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The Effect of Inventory Management Techniques on Supply Chain Efficiency. The Moderating Role of Process Innovation

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Abstract
Effective inventory management techniques are crucial for optimizing the flow of goods across the supply chain. This study aims to determine the moderating effect of process innovation on the relationship between inventory management techniques and supply chain efficiency. A survey method was used in this study. The data collected was cross-sectional, meaning it was gathered at a single point in time. There is a strong positive effect of supplier relationship management on supply performance. Additionally, employee commitment positively and significantly affects supply performance. However, the effect of employee commitment on the relationship between supplier relationship management and supply performance is not statistically significant. When effectively implemented, inventory management techniques can be seen as unique resources specific to an organization. This study aims to contribute to the existing body of knowledge by providing empirical evidence on the interdependence of inventory management techniques, process innovation, and supply chain efficiency.

Keywords: *Inventory Management Techniques, Supply Chain Efficiency, Process Innovation*

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1.0 INTRODUCTION

In today's business environment, supply chain efficiency is a critical determinant of organizational success. Effective inventory management techniques play a crucial role in optimizing the flow of goods across the supply chain. However, the impact of these techniques on supply chain efficiency is complex and dynamic. Additionally, the role of process innovation as a potential moderator in this relationship requires further investigation. Numerous studies (Simchi-Levi, Kaminsky, & Simchi-Levi, 2008; Chopra & Meindl, 2016; Monczka et al., 2015) have acknowledged the significant influence of inventory management on supply chain performance. However, there is a lack of comprehensive insights into how various inventory management strategies, such as just-in-time (JIT), Economic Order Quantity (EOQ), and vendor-managed inventory (VMI), collectively enhance supply chain efficiency. The evolving business landscape also highlights the importance of process innovation as a dynamic factor influencing supply chain dynamics (Roh, Hong, & Min, 2017). Yet, the interaction between inventory management techniques and the moderating role of process innovation in improving supply chain efficiency has not been thoroughly explored. This research aims to fill this gap by investigating the interplay between inventory management techniques and supply chain

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efficiency, with a specific focus on the moderating impact of process innovation. Understanding how these variables interact can provide valuable insights for businesses seeking to optimize their supply chain operations in an era characterized by rapid technological advancements and market dynamics. As organizations increasingly adopt Industry 4.0 technologies and emphasize process innovation (Lee, 2020), it is crucial to analyze how these advancements align with and potentially transform traditional inventory management strategies.

2.0 MATERIALS AND METHODS

2.1 Supply chain efficiency

Supply strategy involves achieving balance within a network, with managers ensuring their organization's success within a broader, interdependent network. Organizational goals must align with network needs, as individual efficiency and relationship effectiveness alone are insufficient. Collaborative strategies extend beyond individual control, affecting goal measurement and definition in supply chain management. A supply chain, part of a network delivering products from raw materials to customers, aims for efficiency (internal performance) and effectiveness (meeting external demands). Efficiency offers cost advantages through practices like Just-in-Time production, while effectiveness enhances customer responsiveness. Value encompasses both monetary and non-monetary outcomes from relationships. Supplier efficiency directly impacts value, while supplier effectiveness and network effects have indirect influences. Efficiency and effectiveness result from value creation processes involving multiple organizations. Use value, linked to effectiveness, arises from cooperative activities leveraging interdependencies. Supply chain activities, characterized by sequential, pooled, and reciprocal interdependencies, are managed through process integration, standardization, specialization, responsiveness, and innovation capability.

2.2 Hypotheses Development: Inventory Management Strategies & Supply Chain Efficiency

Just-in-Time (JIT) is a widely recognized inventory management approach that minimizes inventory levels to meet immediate production needs, thereby reducing carrying costs and the risk of obsolescence (Stevenson & Hojati, 2015). JIT enhances supply chain efficiency by streamlining production processes and eliminating excess inventory. Vendor-Managed Inventory (VMI) is another technique that fosters collaboration between suppliers and retailers. In a VMI system, suppliers manage inventory levels at the retailer's end, leading to more accurate demand forecasting and fewer stockouts (Simchi-Levi et al., 2018).

This collaboration optimizes stock levels, improves responsiveness, and reduces the bullwhip effect. Advanced technologies like RFID and IoT have transformed traditional inventory management by providing real-time visibility into inventory levels, aiding in accurate demand forecasting and optimization (Wu et al., 2020). These technologies enhance supply chain efficiency by reducing uncertainties and increasing responsiveness. Risk pooling, which involves strategically consolidating inventory, helps mitigate disruptions in the supply chain (Lee et al., 2016). This technique minimizes the impact of uncertainties and strengthens supply chain resilience, ultimately improving efficiency.

In summary, the study proposes: H_1: There is a positive relationship between inventory management strategies and supply chain efficiency.

2.3 Hypotheses Development: Role of Innovation and Supply Chain Efficiency

In recent years, the competitive and globalized business environment has driven organizations to adopt innovation as a key strategy to navigate uncertainty (Pan and Li, 2016). Innovation is

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crucial for organizational growth and survival (Hojnik and Ruzzier, 2016). There are different types of innovation, such as process and product innovation. This study focuses on process innovation, which involves introducing new production methods, management approaches, and technologies into an organization's operations (Brem et al., 2016; Salerno et al., 2015). This approach uses new knowledge and tools to optimize resources, reduce costs, and enhance production efficiency (Salerno et al., 2015). Examples include investing in new technology, software for supply chain management, design software, and staff training (Pan and Li, 2016). A new aspect of process innovation is green process innovation, which aims to reduce environmental impacts and pollution through modified manufacturing processes (Wong et al., 2013; Kammerer, 2009; Meeus and Edquist, 2006).

Research shows that process innovation improves customer satisfaction, operational performance, and financial performance (Lau et al., 2010; Lambertini and Mantovani, 2009). Chen et al. (2006) found a direct link between investment in process innovation and competitive advantage, while Chiou et al. (2011) confirmed its positive impact on competitive advantage. Companies use process innovation to reduce production time and costs (Lambertini and Mantovani, 2009). Hojnik and Ruzzier (2016) noted that process innovation enhances profitability, growth, and competitiveness. Kleindorfer et al. (2005) highlighted that it can improve economic and social performance by reducing waste and costs.

Doran and Ryan (2012) found that firms implementing process innovation see higher revenue per employee. Additionally, process innovation can increase employee numbers and turnover (Rennings et al., 2006) and improve market position, corporate image, and competitiveness (Presley et al., 2007; Mu et al., 2009).

This study hypothesized that: H_2: positive relationship exists between role of innovation and supply chain efficiency

2.4 Hypotheses Development: Moderating Impact on Role Of Innovation on the Relationship Between Inventory Management Strategies and Supply Chain Efficiency

Jacobs (2019) notes that an effective supply chain optimally uses financial, human, technological, and physical resources, which reduces operational costs for materials and packaging and minimizes time wastage. Lee et al. (2011) define supply chain efficiency as encompassing profitability, flexibility, reliability, and waste management, and view it as crucial for improving business processes and leveraging information systems to enhance delivery speed and customer responsiveness.

Innovation leadership significantly influences supply chain efficiency, as highlighted by Yoon et al. (2016) and Jermsittiparsert and Srihirun (2019). Effective leaders, who understand supply chain management, maintain strong work ethics, and build open organizational relationships, drive process improvement and efficiency (Lovelace et al., 2001). They foster individual responsibility, encourage transparency, and build trust within teams (Carmeli et al., 2010).

Research indicates that innovation leadership leads to process improvements, which in turn enhance supply chain efficiency (Yoon et al., 2016; Heim & Peng, 2010; Lin, 2014). Process improvements streamline operations, reduce waste and costs, and boost efficiency. Furthermore, process improvement mediates the relationship between innovation leadership and supply chain efficiency, as leaders who focus on innovation and team performance drive better operational

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processes and faster information exchange, ultimately delivering greater customer value (Yoon et al., 2016; Bag and Anand, 2016; Flint et al., 2008).

H_3: Role of innovation positively moderates the relationship between inventory management strategies and supply chain efficiency.

3.0 METHODOLOGY

3.1. Research Strategy Adopted for the Study

The study used quantitative research exclusively to develop a framework for strategic purchasing and organizational performance. This approach was chosen to assess the principles of green city development in Kumasi. Johnson and Onwuegbuzie (2004) describe quantitative research as focusing on deduction, hypothesis testing, explanation, prediction, standardized data collection, and statistical analysis. Borkan (2004) adds that quantitative methods allow researchers to make inferences about specific aspects of interest and use statistical techniques to identify correlations and variations over time.

3.1.1 Data Collection Method

Data collection involves systematically gathering and measuring information about variables of interest to address research questions, test hypotheses, and evaluate outcomes. This process is crucial across various fields, including the physical and social sciences, humanities, and business. While methods may vary by discipline, the emphasis on accurate and honest data collection is consistent. The goal is to obtain high-quality evidence that supports thorough data analysis and leads to credible answers.

Maintaining research integrity requires accurate data collection, whether the data is quantitative or qualitative. Choosing the right data collection instruments whether existing, modified, or new and providing clear instructions for their use are essential for minimizing errors. Effective data collection involves careful planning, hard work, patience, and perseverance. It starts with identifying the necessary data, selecting a sample from the population, and using the appropriate instrument to gather information. In this study, a quantitative approach was used with questionnaires employing numerical scales (Likert scale 1-5) for mathematical computation.

4.0 RESULTS AND DISCUSSIONS

4.1. Reliability and Validity Tests

Reliability refers to the consistency and stability of a measurement tool, indicating how well it produces consistent results over time or under different conditions. DeVellis (2017) explains that a reliable instrument should yield similar results when used repeatedly under the same conditions, enhancing confidence in its accuracy. Validity tests are crucial for research methodology, assessing whether a measure accurately captures what it is intended to measure. Content validity ensures that survey questions are relevant and comprehensive, covering the full range of the construct being measured. Construct validity evaluates whether the survey accurately measures the theoretical concept it claims to assess. For example, if measuring professional qualifications, the questions should appropriately reflect the different qualifications. Factor loadings describe the strength and direction of the relationship between observed variables (items) and underlying latent constructs in factor analysis. According to Stevens (2009), factor loadings indicate how well an observed variable represents the underlying construct, with a loading of 0.5 or higher generally considered acceptable. Higher factor loadings suggest that

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an item is a strong indicator of the latent variable. Table 4.2 provides details on the validity and reliability tests.

Table 4.1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.914
Bartlett's Test of Sphericity	Approx. Chi-Square	4056.549
	df	528
	Sig.	.000

Table 4.2.1 Cronbach's Alpha and Factor loading results

Process Innovation	Inventory Management Techniques	Supply Chain Efficiency
Cronbach's Alpha =.893	**Cronbach's Alpha = .965**	**Cronbach's Alpha = .757**
Factor loadings	**Factor loadings**	**Factor loadings**
PRIN1.605	INMT1.734	SCE1.756
PRIN2.667	INMT2.660	SCEF2.748
PRIN3.761	INMT3.731	SCEF3.572
PRIN4.697	INMT4.704	SCEF4.709
PRIN5.702	INMT5.714	SCEF5.841
PRIN6.671	INMT6.751	SCEF6.849
PRIN7.739	INMT7.715	SCEF7.841
PRIN8.740	INMT8.793	
	INMT9.682	
	INMT10.654	
	INMT11.731	
	INMT12.708	
	INMT13.755	
	INMT14.753	
	INMT15.732	
	INMT16.711	
	INMT17.780	
	INMT18.718	

Source: Field Survey, 2023

The KMO measure evaluates whether a sample is adequate for factor analysis. A value close to 1.0 indicates high sampling adequacy, with a value of 0.914 in this case, suggesting that the data is very suitable for factor analysis.

Cronbach's Alpha measures the internal consistency or reliability of a scale. Values closer to 1.0 indicate greater reliability. In this study, the Cronbach's Alpha values for all three constructs are relatively high, indicating strong internal consistency.

Factor loadings show the strength and direction of the relationship between individual items and the underlying construct, ranging from -1 to 1. Higher values suggest a stronger relationship. For the Process Innovation (PRIN) construct, items PRIN1 to PRIN8 have factor loadings from

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0.605 to 0.740. For Inventory Management Techniques (INMT), items INMT1 to INMT18 range from 0.654 to 0.793. For Supply Chain Efficiency (SCEF), items SCEF1 to SCEF7 range from 0.572 to 0.849. Factor loadings above 0.5 are generally considered good, indicating that the items are effectively represented by their respective constructs.
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Table 4.2. Hypothesis Testing and Findings

Hypothesis	Relationship	Beta	t	p	Remarks
H1	INMT - - > SCEF	.273	3.328	.001	Supported
H2	PRIN - - > SCEF	.548	7.698	.000	Supported
H3	PRIN - - > INMT * SCEF	.0592	.2814	.7789	Not Supported

Source: Field Survey, 2023

4.2. Discussion

Effect of Inventory Management Techniques on Supply Chain Efficiency

The study found that inventory management techniques positively and significantly impact supply chain efficiency. Effective inventory management reduces costs by minimizing holding expenses and optimizing order quantities (Goyal & Gupta, 2019), directly enhancing supply chain efficiency. It also helps mitigate risks from supply chain disruptions by maintaining appropriate safety stock levels (Tang, 2016), which improves the ability to handle uncertainties. Efficient inventory management streamlines warehouse operations (Tomlin, 2016) and prevents issues such as stockouts and overstocks (Simchi-Levi, Kaminsky, & Simchi-Levi, 2013), ensuring optimal stock levels and reducing excess holding costs.

Effect of Process Innovation on Supply Chain Efficiency

The study also showed that process innovation has a positive and significant effect on supply chain efficiency. Process innovations, which often involve new technologies or methodologies, improve operational efficiency by streamlining operations and reducing bottlenecks (Gunasekaran et al., 2017). They include advanced communication tools and better coordination among supply chain partners, leading to faster decision-making and responsiveness (Christopher & Towill, 2012). Innovations in forecasting and demand planning further optimize inventory levels, reducing holding costs and enhancing supply chain efficiency (Cachon & Fisher, 2020).

Moderating Effect of Process Innovation

The study investigated whether process innovation moderates the relationship between inventory management techniques and supply chain efficiency but found no significant moderating effect. Some scholars argue that process innovation and inventory management techniques are separate factors with independent effects on supply chain efficiency (Srinivasan & Swink, 2018). Process innovation often focuses on cost reduction, quality improvement, or speed to market, while inventory management techniques concentrate on optimizing stock levels and minimizing holding costs (Mollenkopf et al., 2010). Because their objectives differ and process innovation is more technology-driven compared to the strategy-driven nature of inventory management techniques (Koh, Saad, & Arun, 2016), process innovation does not significantly moderate the impact of inventory management techniques on supply chain efficiency.

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5.0 CONCLUSIONS

5.1 Managerial Implications

The positive effects of inventory management techniques and process innovation on supply chain efficiency offer several key managerial implications. Managers should prioritize implementing and refining inventory management techniques to maintain optimal stock levels, utilizing advanced forecasting and demand planning tools to reduce excess inventory and holding costs. They should also embrace process innovation by adopting new technologies and methodologies to streamline operations and enhance communication. A holistic approach, where inventory management and process innovations work together, can improve visibility, coordination, and decision-making across the supply chain. Managers should foster a culture of continuous improvement, regularly updating practices to keep pace with industry trends and technological advancements.

5.2 Theoretical Contribution

The Resource-Based View (RBV) offers a framework for understanding how inventory management techniques can provide a sustained competitive advantage and enhance supply chain efficiency. Effective inventory management can be a unique resource, combining tangible assets (like physical inventory and warehouses) with intangible assets (such as knowledge and information systems). The RBV suggests that competitive advantage arises from resources and capabilities that are difficult for competitors to replicate. Effective inventory management techniques, developed through organizational learning and experience, can be a source of such inimitability.

5.3 Recommendations

To maximize the benefits of inventory management techniques and process innovation on supply chain efficiency, organizations should:

- Adopt advanced technologies such as analytics, artificial intelligence, and machine learning to improve forecasting accuracy, automate tasks, and optimize processes.
- Ensure seamless integration between inventory management systems and process innovations for real-time data sharing and better decision-making.
- Promote collaboration between supply chain, operations, and IT teams to create a unified approach to supply chain management.
- Focus on data accuracy and visibility to support effective inventory management and data-driven decision-making.
- Invest in training programs to develop workforce skills in inventory management and new technologies.
- Implement lean inventory management principles and practices like just-in-time (JIT) to reduce waste, lower holding costs, and improve responsiveness.

By following these recommendations, organizations can create a more efficient and agile supply chain, with continuous improvement and adaptability being essential for long-term success.

5.4 Suggestions for Future Study

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Future research could explore the impact of emerging technologies such as blockchain, Internet of Things (IoT), and 5G on inventory management and process innovation, examining how these technologies enhance supply chain visibility, traceability, and efficiency. Comparative studies across different industries could reveal sector-specific best practices and challenges related to inventory management and process innovation. Additionally, investigating the integration of environmentally sustainable practices within these areas could provide insights into how sustainability efforts affect supply chain efficiency and performance. These research directions can offer valuable insights for both practitioners and policymakers. 40 mini

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