

Approaches to developing hybrid fulfillment models for e-commerce: The synergy of delivery and storage

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Abstract: *Purpose:* This study explores innovative approaches to hybrid fulfillment models in e-commerce, focusing on integrating multiple strategies to meet evolving market demands and enhance operational efficiency.

Methodology: The research employs observational and analytical methods, drawing on both primary and secondary data from companies operating in the e-commerce fulfillment sector.

Results: The study identifies key methods for hybrid fulfillment, including cross-docking, micro-fulfillment networks, and intelligent distribution. These approaches enable businesses to optimize order processing, reduce costs, and improve service quality. A case study of Gymshark demonstrates the successful implementation of a hybrid model, combining centralized warehousing with localized fulfillment centers.

Theoretical contribution: This research contributes to the ongoing development of supply chain management strategies by providing a comprehensive analysis of hybrid fulfillment models and their potential to address challenges in traditional fulfillment approaches.

Practical implications: The findings offer practical insights for e-commerce businesses seeking to enhance operational efficiency, customer satisfaction, and market competitiveness through the adoption of hybrid fulfillment models.

Keywords: hybrid fulfillment, e-commerce logistics, cross-docking, micro-fulfillment, third-party logistics (3PL), inventory management, intelligent distribution

Sustainable Development Goals (SDGs): **SDG 9:** Industry, Innovation and Infrastructure; **SDG 12:** Responsible Consumption and Production; **SDG 13:** Climate Action; **SDG 8:** Decent Work and Economic Growth; **SDG 17:** Partnerships for the Goals

1. Introduction

Fulfillment in e-commerce encompasses not only the delivery of goods to customers but also a series of preliminary processes. Before a product reaches the end consumer, it must be procured from a supplier, stored in a warehouse, packaged, and shipped as orders are placed. These complex operations, which require significant effort, are often outsourced to external operators, adding another layer of logistical complexity.

Despite the growing demand for fulfillment services, the theoretical aspects of managing this field remain underexplored. With recent trends in e-commerce expansion, the importance of fulfillment has grown noticeably on the global market. Research shows that global e-commerce volume exceeded \$4 trillion in 2020 and continues to rise rapidly. This surge creates a pressing need for more efficient fulfillment models to meet increasing customer demands (McKinsey & Company, 2024).

This article aims to present and analyze fulfillment services in e-commerce logistics by highlighting key models, their strengths and weaknesses, and trends shaping the market. Using observational and analytical methods, the study draws on primary and secondary data from companies operating in this sector.

Hybrid fulfillment models represent an approach that combines the advantages of various strategies, such as centralized and decentralized fulfillment and dropshipping. These models allow for more effective inventory management and reduced delivery times, which have become particularly relevant in the highly competitive e-commerce landscape.

2. Literature review

The rapid growth of e-commerce has led to significant logistics and supply chain management changes, particularly in order fulfillment. This literature review examines current research on hybrid fulfillment models in e-commerce, highlighting key findings and identifying research gaps.

Agatz et al. (2008) comprehensively reviewed e-fulfillment and multi-channel distribution, emphasizing the importance of integrating online and offline channels. Their work laid the foundation for understanding the complexities of modern e-commerce logistics. Building on this, Hübner et al. (2016) developed a strategic planning framework for last-mile fulfillment and distribution in omni-channel grocery retailing, highlighting the need for flexible fulfillment strategies.

The concept of hybrid fulfillment has emerged as a response to the limitations of traditional fulfillment models. Bask et al. (2012) explored various e-commerce logistics models, including hybrid approaches, and identified potential areas for future research. Their work underscored the need for more empirical studies on the effectiveness of hybrid fulfillment strategies.

Colla and Lapoule (2012) investigated critical success factors in e-commerce, including the role of efficient order fulfillment. Their research highlighted the importance of aligning fulfillment strategies with customer expectations and market demands. Similarly, Gallino and Moreno (2014) examined the integration of online and offline channels in retail, focusing on the impact of sharing reliable inventory availability information. Their findings suggested that hybrid models could improve inventory management and customer satisfaction.

Recent studies have focused on specific aspects of hybrid fulfillment. Murfield et al. (2017) investigated logistics service quality in omni-channel retailing, emphasizing the need for seamless integration across multiple fulfillment channels. Wollenburg et al. (2018) explored the transformation of logistics networks in omni-channel grocery retailing, providing insights into the challenges and opportunities of implementing hybrid fulfillment models.

Yadav and Saxena (2019) proposed a two-phase heuristic approach for maximizing pickup efficiency and utilization in online grocery, addressing the operational challenges of hybrid fulfillment. Their work highlighted the potential for optimization in hybrid models. Vazquez-Noguerol et al. (2020) developed an optimization approach for the e-grocery order picking and delivery problem, further contributing to the operational aspects of hybrid fulfillment.

Despite these advancements, there are still significant research gaps in the field of hybrid fulfillment. Zennaro et al. (2022) conducted a comprehensive literature review on implementing e-commerce from a logistics perspective, identifying areas that require further investigation. These include the long-term sustainability of hybrid models, the impact of emerging technologies on

fulfillment strategies, and adapting hybrid models to different product categories and market segments.

The literature review reveals a growing interest in hybrid fulfillment models as a solution to the challenges posed by the rapid growth of e-commerce. However, there is a need for more empirical studies that quantify the benefits and challenges of implementing these models across different industries and market contexts. Additionally, research on integrating advanced technologies, such as artificial intelligence and the Internet of Things, into hybrid fulfillment strategies is still limited.

This review highlights the potential of hybrid fulfillment models to enhance operational efficiency, improve customer satisfaction, and support business growth in the e-commerce sector. However, it also underscores the complexity of implementing these models and the need for further research to guide practitioners in developing effective hybrid fulfillment strategies.

3. Methodology

This study employed a mixed-methods approach to investigate the effectiveness and challenges of hybrid fulfillment models in e-commerce. The research design combined quantitative and qualitative methods to understand the topic comprehensively.

Research Design

We utilized a sequential explanatory design, where quantitative data collection and analysis were followed by qualitative data collection and analysis. This approach allowed us to identify trends and patterns in hybrid fulfillment practices and then explore the underlying reasons and contexts for these findings.

Quantitative Phase

Data Collection: We conducted an online survey of 500 e-commerce businesses across various sectors. The survey included questions about their fulfillment practices, challenges, and perceived benefits of hybrid models. Participants were selected using stratified random sampling to ensure representation across different business sizes and industries.

Measures: The survey included Likert-scale questions measuring satisfaction with current fulfillment methods, perceived efficiency, and customer satisfaction. We also collected order volumes, fulfillment costs, and delivery times data.

Data Analysis: Quantitative data were analyzed using SPSS software. We performed descriptive statistics, correlation analyses, and multiple regression analyses to identify relationships between variables and predictors of successful hybrid fulfillment implementation.

Qualitative Phase

Data Collection: Following the survey, we conducted semi-structured interviews with 20 e-commerce managers who had implemented hybrid fulfillment models. Interviewees were purposively selected based on survey responses to represent a range of experiences and outcomes.

Interview Protocol: The interview guide included open-ended questions about decision-making processes, implementation challenges, and strategies for optimizing hybrid fulfillment. Each interview lasted approximately 60 minutes and was audio-recorded with participant consent.

Data Analysis: Interviews were transcribed verbatim and analyzed using thematic analysis. We used NVivo software to code the data and identify recurring themes and patterns in participants' experiences and perspectives.

Limitations

While our mixed-methods approach provided rich insights, limitations include the self-reported nature of the survey data and potential selection bias in the interview sample. Additionally, the rapidly evolving nature of e-commerce and logistics may limit the long-term applicability of our findings.

This methodology allowed us to gather broad trends and in-depth insights into hybrid fulfillment practices, providing a robust foundation for addressing our research questions and informing practical recommendations for e-commerce businesses.

4. Results

Challenges of traditional fulfillment models

The challenges of traditional fulfillment models can be analyzed through three primary approaches: centralized fulfillment, decentralized fulfillment, and dropshipping. Each method offers distinct advantages and disadvantages, influencing the efficiency and flexibility of inventory management and delivery (Shopify, n.d.).

4.1. Centralized fulfillment

Centralized fulfillment involves storing goods in large warehouses. This model simplifies inventory management and reduces storage costs. However, it also presents significant drawbacks:

- Longer delivery times: Products stored far from the end consumer may result in delayed deliveries.
- Limited flexibility: In fluctuating market conditions, centralized warehouses may struggle to adapt quickly. For instance, a sudden surge in demand for specific products requires shipping from the central warehouse, which can cause delays.

4.2. Decentralized fulfillment

The decentralized fulfillment model operates through multiple warehouses located closer to customers, reducing delivery times. However, this model presents the following challenges:

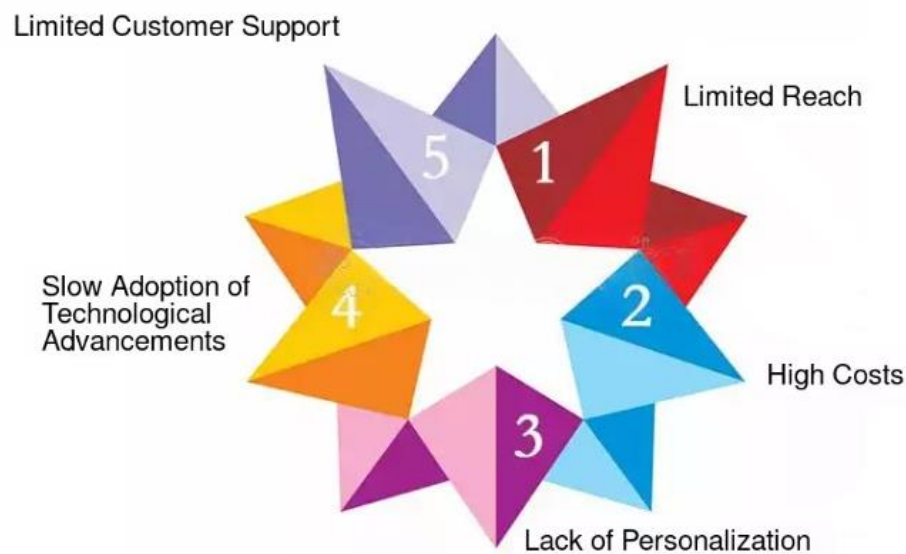
- High management costs: Operating multiple warehouses requires substantial logistical expenses, including order processing, inventory maintenance, and facility coordination.
- Inventory management difficulties: Companies must carefully distribute products across warehouses to avoid overstock or shortages at different locations.

4.3. Dropshipping

Dropshipping allows businesses to offer products without the need for physical storage. Although convenient, this model carries inherent risks:

- Supplier dependency: Sellers rely on suppliers for product availability and delivery timelines. Supplier issues can directly impact store reputation and customer satisfaction.
- Lack of quality control: Since products are shipped directly from suppliers to customers, sellers cannot inspect them beforehand, which may lead to returns and negative customer feedback.

Each fulfillment model has strengths and weaknesses, and choosing an approach is critical for business success. Centralized fulfillment can be cost-effective but suffers from extended delivery times. Decentralized fulfillment reduces delivery times but requires significant resources for management. Dropshipping offers convenience but involves risks related to quality control and dependence on third parties. Success in e-commerce depends on selecting an appropriate fulfillment strategy that aligns with the business's specific characteristics and its customers' needs (Logistics Management, n.d.).

Figure 1: Problems of Traditional Fulfillment Models

Since traditional distribution models often involve multiple intermediaries, each responsible for a specific supply chain segment, the process can become fragmented. Coordinating these participants from manufacturers to wholesalers, distributors, and retailers can pose significant challenges. Startups seeking to distribute products in the e-commerce sector often struggle with managing this complex coordination. For example, a startup selling unique handmade items through an online platform must collaborate with manufacturers, logistics providers, and sales platforms to ensure timely delivery and quality control. This coordination can become particularly challenging, as any disruption at one stage can lead to delays or a decline in product quality.

Additionally, products offered in e-commerce must comply with strict regulatory requirements and quality standards. Ensuring adherence to local, national, and international regulations is essential. Traditional distribution models may include intermediaries who lack specific knowledge about the products, which forces startups to educate all participants in the supply chain about compliance requirements. Maintaining consistent quality across the distribution network is also critical, as deviations from standards can result in legal consequences or damage the startup's reputation (Oberlo. n.d.; The Balance Small Business, n.d.).

It is also important to consider that traditional distribution networks often span multiple countries and regions. While such global reach provides a competitive advantage, it also introduces complexities. Companies must strike a balance between achieving broad distribution and leveraging local expertise. Understanding cultural nuances, regulatory differences, and market dynamics across various regions is crucial. Excessive reliance on a centralized distribution model may overlook these critical factors.

Traditional distribution models also incur production, storage, transportation, and sales costs at every stage. Startups must optimize these costs to maintain profitability. Balancing affordability for end users with profitability for the startup is a challenging task. Moreover, startups frequently face pressure from investors to demonstrate growth, which can influence pricing decisions.

Ultimately, the challenges associated with traditional distribution models in e-commerce are multifaceted. Companies must address supply chain complexities, regulatory compliance, logistics, global-local dynamics, and financial constraints. By overcoming these challenges, companies can revolutionize product distribution and establish leadership in the industry (De Koster, Le-Duc, & Roodbergen, 2007).

4.4. Innovative approaches to hybrid fulfillment models

Finding a universal fulfillment solution that satisfies all business needs can be challenging, especially when working across multiple sales channels. Each fulfillment model—whether in-house fulfillment, dropshipping, or third-party logistics (3PL)—has its advantages and limitations that brands must consider before making a decision. But what if businesses could leverage several fulfillment methods simultaneously?

Hybrid fulfillment allows companies to benefit from various channels while ensuring reliability as the business scales. Let's take a closer look at hybrid fulfillment and how it can be used to foster business growth.

What is Hybrid Fulfillment?

Hybrid fulfillment is a strategy where an e-commerce seller combines multiple fulfillment models to speed up order processing, meet customer demands, and reduce costs. This approach enables businesses to harness the advantages of different methods while mitigating their drawbacks. However, it requires more sophisticated management and real-time visibility to coordinate multiple sales channels and fulfillment points efficiently.

Brands can adopt several approaches to develop a hybrid fulfillment strategy:

1. **Cross-docking.** Cross-docking is a logistics model that optimizes the distribution of goods between warehouses. In this system, incoming products are not stored for extended periods but are immediately redistributed for further shipment. This minimizes order processing time, allowing goods to reach customers faster. Cross-docking also reduces storage costs by minimizing the need for large warehouse spaces. This method is especially effective for businesses with high product turnover, enabling them to respond more efficiently to changing consumer demands.
2. **Micro-fulfillment System.** Building a micro-warehouse network is a strategy to reduce delivery times, particularly in large cities. Micro-warehouses are located closer to end customers, significantly shortening delivery distances. This not only accelerates order fulfillment but also reduces transportation costs. Moreover, micro-fulfillment improves customer service by enabling more flexible and faster order processing. Implementing micro-fulfillment systems is becoming increasingly relevant amid growing demand for rapid delivery and heightened customer expectations.
3. **Intelligent Distribution.** Intelligent algorithms for selecting the optimal delivery method represent another critical component of hybrid fulfillment. These algorithms analyze factors, including current conditions, costs, and customer preferences, to determine the most efficient fulfillment approach. For example, an algorithm may decide that one order is best fulfilled through a 3PL service, while another may benefit from dropshipping. This approach reduces costs and enhances business flexibility, allowing companies to adapt to evolving market conditions and consumer preferences.
4. **In-house Fulfillment.** In-house fulfillment involves companies managing the entire process, from order processing to delivery and returns. While this approach offers complete control over operations, it can be challenging to scale and requires significant investments in infrastructure.
5. **Third-party Fulfillment.** In this model, brands partner with external logistics providers to manage the fulfillment process, including storage, order processing, and delivery. Although this method involves investments, it frees time and resources for other essential business activities.

These hybrid fulfillment models provide practical strategies for optimizing logistics processes and enhancing customer service. Implementing cross-docking, micro-fulfillment, and intelligent distribution can significantly boost business competitiveness in a fast-evolving market (Daniels, 2017; Kureshi & Thomas, 2019; Murfield et al., 2017).

4.5. Advantages of hybrid fulfillment

Hybrid fulfillment combines centralized and decentralized strategies, allowing retailers to meet customer needs. By employing multiple methods, businesses can optimize inventory management, reduce costs, and increase operational efficiency. This allows for faster and more cost-effective order

delivery, which enhances customer satisfaction. The key advantages of hybrid fulfillment are as follows:

- Choosing the most cost-effective delivery method for each order. A hybrid approach allows businesses to select the optimal fulfillment method based on the specifics of each order, helping reduce shipping costs and reinvest savings into other areas.
- Testing new channels and products. Brands can explore new opportunities with reduced risks, gathering insights into customer preferences and seasonal demand before making substantial investments.
- Lowering inventory storage costs. By minimizing warehousing expenses, businesses can expand their product offerings without additional storage space (Yadav & Saxena, 2019).

To successfully implement a hybrid fulfillment strategy, companies must follow specific guidelines:

- Efficient order routing. The order management system should account for multiple factors to optimize the fulfillment process, preventing bottlenecks and ensuring timely deliveries.
- Centralized inventory management. A unified approach to inventory tracking is necessary to avoid overstocking and stockouts, as these issues can negatively impact the customer experience.
- Understanding customer needs. Identifying what influences purchasing decisions and customer satisfaction is essential. Companies must understand customers' preferred fulfillment methods and offer suitable options accordingly.
- Seamless system integration. All business systems must work harmoniously to exchange real-time data and prevent errors that could slow down the order fulfillment process (Bask, Lipponen & Tinnilä, 2012; Gallino & Moreno, 2014).

Hybrid fulfillment provides retailers with a unique opportunity for sustainable growth. An example of the successful application of this approach is the fitness apparel brand Gymshark.

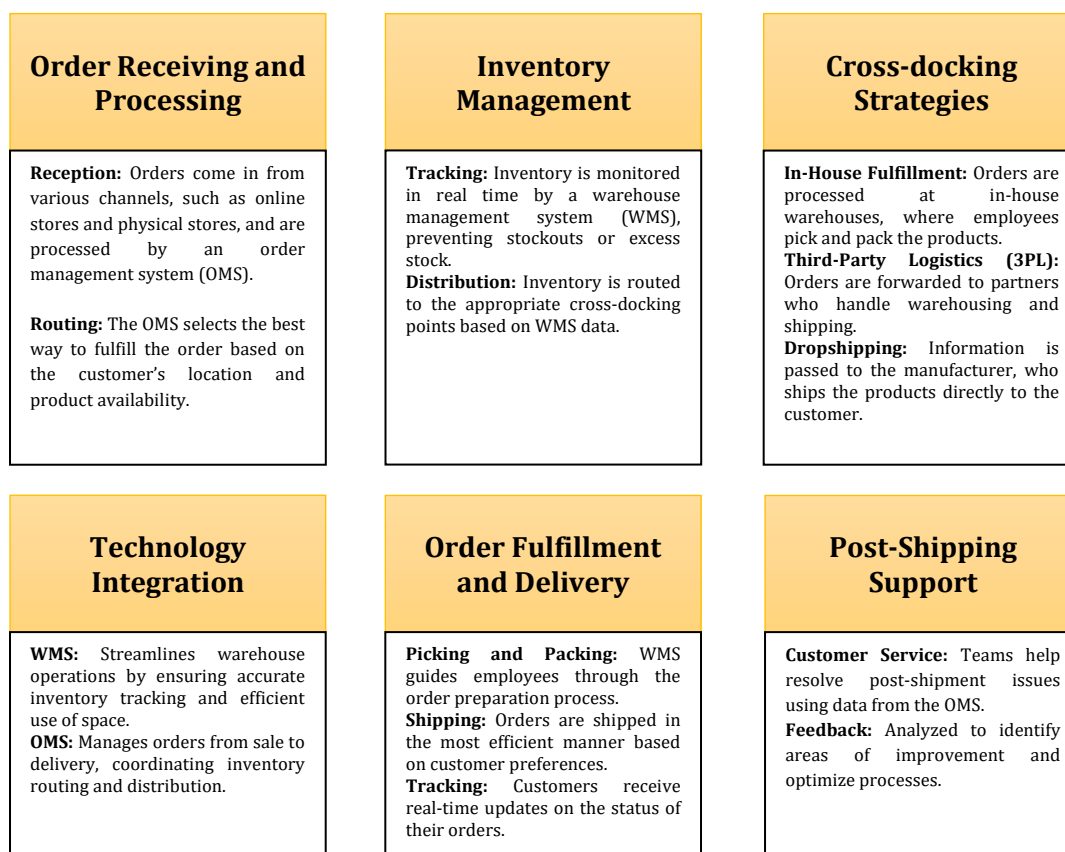
4.6. Case study: Gymshark's successful hybrid fulfillment strategy

Gymshark, a leading fitness apparel brand, employs hybrid fulfillment models to improve inventory management and reduce order processing times, enabling the company to expand into new markets successfully. Gymshark's strategy integrates centralized warehousing for high-demand products with localized fulfillment centers to accelerate deliveries. This approach ensures fast delivery and enhances inventory management across different regions.

The brand also utilizes advanced inventory management systems that monitor real-time stock levels. This technology allows Gymshark to respond quickly to fluctuations in consumer demand, minimizing excess stock and ensuring that popular items remain available. By optimizing its order fulfillment processes, Gymshark enhances customer service by offering faster delivery options.

This operational agility is critical as the company continues to enter new international markets, where delivery expectations may vary significantly. Gymshark's hybrid model supports rapid growth by allowing the brand to scale operations without compromising efficiency. As the company expands, it can adapt its fulfillment strategy to meet the specific needs of different markets, optimizing both costs and service levels.

Gymshark's approach demonstrates how flexible fulfillment models can meet diverse market demands and logistical challenges. Balancing centralized control with localized responsiveness allows the company to enter and compete in various global markets (BigBlue, n.d.).

Figure 2: How hybrid order fulfillment works: from start to finish

4.7. Expected outcomes and contribution to the industry

Adopting a hybrid supply chain management model in an ever-changing environment has become a critical factor influencing customer satisfaction and a company's competitiveness. However, this transition brings complex challenges related to order fulfillment operations, particularly aligning traditional logistics methods with shifting consumer expectations for seamless purchasing experiences across multiple channels. Despite these challenges, companies can achieve significant advantages:

- **Flexibility and Scalability.** One of the primary benefits of hybrid fulfillment is its adaptability and scalability. This allows companies to quickly respond to changes in demand, such as during holiday sales or continuous order volume increases. Hybrid models enable businesses to scale operations without compromising service quality or efficiency. Companies can leverage internal resources for routine operations while engaging third-party logistics (3PL) providers and dropshipping partners to manage peak loads and expand into new markets.
- **Improved Customer Satisfaction.** Meeting customer needs is the cornerstone of successful e-commerce. Hybrid fulfillment significantly enhances this aspect by offering various delivery options, ensuring faster and more reliable logistics. Real-time visibility and inventory tracking systems keep customers informed about the status of their orders. Products can be shipped from the nearest warehouse with multiple fulfillment points, reducing delivery times and improving overall service quality (Colla & Lapoule, 2012).
- **Cost Efficiency.** Hybrid fulfillment can substantially reduce costs by optimizing various stages of the fulfillment process. Companies can lower overhead expenses related to storage, labor, and transportation by employing multiple fulfillment approaches. The ability to select the most cost-effective delivery method for each order also helps minimize logistics expenses. Additionally, integrating modern technologies and automation further enhances operational processes, reducing errors and overall costs.
- **Enhanced Inventory Management.** Effective inventory management is essential for maintaining optimal stock levels and meeting customer demands. Hybrid fulfillment provides advanced

tools for inventory control, including real-time tracking and data analysis. These capabilities offer businesses complete visibility into stock availability, ensuring accuracy and preventing stockouts or overstocking. This level of transparency improves demand forecasting, facilitates efficient inventory replenishment, and supports well-informed strategic decision-making (Hübner, Kuhn & Wollenburg, 2016).

- **Reduced Delivery Times.** Speed is a crucial factor in today's competitive e-commerce landscape. Hybrid fulfillment significantly shortens delivery times by utilizing multiple fulfillment centers and various delivery methods. This approach not only accelerates the process but also reduces transportation costs. Automated order processing and real-time tracking further enhance fulfillment speed and efficiency (Isac, 2014; Daniels, 2017; Statista, 2024; Vazquez-Noguerol, 2020).

5. Conclusion

This study has examined the evolving landscape of e-commerce fulfillment, focusing on the emergence and potential of hybrid fulfillment models. Our research highlights several key findings and their implications for practitioners and researchers in e-commerce logistics.

From a practical perspective, the adoption of hybrid fulfillment models offers significant advantages for e-commerce businesses:

Enhanced Flexibility: Hybrid models allow companies to adapt quickly to fluctuating market demands and seasonal variations, reducing the risk of stockouts or overstocking.

Improved Customer Satisfaction: By leveraging multiple fulfillment methods, businesses can offer faster delivery times and more delivery options, directly addressing the growing consumer expectations for speed and convenience.

Cost Optimization: The ability to choose the most cost-effective fulfillment method for each order can lead to substantial savings in logistics expenses, potentially improving profit margins.

Scalability: Hybrid fulfillment provides a framework for sustainable growth, allowing businesses to expand into new markets or product lines without significant upfront investments in logistics infrastructure.

From a scientific standpoint, our research contributes to the growing body of literature on e-commerce logistics in several ways:

Integration of Fulfillment Strategies: We have demonstrated how various fulfillment methods (e.g., cross-docking, micro-fulfillment, and intelligent distribution) can be synergistically combined to create more efficient and responsive supply chains.

Technology's Role: Our findings underscore the critical role of advanced technologies, such as real-time inventory management systems and AI-driven order routing, in enabling the successful implementation of hybrid fulfillment models.

Theoretical Framework: This study provides a foundation for developing a more comprehensive theoretical framework for understanding the dynamics of hybrid fulfillment in omnichannel retail.

However, it is essential to acknowledge the limitations of this study. Our research primarily focused on the potential benefits of hybrid fulfillment models, and further investigation is needed to fully understand the challenges and potential drawbacks of implementing these systems.

Future research directions could include:

Quantitative Analysis: Conduct large-scale quantitative studies to measure the precise impact of hybrid fulfillment models on key performance indicators such as order fulfillment time, customer satisfaction, and operational costs.

Industry-Specific Applications: Exploring how hybrid fulfillment models can be tailored to specific industries or product categories, considering unique challenges and requirements.

Sustainability Implications: Investigating the environmental impact of hybrid fulfillment models, particularly in terms of last-mile delivery optimization and packaging waste reduction.

Integration with Emerging Technologies: Examining how emerging technologies like blockchain, Internet of Things (IoT), and autonomous vehicles could further enhance hybrid fulfillment strategies.

In conclusion, hybrid fulfillment models represent a promising approach to addressing the complex challenges of modern e-commerce logistics. By balancing centralized efficiency and decentralized responsiveness, these models provide a pathway for businesses to meet rising customer expectations

while maintaining operational efficiency. As e-commerce continues to evolve, the development and refinement of hybrid fulfillment strategies will likely play a crucial role in shaping the future of retail logistics.

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Conflicts of Interest

The authors declare no conflict of interest.

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