STOCK MANAGEMENT IN E-COMMERCE BY 3PL – CASE STUDY

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Purpose: The purpose of this study is to delve into the effectiveness of third-party logistics (3PL) providers in inventory management for retail businesses operating in the e-commerce sector.

Design/methodology/approach: The study focuses on analyzing a conducted case study. The case study aims to compare the currently functioning inventory management system with the system proposed by the 3PL provider for managing the location of SKUs in the warehouse.

Findings: The research has allowed for a positive verification of the posed hypothesis (i.e., a 3PL company is capable of better inventory management for an e-commerce service recipient). The 3PL provider has the potential to implement an improved inventory management system based on location management and automated storage processes built upon the logistic service provider's know-how.

Research limitations/implications: The primary limitation of the research lies in presenting results based solely on a single case study and the instance of a logistics operator with significant experience and an established market position.

Originality/value: This article constitutes a significant contribution to the expanding spectrum of research concerning the role of third-party logistics (3PL) providers in enhancing inventory management processes, particularly in the context of e-commerce. The added value lies not only in confirming the positive affirmation of the research hypothesis but also in highlighting the immense potential that 3PL providers possess in implementing advanced inventory management systems based on location management strategies and warehouse process automation.

Keywords: 3PL, e-commerce, stock management, warehousing.

Category of the paper: Research paper.

1. Introduction

In recent years, the rapid growth of the e-commerce industry has presented significant challenges for retail enterprises in effectively managing their inventory (Pourhejazy, 2020; Pillai, 2022; Jain, Tan, 2022). This challenge arises from the dynamic nature of consumer expectations and the need for efficient order fulfillment. As consumer preferences and

requirements continue to evolve, businesses must ensure that their inventory management processes can adapt to these changes. In this context, third-party logistics (3PL) providers have emerged as strategic allies (Lyu, 2020; Lin, 2022; Sarjono et al., 2021), playing a crucial role in addressing these challenges and optimizing inventory management operations.

The purpose of this study is to delve into the effectiveness of 3PL providers in the realm of inventory management for retail enterprises operating in the e-commerce sector. To achieve this goal, the study is based on a case study, which serves as the foundation for the conducted research. The research hypothesis posited in this study suggests that 3PL companies possess an inherent ability to enhance inventory management practices for e-commerce service recipients. Confirming this hypothesis will not only shed light on the untapped potential of 3PL providers but will also underscore their significant contribution to the implementation of advanced inventory management systems. These systems are built upon strategic location management methodologies and the integration of warehouse automation technologies. These strategies leverage the extensive logistical expertise held by 3PL providers, positioning them as key players in the evolution of inventory management practices. Emphasizing the dynamic role of 3PL providers in boosting inventory management efficiency for e-commerce enterprises, this study reinforces the importance of their involvement in the industry. The symbiotic relationship between 3PL providers and e-commerce businesses is highlighted, demonstrating how these partnerships collectively navigate the complexities of modern inventory management and actively shape this field. As the e-commerce sector continues to experience unprecedented growth, enterprises face mounting pressure to optimize their inventory management practices. The role of 3PL providers in this context becomes increasingly significant, as they offer the knowledge and resources needed to implement advanced inventory management systems based on location-related strategies and automated warehousing. This study underscores the importance of understanding the capabilities and contributions of 3PL providers within the intricate network of e-commerce operations.

2. Theoretical background

2.1. 3PL in the e-commerce and multichannel activity

Companies operating in the e-commerce or multichannel commerce sector are seeking partnerships with third-party logistics (3PL) firms. These logistics companies add value by providing various complementary services and sharing both physical resources and information to optimize flows across the entire supply chain (Rabinovich, Knemeyer, 2006). Retailers can, for example, shorten lead times for orders mainly through order fulfillment services provided by 3PL (Wollenburg et al., 2018). Logistics issues in the e-commerce, multichannel,

and omnichannel domains typically focus on supply chain coordination, warehouse operations, and strategies for warehouse management, e-fulfillment, and customer logistics support (Mishra et al., 2021). Logistics is a critical aspect related to the success of e-commerce operations (Banerjee, 2019) as well as other distribution forms like multi-, cross-, and omnichannels. The dynamic growth of third-party logistics (3PL) services has been accelerated by the expansion of e-commerce and increased logistical operations associated with returns handling. As a result, a significant influx of external logistics firms has been observed, aiming to support the maintenance of this complex supply chain structure and offering a wide array of diverse services (Wang et al., 2021a). 3PL also contributes to environmental impact reduction by increasing the utilization of eco-friendly transportation methods, enhancing delivery efficiency, and boosting delivery flexibility (Buldeo et al., 2019). With the rise of information technology, 3PL is often considered a crucial element for achieving rapid growth in multi-channel business (Gupta et al., 2021). However, it's important to note that engaging with logistics operators is associated with long-term financial decisions (Chiu et al., 2011). For companies operating as third-party logistics service providers (3PL), having tangible resources like warehouses or transport fleets is a crucial aspect, enabling them to conduct flexible operations. The number of logistics companies actively engaging in the distribution of various food products through multiple channels is increasing. DHL, for instance, was a pioneer in the logistics industry that engaged in distributing food products through various channels (Saskia et al., 2016).

The concept of multichannels and the concept of utilizing 3PL entities for logistics services are often treated as separate issues in the literature (Mikhaylyk et al., 2019). This is observed, among other ways, by developing methods for integrating e-commerce platforms in communication between producers and customers. In such approaches, models in which 3PL service providers are treated as separate entities not participating in the flow of information but only carrying out commissioned logistical activities are evident (Wang et al., 2021b). According to some authors, involving logistics operators increases the complexity of multi-channel systems (Wang et al., 2021b). Nevertheless, the benefits from their utilization are significant enough for their role in distribution systems to continuously expand. In the context of multi-channel systems, it's important to maintain and effectively utilize the set of customer information available in different channels (Jeanpert, Pache, 2016). Customer satisfaction is a result of, among other factors, the level of logistical service offered by logistics operators within the network (Chen et al., 2020). 3PL providers offer not only logistical services but also provide sellers with access to their network of contacts, allowing for the effective fulfillment of customer orders through existing relationships. They may handle product returns and collaborate with carriers for last-mile delivery (Rabinovich, Knemeyer, 2006). Some authors particularly focus on "last-mile" delivery and identify it as a key problematic point in the operation of multi-channel systems. They also note that systems that don't primarily focus on improving the last-mile delivery, even if they involve third-party logistics (3PL) providers,

exhibit lower efficiency compared to those that focus on optimizing this delivery stage (Lim, Winkenbach, 2019).

Among the functions of third-party logistics service providers (3PL) in a multi-channel approach, logistics support for drop shipping and assistance to firms in inventory management, such as through the use of Vendor-Managed Inventory (VMI) models, are highlighted (Gupta et al., 2021). An absolutely critical aspect for the effectiveness of online commerce, when considering it from a logistical operations perspective, is an appropriate inventory control system (Rabinovich, Knemeyer, 2006). The biggest challenge for 3PL providers in the era of omnichannel lies in effectively managing the growing number of small parcels, fulfilling more frequent orders, reducing fulfillment times, increased product diversity, and harmonizing distribution processes across different channels (Baglio et al., 2022). Banerjee (2019) notes that logistics service providers should develop their skills and infrastructure towards enhancing their capabilities in automating sorting processes in warehouse management. Concepts like fully automated warehouse centers, zero-carbon emission buildings, hybrid or fully electric trucks, robotics, drones, and warehouse control through voice commands or optical systems are becoming more common among firms in the logistics field (Baglio et al., 2022). Some researchers highlight the potential for integrating technological solutions, including Internet of Things (IoT) technologies, used by manufacturers, with the activities of 3PL (Golinska-Dawson et al., 2023). 3PL should tailor logistical services to specific customer reception methods and demonstrate the ability to integrate their solutions with customer-friendly solutions like QR codes (Buldeo et al., 2019). Among the major challenges for LSPs, it's mentioned that they must satisfy customers with diverse needs across different channels (Chen et al., 2020). Ramanathan et al. (2014) indicate in their research that most LSPs create additional value for customers in omnichannel systems. Frei et al. (2022) point out that selecting and building relationships with 3PL can be considered strategic tasks for an enterprise acting as an omnichannel architect. According to Gupta et al. (2021), companies that transitioned to omnichannel sales models in recent years had the opportunity to increase their profits by 5% to 15%. Moreover, in the realm of innovation development in companies implementing omnichannels, some authors suggest that utilizing logistics service providers (LSPs) is one of the most effective practices (Fleischer et al., 2020). Therefore, while it's a challenging task, integrating logistics service providers into multichannel structures can yield numerous positive effects.

2.2. Chosen storage methods

The storage method is a crucial element of effective inventory management within the supply chain (Fan, 2010). A 3PL company makes decisions regarding storage methods (Baruffaldi et al., 2020) to ensure optimal utilization of warehouse space, easy access to goods, and minimization of losses and damages. The choice of technical storage means depends on various factors such as the type of goods, their size, weight, durability, and customer

requirements. Some of the most popular storage systems in modern warehouses include bulk storage (Sazonova et al., 2021), rack storage (Kostrzewski, 2017; Cormier, Gunn, 1992), very narrow aisle racking (VNA) (Powell, 2015), and Automated Storage & Retrieval System (AS/RS) (Hameed et al., 2019; Lazaro et al., 2023; Yu et al., 2022).

Bulk storage, also known as loose or mass storage, is a storage technique where larger quantities of products are stored together without individual packaging or segregation (Mardaneh et al., 2021). It's a popular storage method in many industries, including the e-commerce sector (Pozzi, 2013). Table 1 provides a concise summary of the advantages and disadvantages of this type of storage.

Table 1.
Advantages and disadvantages of bulk storage

Bulk storage	
Advantages	**Disadvantages**
- Cost-effectiveness. - Quick handling. - Useful for perishable products. - Transportation optimization.	- Lack of segregation. - Risk of damages. - Inventory turnover management.

Source: own elaborated based on: (Kamali, 2019; Pekmez, 2016; Bhisti, Kuhl, 2021).

Bulk storage allows for efficient utilization of warehouse space as it doesn't require individual shelves or racks for each product. This leads to reduced infrastructure costs for the warehouse. Storing products in bulk enables quick and easy loading and unloading, which is particularly useful for products with similar characteristics that can be easily grouped. Bulk storage can be particularly beneficial for items that are not sensitive to storage conditions, such as raw materials or construction materials. Storing in bulk can reduce the amount of packaging, leading to decreased weight of transported goods and transportation costs. However, the lack of individual packaging might make finding specific items more challenging, necessitating accurate labeling and tracking systems. Depending on the type of products, storing in bulk can increase the risk of damages, especially if the products are delicate or sensitive to compression or friction. Effective inventory turnover management is important to prevent products from being held for extended periods, which could lead to obsolescence.

The rack storage method involves storing products on specialized shelves or racks (Cormier, Gunn, 1992). It's a popular inventory management technique due to its advantages in efficiency and organization. Table 2 presents the pros and cons of this storage method.

Table 2.
Advantages and disadvantages of rack storage

Rack storage	
Advantages	**Disadvantages**
- Space optimization. - Work organization. - Easy access to SKUs. - Minimization of losses and damages.	- Infrastructure requirements. - Inventory turnover management. - Costs.

Source: own elaborated based on: (Wang et al., 2022; Park et al., 2020; Addy-Tayie, 2012; Indap, 2018).

Storing on shelves enables the utilization of vertical space, which is particularly valuable in warehouses with limited floor area. This allows for more products to be stored within the same footprint. Shelves facilitate precise organization of products by categories, sizes, types, or expiration dates. This eases inventory management and order preparation. Products stored on shelves are typically easily accessible, speeding up the order picking process and reducing customer service time. Shelf storage minimizes product-to-product contact, which may decrease the risk of damages compared to some other storage techniques. Storing on shelves requires appropriate racks or shelves, which may entail larger investments in warehouse infrastructure. Inadequate inventory turnover management may lead to older products remaining on the shelves, resulting in obsolescence. Despite its numerous advantages, shelf storage can be costly due to the need to purchase and install the shelving.

VNA, or Very Narrow Aisle storage, is an advanced storage technique based on using specialized forklifts and automation systems to enable storing goods on shelves within very narrow aisles (Gue et al., 2006; Fichtinger et al., 2016). The pros and cons of VNA are summarized in Table 3.

Table 3.
Advantages and disadvantages of VNA

VNA storage	
Advantages	**Disadvantages**
• Space optimization. • Increased capacity. • Automation. • Faster handling.	• High costs. • Technical requirements. • Challenges in accessing aisles.

Source: own elaborated based on: (Gue et al., 2006; Hong et al., 2012; De Koster et al., 1999).

VNA allows for the extremely efficient utilization of warehouse space by creating very narrow aisles, resulting in increased available storage area. By enabling storage in narrow aisles, more products can be stored within the same footprint, which is especially valuable for warehouses with limited space. VNA technique is often employed with automated forklifts or conveyor systems, enhancing the efficiency and precision of the storage process. VNA systems allow for swift navigation through narrow aisles, shortening the time required for order picking. Implementing VNA involves high costs, both for specialized equipment and adapting the warehouse to accommodate narrow aisles. Forklifts and VNA systems require specific floor conditions, lighting, and warehouse structure. The narrow aisles might make access to products more challenging, potentially leading to longer handling times.

AS/RS, or Automated Storage and Retrieval System, is an advanced system of automated storage and retrieval that employs specialized machinery, robots, and computer systems to store, organize, and deliver products within warehouses (De Koster et al., 2008; Muralidharan et al., 1995; Manzini et al., 2006). AS/RS is a transformative technology for storage processes, particularly beneficial in the logistics industry, including e-commerce. The pros and cons of AS/RS are presented in Table 4.

Table 4.
Advantages and disadvantages of AS/RS

AS/RS storage	
Advantages	**Disadvantages**
• Automation. • Space optimization. • Speed. • Accuracy.	• High implementation costs. • Vulnerability to breakdowns. • Complexity of management.

Source: own elaborated based on: (Cinar, Zeeshan, 2022; Cunkas, Ozer, 2019; Lazaro et al., 2023; Singbal, Adil, 2019; Sproles, Kuehn, 2014).

AS/RS is a technology based on automation, meaning that many processes such as storage, retrieval, and picking are performed by machines or robots with minimal human involvement. AS/RS utilizes warehouse space more efficiently than traditional storage methods, allowing for the storage of a greater number of products within the same area. AS/RS systems enable rapid retrieval and delivery of products, accelerating customer service processes and order picking. With automation, the risk of human errors is significantly reduced, leading to greater accuracy in inventory management. Introducing an AS/RS system typically comes with high costs due to the need to acquire specialized equipment and adapt the warehouse to the new technology. In the event of an AS/RS system failure, operational downtime can occur, which can have a significant impact on a company's operations. AS/RS systems require advanced management and maintenance, which might pose challenges for some companies.

An operator possessing inventory management skills across various storage techniques like bulk storage, rack storage, VNA, and AS/RS is an invaluable asset for logistics companies and the e-commerce sector. Such an entity is capable of adapting their skills to the specifics of each technique, contributing to optimized inventory management and efficient use of warehouse space. With this ability, the operator can effectively organize, monitor, and pick products, ensuring smooth warehouse operations and meeting customer requirements effectively and punctually. In the article, the following hypothesis related to inventory management by a 3PL logistics operator is presented:

H1: A 3PL company is better equipped to manage the inventory of an e-commerce service recipient.

This hypothesis will be tested based on the conducted case study.

3. Methods

3.1. Case study description

The entity considered in the case study is an international logistics company specializing in providing various logistics services, including the 3PL model, as well as offering warehouse services on the international market. When selecting a company to carry out a case study,

it was guided by the fact that it must belong to a group of large enterprises with an established market reputation and serve the e-commerce sales market. As a chosen logistics operator, the entity in question plays a pivotal role in the supply chains of numerous companies. The 3PL model involves outsourcing logistics processes to a specialized external provider. Similar to the investigated 3PL company, the entity manages and organizes logistics activities on behalf of its clients, allowing them to focus on their core business functions. This approach enables companies to reduce operational costs, enhance efficiency, and adapt to fluctuating market conditions. The subject of the case study offers a wide range of logistics services within the 3PL model, including warehousing, transportation, inventory and order management, and value-added services. The investigated 3PL company operates an extensive network of warehouses with varying capacities and specializations, allowing for the storage of diverse goods, from food products to industrial and pharmaceutical items. In terms of warehousing services, the logistics operator utilizes advanced warehouse technologies such as inventory management systems and warehouse automation systems. This enables effective management of goods flow, optimization of warehouse space, and increased precision and operational efficiency.

Moreover, the entity under study places emphasis on sustainable development and social responsibility by implementing eco-friendly practices in its operations. The company operates in areas related to CO_2 emission reduction, energy conservation, and transport optimization. The investigated 3PL company is a significant player in the logistics market, offering 3PL services and warehousing services, assisting clients in efficiently managing their supply chains and enabling them to focus on their core business activities. In the context of the discussed case study, the activities of the 3PL company within the provided services for an e-commerce business will be analyzed. The overall distribution network dependencies are illustrated in Figure 1.
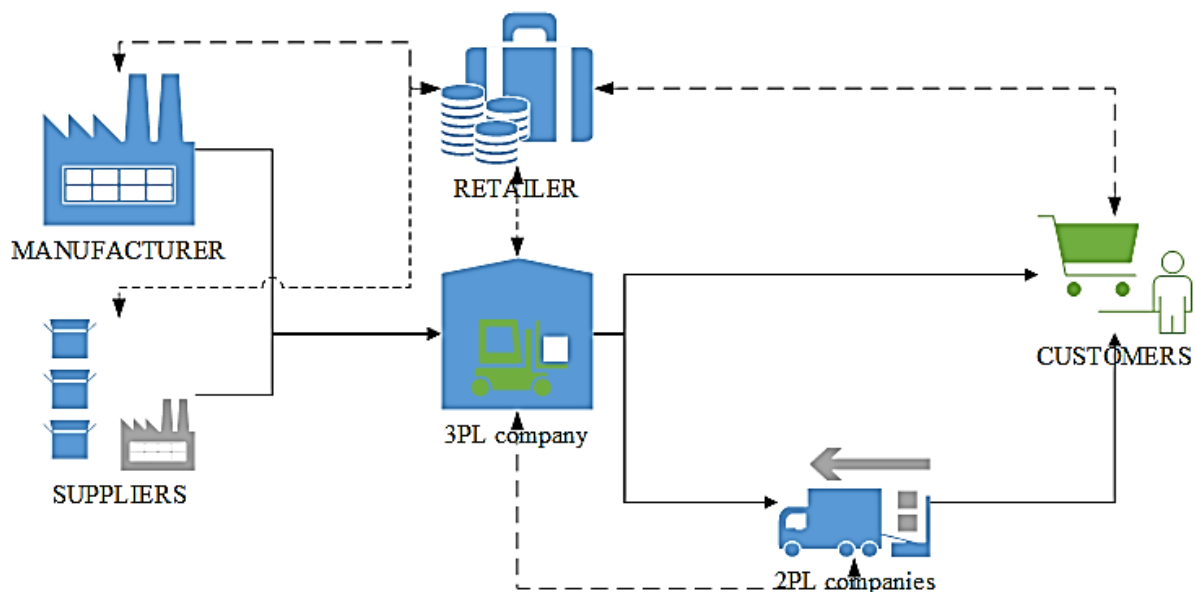
Figure 1. General overview on distribution network.

Source: own elaboration.

In the analyzed scenario, the 3PL company provides operational support for a retailer's warehouse involved in retail sales. Within the distribution network (Figure 1), there are both material flows (solid line arrows) and information flows (dotted line arrows). As seen in the illustration, the 3PL company operates with limited access to information and currently does not engage in activities related to planning or managing inventory location within the warehouse. Instead, it solely provides operational assistance for receiving, storing, and dispatching activities. In the examined case studies, the author investigates the possibility of changing the storage methods and relocating SKUs (Stock Keeping Units) into four storage zones (bulk, rack, VNA, and AS/RS), based on a methodology employed by the logistics operator for SKU classification.

3.2. Data description

In the described case, the examined logistics operator handles a total of 33,894 SKUs. These SKUs occupy an average of 62,493 pallet locations in the last six months, considering the standard EUR1 pallet size. This SKU count represents the status over the past six months. According to the methodology adopted by the retailer, SKUs that haven't experienced any rotation in the last six months are classified as "dead stock", which needs to be removed from the warehouse. The total number of SKUs that have appeared in the records during the collaboration between the operator and the retailer is 144,494 SKUs, indicating a significant level of rotation and turnover of products in the warehouse. The data has been sourced from the Warehouse Management System (WMS) and classified into various groups based on their dimensions, as shown in Table 5.

**Table 5**.
SKU shares via size category

Category	% of SKU
Extra small	34,63%
Extra small heavy	0,16%
Small	13,69%
Small heavy	0,07%
Medium	8,82%
Large	14,88%
Large heavy	0,01%
Pallet size	6,56%
Oversize	11,06%
Long	10,13%

Source: own elaboration.

The largest number of SKUs belongs to the "extra small" category (34.63%), which complicates the operational management of the stock.

3.3. Main research steps

As part of the warehouse reorganization and the expansion of services offered by the logistics operator, a storage procedure involving the relocation of SKUs to four zones (bulk, rack, VNA, and AS/RS) can be proposed. The main steps taken in the study are depicted in Figure 2.
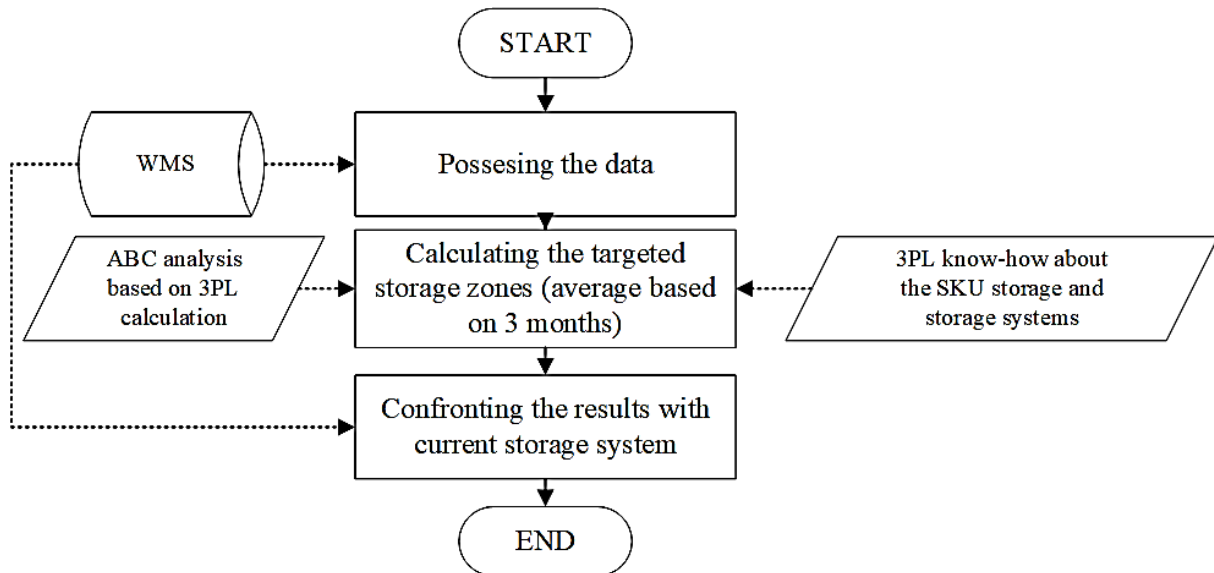
Figure 2. General overview on research procedure.

Source: own elaboration.

Based on the provided data, the information acquisition process occurred through the operator's WMS system, which served as the central point for collecting data regarding the movements of individual products (SKUs). A key aspect of calculating targeted locations involved analyzing various parameters related to specific SKUs. These parameters included information about the size of products, their categorization into appropriate classes considering hazardous nature of products, as well as an analysis of rotation using the ABC methodology. The analysis process focused on identifying optimal locations to which specific products should be directed. Acting based on the company's knowledge, detailed guidelines for allocating individual SKUs to specific storage zones were taken into account. These guidelines, though not disclosed in this article due to their confidential nature, constituted an essential element of the process of optimizing product locations in the warehouse. The data used in the analysis were averaged data collected over a three-month period. The extended data collection period allowed for considering various seasonal and cyclical patterns of SKU movement. Subsequently, the results of the analysis and the assignment of individual products to specific storage zones were confronted with the current SKU location management system as part of the comprehensive inventory management by the retail business. This holistic process of analysis and optimization of product locations in the warehouse constituted a crucial step in effective inventory management, enabling the optimization of product availability, minimization of storage costs, and optimal utilization of warehouse space.

4. Results

Table 6 presents the categorization of SKUs in terms of targeted storage zones for individual SKU categories based on their dimensions, along with the percentage distribution of SKUs to be stored in specific locations.

Table 6.
Category of SKU in the targeted storage zones

Targeted storage zone	Category of SKU (size)	% of SKU stored in targeted location
AS/RS	Extra small	34,63%
AS/RS	Small	13,69%
AS/RS	Extra small heavy	0,16%
BULK	Oversized	11,06%
RACK	Large	14,88%
RACK	Pallet size	6,56%
RACK	Long	0,03%
RACK	Medium	0,03%
RACK	Larg heavy	0,01%
VNA	Long	10,10%
VNA	Medium	8,79%
VNA	Small heavy	0,07%

Source: own elaboration.

In AS/RS, SKUs from the categories extra small, small, and extra small heavy will be stored. Only oversized SKUs will be stored in bulk. In VNA, long, medium, and small heavy SKUs will be stored. The remaining SKUs will be stored in rack. Table 7 illustrates the allocation of the warehouse to respective spaces and the average number of SKUs to be stored within each of them.

Table 7.
Repartition of busy locations in the warehouse and quantity of SKU in targeted zones

| Targeted location	Global repartition of busy location	No of SKU
AS/RS	36,15%	15135
RACK	26,08%	6498
VNA	21,86%	8442
BULK	15,91%	3819

Source: own elaboration.

As seen from the table, 3PL proposes the highest number of locations in the AS/RS area, mainly to automate the retrieval and preparation for shipment of small parcels. The comparative analysis was conducted by comparing the currently utilized locations with the targeted storage zones based on the percentage indicators of orderlines, orders, and units picked. Orderlines indicate how many unique orders were placed for a given SKU, and this metric is important as it signifies how many times an SKU location was visited by a picker (each order, regardless of the quantity of ordered units of a specific SKU, counts as one location visit). Orders represent the number of orders for a specific product, and units picked denote the number of picked units for a particular SKU.

Workload-related data based on the aforementioned indicators for the situation where the retailer independently manages SKU locations and stock is depicted in Figure 3. On the other hand, the target scenario in which the 3PL expands its operations to encompass the mentioned elements is presented in Figure 4.
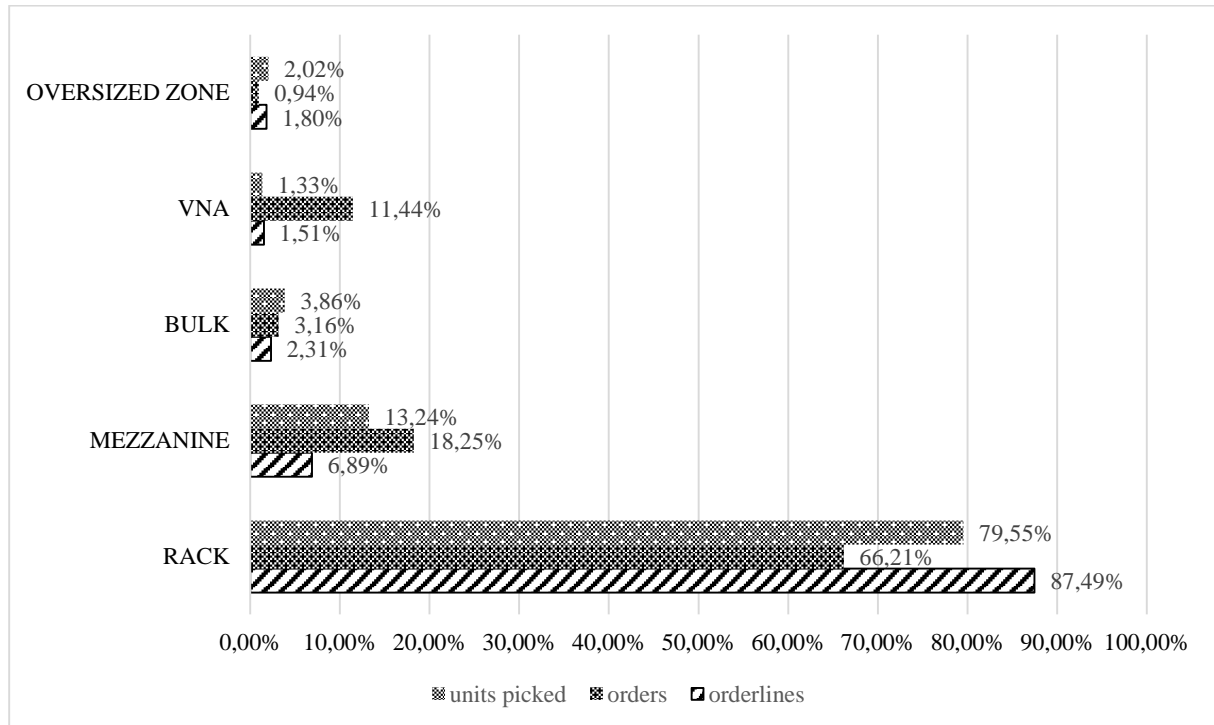
Figure 3. Current repartition of workload in the particular storage zones.

Source: own elaboration.
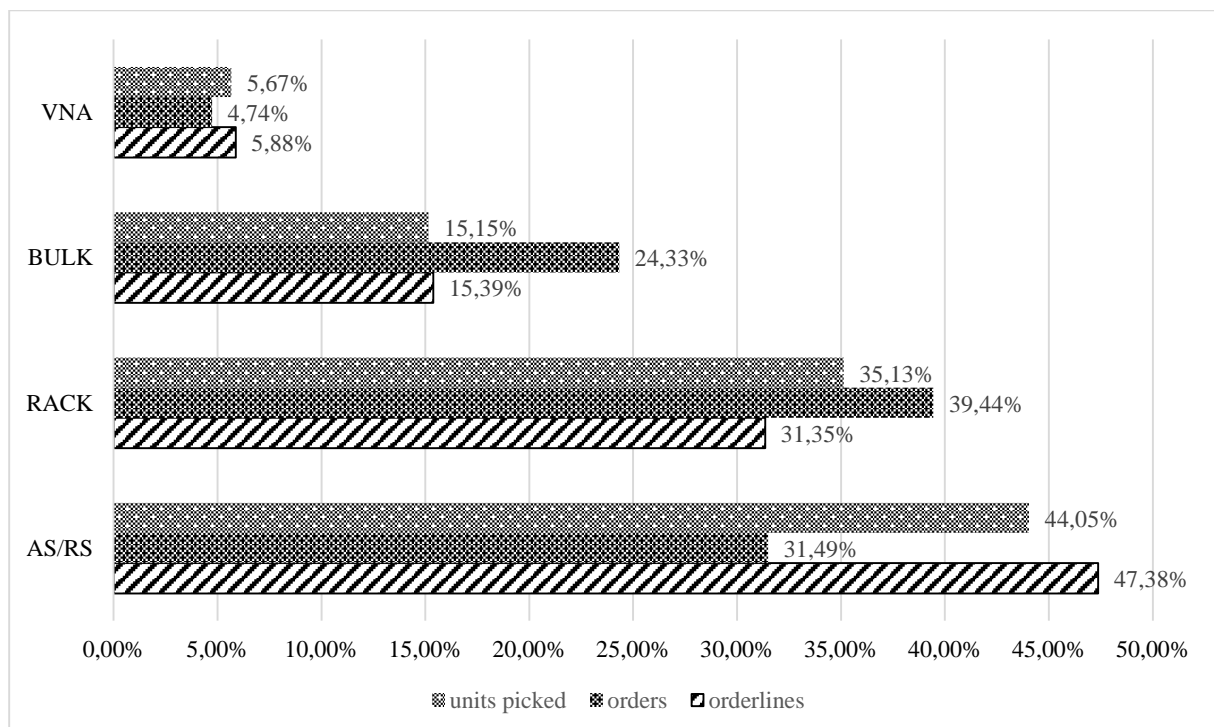
Figure 4. Targeted storage zones repartition of workload in the particular storage zones.

Source: own elaboration.

In the case of managing the e-commerce retailer's stock, the majority of the workload is concentrated on handling SKUs located in the rack. However, when entrusting this function to a logistics operator, it is evident that a better workload balance between different storage zones can be achieved, and a higher level of automation can be realized by leveraging AS/RS to a greater extent than picking from racks. The conducted research allowed for a positive validation of the hypothesis stated (i.e., the 3PL company is capable of better inventory management for the e-commerce service recipient). The logistics provider has the opportunity to implement an improved inventory management system based on location management and automation of the storage process, leveraging the logistics service provider's know-how.

5. Discussion

5.1. Stock management by 3PL in the case of e-commerce activity

This study aimed to investigate the effectiveness of third-party logistics providers (3PL) in inventory management for retail companies operating in the e-commerce market. The research hypothesis suggested that 3PL companies are capable of enhancing inventory management for e-commerce service recipients. The results of this study support and confirm the proposed hypothesis, indicating that 3PL providers can indeed introduce improved inventory management systems based on location management and warehouse automation, utilizing their logistic capabilities. In recent years, the e-commerce industry has experienced exponential growth (Risberg, 2023; Kedah, 2023; Lucas et al., 2023), presenting challenges for efficient inventory management (Pourhejazy, 2020) due to the dynamic nature of consumer expectations (Ingaldi and Ulewicz, 2019) and the need for swift order fulfillment (Camilleri, 2021). Consequently, many companies have turned to 3PL providers (Ngah et al., 2021; He et al., 2019; Yan et al., 2023) to address these challenges and optimize inventory management processes.

The results of this study underline the significant role that 3PL providers play in enhancing inventory management for e-commerce enterprises. Through the implementation of advanced systems based on location management strategies, these providers can effectively allocate products in strategic geographical locations, minimizing delivery distances, and accelerating order fulfillment. Furthermore, the integration of warehouse automation technologies further streamlines storage and retrieval processes, reducing human errors and enhancing overall supply chain efficiency. The positive findings observed in this study align with previous research that highlighted potential benefits of partnering with 3PL providers in inventory management (Kmiecik, 2022; Skender et al., 2022; Zissis et al., 2019; Parasad, Venkatasubramanian, 2019; Al. Mesfer, 2023). Nonetheless, this study goes beyond existing

literature, focusing particularly on the context of the e-commerce market and showcasing the case of assuming functions previously carried out by e-commerce retailers for the handling of a large quantity and variety of SKUs. The results demonstrate that leveraging 3PL capabilities can bring even more significant improvements in inventory management when applied in the dynamic and rapidly evolving environment of online retail. However, it's important to recognize that the effective implementation of inventory management systems by 3PL requires a comprehensive understanding of the unique requirements and characteristics of each e-commerce enterprise. While the results support the overall effectiveness of the proposed approach, factors such as product diversity, demand variability, and market positioning can influence the optimal design and adaptation of inventory management strategies.

5.2. Main limitations and further research directions

The main limitation of this study is that it presents results based on a single case study and focuses on a logistics operator with substantial experience and an established market position. To delve deeper into this topic, future research could concentrate on a detailed analysis of the implementation of advanced inventory management systems in diverse e-commerce enterprises. Such studies could provide new insights, considering the variety of industries, product types, and operational scales that influence inventory management strategies and effectiveness. One of the key areas for investigation would be the assessment of the implementation process of advanced systems in practice. This would help understand the challenges that may arise when adapting these systems to the specific needs and characteristics of e-commerce enterprises. The analysis would encompass technical, organizational, and cultural aspects, as well as the effects of changes on the entire supply chain and customer relationships. Furthermore, a significant topic for examination would be the long-term sustainability of the introduced solutions. Research could evaluate how these advanced systems impact profitability, resource savings, and the environmental aspects of business operations. Do the introduced changes contribute to waste reduction, greenhouse gas emission reduction, and an overall more sustainable approach to logistics? Given the dynamic changes in the e-commerce market, the adaptive capabilities of the implemented solutions would also require investigation. How do these systems perform in situations of changing market trends, seasonal demand fluctuations, or unexpected crises? Research on adaptability will identify whether these systems are flexible and effective in a changing environment. All these aspects could provide deeper insights into the effectiveness and future prospects of inventory management systems in e-commerce. Future research will be crucial in shaping logistics strategies for companies in the dynamically evolving e-commerce landscape.

6. Conclusions

This article constitutes a significant contribution to the expanding realm of research regarding the role of third-party logistics providers (3PL) in enhancing inventory management, particularly in the context of e-commerce. The added value lies not only in confirming the positive hypothesis but also in emphasizing the immense potential that 3PL providers possess in implementing advanced inventory management systems based on location strategies and warehouse automation. As the e-commerce industry continues to evolve, companies face growing challenges in efficiently managing their inventories. The dynamic nature of consumer demand and the need for efficient order fulfillment require sophisticated logistics and warehousing approaches. In this context, collaboration with 3PL providers becomes pivotal as it allows companies to access logistics expertise and modern technologies, enabling them to adapt effectively to changing market conditions.

The positive results observed in the study confirm that 3PL providers can implement optimized inventory management systems that significantly contribute to shorter delivery times, minimized logistics costs, and increased efficiency throughout the supply chain. As e-commerce continues to evolve, businesses are compelled to continuously refine their logistics strategies. In this context, partnering with 3PL providers becomes a key element in achieving success. Effective inventory management, enabled by advanced systems and the knowledge of 3PL providers, translates into customer satisfaction through faster and more reliable deliveries. To further deepen the understanding of this topic, future research could focus on analyzing the implementation details of advanced inventory management systems in diverse e-commerce enterprises. Additionally, investigating the long-term sustainability of these solutions and their adaptability in a dynamically changing market environment will also be crucial.

List of abbreviations

2PL – second-party logistics.
3PL – third-party logistics.
AS/RS – Automated Storage & Retrieval System.
SKU – Stock Keeping Unit.
WMS – Warehouse Management System.
VNA – very narrow aisle racking.

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