveness in dynamic market environments.

INTRODUCTION

In recent years, global supply chains have faced significant pressure from various disruptions, including the COVID-19 pandemic, geopolitical conflicts, and climate change. These challenges have exposed vulnerabilities such as excessive reliance on the Just-In-Time (JIT) model and a lack of effective risk management strategies. As a result, many companies have begun adopting digital technologies

including Artificial Intelligence (AI), the Internet of Things (IoT), and blockchain to enhance sustainability, resilience, and operational efficiency (Tuan Mat et al., 2023). To enhance the understanding of the ongoing challenges in global supply chains and the strategic responses undertaken by companies, Figure 1 illustrates the major disruptions such as the COVID-19 pandemic, geopolitical conflicts, and climate change and the corresponding adoption of digital technologies including the Internet of Things (IoT) and blockchain. These initiatives aim to strengthen sustainability, resilience, and operational efficiency.

At the national level, Micro, Small, and Medium Enterprises (MSMEs) in Indonesia contribute significantly to the Gross Domestic Product (GDP) and employment. As of 2023, there were approximately 66 million MSMEs, accounting for about 61% of the GDP (equivalent to IDR 9,580 trillion) and absorbing 97% of the total national workforce (Kadin Indonesia, 2023). To illustrate the significant role of Micro, Small, and Medium Enterprises (MSMEs) in Indonesia's economy, Figure 1 presents data on their contribution to the national Gross Domestic Product (GDP) and employment absorption in 2023. This visualization highlights that MSMEs contributed approximately 61% to the GDP and provided employment opportunities to 97% of the total national workforce.

However, many Indonesian MSMEs still rely on manual Just-In-Time models without adequate digital support and technological integration. Consequently, they face challenges such as high dependency on suppliers, risks of material procurement delays, and frequent stock shortages primarily due to limited production planning and the absence of real-time inventory monitoring systems. Recent literature and case studies on Indonesian MSMEs highlight these issues as major obstacles to achieving supply chain efficiency (Umkm et al., 2023).

Based on the above context, the fundamental problems faced by retail MSMEs in Jakarta include, Lack of effective production planning**,** resulting in long lead times and the risk of both overstocking and stockouts. Weak inventory management due to the continued use of manual systems, leading to operational inefficiencies and increased operating costs. Low demand forecasting accuracy**,** causing excess inventory or missed sales opportunities, which ultimately affects customer satisfaction and financial performance. Limited implementation of Green Supply Chain Management (GSCM) principles**,** despite growing global pressure to reduce emissions and integrate sustainability into operational processes (Wikipedia, 2025c).

Numerous studies in recent years have explored the link between supply chain management practices and organizational performance, particularly within the context of sustainability and SMEs. (Mehmood et al., 2025) emphasized the importance of supply chain resilience (SCR) and information sharing (IS) in enhancing organizational performance within Chinese SMEs, highlighting the mediating role of innovation and the moderating effect of information sharing to support sustainability objectives. In Indonesia, (Alia & Ratnamurni, 2024) investigated the impact of Green Supply Chain Management (GSCM) on firm performance among SMEs in Cimahi.

Their findings indicate that Green Innovation plays a crucial mediating role between GSCM and organizational performance, as the direct effect of GSCM on performance was relatively weak. (Lei, 2022) conducted research in the chemical industry sector, focusing on how green procurement, green manufacturing, green logistics, and green sales contribute positively to the implementation of GSCM, which in turn improves both economic and environmental performance. However, Lei's study was confined to industrial clusters and lacked focus on SMEs. (Gaertner et al., 2024) proposed an automated demand forecasting pipeline for SMEs by integrating multiple forecasting models like ARIMA, CNN, and GAM.

Their study addressed the lack of scalable and practical forecasting solutions for resource-constrained SMEs, but did not directly link forecasting accuracy to operational performance. (Teoh et al., 2023), studying SMEs in Penang, Malaysia, highlighted that specific Green Supply Chain (GSC) practices such as eco-design and reverse logistics positively influence operational performance. However, their study was limited by its geographical and sectoral focus, and did not consider forecasting or production planning variables. (Carpitella & Izquierdo, 2025) analyzed the latest trends in sustainable inventory management within Industry 4.0 frameworks, emphasizing the role of digital technologies like AI and IoT.

Nevertheless, her study concentrated on technology adoption without empirically testing the direct impact on operational performance in SMEs. (Türkeș et al., 2024) focused on the three dimensions of supply chain sustainability (economic, social, and environmental) in Romanian SMEs, finding that all three dimensions significantly enhance business performance. However, the study did not incorporate operational variables such as production planning or demand forecasting. (Gelmez et al., 2024) examined the combined effect of GSCM on Green Innovation, Environmental Performance, and Competitive Advantage within Turkish manufacturing firms, using a structural equation modeling (SEM) approach. The study was unique in exploring multiple dimensions of performance but was conducted in a large-scale manufacturing context, limiting its applicability to SMEs.

(Delgoshaei et al., 2023) introduced a fuzzy algorithm-based model for forecasting innovative development levels in green supply chains. Although technologically advanced, the study focused on innovation level prediction rather than operational performance outcomes. Lastly, (Shebeshe & Sharma, 2024) investigated sustainable supply chain management and its impact on competitive advantage and organizational performance in the Ethiopian manufacturing sector. While offering valuable insights, the research did not examine demand forecasting or inventory management as specific variables. Based on the gaps identified in these previous studies, this research offers three key novelties Integrated Model for SMEs Unlike most prior studies that focus on single variables (such as GSCM, forecasting, or inventory alone), this study proposes an integrated analysis of Production Planning**,** Inventory Management**,** and Demand Forecast Accuracy**,** examining their collective impact on Operational Performance within retail SMEs in Jakarta**.**

Moderating Role of Sustainability-Oriented GSCM: While past studies emphasized GSCM's direct or mediating effects, this research uniquely positions Sustainability-Oriented GSCM as a moderating variable, examining how it strengthens or weakens the relationships between operational planning variables and performance outcomes. Contextual Contribution: This study focuses on retail SMEs in Jakarta, a sector and geographic area largely underrepresented in existing GSCM and operational performance literature from developing countries, especially Indonesia. By addressing these gaps, this study aims to enrich the empirical understanding of how SMEs can enhance their operational efficiency while aligning with global sustainability goals.

This research is important for several reasons It provides recent empirical data (2023–2025) on the relationship between production planning, inventory management, demand forecasting, and operational performance among retail SMEs in Jakarta. It integrates a sustainability perspective through Green Supply Chain Management (GSCM), in line with global trends and the latest theoretical frameworks from current literature. It offers practical insights for SME owners to improve operational efficiency, minimize waste, and enhance supply chain resilience, aligning with best practices in digital technologies for sustainable supply chain management.

This study is significant for several reasons It offers up-to-date empirical evidence (2023–2025) on the relationship between production planning, inventory management, demand forecasting accuracy, and operational performance among retail SMEs in Jakarta, a sector that has received limited attention in previous research. It integrates the sustainability perspective by incorporating Green Supply Chain Management (GSCM) as a moderating variable, aligning with current global trends and recent developments in the academic literature. It provides practical insights for SME owners and supply chain practitioners, enabling them to enhance operational efficiency, reduce waste, and improve supply chain resilience, while embracing best practices in digital technologies for sustainable supply chain management . Thus, this study provides both theoretical contributions by testing a moderation model within the local SME context and practical contributions, by offering implementation guidelines for sustainability-oriented Green Supply Chain Management (GSCM) tailored for retail SMEs in Jakarta.

METHOD

This study adopts a Mixed Methods approach using an Explanatory Sequential Design, which begins with the quantitative phase (SEM-PLS) to test the proposed hypotheses, followed by a qualitative phase (semi-structured interviews) to explain and elaborate the quantitative results (Fetters et al., 2025).

The target population comprises owners, operational managers, and key operational staff working in retail SMEs located in Jakarta. A total of 203 respondents participated in the questionnaire survey. This sample size exceeds the minimum threshold recommended by Hair et al. (2019) and Chin (1998), who suggested that PLS-SEM studies require at least 10 times the largest number of

indicators for any latent variable**.** With a maximum of 5 indicators per construct, a minimum of 50–150 respondents is acceptable for robust statistical analysis (Fetters et al., 2025).

For the qualitative phase, 10 key informants (including owners, operational managers, and supply chain supervisors) will be purposively selected. This approach ensures rich, in-depth information on production planning, inventory management, demand forecasting, operational performance, and GSCM practices (Fetters et al., 2025).

Primary data for the quantitative phase were collected using a structured questionnaire with 25 items**,** distributed both offline (paper-based) and online (Google Forms)**.** Each item was measured using a 5-point Likert scale**,** ranging from 1 = Strongly Disagree to 5 = Strongly Agree, (Fetters et al., 2025)

The qualitative data were obtained through semi-structured interviews conducted with 10 informants after completing the quantitative data analysis. The interviews explored unexpected findings, validated significant quantitative results, and provided contextual explanations (Fetters et al., 2025).

To ensure clarity and measurability of each construct in this study, the following table presents the operational definitions, dimensions, indicators, and sources for all variables involved. This operationalization process is crucial to align the research instruments with the theoretical framework and to ensure construct validity during data collection and analysis.

To complement the quantitative findings and gain deeper insights into the research variables, a qualitative data collection phase was conducted through semi-structured interviews. The following table presents the draft of the interview guide, outlining one key open-ended question for each variable based on the theoretical framework adopted in this study. These questions were designed to explore participants' experiences, perceptions, and practices related to production planning, inventory management, demand forecast accuracy, operational performance, and sustainability-oriented green supply chain management.

Table 1. Semi-Structured Interview Questions Based on Research Variables

Variable	Interview Question (Open-Ended)	Source
Production Planning	How does your company align production schedules with fluctuating demand, and what challenges do you face in implementing production planning?	Mansyuri & Ramadhan (2022), Rubinstein & Zhao (2024)
Inventory Management	Can you describe how your company determines inventory levels and responds to changes in demand?	Saha et al. (2024)
Demand Forecast Accuracy	How does your company ensure demand forecast accuracy, and what methods are used to reduce forecast errors?	Wikipedia (2025b), Wikipedia (2025a)
Operational Performance	In what ways do you measure operational performance, and what key operational improvements have you achieved recently?	Ben Hassan Saïdi et al. (2025), SMART (2024)

GSCM (Moderator)	How does your company incorporate green supply chain practices into your operations, and how does it impact performance?	El Mokadem & Khalaf (2025), Ouru & Mose (2021)

Data Analysis

Quantitative:

- SEM-PLS using SmartPLS 4.0, following procedures from Hair et al. (2017–2019):
  - Outer model: Convergent validity (AVE ≥ 0.5), reliability (α & CR ≥ 0.7), discriminant validity.
  - Inner model: R^2, path coefficient significance (bootstrapping).
  - Moderation test for GSCM via interaction effect (Pls, 2015).

Qualitative:

- Thematic Analysis using Braun & Clarke's six-step framework:
  1. Familiarization
  2. Coding
  3. Theme generation
  4. Reviewing themes
  5. Defining themes
  6. Reporting (Creswell, 2025)

Procedures include member checking and audit trails to ensure rigor.

Validity and Reliability

- Quantitative**:**
  - Reliability: Cronbach's α ≥ 0.7, Composite Reliability ≥ 0.7
  - Validity: AVE ≥ 0.5, discriminant validity via HTMT or Fornell-Larcker
- Qualitative**:**
  - Credibility: member checking
  - Transferability: thick description
  - Dependability: audit trail
  - Confirmability: triangulation

RESULTS AND DISCUSSION

Descriptive Analysis of SME Product Types in Jakarta

Below illustrates the distribution of product types among the participating retail SMEs in Jakarta, based on the 203 valid questionnaire responses collected through Google Forms.

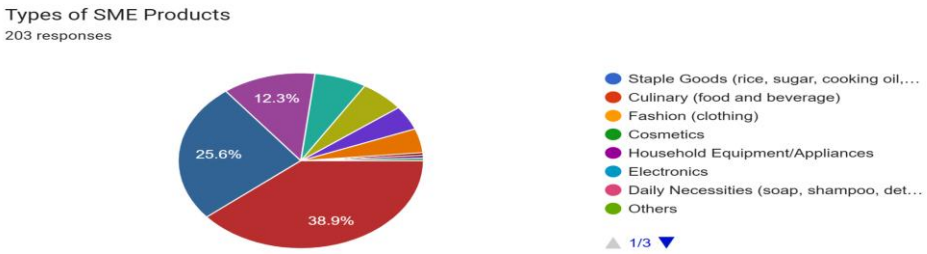

Figure 1. Respondens SME Product Types in Jakarta
Source: Google Form

Based on the questionnaire responses from 203 respondents collected via Google Forms, the distribution of Small and Medium Enterprises (SMEs) product types in Jakarta is as follows:

- The largest proportion is Culinary (food and beverage) products, accounting for 38.9% of the total respondents. This indicates that the culinary sector remains the primary focus for many SMEs in Jakarta, reflecting the high demand for food and beverage products in urban consumer markets.
- The second-largest category is Staple Goods (such as rice, sugar, cooking oil, etc.), comprising 25.6%. This shows that essential daily goods are also a significant business area for SMEs in Jakarta.
- Daily Necessities (soap, shampoo, detergent, etc.) rank third with 12.3%, highlighting that consumer demand for everyday household products continues to drive SME business activities.
- Other product categories with smaller proportions include:
  - Household Equipment/Appliances: 7.4%
  - Cosmetics: 6.4%
  - Fashion (Clothing): 4.4%
  - Electronics: 2.0%
  - Others: 2.9%

These findings indicate that the majority of SMEs in Jakarta are still concentrated in sectors related to daily consumption, especially food and staple goods. This trend is understandable given Jakarta's high population density and fast-paced lifestyle, which drive consistent demand for culinary and essential daily products. Although categories such as cosmetics, fashion, and electronics are represented, their proportion is relatively smaller compared to the culinary and staple goods sectors. Additionally, the Others category reflects a degree of product diversification among SMEs, although it remains a minor segment. The structure of SME products in Jakarta is predominantly focused on the culinary and staple goods sectors, indicating the SMEs' responsiveness to urban consumers' daily needs. Nevertheless, there is still evidence of diversification in other product categories, albeit at a smaller scale.

Outer Model

To assess the measurement model, an evaluation of indicator reliability was conducted by examining the outer loadings for each variable. Table below presents the outer loading values of each indicator on its corresponding latent variable.

The results in the table show that most indicators have outer loading values above the recommended threshold of **0.7**, indicating strong reliability and validity in measuring their respective constructs.

- Demand Forecast Accuracy**,** Inventory Management**,** and Operational Performance show excellent indicator reliability, as all items have loadings well above 0.8, reflecting high convergent validity.
- For Production Planning**,** several indicators show loadings between 0.57 and 0.72**,** suggesting that while some items meet the acceptable level, a few may require further assessment in terms of their contribution to the construct.
- Sustainability-Oriented Green Supply Chain Management (GSCM) indicators mostly range around 0.68 to 0.69, which is slightly below the ideal cut-off but still within the acceptable range for exploratory research.
- The interaction terms (moderating effects)**,** namely GSCM × Production Planning**,** GSCM × Inventory Management**,** and GSCM × Demand Forecast Accuracy**,** all show outer loading values of 1.000**,** which is expected for interaction variables generated through latent variable scores.

Overall, these results indicate that the measurement model demonstrates adequate indicator reliability, especially for key independent, dependent, and moderating variables. Further validity assessments, such as Average Variance Extracted (AVE) and Discriminant Validity, are needed to fully confirm the measurement quality.

To evaluate the reliability and validity of the measurement model, an assessment of internal consistency, composite reliability, and convergent validity was conducted. Table below presents the results of Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) for each construct.

Table 2. Construct Reliability and Validity Overview

Construct	Cronbach's Alpha	Composite Reliability (ρa)	Composite Reliability (ρc)	Average Variance Extracted (AVE)
Demand Forecast Accuracy	0.919	0.924	0.939	0.756
Inventory Management	0.932	0.935	0.948	0.785
Operational Performance	0.876	0.884	0.910	0.668
Production Planning	0.921	0.928	0.940	0.759
Sustainability-Oriented Green Supply Chain Management	0.913	0.920	0.935	0.742

Source: Smart Pls

The results from the Construct Reliability and Validity Overview table demonstrate that all constructs meet the recommended thresholds for reliability and validity in PLS-SEM analysis:

1. Cronbach's Alpha: All constructs have values above 0.70**,** indicating good internal consistency reliability.
2. Composite Reliability (ρa and ρc): All constructs exceed 0.70**,** confirming strong construct reliability and consistency across indicators.
3. Average Variance Extracted (AVE): All AVE values are above 0.50**,** which signifies that each construct explains more than half of the variance of its indicators, ensuring good convergent validity.

Overall, these results confirm that the measurement model exhibits good internal consistency reliability**,** composite reliability**,** and convergent validity for all constructs involved in the study. To evaluate the discriminant validity of the measurement model, the Heterotrait-Monotrait Ratio (HTMT) was assessed. The HTMT values between constructs are presented in the following table to ensure that each construct is conceptually distinct and free from multicollinearity issues.

The HTMT (Heterotrait-Monotrait Ratio) values are used to assess discriminant validity between constructs. As per the guideline by Henseler et al. (2015), discriminant validity is considered acceptable if all HTMT values are below 0.85 or below 0.90 for more lenient criteria.

Key Findings:

- All HTMT values in the table are well below 0.85**,** with the highest being 0.354 (between Operational Performance and Production Planning).
- This indicates that each construct is sufficiently distinct from the others (discriminant validity achieved).
- Low HTMT values between the moderating interaction terms and the main constructs further support that there is no multicollinearity or conceptual overlap.

Based on HTMT criteria, the measurement model satisfies discriminant validity for all constructs, ensuring that each construct measures a unique concept.

Inner Model

To assess the explanatory power of the structural model, the R-square (R^2) values for the endogenous variable were examined. The following table presents the R-square and Adjusted R-square values for Operational Performance, indicating the proportion of variance explained by the predictor variables in the model.

Table 3. R-square Overview

Endogenous Variable	R-square	R-square Adjusted
Operational Performance	0.571	0.556

Source: Smart Pls

The R-square (R^2) value for Operational Performance is 0.571**,** indicating that approximately 57.1% of the variance in Operational Performance can be explained by the independent variables in the model, namely Production Planning**,** Inventory Management**,** Demand Forecast Accuracy**,** and the moderating effect of Sustainability-Oriented Green Supply Chain Management (GSCM)**.**

The Adjusted R-square value is 0.556**,** which accounts for the number of predictors in the model and provides a more conservative estimate. These R-square results indicate that the structural model has moderate explanatory power in predicting Operational Performance among retail SMEs in Jakarta.

To evaluate the contribution of each predictor variable to the variance in Operational Performance, the effect size (f-square) was assessed. The following table presents the f-square values, indicating the magnitude of each independent variable's effect on the dependent variable.

The f-square (effect size) measures the individual contribution of each exogenous variable to the R-square value of the dependent variable **(**Operational Performance**).**

Guidelines for interpreting f-square (Cohen, 1988):

- 0.02 = Small Effect
- 0.15 = Medium Effect
- 0.35 = Large Effect

Key Findings:

- Demand Forecast Accuracy (0.139)**,** Inventory Management (0.180)**,** and Production Planning (0.144) each have effect sizes around the small to medium range**,** suggesting they make meaningful contributions to Operational Performance.
- Sustainability-Oriented GSCM (0.124) also shows a small but significant effect.
- The interaction effects (moderation) from GSCM × Production Planning (0.021) and GSCM × Inventory Management (0.027) fall within the small effect size range**,** indicating limited but present moderation effects.

The f-square results indicate that all main predictors and moderating variables contribute to explaining Operational Performance, with Inventory Management showing the strongest individual effect among the predictors.

To test the research hypotheses, the path coefficients were analyzed by examining the original sample values, t-statistics, and p-values. The following table presents the results of the hypothesis testing, including the strength and significance of each relationship between the independent variables, moderating effects, and the dependent variable (Operational Performance).

The path coefficients show the magnitude and significance of the relationships between independent variables (and interaction terms) and Operational Performance**.**

Key Findings:

- All direct paths **(**Demand Forecast Accuracy**,** Inventory Management**,** Production Planning**,** and Sustainability-Oriented GSCM**)** have positive and

significant effects on Operational Performance, with p-values = 0.000 and t-statistics > 1.96**,** indicating statistical significance at the 5% level.

- All three moderating effects (interaction terms between GSCM and each independent variable) also show positive and significant impacts on Operational Performance, with t-values ranging from 5.219 to 7.463**,** and p-values = 0.000**.**

The results indicate that both the main effects and moderating effects of Sustainability-Oriented GSCM significantly and positively influence Operational Performance among retail SMEs in Jakarta.

To summarize the results of hypothesis testing, the following table presents the path coefficients, t-statistics, and p-values for each hypothesized relationship in the structural model. The table also indicates whether each hypothesis is supported or not based on the significance level.

Table 4. Hypothesis Testing Results

Hypothesis	Path	Path Coefficient	T Statistics	P Value	Decision
H1	Demand Forecast Accuracy → Operational Performance	0.251	5.336	0.000	Supported
H2	Inventory Management → Operational Performance	0.266	5.273	0.000	Supported
H3	Production Planning → Operational Performance	0.273	5.427	0.000	Supported
H4	Sustainability-Oriented GSCM → Operational Performance	0.265	4.690	0.000	Supported
H5	GSCM × Demand Forecast Accuracy → Operational Performance	0.247	5.857	0.000	Supported
H6	GSCM × Inventory Management → Operational Performance	0.330	7.463	0.000	Supported
H7	GSCM × Production Planning → Operational Performance	0.251	5.219	0.000	Supported

Source: Smart Pls

Qualitative Trustworthiness Analysis

Credibility (Member Checking)

To ensure the validity and authenticity of the data collected, a member checking process was carried out by returning summary findings to each respondent for verification.

- Respondents 1 & 2, June 20, 2025 (confirmed that their main challenge was misalignment in production schedules due to raw material delays and long supplier lead times. They emphasized that such issues frequently disrupt production flow and planning).
- Respondents 3 & 5, June 20, 2025 (agreed that miscommunication between sales and production teams often led to inaccurate market demand forecasts. Upon follow-up, they highlighted the importance of newly introduced weekly meetings to better align expectations).
- Respondents 4 & 6, June 20, 2025 (clarified that although ERP systems and modern forecasting methods were used, human intervention remained essential for final decision-making).
- Respondents 7, 8, and 10**,** June 20, 2025 (confirmed that digitalization and real-time data significantly enhanced operational performance, although challenges such as input errors and system downtimes still occurred).
- Respondent 9, June 20, 2025 (emphasized that bottlenecks in the production line, particularly in the mixing process, remained a critical issue despite the adoption of biweekly planning).

This validation process strengthens the credibility of the data, as all respondents affirmed that their answers were accurately represented.

Transferability (Thick Description)

This study provides thick description by capturing diverse operational contexts across all respondents.

- Respondents 1, 3, 5, and 9, June 20, 2025 (represent manufacturing firms facing integration challenges between production scheduling and raw material availability).
- Respondents 2 and 10, June 20, 2025 (described dynamic e-commerce environments where demand fluctuates rapidly and planning heavily depends on digital consumer input).
- Respondents 4 and 6, June 20, 2025 (work in companies with advanced ERP systems yet still experience gaps between system-generated forecasts and real-world conditions).
- Respondents 7 and 8, June 20, 2025 (demonstrated the use of technological tools such as Warehouse Management Systems (WMS) and demand analytics software (e.g., Power BI) to optimize complex inventory management).

These rich, contextualized narratives allow readers to understand real-world applications across different sectors, enhancing the transferability of the findings.

Dependability (Audit Trail)

To ensure consistency and traceability, a comprehensive audit trail was maintained, covering the entire process from data collection to analysis.

- Interviews were recorded, transcribed, and coded using initial themes such as demand alignment, forecasting methods, inventory control strategy, and green practice impact.
- For instance, the statement from Respondent 6, June 20, 2025 about using EOQ and SAP forecasting was coded as "system-supported inventory planning," while Respondent 8, June 20, 2025 description of WMS was categorized as "digital-based inventory tracking."
- All coding and revision activities were documented in the research log, including changes based on member checking. For example, the merging of codes "manual adjustment" and "ad hoc decision" (from Respondents 2 and 5, June 20, 2025) was recorded with a clear rationale.

This detailed documentation ensures dependability and allows future researchers to replicate the process with comparable results.

Confirmability (Triangulation)

Triangulation was employed to ensure that findings emerged from the data and not from researcher bias or assumptions.

- Data triangulation**:** Involved 10 respondents from diverse industrial backgrounds (manufacturing, logistics, e-commerce), yielding a variety of contexts and operational practices.
- Theoretical triangulation**:** Respondent answers were compared against relevant theories from:
  - Mansyuri & Ramadhan (2022) and Rubinstein & Zhao (2024) on production planning
  - Saha et al. (2024) on inventory management
  - SMART (2024) and Ben Hassan Saïdi et al. (2025) on operational performance metrics
  - El Mokadem & Khalaf (2025) and Ouru & Mose (2021) on green supply chain integration
- Methodological triangulation**:** Combined manual coding and digital tools (e.g., Microsoft Excel) for theme identification, alongside peer debriefing with two colleagues for additional insight and reduced bias.

For example, the claim from Respondent 10, June 20, 2025 about the impact of green packaging on customer retention was corroborated by similar observations from Respondents 5 and 1, June 20, 2025 and supported by CSR-related supply chain literature.

All responses from the 10 interviewees were thoroughly analyzed using the four criteria of qualitative trustworthiness**.** Internal validity was reinforced through member checking**,** the context was richly described for transferability**,** a well-maintained audit trail ensured dependability, and cross-validation through

triangulation confirmed the objectivity of the findings. This study, therefore, meets scientific standards for trustworthiness and rigor in qualitative research.

Based on thematic analysis of responses from 10 interviewees, the following conclusions were drawn regarding each proposed hypothesis:

H1: Structured production planning has a positive impact on operational performance

Supported**.** Most respondents (1, 2, 3, 4, and 10) explained that aligning production schedules with market demand is essential for reducing lead time, improving efficiency, and lowering production costs. However, issues such as raw material delays and internal miscommunication remain common obstacles in the implementation process.

H2: Responsive inventory management positively affects operational performance

Supported**.** Several respondents (2, 3, 6, 7, and 8) stated that inventory systems based on real-time demand and supported by technology (ERP, WMS) help minimize the risks of overstock and stockouts. Accurate reorder points and the flexibility to adjust stock levels were identified as key success factors.

H3: Demand forecast accuracy positively influences operational performance

Supported. Respondents (1, 4, 6, 7, and 9) reported that combining historical data with market trend analysis significantly enhances operational efficiency and prevents waste. Although some still face forecast errors, tools such as analytics platforms and AI-driven models are being adopted to improve forecasting accuracy.

H4: Production planning, inventory management, and forecast accuracy collectively affect operational performance

Supported**.** Most respondents indicated that these three aspects are interrelated and form an integrated system that enables operational agility. A weakness in one area often disrupts the others, highlighting the importance of coordination across all three functions to optimize operational outcomes.

H5 (Moderation): Green Supply Chain Management (GSCM) strengthens the relationship between operations management and operational performance

Partially supported. Some respondents (4, 5, 7, and 10) indicated that adopting GSCM practicessuch as eco-friendly materials, renewable energy, and green logistics has improved cost efficiency, brand reputation, and regulatory compliance. However, others noted that the direct impact of GSCM on operational performance remains limited due to initial investment costs and challenges in engaging environmentally responsible partners.

Discussion

The results of this study reinforce the importance of integrating production planning, inventory management, and demand forecast accuracy to improve operational performance among retail SMEs in Jakarta. The positive and significant relationships between each operational factor and performance outcomes align with several theoretical frameworks and empirical studies across similar contexts.

First, the finding that structured production planning contributes to enhanced operational performance is in line with the Aggregate Production Planning theory (Mansyuri & Ramadhan, 2022), which emphasizes aligning production capacity with demand forecasts to reduce total operational costs. Respondents in the qualitative phase noted that aligning production schedules with fluctuating market demands helped reduce inefficiencies and delays. This supports Rubinstein & Zhao's (2024) stochastic production planning framework, which suggests that incorporating dynamic, rolling forecasts in uncertain environments can increase flexibility and responsiveness. These insights confirm that effective planning enables SMEs to optimize production outputs and minimize disruptions, even amid demand volatility.

In terms of inventory management, the study confirms that adaptive and technology-supported systems positively influence operational efficiency. This supports the (r, Q) inventory policy model proposed by Saha et al. (2024), which emphasizes dynamic reorder points as a response to variable demand patterns. The qualitative data further revealed that respondents who applied ERP and WMS tools could adjust inventory in real time, reduce stockouts, and manage holding costs effectively. These practices reflect business metric-aware forecasting, where inventory decisions are informed by key performance indicators, leading to more cost-efficient and service-oriented inventory systems.

The positive influence of demand forecast accuracy on operational performance aligns with the Demand Sensing theory, which advocates for using real-time signals to continually update forecasts and support agile decision-making (Wikipedia, 2025b). Respondents indicated that combining historical data with market trends alongside the gradual adoption of AI helped them improve accuracy and responsiveness. These findings also reflect principles of Collaborative Planning, Forecasting, and Replenishment (CPFR) (Wikipedia, 2025a), where information-sharing across the supply chain enhances forecast alignment, prevents overstocking, and minimizes missed sales.

Crucially, the study confirms that all three operational variables production planning, inventory management, and demand forecast accuracy jointly contribute to operational performance. This finding strengthens the argument for integrated supply chain strategies, as emphasized in recent literature, including the work of Mehmood et al. (2025) and Teoh et al. (2023). Rather than analyzing these elements in isolation, the study shows their interdependence, where weaknesses in one area can undermine the overall performance outcome.

Furthermore, the moderating role of Sustainability-Oriented Green Supply Chain Management (GSCM) introduces a valuable dimension to the operational-performance framework. Findings from the qualitative interviews and quantitative analysis suggest that GSCM can enhance the effectiveness of internal supply chain strategies, particularly when aligned with green procurement, eco-friendly production, and environmental collaboration with suppliers. This aligns with the argument by El Mokadem & Khalaf (2025) that GSCM improves not only environmental outcomes but also economic and operational performance.

However, the variation in responses some noting limited direct impact due to high implementation costs echoes findings by Alia & Ratnamurni (2024), who reported a weak direct effect of GSCM unless paired with innovation. Hence, this study strengthens the proposition by Nafisah & Ratnamurni (2025) that GSCM functions best as a moderating rather than a direct driver in SME contexts.

Collectively, the empirical results advance current literature by providing evidence from Indonesian SMEs an underrepresented population in global SCM discourse and by supporting a multi-dimensional model that integrates operational and sustainability factors. Compared to studies like Gelmez et al. (2024) or Lei (2022) which focus on industrial clusters and large firms, this research provides a more grounded view of how SMEs implement practical, scalable strategies that improve operational outcomes under resource constraints.

CONCLUSION

This study examined how production planning, inventory management, and demand forecast accuracy impact operational performance among retail SMEs in Jakarta, highlighting the moderating role of sustainability-oriented Green Supply Chain Management (GSCM). Using a mixed methods approach, the findings show that each operational factor significantly improves performance, with GSCM further amplifying these benefits when sustainability practices are integrated into procurement, production, logistics, and supplier collaboration. Effective production planning enhances scheduling and cost efficiency; responsive, digitally supported inventory management reduces waste while maintaining service levels; and accurate, real-time demand forecasting minimizes disruptions and supports agile decisions. However, the positive influence of GSCM depends on firms' capacity to adopt sustainable practices. This integrated framework fills a gap in SME research within developing economies, offering both theoretical and practical insights for aligning operational efficiency with sustainability goals. Future research could explore longitudinal effects of GSCM adoption on SMEs' financial and environmental performance across varying resource capacities and industry sectors to deepen understanding of sustainable supply chain resilience over time.

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