

Analysis of the Implementation of Digital Warehouse Systems in Supporting Operational Efficiency and Inventory Accuracy

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Abstract

Advances in information technology and digital transformation have driven companies to make changes across various aspects of their business operations, including warehouse and inventory management systems. This research aims to analyze the implementation of a digital warehouse system in supporting operational efficiency and inventory accuracy at XYZ Distribution Company, as well as to identify obstacles and its optimization strategies. The method used is descriptive qualitative with a case study approach. Primary data were obtained through observation and semi-structured interviews with the operational manager and warehouse staff, while secondary data came from internal company documents. The results show that the transition from manual recording to a digital system integrates the workflow centrally. Digitalization successfully reduced item search time from 15–20 minutes to be much more efficient, resolved bottlenecks in the picking area, and accelerated the stock opname process. Furthermore, inventory accuracy increased significantly, marked by a drastic decrease in inventory discrepancy from 2,789 units in 2022 to 250 units in 2025. The main obstacle faced is that barcode scanning technology has not been adopted, so data input is still performed manually and leaves potential for human error. The company's mitigation strategy is carried out through tightening SOPs in the form of a double-checker system and product specification coding standardization.

Keywords

digital warehouse system, distribution company, inventory accuracy, operational efficiency.



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INTRODUCTION

Advances in information technology and digital transformation have driven companies to make changes across various aspects of their business operations, including warehouse and inventory management systems. Digitalization is now viewed as a crucial strategy for companies to improve operational efficiency, accelerate the flow of information, and minimize the risk of data entry errors. Within the supply chain ecosystem, warehouses play a strategic role as centers for the storage, control, and distribution of goods, ensuring the stability and smooth operation of the overall business process. Conversely, conventional and ineffective warehouse

management risks causing distribution delays, inventory discrepancies, and even a surge in the company's operational costs

The growth of the trade and distribution sector in Indonesia has also driven an increased need for more effective and integrated warehouse management systems. According to data from (Badan Pusat Statistik, 2024), the transportation and warehousing sector experienced growth of 8.62%–9.01%, higher than that of several other sectors. Additionally, the (Badan Pusat Statistik, 2024) indicates that e-commerce business growth in 2024 rose by 15.3%, with 31.88% of businesses operating in the wholesale and retail trade sector. These conditions underscore the need for companies to manage inventory quickly, precisely, and accurately to ensure the smooth operation of the supply chain and meet the demands of an increasingly dynamic market.

In practice, warehouse systems that are still managed manually often lead to various operational challenges. Paper-based or spreadsheet-based inventory tracking is prone to human error, delays in data updates, and discrepancies between physical stock and inventory data. Additionally, the lack of real-time data integration prolongs the item search process and hinders picking, packing, and distribution activities, leading to increased distribution lead times and a decline in the company's service quality to customers. (Gugat, 2023) explains that non-integrated warehouse management can result in low operational effectiveness and a high risk of errors in inventory control. Another risk of manual recording is the difficulty management faces in obtaining real-time inventory information, thereby increasing the likelihood of lost goods or untracked inventory data due to a weak monitoring system. The use of digital systems allows the recording process to be more structured, minimizes the risk of errors, and helps management make decisions more quickly and accurately, thereby increasing the company's productivity and operational effectiveness (Syafnur et al., 2025).

The use of a digital warehouse system, or Warehouse Management System (WMS), has become a widely adopted solution for companies looking to improve operational efficiency and inventory accuracy. Digital warehouse systems enable companies to centralize inventory tracking, update data in real time, and integrate information across operational departments. Through these systems, companies can accelerate the process of identifying goods, minimize recording errors, and improve the effectiveness of inventory control

Several previous studies have shown that the implementation of digital warehouse systems has a positive impact on a company's operational activities. Research by (Ma'rifat et al., 2025) indicates that the implementation of a Warehouse Management System (WMS) can improve warehouse management efficiency by reducing lead times, increasing inventory accuracy, and minimizing human error in warehouse operations. Additionally, (Putra & Rosyani, 2022) found that the implementation of a FIFO-based WMS system can improve storage efficiency and inventory accuracy through more structured inventory management.

Another study conducted by (Susanto et al., 2026) explains that the development of a web-based Warehouse Management System can support real-time inventory data integration, thereby making warehouse operations more effective and automated. (Rhomazani et al., 2025),

in a systematic literature review, explain that the implementation of a Warehouse Management System (WMS) contributes to improved order-picking accuracy and a reduction in human error through the integration of digital technology into warehouse operations.

Although there has been extensive research on Warehouse Management Systems (WMS), most previous studies have focused on system development, the implementation of barcodes or RFID, and quantitative efficiency measurements in large-scale manufacturing and logistics companies. Research discussing the transition process from manual systems to digital warehouse systems in distribution companies remains relatively limited, particularly in companies that have not fully adopted automation technologies such as barcode scanning. Furthermore, most previous studies have emphasized the technical aspects of system development rather than analyzing the impact of digital system implementation on operational efficiency and inventory accuracy based on user experiences in daily warehouse operations. Therefore, this study was conducted to provide a more contextual understanding of the implementation of digital warehouse systems in distribution companies to support operational efficiency and inventory accuracy.

Based on this phenomenon, this study aims to analyze the implementation of a digital warehouse system in supporting operational efficiency and inventory accuracy at XYZ Distribution Company. This study also examines the obstacles faced by the company in implementing the digital warehouse system, as well as the strategies employed to optimize inventory management. This study is expected to provide an academic contribution to the development of research on operational management and digital warehouse management, as well as serve as a practical reference for distribution companies in continuously improving the effectiveness of their warehouse systems.

METHODS

This study employs a descriptive qualitative approach using the case study method at XYZ Distribution Company. The qualitative approach is used to gain an in-depth understanding of the implementation of a digital warehouse system in supporting operational efficiency and inventory accuracy based on actual conditions in the field. According to (Sugiyono, 2018), qualitative research is used to examine the natural conditions of the research subject, with the researcher serving as the primary research instrument.

Informants were selected using purposive sampling, which involves selecting informants based on their knowledge, experience, and direct involvement in the implementation of the digital warehouse system at the company (Sugiyono, 2018). The informants in this study consisted of operational managers and warehouse staff who had worked for at least one year and were directly involved in storage and inventory management activities. To maintain the confidentiality of the informants' identities, the researcher used informant codes in presenting the interview results, namely Informant 1 (I1) for the operational manager and Informant 2 (I2) for the warehouse staff.

The research data sources consist of primary and secondary data. Primary data was obtained through semi-structured interviews and direct observation of warehouse operational activities, while secondary data was obtained from company documents such as warehouse SOPs, inventory reports, stock-taking data, and scientific literature relevant to the research topic. According to (Moleong, 2018), interviews are used to obtain in-depth information regarding the phenomenon under study.

The data analysis technique employs the interactive analysis model (Huberman & Miles, 2014), which consists of data reduction, data presentation, and drawing conclusions. To ensure data validity, this study employs source triangulation and methodological triangulation through the comparison of data from interviews, observations, and documentation.

FINDINGS AND DISCUSSION

PT XYZ is a distributor of beverage bottles (tumblers or thermoses) with a wide distribution network, both in the domestic market and across various online marketplaces. As a distribution entity, the company's primary operational activities include receiving goods, storage, inventory management, and product distribution to customers and business partners.

Prior to the implementation of the digital system, all warehouse activities were conducted traditionally through paper-based record-keeping and manual data entry or stock cards into spreadsheets.

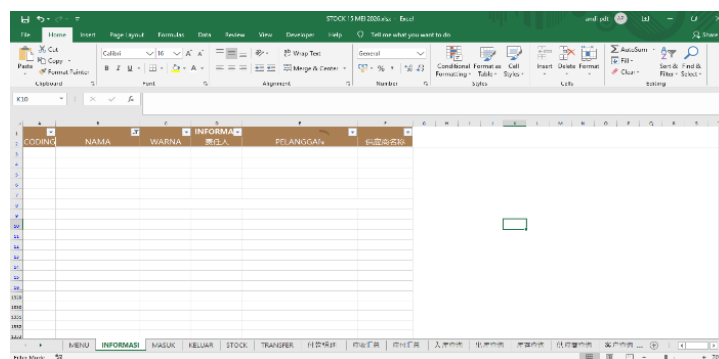


Figure 1. Inventory Count Sheet

This practice results in a heavy administrative workload and operational inefficiencies, as staff must repeatedly reconcile data to ensure the validity of the information. Furthermore, the complexity of manual procedures increases the risk of human error in inventory recording and discrepancies between physical inventory and data on worksheets. The lack of real-time data integration also complicates internal bureaucracy, where coordination between departments takes longer because it requires physical verification of documents that are prone to damage or loss.

The transition to a digital warehouse management system was implemented to accommodate the increase in import volumes in a more structured manner. Although it has not yet adopted barcode scanning technology, this new system has integrated centralized inventory tracking and automated inventory movement reports that are directly connected to

the company's data center. This implementation enables real-time data synchronization across departments, thereby minimizing the information discrepancies that previously occurred frequently in the manual system.

The digitalization that has been implemented has transformed the workflow from an unorganized push system to an integrated workflow. The implementation of a digital warehouse system has brought about significant changes to warehouse operations.

Changes in Warehouse Operational Processes Following Digitization

The implementation of a digital warehouse system has led to operational efficiencies at PT XYZ. Prior to digitization, all inventory management activities were conducted conventionally using paper-based records (ledgers/stock cards).

In practice, the manual process required complete reliance on the accuracy of warehouse staff. When goods were received or issued, staff had to make physical entries on stock cards at each storage location, which were then periodically summarized into the ledger. This situation created significant challenges, especially as the volume of goods increased; locating items became inefficient because staff had to check administrative sheets one by one or conduct random physical searches (trial and error) throughout the warehouse. Additionally, the risk of data discrepancies was very high due to the time lag between physical activities and the updating of administrative records.

The high complexity of tumbler products with their variety of sizes, colours, and specifications makes the product search process inefficient, especially as inventory volumes increase. Informant 1 (I1) explained that before digitization, searching for a single SKU could take quite a long time due to inaccuracies in physical inventory records.

“Before digitization, locating a single SKU could take up to 15–20 minutes due to inaccuracies in the physical inventory cards.” (I1)

These findings indicate that the manual system resulted in low inventory visibility, making the product search process ineffective. This situation also caused bottlenecks in the picking area because staff had to manually search for items in the warehouse storage area. A similar point was made by a warehouse staff member, who stated:

“In the past, we often had to unpack stacks of pallets just to find items that were listed in the records but couldn't be found in the physical location.” (I2)

This statement indicates that the limitations of the manual system led to discrepancies between administrative data and the physical condition of goods in the warehouse. Following the implementation of the digital system, inventory management processes became more integrated because stock data is stored centrally and can be accessed in real-time by all operational departments. Information regarding the quantity, location, and specifications of goods can be obtained more quickly, making receiving, storage, and issuing activities more efficient.

The results of this study align with research (Ma'rifa et al., 2025), which states that the implementation of a Warehouse Management System (WMS) can improve warehouse

management efficiency by accelerating access to inventory data and reducing human error in warehouse operations.

Time Efficiency and Reduction of Operational Errors

The implementation of a digital warehouse system has a positive impact on the company's operational time efficiency. Before digitization, the processes of item identification and inventory counts took a relatively long time because staff had to check physical documents and manually match data. After the implementation of the digital system, item searches can be conducted through an integrated data search system, so staff no longer rely on physical document checks.

Digital systems also help speed up the inventory counting process because inventory data is automatically updated within the system. This makes the stock verification process faster and minimizes the risk of data recording errors. Additionally, records of incoming and outgoing goods are entered directly into a centralized database, ensuring that inventory updates are consistent and real-time.

The operational efficiency achieved through digital systems demonstrates that inventory data integration can improve warehouse management effectiveness, particularly in companies with a high level of SKU complexity. This finding aligns with research (Putra & Rosyani, 2022), which states that the implementation of a WMS system can improve storage efficiency and inventory accuracy through more structured stock data management.

The Impact of Digital Warehouse Systems on Operating Costs

Several manual administrative tasks can be reduced after implementing a digital system, making paper usage and work hours more efficient. Cost efficiency is most evident in the reduction of office supplies (paper and document printing) and in optimized work hours. With centralized data, companies no longer need as many staff members to re-enter information from paper records into computers, thereby reducing overhead costs.

Implementation of a Digital Warehouse System to Support Inventory Accuracy

Based on in-depth interviews with warehouse staff, it was found that the transition from paper-based record-keeping to a digital system mitigates the risk of human error, which had previously been a major obstacle.

"Before using this system, stock discrepancies between our records and final reports often didn't match, or there were even missing record sheets. Not to mention that items with similar colours were frequently mixed up; now, thanks to the system's clear categories and codes, that no longer happens." (I2)

This statement indicates that the digital system helps improve inventory recording accuracy through standardized product categories and more structured stock data integration. The use of product codes within the system also helps minimize misidentification of items with nearly identical characteristics.

Referring to the company’s internal data, there has been a decrease in the discrepancy rate, as presented in Table 1.

Table 1. Comparison of Inventory Discrepancies (Units) Before and After Digitization

Observation Period	Method	Number of Inventory Discrepancies
Years 2022	Manual (Paper/Spreadsheet)	2.789 pcs
Years 2023	Manual (Paper/Spreadsheet)	1.438 pcs
Tahun 2024	Digital	800 pcs
Tahun 2025	Digital	250 pcs

Source: Internal Data from Company XYZ, (2026)

The data shows a significant downward trend in inventory discrepancies following the transition to the new warehouse management system. During the period when manual methods were used (2022–2023), the average inventory discrepancy remained quite high. This was due to the limitations of manual record-keeping, which was prone to data entry errors (human error), as well as weak oversight of the physical location of items (misplaced items).

Following the implementation of the digital system in 2024, the effectiveness of oversight improved, reducing the number of discrepancies to 800 units. This transformation reached its optimal point in 2025, when the inventory discrepancy figure dropped drastically to 250 units. This reduction was made possible because the system requires real-time data input for every movement of goods, ensuring synchronization between system records and physical availability in the warehouse. This integration effectively mitigates the risk of data loss and improves overall inventory accuracy. These findings align with research (Rhomazani et al., 2025) explaining that the implementation of a WMS contributes to improved inventory accuracy and a reduction in human error in warehouse operations.

Challenges and Strategies for Companies in Optimizing Warehouse Operational Efficiency

In a manual system, the administrative workload is high, especially due to the complexity of product characteristics, resulting in a high risk of data discrepancies. Currently, although the company has transitioned to a digital system, the system in use still focuses solely on integrating inventory data and does not yet utilize barcode technology. Without barcodes, data entry is done manually, which is time-consuming; consequently, human errors in the data entry process still occur, although not as frequently as when using a manual system. The company is currently gradually optimizing centralization and centralized data integration. Categorization and coding of each product specification are also being implemented to minimize errors. Additionally, operational standards have been tightened, including the implementation of a double-checker system to ensure data is accurately validated.

CONCLUSION

Based on the research findings, the implementation of a digital warehouse system at PT XYZ has proven effective in improving the company's operational efficiency and inventory accuracy. The implementation of the digital system has transformed warehouse operations which were previously conducted manually into a more integrated and structured process. The centralized, real-time inventory tracking system helps speed up the item search process, reduces bottlenecks in the picking area, and improves the efficiency of the physical inventory count process. Additionally, inventory digitization has significantly contributed to reducing human error and inventory discrepancies, as evidenced by a decrease in stock discrepancies from 2,789 units in 2022 to 250 units in 2025. These research findings indicate that the implementation of a digital warehouse system plays a crucial role in enhancing inventory management effectiveness within distribution companies dealing with highly complex product lines.

However, the implementation of the digital warehouse system at PT XYZ still faces several challenges, primarily because the company has not yet fully adopted barcode scanning technology, so data entry is still done manually. This situation means that potential data entry errors can still occur, although at a lower rate compared to the previous manual system. Therefore, the company is advised to develop a warehouse system that is more integrated with barcode technology or other automation systems to further optimize inventory accuracy and operational efficiency. Additionally, the company also needs to conduct ongoing training and reinforce operational standards so that the implementation of the digital system can run more effectively and consistently.

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