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Research Article

Analysing the Role of Inventory and Warehouse Management in Supply Chain Agility: Insights from Retail and Manufacturing Industries

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Abstract

Inventory and warehouse management function as one of the critical success factors in today's supply chain because they affect the company's performance and its customers' satisfaction. Today, competition and volatility across the global markets are on the rise and for an organisation to be sustainable competitive the supply chain must be agile. Published within this review paper are details of the importance of inventory and warehouse management to supply chain adaptability with an emphasis on the findings of the retail and manufacturing industries. Specifically, it examines the way practices like lean inventory, automation, and the use of real-time data help organizations to become more flexible and respond to market signals more quickly. The paper also discusses the major issues, such as inventory management and service delivery, technology implementation issues, and disruption of the supply chain. Also, possibilities to advance, for example, via adoption of smart warehousing solutions and optimization via predictive analysis are mentioned to advance the supply chain. This study lays the groundwork for future research on improving supply chain responsiveness through improved inventory and warehouse management and provides suggestions for supply chain industry practitioners.

Keywords*: Inventory Management, Warehouse Management, Supply Chain Agility, Retail Industry, Manufacturing Industry, Operational Efficiency, Supply Chain Optimization, Logistics Management.*

Introduction

The current dynamic and competitive market climate has made supply chain agility a crucial aspect for most organisations' success. Many changes have occurred since "supply chain management" was first proposed by. A supply chain is frequently associated with the process of optimising the production process using the available resources in its more conventional form [1], [2], [3]. Christopher and Towill, (2001) and Birasnav and Bienstock, (2019) claimed that lean assumptions organise a complicated network of supply chain operations. It addresses the capability that is flexibility of a supply chain to respond to changes in the market forces, volatility of demand and other risks in equal measure as it does the discipline of supply chain services. Retail and manufacturing industries specifically require agility to improve the overall supply chain by reducing delivery time and cost along with meeting customer demands. Inventory and warehouse management are two of the most important sub-processes of an effective and efficient supply chain. This is because right products are in the right place at the right time hence avoiding either a stock out or having too many stocks. Also, warehouse management is another key element to enhance storage, order picking and to reduce lead time. Combined, the above functions are the core of supply chain management systems that allow organizations to respond promptly to market needs. Warehouse management also has an important part in effectively storing inventory, efficiently fulfilling orders and shortening lead times .

One of the most crucial business operations for a manufacturing or production organisation is inventory management, which includes purchasing, selling, and logistics [6]. It focusses on inventory management across the whole supply chain. The data level, where daily operations are structured, is where inventory control is located. Short-term planning and event recording are the main focus of these data-driven activities. Maintaining the proper amount of stock and tracking its movement are the two basic goals of inventory control.

According to [7], Inventory management refers to all the processes of acquiring, putting in stock and using inventories of raw materials, work-in-progress and finished goods to ensure there is the optimum

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supply of stores and to minimise costs attributable to over-inventory or under-inventory. Maintaining the market, the production machinery, and the distribution network all depend on inventories. They act as a spring and lubricant for an organization's distribution and production systems. Maintaining plant and machinery, organising industrial activities, and meeting other operational needs all depend on inventory [8]. As a result, funds or capital that could have been put to better use are tied up. When inventory stocks are high, an organization's management becomes extremely anxious. As a result, management needs to closely examine it. When it comes to any shortfall of inventory products needed for production, management is quite crucial. Any increase in machinery or operation redundancy brought on by inventory shortages could result in a loss of productivity and the expenses that go along with it. However, in a manufacturing system, the physical configuration and capacity of equipment typically predetermines the control of a very intricate and versatile process of different goods [9][10]. The machines are not designed to perform a specific task; each of the tools requires configuration every time the type of work changes [11]. It is imperative that an organisation hires skilled staff who are conversant with inventory control processes to deal with the cost of operation from the supply chain, which is the most critical factor in any business.

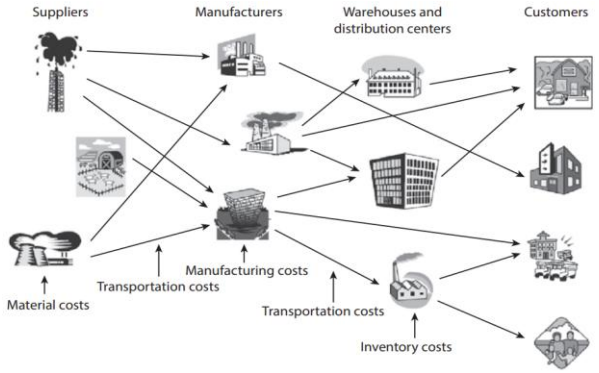

Fig.1 A Typical Supply Chain[11]

Figure 1 shows a supply chain network as a complex structure; the different costs are also shown in the following stages. This reveals how the input resources are purchased from the sellers and then taken to industrial producers, where they are embodied into final products. These products are then transferred to the warehouses and distribution channels for storage and other distribution residuals to clients. The key cost parameters include cost of materials (acquired from suppliers), the cost of manufacture, transportation expense cost (between stages), and cost associated with inventories (of goods). The picture illustrates how this has to be done to bring down these costs and the importance of efficient supply chain in delivering a manufactured product to the consumer.

Purchasing and stocking of raw material, work-in-progress and finished goods are the key components of inventory control that helps to meet the organizational requirement at low cost either it may be over or under stock [7]. Production, the market, and distribution depend on inventories. Organisational production and distribution systems use them for lubrication and spring. Production, plant and machinery maintenance, and other operational needs require inventory. This ties up money or capital that may be better spent. High inventory stocks worry management. Therefore, management must closely monitor it. Management is highly concerned about manufacturing inventory shortages. Due to inventory shortages, machines or activities may become redundant, resulting in output loss and expenditures. Production control is determined by machine layout and capabilities, even in complicated and adaptable manufacturing processes that produce a wide range of goods. Because the machines are not made for a single task, different tools need to be set up for each variation in the work [11]. Cost control is an important factor that is facing organizations today and this makes supply chain costs a main concern and thus requires professional inventory management specialists. Supply chain resilience is defined as the ability of the supply chain "to regain its equilibrium or transition to a higher state of equilibrium in the wake of disturbance" [13]. It suggests the capacity of the supply chain to avoid, control for, and correct risks leading to supply-demand fluctuations. Hence, if the probability of misfit is small, timeless or status after recovery is better, the supply chain is more robust.

Due to globalization occurrences such as the current coronavirus (COVID-19) pandemic will bring about significant and long term implications to supply chain logistics, suppliers and employees [14]. Events such as local natural disasters such as earthquakes and floods and global factors such as changes in inflation rates, market forces, political policies and climatic change factors also have a similar impact to local disruptions on global supply chain management [15]. At the same time, ubiquitous digital technologies are changing the configurations and procedures of supply chains [16]. However, these developmental changes could further complicate supply chain risk because the Industry 4.0 designs enhance the coordination complexity and cause delays in information flow due to concerns over data security [17]. Significant changes in consumer behaviour, particularly in the aftermath of the epidemic, create additional challenges. Because of the significant mismatches between supply and demand caused by erratic demand, such changes have the potential to upset supply networks [18]. Additionally, supply chain participants are increasingly coming into situations for the first time where neither the likelihood nor the consequences of risks are understood, which raises uncertainty and disruption risks towards unknown unknowns [19]. The continuous and crucial task of creating a more robust supply chain is highlighted by these advancements.

Industry 4.0 has revolutionised the way supply chain management was previously perceived and has transformed future roles and jobs by challenging the ability to develop new techno-commercial skills to get increased value from optimised resource consumption [20][21]. The services and manufacturing sectors differ, thus it was not surprising that there was a lack of prior study and writing on the subject, even with these resources and the vastly disparate adoption and benefit realisation rates of Industry 4.0. Research relating supply chain integration to improved business success makes this even more clear [22], [23] and how supply chain integration is made possible and increased by Industry 4.0. The question then becomes to what extent the degree of integration can boost businesses' flexibility and agility. What internal and external factors enable businesses to better integrate?
Over the past 200 years, supply chain management's focus has changed. In the 19th century, supply chain participants placed a strong emphasis on establishing specific goals and fostering more partnerships. However, in the 20th century, this has evolved into a distinct understanding of association and the fortification of relationships between supply chain actors [24]. In a similar vein, the rise in globalisation has made markets extremely competitive. Both domestic and foreign markets now face increased rivalry. Because of Zara's speed in incorporating new fashion industry trends, their performance has attracted people's attention [25]. Because of the pressure from retailers and the "e" and "m"-commerce industries, there is a greater requirement for quick inventory turnover. Members of the supply chain have attempted to save expenses while optimising the quality of services. Additionally, in response to changing consumer tastes and behaviour, the product's design, features, and quality must be modified [26].

In order to adjust to shifting market conditions and heightened competition, supply chain managers need to make their supply chains more flexible [27]. Technology and consultancy firms have begun offering management and ICT tools to improve supply chain agility [28]. It is possible to increase supply chain agility by utilising better IT tools and technology. According to literature, supply chain managers are increasingly concerned about the idea of agility [29].

Using data from the manufacturing and retail sectors, this research examines how inventory and warehouse management might improve supply chain agility. Consequently, this article's goal is to take a look at the ways in which these practices promote agility, the challenges that are being encountered, and the possibilities for future innovation.

Warehouse And Inventory Management's Part in Supply Chain Agility

Contribution of Inventory Management to Agility

Maintaining the correct supply-to-demand ratio is crucial for enhancing supply chain agility, and inventory control plays a key role in this [30]. With the help of just-in-time (JIT) technology, safety stock optimisation, and demand forecasting, businesses can respond swiftly to shifts in consumer demand and the market. Businesses may make their supply chains more responsive and flexible by keeping appropriate inventory levels and reducing lead times, holding costs, and stockouts [31]. A critical factor in supply chain agility, well-structured inventory control also makes it possible for better resource allocation, enhanced cash flow management, and increased flexibility in the face of unforeseen interruptions.

These attributes determine the layout (size or size-class, or length, width and height of the overall supply chain and the network of facilities that compose it). The supply chain may consist of multiple related companies where each performs a different activity. The diagram in Figure 2 shows the normal supply chain structure, with suppliers, producers, distributors, retailers and customers. Additionally, there are numerous service providers who support these components with additional services. The principal company's suppliers and consumers make up the most fundamental link in a supply chain. In extended supply chains, there are three more types of participants: (i) the initial supplier or ultimate supplier; (ii) the final consumer or customer; and (iii) service providers to other businesses in the supply chain that provide services in various areas, such as IT, marketing, finance , logistics, and so on.

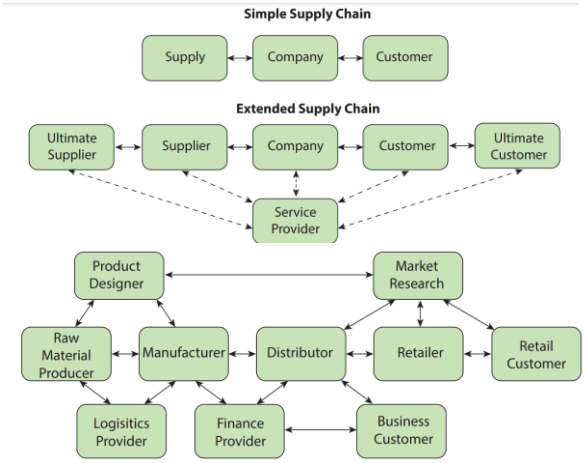

Fig.2 Different Supply Chain Structures [12]

Efficient inventory management is all about making it easy to have the right item in the right quantity in the right time for supply chain responsiveness [32]. The ability of businesses to swiftly adjust to shifting consumer demands, supply shocks, and market shifts is the essence of supply chain responsiveness. Demand forecasting, JIT management, and real-time inventory control are some strategies that assist businesses keep the proper amounts of inventory on hand at the correct times to satisfy customer demands without going overboard [33][34]. This equilibrium helps companies reduce lead times, boost order delivery rates, and eventually boost customer happiness, all of which help to increase the supply chain's overall flexibility.

In addition, strategic inventory management enhances supply chain flexibility by enhancing the use of resources as well as costs, encouraging efficient practices. Thus, using such approaches as safety stock management and ABC analysis companies can identify and give preference to the goods that are in great demand or are most valuable, giving the priority to have quick access to crucial products [35]. To enhance supply chain performance, this method aids in preventing interruptions caused by suppliers' delays or changes in market trends. Moreover, inventory and analysis software as well tools such as predictive analysis give an immediate response, optimising the management and change of inventory tactics required due to alterations of the market environment.

Inventory management can also be regarded as a key principle of supply chain responsiveness because it forms the basis through which organisations can respond quickly to dynamic conditions, although supply chain performance may be affected [36]. Through the integration of inventory data with demand data and by applying managerial decision-making, flexibility, increased services, and decreased costs are possible. Such responsiveness does not only improve competitiveness but also ensures long term immunity from market volatilities and supply shocks.

Importance of Warehouse Management in Enhancing Responsiveness

Because warehouse management makes sure that commodities are handled, stored, and distributed efficiently, it is essential to improving supply chain responsiveness [37]. An optimised warehouse management system (WMS) allows businesses to streamline operations, reduce order processing times, and ensure faster delivery to customers. By implementing strategies such as proper space utilisation, automation, and inventory tracking, warehouses can minimise delays and improve order accuracy. Businesses may avoid overstocking or running out of stock, two situations that could slow down responsiveness, with the help of modern WMS platforms that show inventory levels in real-time.

Moreover, effective warehouse management contributes to supply chain responsiveness by facilitating better coordination between different supply chain stages. Modern practices like cross-docking, zone picking, and batch processing help accelerate order fulfilment while reducing handling times. A well-organized warehouse layout, coupled with technologies such as barcode scanning and RFID systems, further ensures efficient movement of goods and reduces the likelihood of errors during order picking and shipping. By enabling faster decision-making and improving operational efficiency, warehouse management becomes a critical component in meeting customer expectations for speed, accuracy, and service reliability [38].

In addition to enhancing operations, warehouse management enables faster and more accurate order processing, which significantly boosts supply chain flexibility. Robots and automated storage and retrieval systems (AS/RS) are two other technologies that considerably cut down on handling time, allowing for fast order processing [39]. It also reduces picking and packing errors, making customers happy, and therefore the company makes more profit. Moreover, the kind of warehouses that have operational real-time data analysis and effective tools for demand forecasting are in a position to predict the next demand of inventory, hence having the correct kind of products readily available in all the places required at specific time periods [40]. The benefit of this proactive approach is a reduction in lead times and the improvement of total supply chain time.

Another important element of managing a warehouse as a tool for improving the company's responsiveness is its contribution to the fulfilment of the last-mile delivery, which is an important aspect of customer satisfaction. Some coverable fixed expenses include better-placed warehouses and distribution facilities since they enable organizations to stock merchandise closer to the consumers so as to be able to offer same-day or next-day deliveries. Effective implementation of reverse logistics or management of returns and exchange also creates good customer value and effective supply chain management [41]. When warehouse strategies are properly synchronised with strategic initiatives of the supply chain, companies are likely to enhance adaptability to shifts in customer preferences and the market environment.

Consequently, making use of modern technology, designing effective processes, and strategically arranging stocks are crucial components of supply chain performance that lead to responsive WMS. Whenever customers are demanding high service delivery in terms of speed and accuracy, it is compulsory for the firm to improve its warehouse operations. With real-time people and process integration, advanced automation and integration with other business operations, warehouses serve as critical processes for helping organizations respond rapidly to changing demands and deliver superior service quality to their customers.

Challenges And Opportunities

Barriers to Effective Inventory and Warehouse Management

Challenges in inventory control and warehouse can be rooted in operations, technology, and partnerships with other supply chain partners [42]. Lack of effective demand forecasting will see supply chain inventory levels not being replenished properly and hence, seeing high levels of overstock or stock out situations. Thus, suboptimal technology usage, including the absence of sophisticated tools for inventory management or automation of storage facilities, can continue to exacerbate the problem of visibility and

control over inventory levels [43]. However, inadequate layout design, improper space management, and paper-based operations slow down order delivery and cause errors in stock management. Warehouse workers' inability to effectively communicate with suppliers and other members of the supply chain is one indicator of the broader problem of mismatches between supply chain participants. Overcoming these barriers requires the integration of technology in the system, training of the staff, and the redesigning of the process in a way that can help in responding to the inventory requirements effectively [44].

The problem is that warehouse space isn't being used to its maximum capacity. With a well-organised warehouse, your company's performance, productivity, and key performance indicators will all be up. This is because organisational process improves every aspect of a firm [45]. Optimisation of put-away, picking, packing, storage, shipment, and reception processes is necessary due to the high probability of shipping errors, which include, but are not limited to, any shortage of goods, damage, improper picking, overage, incorrect labelling, and incorrect ordering. A manufacturing or production warehouse holds the supplies required for manufacturing operations. These facilities are used to supply and store raw materials, production parts, components, and semi-finished goods. Many objectives are taken into consideration, such as inventory management, material handling, storage, resource planning, and internal and external logistics.

Emerging Opportunities Through Technology and Sustainability

New opportunities through IT advancement and sustainability issues are reviving inventory and warehouse management by making it faster and environmentally sustainable [46]. Machine learning (ML) , artificial intelligence (AI), and the Internet of Things (IoT) are transforming inventory tracking and control. Organisations should be able to better manage surplus supplies and other wasted items if AI and ML were to improve the demand forecast. IoT applies real-time visibility to stock movements thus minimising on probability of stock out or overstocking. Also, robotic systems in warehouses become especially effective for order picking, sorting, and packing because these activities are time-saving and less costly than manual operations. Not only do these technologies improve operational performance, but they also provide avenues for organizations to grow their operations quickly in response to market dynamics.

Sustainability is moving into the focus of inventory and warehouse management due to the environmental and customer changes that are taking place [47]. Sustainable technologies include green systems for storage, solar power structures and environment-friendly packaging to minimise the extent of carbonisation [48]. A substantial reduction of energy use is achieved by incorporating renewable energy in warehouse systems, in addition to efficient hardware and cooling systems. In addition, improved, innovative methods in recycling and management of waste reduce the levels of e-waste produced by outdated stocks and equipment. This paper has discussed ways in which embracing sustainable practices results not only in environmental conservation but also in business benefits such as protecting and enhancing business image and providing for customer demands for sustainability which can be strategic tools to achieve competitive advantage.

Combined, the integration of emerging technologies and sustainability represents a compelling prospect to improve inventory and warehouse operations. Many firms that invest in these areas are in a relatively better position to fine-tune their operations, cut costs, and address the demand for faster and ‘greener’ products and services. These trends hence can be used by the company to cover more grounds in terms of business competition and efficient supply chain system.

Literature Review

Inventory and warehouse management play a crucial role in enhancing supply chain agility, particularly in the retail and manufacturing sectors, by optimising product availability, operational effectiveness, and profitability. Efficient inventory management directly impacts financial performance, with studies showing that raw materials and work-in-progress inventories significantly affect profitability, especially in manufacturing, where longer inventory days negatively impact returns [49]. In retail, centralised inventory coordination improves profit margins by optimising pricing and scheduling to accommodate varying demand scenarios [50]. Techniques such as ABC analysis and genetic algorithms help optimise warehouse operations by reducing transfer distances and improving service levels [51], while the integration of Industry 4.0 technologies like IoT and RFID enhances inventory control and responsiveness to market changes [52]. Effective inventory management drives supply chain responsiveness, with IT integration and coordination boosting agility, particularly in retail [53]. However, challenges such as fluctuating demand and supply chain disruptions require continuous adaptation and innovation to maintain agility and efficiency in inventory and warehouse management practices.

Inventory and warehouse management play a pivotal role in enhancing supply chain agility, particularly in retail and manufacturing sectors, by improving efficiency and mitigating supply chain risks. Automated systems such as RFID, ERP, and EDI significantly streamline processes and reduce risks, especially within manufacturing firms [54]. Additionally, integrating lean and agile inventory practices, known as Leagile Supply Chain Inventory

(LASCI), optimises responsiveness to demand variability, allowing companies to adapt more swiftly to changing market conditions [55]. As evidenced by Kenyan manufacturing companies, efficient warehouse management techniques not only increase supply chain performance overall but also highlight the significance of strategically allocating warehouse resources to save operating costs and boost productivity [56]. The agility framework, highlighted in the Indian garment industry, underscores the value of information sharing and flexibility in sourcing and order fulfilment, while positioning a well-placed Decoupling Point (DP) in inventory management ensures quick replenishment and enhances customer satisfaction [57]. However, despite these advancements, challenges such as infrastructure constraints and the need for continuous employee training can hinder the optimal performance of inventory and warehouse management systems, necessitating ongoing investment in both technology and workforce development [54], [57].

Table 1 Summery of literature

Author(s) and Year	Objective/Focus	Technology/Platform Used	Key Contributions	Limitations/Gaps	Future Work
Goals, (2020)	determines how inventory management affects the bottom line in industrial processing.	Descriptive Statistics, Dynamic Panel Regression	Identified significant relationships between inventory management and profitability, focusing on raw materials, intermediates, and work-in-progress.	Focused on Polish industrial sector, does not generalise to other countries or sectors.	Extend to different sectors and countries; analyze impacts of different inventory components.
Barman, Das and De, (2020)	Analyses the process of managing inventory in a supply chain that consists of two links—a manufacturer and a retailer.	None Specified	compares total profit under two demand functions under centralised coordination, demonstrating the impact of inventory management on profitability.	Lack of empirical validation; assumes specific demand functions.	Investigate real-world scenarios and additional demand functions; consider multi-echelon supply chains.
Granillo Macías, García Ramírez and Simón Marmolejo, (2020)	Analyses warehouse distribution in food sector to optimise inventory management.	ABC Analysis, Genetic Algorithm	Proposed optimal warehouse distribution routes, reducing transfer distances and improving service levels.	Focuses only on the food sector; assumes specific product characteristics.	Apply to other sectors; improve scalability for larger operations.
González-Hernández et al., (2020)	Discovers what makes an intelligent inventory management system using Industry 4.0 technologies.	IoT, RFID	Explores architecture for intelligent inventory management, based on IoT and RFID systems, aimed at improving warehouse operations.	Limited to theoretical framework; lacks empirical validation.	Test in real-world environments; explore integration with other technologies such as blockchain.
Rana, (2020)	Explores drivers of retail supply chain responsiveness.	PLS-SEM	Identifies significant drivers of retail supply chain responsiveness, including supplier role, IT use, and inventory management.	Limited to retail sector; focused on India.	Apply to different sectors; consider additional variables affecting responsiveness.
Saleem, (2020)	Investigates automated inventory management systems as a risk mitigation strategy.	RFID, ERP, EDI, MRP	Examines role of automated systems (RFID, ERP, EDI, MRP) in mitigating supply chain risks and enhancing efficiency.	Focused on Pakistan's manufacturing sector; does not include other industries.	Test in diverse industries; evaluate additional risk factors.
Kumar, Garg and Agarwal, (2019)	proponents of integrating agile and lean inventory characteristics in supply networks (Leagile Inventory).	None Specified	Identifies Leagile Supply Chain Inventory (LASCI) attributes for effective cost reduction and enhanced responsiveness.	Focused on case studies; lacks large-scale validation.	Expand to other industries; analyse real-world applications and broader supply chain environments.
Muema and Achuora, (2020)	Examines how supply chain performance in Kenyan industry is affected by logistics management.	SPSS, Regression Analysis	Found that effective warehousing and inventory management positively impact supply chain performance in Kenyan manufacturing.	Limited to Kenya; does not generalise to other regions or sectors.	Apply in other countries; explore additional supply chain factors affecting performance.
Rai and Giri, (2019)	offers a three-stage performance evaluation approach for supply chain agility.	SEM (Structural Equation Modeling)	examines the effects of information exchange, resilience, flexibility, and strategic partnerships on supply chain agility in the apparel sector.	Limited to the Indian garment industry; may not generalise across other sectors.	Apply framework to other industries and countries; extend to multi-industry analysis of supply chain agility.

Conclusion

In conclusion, supply chain studies stress the significance of relevant inventory management for achieving great results and enhancing company's financial performance in such sectors as manufacturing, retail, and food industries. The studies' particular findings and suggestions centre on the idea

that better inventory management of raw materials, work-in-progress, and finished goods has a direct and substantial impact on higher profitability. It is suggested that inventory days be optimised for a higher return on assets. Moreover, the implementation of sophisticated innovations, in particular the RFID, ERP, MRP systems, as well as Industry 4.0 technologies like IoT and RFID, have shown the possibility to enhance the company's performance and providers' services. The integration of lean, agile and agile inventory management also appears to be a key approach to address supply chain dynamics and satisfy customers' needs for goods to support competitive advantage and supply chain sustainability.

For practical application, they suggest that businesses embrace new technological systems of inventory, incorporate new technologies for real-time tracking and consider staff development regarding these changes. The study also hints at the fact that organizations should formulate the dispositions of inventory management with respect to the classification of the organizations, the market trends, and the features of the product. More studies are required on the existing and emerging uses of these technological advances in numerous sectors, the correlation between supply chain adaptation capability and operational risk management, and the effect of supply chain receptiveness on adaptation. The findings on cross-industry inventory management practices and the type of relationship between supply chain and environmental sustainability need further research in view of contemporary global challenges.

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