

A Conceptual Framework: The Effect of Digital Integration on Inventory Performance Through Supply Chain Visibility and Demand Forecast Accuracy in Indonesian FMCG Firms

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ABSTRACT

The Fast-Moving Consumer Goods (FMCG) industry in Indonesia has shown strong growth in recent years; however, firms still face ongoing supply chain challenges, such as high logistics costs, complex multi-tier distribution networks, and uneven levels of digital adoption. These issues highlight the importance of understanding how digital capabilities can effectively translate into improved operational performance. In response, this study proposes a conceptual framework that examines the impact of digital integration on inventory performance through the sequential mediating roles of supply chain visibility and demand forecast accuracy. Drawing on Information Processing Theory (IPT), digital integration is viewed as a key information-processing capability that helps firms manage uncertainty by improving data sharing, visibility, and decision-making across the supply chain. A quantitative, cross-sectional research design is proposed, with a target sample of at least 150 respondents from FMCG firms operating in Indonesia. Data will be collected using structured questionnaires and analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The framework also includes control variables, such as firm size, firm age, and FMCG sub-sector, to capture differences across organizations. This study contributes to the existing literature by extending IPT into a multi-stage sequential mediation model, demonstrating how digital integration is translated into measurable performance outcomes through intermediate information-processing stages. It also offers practical insights for managers and policymakers by emphasizing that fully integrated digital ecosystems, rather than fragmented technological solutions, are essential for enhancing supply chain efficiency and inventory performance in emerging markets.

Keywords: Digital Integration, Supply Chain Visibility, Demand Forecast Accuracy, Inventory Performance, FMCG Industry.

1. INTRODUCTION

The Fast-Moving Consumer Goods (FMCG) sector plays a vital role in Indonesia's economy. Supported by a population exceeding 270 million people, ongoing urbanization, and increasing household income levels, the industry has experienced steady growth across food,

beverage, personal care, and household product segments. According to Kantar (2025), Indonesia's FMCG market expanded by approximately 7 percent in 2024, even in the presence of inflationary pressures and relatively cautious consumer spending behavior.

Further market insights suggest that the Indonesian FMCG sector is valued at more than USD 100 billion and is expected to grow at a compound annual growth rate (CAGR) of around 7.6 percent between 2021 and 2025 (Mordor Intelligence, 2025). In addition, households in Indonesia have consistently spent close to 20 percent of their total expenditures on FMCG products since 2018, highlighting the sector's strong economic significance (Statista, 2024).

Despite this growth trajectory, FMCG firms in Indonesia continue to face substantial supply-chain challenges. The country's geographic structure, consisting of over 17,000 islands, creates significant logistical complexity and uneven infrastructure development. Logistics costs account for approximately 14.3 percent of Indonesia's Gross Domestic Product, making them among the highest in Southeast Asia (World Bank, 2023; Asian Development Bank, 2020). By contrast, logistics costs in more developed economies are generally below 10 percent of GDP, indicating considerable potential for efficiency improvements. Moreover, Indonesia's position in the Logistics Performance Index declined from 46th in 2018 to 61st in 2023, reflecting ongoing issues related to timeliness, infrastructure quality, and tracking systems (World Bank, 2023).

In response to these challenges, the Indonesian government has introduced several initiatives under the *Making Indonesia 4.0* framework, including the National Logistics Ecosystem (NLE), with the objective of improving efficiency and reducing logistics costs. However, progress in digital adoption remains inconsistent. Reports from leading consulting firms indicate that many companies in Southeast Asia, including Indonesia, are still at an early or fragmented stage of digital maturity, with limited integration across enterprise resource planning (ERP), warehouse management, and distribution systems (Kearney, 2022; A.P. Moller–Maersk, 2024). The ERP software market in Indonesia remains relatively small, valued at approximately USD 88.85 million in 2024, suggesting substantial room for further digital integration (Ken Research, 2024).

Within the FMCG sector, these infrastructural and digital limitations have direct operational implications. Short product life cycles, high variability in demand, and complex multi-layered distribution networks contribute to the bullwhip effect, leading to increased stockouts and higher inventory holding costs (Lee et al., 1997). Industry evidence further indicates that firms with advanced demand forecasting capabilities achieve up to 15 percent lower inventory levels, 17 percent higher perfect-order fulfillment rates, and significantly fewer stockouts compared to their competitors (Supply Chain 24/7, 2016). These findings underline the strong interconnection between digital integration, supply chain visibility, demand forecast accuracy, and overall inventory performance.

Despite extensive research on digital transformation and supply chain performance, most prior studies have focused on direct relationships between digital technologies and operational outcomes, with limited attention to the underlying mechanisms linking them (Wamba et al., 2020; Dubey et al., 2021). In particular, sequential mediation models that explain how digital integration is translated into performance through supply chain visibility and demand forecast accuracy remain underexplored (Ivanov & Dolgui, 2021). Moreover, existing research is largely concentrated in developed economies, with limited focus on emerging markets such as Indonesia, where infrastructural fragmentation, geographic dispersion across more than 17,000 islands, and the dominance of traditional trade create unique operational challenges (Kearney, 2022; World Bank, 2023). These conditions make the FMCG sector a highly relevant context for examining how digital integration enhances information-processing capabilities and improves inventory performance.

To illustrate the scale and structure of Indonesia’s FMCG market, Figure 1 presents the recent growth and channel structure of the industry.

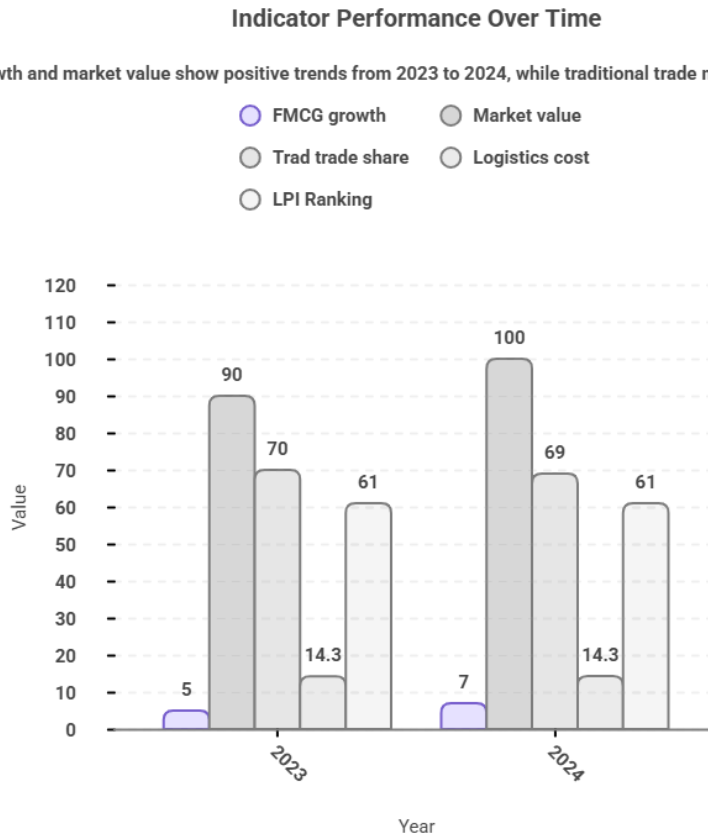


Figure 1. Indonesian FMCG Market Indicators, 2023–2024

Source: Compiled from Kantar (2025), Statista (2024), PwC Indonesia (2024), and World Bank (2023).

The combination of strong market growth, structural logistics inefficiencies, uneven digital adoption, and intense competition motivates this study. Understanding how digital integration translates into inventory performance, and which mediating mechanisms explain this relationship, is essential for FMCG firms seeking to sustain competitiveness in the Indonesian market.

Moreover, the increasing penetration of e-commerce platforms, the expansion of omnichannel retailing, and the growing demand for real-time responsiveness are further intensifying the need for digitally enabled supply chain systems in Indonesia. Firms that fail to integrate digital technologies across their supply chains risk losing competitiveness due to delayed decision-making, poor demand visibility, and inefficient inventory practices. In this context, examining the role of digital integration not only addresses operational inefficiencies but also contributes to the broader transformation toward data-driven and resilient supply chain ecosystems in emerging markets.

1.1 PROBLEM STATEMENT

Although the Indonesian FMCG industry continues to expand, many firms still experience inefficiencies in their supply-chain operations that do not align with the sector’s overall economic importance. Logistics costs remain above 14 percent of GDP, and findings from the National Logistics Ecosystem (NLE) program suggest that while improvements have been made in vessel and cargo clearance times, variations in information technology maturity among different stakeholders continue to restrict system interoperability (World Customs

Organization, 2024; A.P. Moller–Maersk, 2024).

Digital integration, which refers to the use of interconnected technologies such as ERP systems, cloud platforms, and IoT to facilitate real-time information exchange across supply-chain partners, has been widely recognized as a driver of improved operational and supply-chain performance (Jing & Fan, 2024; Ivanov & Dolgui, 2021; Wamba et al., 2020). However, in the Indonesian FMCG sector, many firms still rely on fragmented systems and partially manual processes. This situation limits the flow of real-time data and reduces overall supply-chain visibility (Kearney, 2022; A.P. Moller–Maersk, 2024). Prior studies consistently demonstrate that timely and high-quality information enhances forecasting accuracy and organizational performance (Wamba et al., 2020; Dubey et al., 2021). In contrast, insufficient integration weakens forecasting capabilities and increases the risk of both stockouts and excess inventory.

Despite the growing body of research in this area, most studies on digital integration and supply-chain performance have been conducted in developed economies such as the United States, Europe, and China, where digital infrastructure and maturity levels are significantly higher (Wamba et al., 2020; Jing & Fan, 2024). There is still limited empirical evidence focusing specifically on Indonesian FMCG firms, particularly studies that examine firm-level data and explore the underlying mechanisms linking digital integration to operational outcomes. Furthermore, existing research has primarily focused on direct relationships between digital technologies and firm performance, with comparatively less attention given to sequential mediation processes that explain how digital integration influences inventory performance through supply chain visibility and demand forecast accuracy.

Therefore, this study addresses the following research question: How does digital integration affect inventory performance in Indonesian FMCG firms, and to what extent do supply chain visibility and demand forecast accuracy sequentially mediate this relationship?

1.2 SIGNIFICANCE OF STUDY

The significance of this study can be understood from both theoretical and practical perspectives within the context of the Indonesian FMCG industry.

From a theoretical standpoint, this research develops a conceptual framework that addresses several gaps identified in existing literature. Previous studies have largely concentrated on the direct relationship between digital technologies and firm performance, with limited attention given to sequential mediation mechanisms. By introducing supply chain visibility and demand forecast accuracy as sequential mediators between digital integration and inventory performance, this study extends Information Processing Theory (Galbraith, 1974) into a multi-stage information-processing framework. This approach enhances the understanding of how digital capabilities are transformed into measurable operational outcomes, particularly in emerging economies where infrastructural and institutional conditions differ significantly from those in developed markets.

From a practical perspective, this study provides valuable insights for improving operational performance in the FMCG sector. The findings are expected to assist supply-chain and operations managers at companies such as Unilever Indonesia, Indofood, Wings Group, and Mayora Indah in making more informed decisions regarding digital investments, emphasizing the importance of integrated systems rather than isolated technological solutions. Furthermore, the study offers relevant implications for technology providers, logistics partners, and policymakers engaged in initiatives such as Making Indonesia 4.0 and the National Logistics Ecosystem (World Customs Organization, 2024). As improvements in inventory performance contribute directly to efficiency and competitiveness within the FMCG sector, this research is also expected to support broader national objectives, including enhanced supply-chain productivity and the reduction of logistics costs as a proportion of

GDP (World Bank, 2023; Asian Development Bank, 2020).

2. LITERATURE REVIEW

The theoretical foundation of this study is Information Processing Theory (IPT), originally introduced by Galbraith (1974). This theory conceptualizes organizations as open systems that must continuously process information to reduce uncertainty and sustain performance. According to IPT, organizational effectiveness is achieved when there is a proper alignment between information processing needs driven by environmental uncertainty and task complexity and information processing capabilities, which are supported by organizational structures and technological systems (Galbraith, 1974; Tushman & Nadler, 1978). In complex and dynamic supply-chain environments, digital technologies act as key enablers of information processing by allowing firms to collect, share, and analyze high-quality data, ultimately enhancing decision-making and overall performance (Wamba et al., 2020; Dubey et al., 2021). This perspective is particularly relevant to the FMCG sector, where short product life cycles and high demand volatility create significant information-processing requirements.

Although previous research consistently shows that digital technologies can improve organizational performance, the magnitude of these benefits is not uniform across different contexts. Empirical findings indicate that while digital integration enhances decision-making and supply-chain outcomes (Ivanov & Dolgui, 2021; Wamba et al., 2020), its effectiveness largely depends on factors such as organizational readiness, data quality, and the level of digital maturity. This issue is especially significant in emerging economies, where infrastructural limitations and fragmented systems may constrain the full utilization of digital capabilities (Dubey et al., 2021).

2.1 Inventory Performance

Inventory performance refers to how efficiently a firm manages its inventory in order to satisfy customer demand while controlling associated costs. It is commonly assessed using indicators such as inventory turnover, frequency of stockouts, holding costs, fill rate, and order fulfilment accuracy (Ivanov & Dolgui, 2021; Queiroz et al., 2020). Within the FMCG sector, inventory performance is especially important due to short product life cycles, the perishable nature of many products, high fluctuations in demand, and intense market competition. Ineffective inventory management is typically reflected in two costly extremes: stockouts, which result in lost sales and reduced customer satisfaction, and excess inventory, which increases storage costs and the risk of product obsolescence. Empirical evidence suggests that improvements in forecasting and coordination can significantly lower inventory levels and reduce the occurrence of stockouts (Lee et al., 1997).

From the standpoint of Information Processing Theory, inventory performance is closely linked to a firm's ability to process information related to demand, supply, and internal operations in a timely and accurate manner. Organizations with stronger information-processing capabilities are better positioned to align supply with demand, minimize uncertainty, and respond effectively to disruptions, thereby enhancing overall inventory performance (Ivanov & Dolgui, 2021; Dubey et al., 2021).

2.2 Digital Integration

Digital integration refers to the application of interconnected digital technologies—such as ERP systems, cloud computing platforms, Internet of Things (IoT) devices, and advanced analytics—to facilitate real-time data exchange and coordinated decision-making across both internal functions and external supply-chain partners (Wamba et al., 2020; Ivanov & Dolgui, 2021; Shakur et al., 2024). It includes internal integration, which connects key business functions like procurement, production, logistics, and sales, as well as

external integration, which links the firm with suppliers, distributors, and retailers.

Existing literature highlights that digital integration improves traceability, responsiveness, and coordination throughout the supply chain (A.P. Moller–Maersk, 2024; Barratt & Oke, 2007). In the FMCG sector, it also enables real-time visibility of stock levels across warehouses, distribution centers, and retail outlets. This capability is particularly important in Indonesia due to its archipelagic structure and the continued dominance of traditional trade channels, which account for approximately 69 percent of FMCG distribution (Statista, 2024).

However, despite these advantages, the adoption of digital technologies in emerging economies remains uneven. Many firms continue to rely on fragmented or partially integrated systems, limiting the full potential of digital transformation (Kearney, 2022). In line with Information Processing Theory, digital integration is therefore viewed in this study as an information-processing capability that helps firms reduce uncertainty and improve coordination across the supply chain.

2.3 Supply Chain Visibility

Supply chain visibility refers to the extent to which supply-chain participants have access to accurate, timely, and complete information regarding the location, status, and movement of goods, orders, and inventory throughout the network (Dubey et al., 2021; GEP, 2023). Improved visibility enables firms to identify bottlenecks, anticipate disruptions, align supply with demand, and strengthen collaboration with partners (Golpîra & Khan, 2023).

From the viewpoint of Information Processing Theory, supply chain visibility represents the outcome of effective information processing, where raw operational data is converted into meaningful insights that reduce uncertainty and support better decision-making (Galbraith, 1974; Dubey et al., 2021). Empirical evidence shows that firms with higher levels of visibility achieve improved demand forecasting, reduced bullwhip effects, and more efficient inventory management (Ali et al., 2024; Alkhatib & Momani, 2023; Kamble et al., 2021). In the Indonesian FMCG sector, where distribution networks are complex and multi-layered, supply chain visibility is expected to play a crucial role in enhancing inventory performance.

2.4 Demand Forecast Accuracy

Demand forecast accuracy refers to the degree of alignment between predicted demand and actual demand over a given time period. It is commonly evaluated using measures such as Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE), and bias (Queiroz et al., 2020). Accurate forecasting is essential for FMCG firms, as it directly supports decisions related to production planning, procurement, distribution, and retail replenishment. Research indicates that higher forecasting accuracy leads to reduced inventory levels, fewer stockouts, and improved service performance (Lee et al., 1997).

Modern forecasting approaches increasingly rely on demand-sensing techniques that integrate historical sales data, real-time point-of-sale information, promotional activities, macroeconomic indicators, and external data sources using advanced analytics and machine learning (Choi et al., 2023; NielsenIQ, 2024). This highlights the importance of high-quality data, which is largely enabled by supply chain visibility. From an Information Processing Theory perspective, forecasting accuracy depends on the organization's ability to collect, process, and interpret large volumes of diverse information capabilities that are strengthened by digital integration and supported by enhanced visibility (Dubey et al., 2021).

In this framework, demand forecast accuracy is considered a downstream outcome of both digital integration and supply chain visibility. Greater visibility provides richer and more timely data inputs, which improve forecasting models and reduce uncertainty. As a result, higher forecasting accuracy is expected to lead to better inventory management, including

fewer stockouts and more optimized inventory levels.

2.5 FMCG Industry Context in Indonesia

The Indonesian FMCG industry exhibits several unique characteristics that justify a context-specific analysis. First, traditional trade channels including neighborhood *warungs* and small kiosks continue to dominate the market, accounting for approximately 69–70% of total FMCG sales. This reflects the fragmented nature of retail distribution across the country (Statista, 2024). Second, modern retail and online channels are expanding rapidly, supported by increasing internet penetration, which exceeded 77% of the population in 2023, along with the growth of e-commerce platforms (We Are Social & DataReportal, 2024).

Third, FMCG firms must manage distribution across more than 17,000 islands, which significantly increases logistical complexity and contributes to national logistics costs of approximately 14–15% of GDP among the highest in Southeast Asia (World Bank, 2023). Additionally, Indonesia’s ranking in the Logistics Performance Index declined to 61st in 2023, indicating ongoing challenges related to infrastructure quality, tracking systems, and delivery reliability (Asian Development Bank, 2020).

Finally, the sector is characterized by short product life cycles, strong price competition, and highly price-sensitive consumers, all of which contribute to significant demand volatility (Kantar, 2025; He et al., 2024). Together, these conditions increase the information-processing demands placed on FMCG firms, highlighting the importance of digital integration, supply chain visibility, and accurate demand forecasting.

Table 1. Indonesian FMCG Industry Key Indicators

| Indicator | Value (Latest) | Source |
|---------------------------|--------------------|-------------------------|
| FMCG Market Value | > USD 100 Billion | Statista (2024) |
| FMCG Growth Rate | ~7–7.6% CAGR | Market Research Reports |
| Traditional Trade Share | 69–70% | Kantar / NielsenIQ |
| Internet Penetration | ~77% | DataReportal (2024) |
| Number of Islands | >17,000 | World Bank |
| Logistics Cost (% of GDP) | 14–15% | World Bank / PwC |
| LPI Ranking (2023) | 61st | World Bank (2023) |
| E-commerce Growth (FMCG) | Rapidly increasing | Industry Reports |

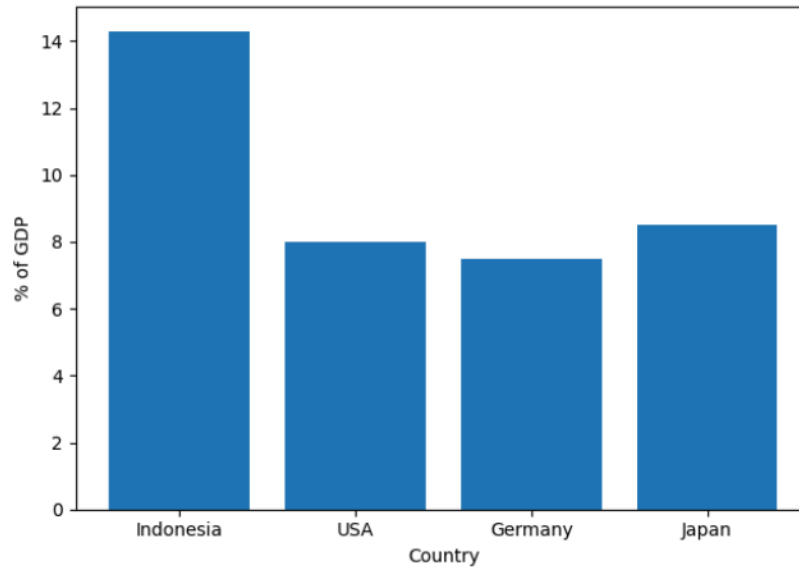


Figure 2: Logistics Cost Comparison (Logistics Cost as % of GDP)
Source: Adapted from World Bank (2023) and Council of Supply Chain Management Professionals (2023).

3. HYPOTHESES DEVELOPMENT

3.1 Digital Integration and Supply Chain Visibility

Digital integration forms the backbone of supply chain visibility by providing the technological and organizational foundation required for effective information flow. Technologies such as ERP systems, cloud-based platforms, and IoT devices enable continuous data collection, storage, and sharing across both internal departments and external supply chain partners (Shakur et al., 2024; Ivanov & Dolgui, 2021). Existing empirical studies indicate that digital transformation enhances traceability and improves visibility of product flows, which ultimately strengthens overall supply chain performance (Dubey et al., 2021; Sanders & Ganeshan, 2020). In addition, earlier research highlights that digital transformation contributes to improved responsiveness and resilience through better visibility (Barratt & Oke, 2007). Similarly, the adoption of digital technologies has been shown to significantly enhance visibility and operational outcomes (Kamble et al., 2021).

Within the Indonesian FMCG environment, where supply chains are geographically dispersed and largely dependent on traditional trade networks, digital integration plays a particularly important role in overcoming fragmented information systems. Firms that adopt integrated digital solutions are more capable of tracking inventory, monitoring shipments, and coordinating replenishment activities across multiple levels of the supply chain. Based on this reasoning, the following hypothesis is proposed:

Hypothesis 1 (H1): Digital integration will positively affect supply chain visibility in Indonesian FMCG firms.

3.2 Supply Chain Visibility and Demand Forecast Accuracy

Supply chain visibility serves as a critical input for improving demand forecast accuracy. When organizations gain real-time access to key data such as point-of-sale information, inventory levels, promotional activities, and supplier performance, they are able to enhance the quality of inputs used in forecasting models and detect demand patterns earlier (Golpîra & Khan, 2023; McKinsey & Company, 2021). Empirical findings suggest that organizations with stronger information-processing capabilities, particularly those with high levels of visibility across their supply chains, achieve better predictive performance (Dubey et

al., 2021). Industry insights also emphasize that real-time visibility enables the creation of a unified and reliable data source, which significantly improves forecasting accuracy (Choi et al., 2023).

In the FMCG sector, demand is highly dynamic and often influenced by factors such as promotions, seasonal changes, and competitor actions. Without sufficient visibility, forecasting models tend to rely on outdated or aggregated data, limiting their effectiveness. Therefore, enhanced visibility is expected to improve forecasting outcomes. Accordingly, the following hypothesis is proposed:

Hypothesis 2 (H2): Supply chain visibility will positively affect demand forecast accuracy in Indonesian FMCG firms.

3.3 Demand Forecast Accuracy and Inventory Performance

The accuracy of demand forecasts plays a direct role in determining the effectiveness of inventory management. When forecasted demand closely matches actual demand, firms are better positioned to minimize stockouts and avoid excess inventory, thereby reducing safety stock requirements and improving inventory turnover (Queiroz et al., 2020; Lee et al., 1997). Empirical evidence consistently supports the view that improvements in forecasting accuracy lead to lower inventory levels, fewer stockouts, and enhanced service performance (Lee et al., 1997).

This relationship is particularly critical in the FMCG sector, where short product life cycles and high competition make inventory decisions highly sensitive. In such environments, even small forecasting errors can result in significant operational inefficiencies. Therefore, improved forecast accuracy is expected to directly enhance inventory performance. The following hypothesis is proposed:

Hypothesis 3 (H3): Demand forecast accuracy will positively affect inventory performance in Indonesian FMCG firms.

3.4 Digital Integration and Inventory Performance

In addition to its indirect effects through supply chain visibility and forecasting, digital integration is also expected to influence inventory performance directly. Integrated systems facilitate automation in key operational processes such as ordering, replenishment, and warehouse management, thereby reducing manual errors and speeding up decision-making (Ivanov & Dolgui, 2021; Maersk, 2024). Empirical studies further demonstrate that digital transformation improves inventory turnover and enhances overall supply chain efficiency (He et al., 2024).

For FMCG firms, digital integration also enables advanced practices such as automated promotion planning, SKU optimization, and inventory redistribution across distribution centers. These capabilities directly impact cost efficiency and inventory utilization. Based on this understanding, the following hypothesis is proposed:

Hypothesis 4 (H4): Digital integration will positively affect inventory performance in Indonesian FMCG firms.

3.5 Sequential Mediation of Supply Chain Visibility and Demand Forecast Accuracy

According to Information Processing Theory, the impact of digital integration on performance occurs through a sequence of information-processing stages. Initially, digital integration improves the generation and sharing of high-quality data across the supply chain, leading to enhanced visibility. This improved visibility then supports more accurate demand forecasting by providing better and more timely data inputs. Ultimately, higher forecast accuracy translates into improved inventory performance through optimized replenishment, reduced stockouts, and lower holding costs (Galbraith, 1974; Dubey et al., 2021).

This step-by-step mechanism aligns with prior empirical findings that emphasize the

mediating roles of integration and visibility in improving supply chain outcomes (Dubey et al., 2021; Barratt & Oke, 2007). However, limited research has examined this full sequential mediation structure, particularly within FMCG firms operating in emerging markets such as Indonesia. Therefore, the following hypothesis is proposed:

Hypothesis 5 (H5): Supply chain visibility and demand forecast accuracy sequentially mediate the relationship between digital integration and inventory performance in Indonesian FMCG firms.

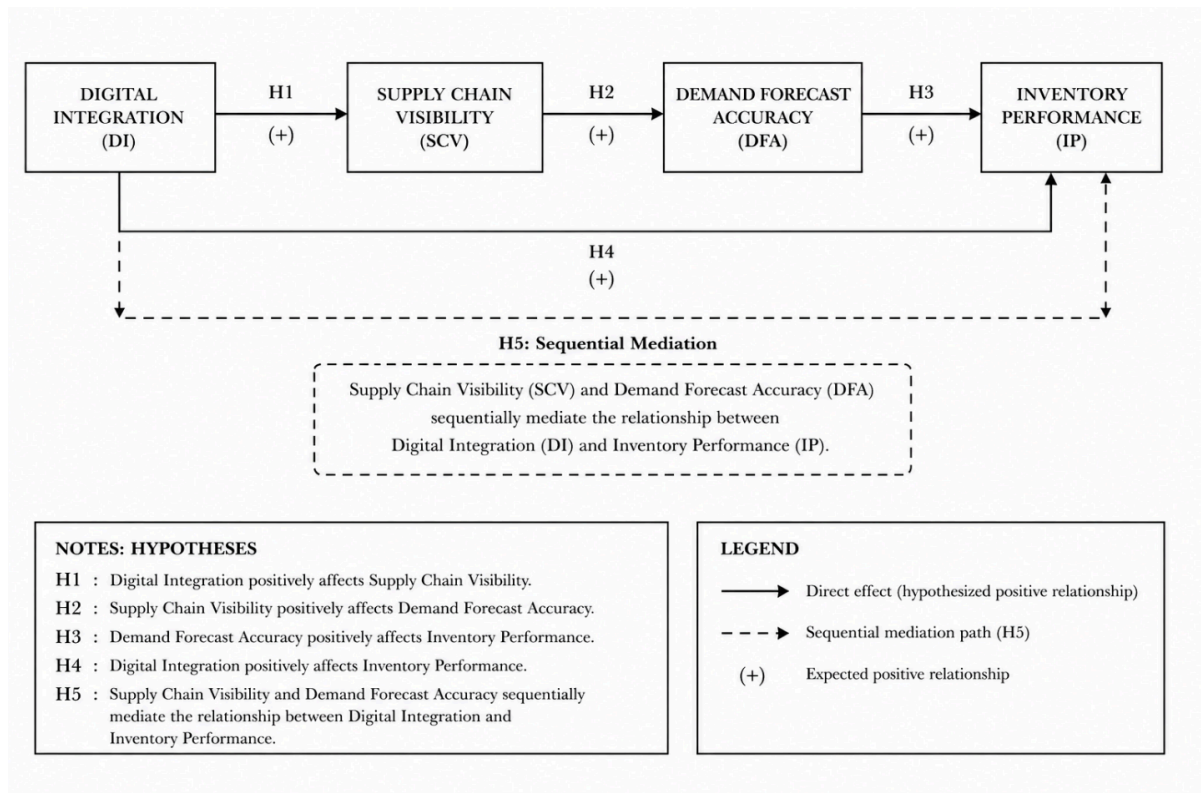
4. CONCEPTUAL FRAMEWORK:

Based on the theoretical discussion above, the proposed conceptual framework of this study integrates digital integration, supply chain visibility, demand forecast accuracy, and inventory performance into a sequential-mediation model. Firm size, firm age, and FMCG sub-sector are included as control variables.

Figure 3. Conceptual Research

Control Variables: Firm Size, Firm Age, FMCG Sub-sector

Source: Developed by the Author (2026) based on Galbraith (1974), Jing & Fan (2024), and Dubey et al. (2021).



The figure illustrates a conceptual framework linking digital integration to inventory performance in the FMCG sector. Digital Integration (DI) acts as an independent variable influencing both direct and indirect outcomes. It directly affects Inventory Performance (IP) through H4. Indirectly, DI enhances Supply Chain Visibility (SCV) (H1), which improves Demand Forecast Accuracy (DFA) (H2). Improved DFA subsequently leads to better Inventory Performance (IP) (H3). The model also incorporates a sequential mediation effect (H5), where SCV and DFA jointly transmit the impact of DI on IP. All relationships are hypothesized to be positive. Overall, the framework reflects how information-processing capabilities translate into operational performance.

5. RESEARCH METHODOLOGY

5.1 Research Design

This study follows a quantitative, cross-sectional, and explanatory research design within the positivist research paradigm. A quantitative approach is suitable as the study aims to test hypothesized causal relationships among latent constructs. The cross-sectional design allows these relationships to be examined at a single point in time across a sample of FMCG firms in Indonesia. Data is collected through a survey-based approach using a structured questionnaire.

5.2 Population and Sample

The population consists of FMCG firms operating in Indonesia, including both multinational and local companies across sub-sectors such as food and beverages, personal care, home care, and household products. To ensure alignment with the study objectives, firms are selected based on three conditions:

- (1) the use of digital systems such as ERP, warehouse management, or distribution management systems;
- (2) a minimum of three years of operational experience; and
- (3) distribution activities covering multiple regions within Indonesia, including areas beyond Java.

A purposive sampling method is applied to identify firms that meet these criteria. Respondents within each firm are selected based on their involvement in supply chain and inventory-related functions. Following the guidelines of Hair et al. (2019) for PLS-SEM, the minimum required sample size is determined using the “ten-times rule,” which recommends at least ten observations per structural path. Based on this, the study targets a minimum sample of 150 respondents.

The use of purposive sampling is justified due to the study’s focus on firms with established digital and supply chain practices. By selecting firms that have implemented ERP or related digital systems and have operated for more than three years, the study ensures that respondents possess sufficient experience and exposure to digital integration processes. This approach improves the relevance and quality of responses while capturing meaningful variation across firms. Furthermore, including firms that operate across multiple regions in Indonesia enhances representativeness by reflecting the geographical and operational complexity of the national FMCG sector.

5.3 Data Collection

Primary data is gathered using a structured questionnaire distributed to professionals such as supply chain managers, operations managers, and logistics or planning managers within selected FMCG firms.

The questionnaire is divided into five sections:

- (1) respondent and firm profile;
- (2) digital integration;
- (3) supply chain visibility;
- (4) demand forecast accuracy; and
- (5) inventory performance.

All responses are measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), consistent with prior empirical studies (Wamba et al., 2020; Dubey et al., 2021; Jing & Fan, 2024). Data collection is carried out through both online survey forms and, where possible, in-person visits.

5.4 Measurement and Operationalization

The study employs multi-item scales adapted from established and validated literature to measure each construct. Digital integration is assessed using indicators related to ERP connectivity, cloud-based systems, IoT usage, and cross-functional data exchange (Queiroz et al., 2020; Ivanov & Dolgui, 2021). Supply chain visibility is measured through dimensions such as inventory, shipment, and demand visibility across the network (Dubey et al., 2021; Alkhatib & Momani, 2023).

Demand forecast accuracy is evaluated using perceptual measures of forecast reliability and error frequency, supported where possible by firm-level metrics such as MAPE (Slimstock, 2025). Inventory performance is captured using indicators including inventory turnover, stockout occurrence, holding cost levels, and order fulfilment rates (Ivanov, 2021; Supply Chain 24/7, 2016).

In addition, control variables include firm size (number of employees), firm age (years of operation), and FMCG sub-sector classification.

Control variables such as firm size and firm age are included to account for structural differences across organizations. Larger firms, such as multinational FMCG companies, typically possess greater financial resources, advanced technological infrastructure, and higher levels of digital maturity, which may enhance the effectiveness of digital integration. In contrast, smaller firms may face resource constraints that limit their ability to fully implement integrated systems. Similarly, firm age may influence organizational routines, technological adoption, and resistance to change, thereby affecting how digital integration translates into operational outcomes. Therefore, controlling these variables allows for a more accurate estimation of the relationships proposed in the model.

5.5 Data Analysis

Data analysis is conducted using Partial Least Squares Structural Equation Modelling (PLS-SEM) with software such as SmartPLS. The process is carried out in two stages.

First, the measurement model is evaluated by examining indicator reliability, internal consistency reliability (Cronbach's alpha and composite reliability), convergent validity (average variance extracted), and discriminant validity (Fornell-Larcker criterion and HTMT ratio).

Second, the structural model is assessed using path coefficients, bootstrapped t-values, coefficient of determination (R^2), predictive relevance (Q^2), and effect size (f^2). The sequential mediation effect (H5) is tested through specific indirect effects using bootstrapping procedures, following the recommendations of Hair et al. (2019).

5.6 Expected Results and Model Evaluation

The proposed conceptual model is intended to be empirically tested in future research using Partial Least Squares Structural Equation Modelling (PLS-SEM). The structural model will be evaluated by estimating path coefficients (β) to determine the strength and direction of relationships among constructs. Statistical significance will be assessed using bootstrapping procedures, with t-values and p-values indicating hypothesis support.

In addition, the coefficient of determination (R^2) will be used to assess the explanatory power of the model for key endogenous constructs, namely supply chain visibility, demand forecast accuracy, and inventory performance. Higher R^2 values will indicate stronger predictive capability of digital integration and the mediating variables.

The sequential mediation effect (H5) will be examined through indirect path analysis, where the significance of the chain relationship (Digital Integration \rightarrow Supply Chain Visibility \rightarrow Demand Forecast Accuracy \rightarrow Inventory Performance) will be tested. The results are expected to provide empirical validation of the proposed information-processing

mechanism underlying supply chain performance improvements.

6. PRACTICAL IMPLICATIONS

The findings of this study offer several important implications for FMCG firms operating in Indonesia. First, companies such as Unilever Indonesia, Indofood, Wings Group, and Mayora can utilize the proposed framework to prioritize investments in fully integrated digital systems rather than isolated technologies. This is because the benefits of digital integration are realized through the downstream effects of visibility and forecasting improvements, rather than through standalone adoption (Ivanov & Dolgui, 2021; Wamba et al., 2020).

Second, firms should develop supply chain visibility systems and dashboards that directly support forecasting activities. Aligning visibility initiatives with forecasting requirements ensures that data-sharing efforts contribute meaningfully to improved predictive accuracy rather than functioning solely as reporting tools (Dubey et al., 2021).

Third, organizations need to link improved forecasting capabilities with responsive replenishment strategies and inventory deployment policies. This alignment ensures that gains in forecasting accuracy translate into tangible reductions in stockouts and inventory holding costs (Christopher, 2016).

However, several challenges must also be acknowledged. Infrastructure limitations outside Java continue to restrict the effectiveness of digital integration, particularly in remote regions. In addition, shortages of skilled digital talent and resistance to data-driven practices remain barriers within many organizations. These challenges highlight the importance of combining digital initiatives with organizational change management, workforce training, and targeted investments in last-mile digital infrastructure. From a policy perspective, the results reinforce the importance of initiatives such as the National Logistics Ecosystem and Making Indonesia 4.0 in promoting system-wide integration (Kearney, 2022).

Furthermore, firms are encouraged to invest in advanced analytics and artificial intelligence capabilities to strengthen real-time demand sensing and predictive decision-making (Kamble et al., 2021; Choi et al., 2023). Enhancing collaboration with suppliers and distributors through shared digital platforms can further improve data quality and responsiveness across the supply chain (Queiroz et al., 2020). Continuous employee training in digital tools and data interpretation is also critical to ensure that technological investments deliver meaningful operational benefits (Wamba et al., 2020). Finally, integrating performance monitoring systems with clearly defined key performance indicators (KPIs) will allow firms to evaluate the impact of digital integration on inventory efficiency and overall supply chain performance (Ivanov, 2021).

The role of control variables such as firm size and firm age is also expected to influence the effectiveness of digital integration. Larger firms, such as Unilever Indonesia or Indofood, typically possess greater financial resources, advanced technological infrastructure, and higher digital maturity, which may strengthen the impact of digital integration on supply chain outcomes. In contrast, smaller firms may face constraints related to investment capacity and technical expertise, potentially limiting the benefits of integration. Similarly, older firms may exhibit more established processes but could face resistance to digital transformation, while younger firms may demonstrate greater flexibility in adopting new technologies. These differences highlight the importance of considering firm-level heterogeneity in future empirical analysis.

7. CONCLUSION

This study contributes to the understanding of supply chain management by proposing and theoretically supporting a sequential mediation framework that links digital integration to inventory performance through supply chain visibility and demand forecast accuracy in

Indonesian FMCG firms. Based on Information Processing Theory (IPT), digital integration is viewed as a key information-processing capability, where its influence on performance is achieved through improved visibility and more accurate forecasting, while also directly enhancing performance through automation and greater operational efficiency.

One of the main contributions of this study is the reconceptualization of supply chain visibility. Rather than being seen only as a technological outcome, it is positioned as a critical intermediary capability that converts raw and fragmented data into meaningful insights for forecasting and operational decision-making. In this way, visibility acts as an essential link between digital systems and performance outcomes, instead of simply being a result of technology adoption. This multi-stage perspective extends existing research by clearly outlining a three-step sequential mediation mechanism, especially within the relatively underexplored context of emerging markets such as Indonesia.

From a contextual perspective, the framework captures the unique characteristics of the Indonesian FMCG sector, including its archipelagic structure, high logistics costs, dependence on traditional trade channels, and uneven levels of digital maturity. These factors highlight the importance of integrated digital systems in managing complexity and uncertainty.

From a policy standpoint, the findings emphasize the strategic role of initiatives such as the National Logistics Ecosystem (NLE) and Making Indonesia 4.0. The results suggest that comprehensive digital integration focusing on interoperability, data standardization, and cross-platform connectivity is more effective than fragmented technological adoption. Strengthening these initiatives will be important for improving supply chain efficiency, reducing logistics costs, and enhancing the global competitiveness of Indonesia's FMCG sector.

Finally, this study highlights the increasing importance of data-driven decision-making and provides a foundation for future empirical research, including the exploration of moderating factors such as firm size, technological readiness, and environmental uncertainty in emerging-market contexts.

REFERENCES

- A.P. Moller–Maersk. Southeast Asia logistics digitalisation report [Internet]. 2024 [cited 2026 Apr 23]. Available from: <https://www.maersk.com>
- Ali I, et al. Supply chain analytics and performance. *Technol Forecast Soc Change*. 2024.
- Alkhatib SF, Momani AM. Supply chain visibility and operational performance. *Uncertain Supply Chain Management*. 2023.
- Asian Development Bank. Indonesia: Critical development constraints [Internet]. Manila: ADB; 2020 [cited 2026 Apr 23]. Available from: <https://www.adb.org>
- Barratt M, Oke A. Antecedents of supply chain visibility. *Int J Prod Res*. 2007;45(6):1213–1234.
- Choi, T. M., Wallace, S. W., & Wang, Y. (2023). Big data analytics in operations management. *Production and Operations Management*.
- Choi TM, Wallace SW, Wang Y. Big data analytics in operations management. *Prod Oper Manag*. 2023.
- Christopher, M. (2016). *Logistics and supply chain management* (5th ed.). Pearson.
- Council of Supply Chain Management Professionals (CSCMP). (2023). *State of Logistics Report*.
- Dubey, R., Gunasekaran, A., Childe, S. J., Blome, C., & Papadopoulos, T. (2021). Big data and predictive analytics and manufacturing performance. *International Journal of Production Economics*, 231, 107–118.
- Dubey R, Gunasekaran A, Childe SJ, Blome C, Papadopoulos T. Big data and predictive analytics and manufacturing performance. *Int J Prod Econ*. 2021;231:107–118.
- Galbraith JR. Organization design: An information processing view. *Interfaces*. 1974;4(3):28–36.
- GEP. Supply chain visibility report [Internet]. 2023.
- Golpîra H, Khan SAR. Supply chain visibility and resilience. *Int J Logist Res Appl*. 2023.

- Hair JF Jr, Hult GTM, Ringle CM, Sarstedt M. *A primer on partial least squares structural equation modeling (PLS-SEM)*. 3rd ed. Thousand Oaks (CA): Sage Publications; 2021.
- He Y, et al. Digital transformation and inventory efficiency: Evidence from manufacturing firms. *Int J Prod Econ*. 2024.
- Ivanov, D., & Dolgui, A. (2021). Digital supply chain twin. *Transportation Research Part E*, 147, 102204.
- Ivanov, D. (2021). Supply chain viability and resilience. *International Journal of Production Research*, 59(12), 3535–3552.
- Ivanov D, Dolgui A. A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0. *Transp Res Part E Logist Transp Rev*. 2021;147:102204.
- Jing R, Fan Y. Digital integration and supply chain performance: Evidence from emerging markets. *Int J Prod Econ*. 2024.
- Kamble, S. S., Gunasekaran, A., & Gawankar, S. A. (2021). Data-driven supply chains. *International Journal of Production Economics*, 231.
- Kamble SS, Gunasekaran A, Gawankar SA. Achieving sustainable performance in supply chains. *Int J Prod Econ*. 2021;231:107–118.
- Kantar. Indonesia FMCG market report 2025 [Internet]. 2025 [cited 2026 Apr 23]. Available from: <https://www.kantar.com>
- Kearney. (2022). Digital supply chain maturity in Southeast Asia.
- Kearney. Digital supply chain maturity in Southeast Asia [Internet]. 2022 [cited 2026 Apr 23]. Available from: <https://www.kenresearch.com>
- Ken Research. Indonesia ERP software market outlook [Internet]. 2024 [cited 2026 Apr 23]. Available from: <https://www.kenresearch.com>
- Lee HL, Padmanabhan V, Whang S. The bullwhip effect in supply chains. *Sloan Manage Rev*. 1997;38(3):93–102.
- McKinsey & Company. Demand forecasting in the digital age [Internet]. 2021.
- Mordor Intelligence. Indonesia FMCG market – growth, trends, and forecast (2021–2025) [Internet]. 2025 [cited 2026 Apr 23]. Available from: <https://www.mordorintelligence.com>
- NielsenIQ. Indonesia FMCG outlook report. 2024.
- Queiroz, M. M., Ivanov, D., Dolgui, A., & Wamba, S. F. (2020). Digital supply chains. *Annals of Operations Research*, 291, 241–265.
- Queiroz MM, Ivanov D, Dolgui A, Wamba SF. Impact of epidemic outbreaks on supply chains. *Ann Oper Res*. 2020;291:241–265.
- Sanders NR, Ganeshan R. Forecasting in supply chains: The role of information sharing. *J Oper Manag*. 2020.
- Shakur M, et al. Digital supply chain integration and performance. *Sustainability*. 2024;16.
- Statista. Fast-moving consumer goods (FMCG) market revenue in Indonesia [Internet]. 2024 [cited 2026 Apr 23]. Available from: <https://www.statista.com>
- Supply Chain 24/7. Demand forecasting benchmarks and performance indicators [Internet]. 2016 [cited 2026 Apr 23]. Available from: <https://www.supplychain247.com>
- Tushman ML, Nadler DA. Information processing as an integrating concept in organizational design. *Acad Manage Rev*. 1978;3(3):613–24.
- Wamba, S. F., Gunasekaran, A., Akter, S., et al. (2020). Big data analytics and firm performance. *Journal of Business Research*, 117, 356–365.
- Wamba SF, Gunasekaran A, Akter S, Ren SJF, Dubey R, Childe SJ. Big data analytics and firm performance: Effects of dynamic capabilities. *J Bus Res*. 2020;117:356–65.
- World Bank. (2023). *Connecting to Compete 2023: Trade Logistics in the Global Economy (Logistics Performance Index)*.
- World Bank. Connecting to compete 2023: Trade logistics in the global economy [Internet]. Washington, DC: World Bank; 2023 [cited 2026 Apr 23]. Available from: <https://lpi.worldbank.org>
- World Customs Organization (WCO). National Logistics Ecosystem performance report [Internet]. 2024 [cited 2026 Apr 23].