

DEVELOPMENT OF A WAREHOUSE ACCOUNTING SYSTEM IN WHOLESALE TRADE ENTERPRISES BASED ON THE TOE METHODOLOGY

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Abstract. *The purpose* is to establish the theoretical foundation for organising accounting in trade enterprises with consideration of the TOE model, to substantiate the accounting and economic functions of inventories, and to determine the methodological principles for implementing a warehouse accounting system under conditions of digital transformation. *Methodology.* The study is grounded in systemic and process-oriented approaches, combining theoretical generalisations of scientific principles with a practical analysis of warehouse operations in retail enterprises. The systems approach was applied to conceptualise warehouse management as an integrated, multifunctional system, while the process approach enabled the interdependence of its elements to be described within the framework of management accounting. General methods of analysis and synthesis were employed to generalise scientific principles regarding the role of inventory in business operations. The theoretical foundation of the study is the TOE model, which explains the implementation of innovative warehouse accounting systems through technological, organisational, and environmental contexts, including an assessment of the impact of digital technologies such as automation, robotisation, cloud solutions, and artificial intelligence. *Results.* The study found that warehouse management in wholesale enterprises plays a strategic role by forming the basis for competitive advantages and economic stability. The use of the TOE model enabled the systematic identification of factors influencing the implementation of innovative solutions in warehouse management and their adaptation to the needs of trading enterprises. The technological context encompasses process automation, the use of cloud platforms, robotic systems, blockchain solutions, and artificial intelligence. The organisational context is determined by staff readiness, management support, and the structural characteristics of the enterprise. The external environment includes competitive pressure, regulatory requirements, and customer expectations. The modernisation of warehouse accounting helps to optimise business processes in several dimensions: time, physical volumes, information, and storage conditions. *Practical implications.* The proposed approach can be applied by retail enterprises to optimise warehouse processes, reduce the risk of asset loss, and improve the accuracy of accounting data. Its practical significance lies in utilising the TOE model to introduce innovative accounting technologies, thereby enhancing the competitiveness and resilience of enterprises in times of crisis. *Value / originality.* The originality of this study lies in the combination of an accounting and economic analysis of inventories with a process-based approach to warehouse operations and the application of the TOE model in explaining the digital transformation of accounting. This provides a comprehensive understanding of the role of warehouse management as a strategic tool for the development of retail enterprises, integrating economic, organisational, and technological aspects.

Keywords: warehouse accounting, inventories, trading enterprises, digital transformation, TOE methodology, management accounting.

JEL Classification: M41, M49, L81, O33

1. Introduction

Warehouse accounting is of crucial importance in accounting for the logistics processes of wholesale trading enterprises, which are focused on managing

the movement of goods from the point of dispatch to the point of destination. Warehouse business processes are characterised by their intermediary function between the participants of the supply

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chain and generate a wide range of accounting objects: costs, inventories, settlements, services, non-current assets, and others. The expansion of the customer base in modern wholesale enterprises, the growing complexity of internal logistics processes, the centralisation of warehouse facilities, and the streamlining of supply chain operations necessitate the restructuring, modernisation, or even the implementation of a new warehouse accounting system in trading companies.

The development of digital technologies and their integration into accounting create new opportunities for optimising warehouse processes. The use of automated inventory management systems, cloud-based accounting platforms, and robotic solutions in logistics enables significant improvements in data accuracy, reduces the risk of asset loss, and ensures that management decisions are made promptly. In this context, warehouse accounting is no longer merely a technical tool for recording the movement of goods but rather a strategic resource that contributes to the company's competitive advantage.

The integration of warehouse accounting with other enterprise management subsystems, in particular the financial and management accounting subsystems, is of particular importance. Such integration provides a comprehensive approach to the analysis of costs, revenue, and the efficient use of resources. The practical significance of modernising warehouse accounting consists in its potential to strengthen the economic resilience of wholesale trading enterprises. Optimising warehouse processes contributes to cost reduction, enhances demand forecasting accuracy, and ensures flexibility in responding to market fluctuations. This, in turn, provides the foundation for strategic planning, financial stability, and the long-term development of enterprises.

The aim of this article is to outline the role of warehouse accounting in managing logistics processes within the wholesale trade sector and to identify approaches to its modernisation, with reference to the "technology-organisation-environment" (TOE) model and the challenges of digital transformation. To understand the role of accounting within the complex interrelations of the supply chain, it is necessary to address two critical questions: the place of accounting in the human-centred paradigm of Industry 5.0, and the organisation of accounting and warehousing processes through the "technology-organisation-

environment" (TOE) methodology. Other objectives of the study include identifying the functional role of warehouse accounting in supporting management decisions, analysing the impact of digital technologies on the efficiency of resource utilisation, applying the TOE model to explain innovative changes in warehouse processes, and developing practical recommendations for improving accounting and analytical procedures in wholesale trade enterprises.

The research methodology is based on a combination of systemic and process-based approaches, which allow warehouse operations to be considered as a multifunctional system and the interdependence of its elements to be described within the framework of management accounting.

2. Accounting and Economic Functions of Inventory in Retail Enterprises

Current market requirements characterise a warehouse as a complex technical facility consisting of many interrelated elements, with a defined structure, performing functions of transforming material flows as well as storing, processing, and redistributing cargo flows to consumers (Ptytsia & Kovtsur, 2022). The core concept of warehousing policy development is to reduce inventory levels while minimising order lead times and operating costs (Suesut, Gulphanich, Nilas, Roengruen & Tiraseth, 2004). In order for the inventory system to meet the enterprise's dynamic or static needs in terms of inventory accounting and management, financial personnel and related departments must develop their own inventory environment, personalising parameters such as business scale, inventory records, methods of inventory valuation, distribution fees, and other relevant settings (Jinping, 2017). Within modern enterprises, the key weakness in their management structure is an inefficient management accounting system, which, through the provision of distorted information, may undermine the efforts of firms with strong R&D, production, and marketing capacities (Ocheretenko, Korovko & Zhatkanbaeva, 2023). At the same time, the adoption of new technologies in warehousing (particularly in the field of accounting) has inherently been a process of social consensus, whose success depends on the acceptance and involvement of the stakeholders (Mahroof, 2019). The warehouse accounting system (including its automated form) is intended

to: improve service quality by preventing supply disruptions; reduce technical errors by minimising human error; mitigate the risk of asset loss or damage; streamline logistics operations; and ensure real-time monitoring of warehouse goods (Gulyamov, 2022).

For wholesale enterprises, inventory constitutes a significant part of their assets and has a dichotomous nature. On the one hand, excessive inventory generates additional costs and adversely affects business performance. On the other hand, extensive inventories ensure a high degree of product diversity, which contributes to attracting customers (Yong & Jingyun, 2010). As noted by Chen H., Frank M.Z. and Wu O.Q. (Chen, Frank & Wu, 2007), recent trends (such as the 'just-in-time' philosophy, advances in information technology, and outsourcing) indicate a strategy of reducing inventory levels; however, demand uncertainty and the need to enhance customer service compel enterprises to maintain higher inventories.

In this way, inventory plays a pivotal role in the operations of wholesale enterprises, performing the following essential functions:

- decoupling – goods are maintained in sufficient quantities to meet customer demand independently of suppliers; since consumer demand is often difficult to forecast, the inventory held to satisfy it tends to fluctuate;
- determining the optimal batch size – purchasing and transportation costs per unit must be minimised to reduce the overall price of goods;
- forecasting – enterprises face demand fluctuations that can be assessed on the basis of past experience, enabling them to anticipate seasonal demand and adjust inventory accordingly (Hasti, Kom & Syafariani, 2017).

Inventory is an important component of an enterprise's resource potential, alongside non-current assets, intangible resources, financial resources, and labour. It can be classified according to accounting objects as low-value and rapidly depreciating items, raw materials, direct and auxiliary materials, fuel, semi-finished products, components, spare parts for repairs, and material costs in the production of work-in-progress and finished goods (Shevchenko et al., 2018).

The specific nature of inventory management in wholesale enterprises underscores the need for modern monitoring and optimisation tools. In this context, the digital transformation of warehouse processes is of growing importance.

3. Digital Transformation of Warehouse Management Accounting Processes

As a significant proportion of inventory is held in wholesale warehouses, improving the efficiency of processes related to the internal movement of goods emerges as a key economic and accounting concern. In general, warehouse operations include the following processes: receiving; put-away; storage; order picking; packing, labelling and documentation; and dispatch (Roth & Sims, 1991).

Figure 1 presents typical operational warehouse processes in wholesale trade that are addressed by accounting activities.

This process is described in more detail in the paper by Aulin V. et al. (2020) and consists of eleven consecutive operations: 1) arrival of goods at the warehouse; 2) checking the integrity of goods packaging in the vehicle; 3) unloading of goods; 4) receiving and stacking of goods in the reception area; 5) inspection of goods for quantity and quality; 6) allocation and transfer of goods to the storage or order-picking area; 7) storage of goods in the warehouse; 8) order picking and release from the storage area; 9) transfer of ready goods to the dispatch area; 10) verification of goods for quantity and compliance with documentation; 11) loading of goods onto the vehicle.

With the aim of optimising supply chain processes and ensuring cost control, leading global trading companies increasingly rely on information technologies that support internal and inter-organisational processes, decision-making, workflow management, and automated information exchange among partners (Lefebvre, Lefebvre, Wamba & Boeck, 2007). Lefebvre, L.-A., Lefebvre, E., Wamba, S.F., and Boeck, H. identify more than ten programmes that, at the time of writing, were being implemented in supply chain management, aimed at improving productivity.

In today's environment, none of these processes can be considered without an understanding of the evolution of warehouse management in an era of rapid digital transformation, which is designed to improve the efficiency of the supply chain. As noted by Kumar R.J., Kumar I.A., Ronald Aseer J. and Bahubalendruni M.V.A.R. (Kumar, Kumar, Ronald Aseer & Bahubalendruni, 2026), the progress brought about by the industrial revolutions has permanently transformed the design and functionality of warehousing. Early warehouses during the Industry 1.0 era relied on manual labour and simple mechanical devices.

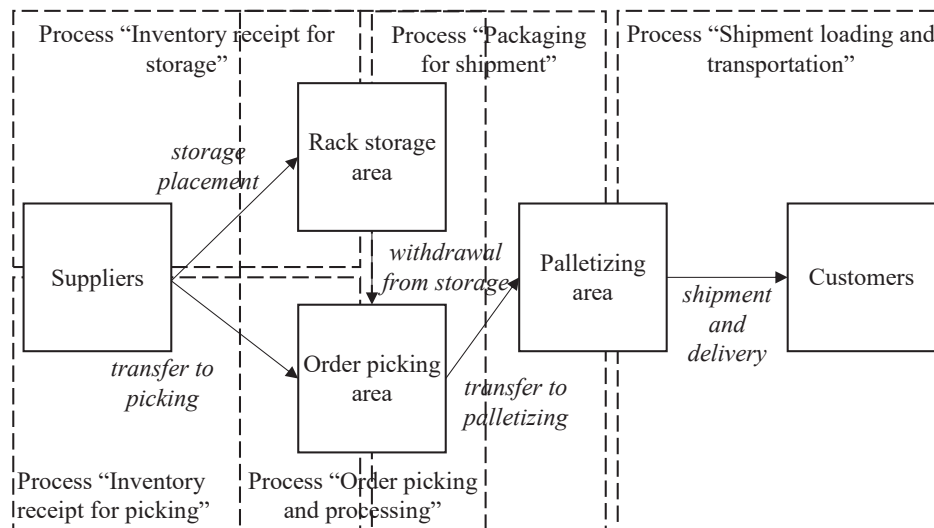


Figure 1. Process-based approach to the organization of warehouse accounting processes within wholesale enterprises

Source: compiled by the author

Electrification, conveyor belts and electrically powered systems in Industry 2.0 improved throughput and ergonomics. Industry 3.0 brought computerisation, barcoding and the first warehouse management systems. Industry 4.0 integrated automation, robotics, Internet of Things sensors and cloud analytics. Now, Industry 5.0 aims to humanise this warehouse automation by using immersive and collaborative technologies, such as augmented and virtual reality.

4. The TOE Methodology in the Implementation of Warehouse Accounting for Retail Enterprises

The implementation of a warehouse accounting system can be regarded as an innovation for a business entity; therefore, in our study we will use the theoretical model proposed by Tornatzky L.G. and Fleischer M. “technology-organisation-environment (TOE)” model from 1990 (Tornatzky & Fleischer, 1990), which is capable of explaining the adoption of innovations by companies, drawing on three key business contexts:

- technological level – this takes into account existing technologies, both internal and external, that are important to the company and may be useful for improving productivity;
- organisational level – resources available to support the adoption of innovation (including the company’s size, scope of operations, management structure and human resource capabilities);

- external environment level – external influences from the industry and competitors, and the company’s ability to access resources.

The factors listed below can be broken down in a wide variety of ways. For example, Chen J., Tian T., Wong C.W. and Lai K.-H. (Chen, Tian, Wong & Lai, 2026) propose the following classification:

- technology: technology intensity (technological advantages and compatibility);
- organisation: size (infrastructure); type of ownership (public/private); management experience (professional or educational experience in the relevant field);
- external environment: competition within the sector (pressure from competitors); uncertainty (lack of reliable information regarding future conditions); risk in the supply chain (disruption to the flow of goods, information or funds).

In the field of accounting, the TOE framework has most frequently been applied in recent years to assess the implementation of a range of technological innovations, such as:

- cloud accounting: Putri E., Bandi B., Widarjo W. and Arifin T. argue that factors such as IT infrastructure, organisational readiness, stakeholder pressure, and regulatory compliance exert the greatest impact on the adoption of cloud accounting (Putri, Bandi, Widarjo & Arifin, 2025); Yaputri J.A. and Widuri R. highlight the crucial importance of perceived usefulness and ease of use for adoption in start-up companies (Yaputri & Widuri, 2024); a study (Kamal, Jasni, Razali & Shah,

2023) demonstrated that management support and competitive pressure were key drivers for adoption in small and medium-sized enterprises;

- Robotic Process Automation (RPA): Gold N.O., Coovadia H. and Thiye K. demonstrated the crucial role of organisational and technological readiness, as well as managerial support, for the successful implementation of RPA (Gold, Coovadia & Thiye, 2026);

- blockchain: Seshadrinathan S. and Chandra S. demonstrated the role of trust and the mediating influence of TOE variables on the implementation of blockchain-based accounting solutions (Seshadrinathan & Chandra, 2025);

- artificial intelligence systems: internal and external business environments are decisive factors influencing decisions on the implementation of AI in accounting (Sharbek & Dutescu, 2025);

- mobile accounting applications: Moreno D.E.L., Gomez K.M.D., Cajés R.K.S. and Lavin R.E.M. argue that digital orientation, organisational readiness, and competitive pressure positively influence the feasibility of implementing mobile accounting systems in business operations, particularly through their link to perceived usefulness and ease of use (Moreno, Gomez, Cajés & Lavin, 2024).

The stages of establishing an inventory accounting system in wholesale trade enterprises, based on the TOE methodology (drawing on the research of (Hassan, Ali, Aktas & Alkayid, 2015)), are as follows:

1. Organisational stage: identifying internal issues and needs within the warehouse that an accounting system can address; specifying the aims and objectives of warehouse accounting; securing management support; conducting a preliminary assessment of the preparedness and skills of warehouse staff.

2. Operational stage: specifying warehouse processes and identifying areas for improvement through accounting measures; assessing the current state of business processes; defining the desired accounting and technical processes for procurement, warehousing, and sales.

3. Structural stage: examining the factors that influence the analytical capabilities of the accounting system (type of goods, warehouse size, number of racking units, zoning, unit of stock-taking, e.g., pallet, box).

4. Resource stage: establishing accounting procedures for individual functional areas –

accounting for the storage and movement of goods, goods-handling equipment, general warehouse costs, warehouse staff labour and wages, warehouse premises, automation systems, among others.

5. External stage: taking into account pressures from customers, competitors, and government authorities, as well as support from suppliers.

6. Technical stage: analysing various options for organising warehouse accounting (including the potential for process automation); evaluating the costs and benefits of the new warehouse accounting system; testing the system to identify strengths and weaknesses.

7. Decision-making stage: making the final decision and engaging relevant personnel in project implementation.

The practical benefits of implementing an effective warehouse accounting system in wholesale enterprises are reflected in the optimisation of business processes in terms of: time (movement of goods between receiving, storage, order picking, palletising, and dispatch areas; locating goods; recording their positions); physical volumes (reducing stock losses; establishing safety stock; preventing shortages; facilitating stock-taking); information (obtaining accurate data on the location of each item; analysing purchase and sales volumes; analysing data by warehouse zones and product lines; reducing labour costs for handling); and conditions (monitoring storage; optimising warehouse space), among other aspects.

5. Conclusions

Industry 5.0 has highlighted the need to optimally combine the capabilities of information technology with human potential to achieve synergistic results. This development has generated renewed interest in research on the application of digital innovations such as cloud technologies, robotic process automation, blockchain, artificial intelligence, and mobile applications in warehouse management, while maintaining a human-centred orientation. An effective warehouse accounting system in the wholesale trade is not only a technical tool for recording the movement of goods but also a strategic resource that provides enterprises with competitive advantages. Its integration with financial and management accounting establishes the basis for a comprehensive analysis of costs, revenues, and resource utilisation.

Over the past three decades, the “technology-organisation-environment” concept has evolved into a powerful theoretical tool for explaining the motivation of business entities to implement innovative developments in their operations. The use of the TOE methodology ensures the systematic consideration of technological, organisational, and external factors in the process of modernising warehouse accounting, establishing a sequence of actions ranging from organisational diagnosis and goal-setting, through the specification of operational and structural parameters and the structuring of accounting by

functional units, to technological analysis and system testing, culminating in informed managerial decision-making.

Sub-categorisation of factors influencing the effective implementation of warehouse accounting within a management system, based on the “technology-organisation-external environment” triad, together with the creation of an integrated information environment that links warehouse accounting to planning and control systems while accounting for external factors and the specific characteristics of wholesale trade, represents a promising direction for further research.

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Received on: 15th of August, 2026

Accepted on: 25th of September, 2026

Published on: 14th of October, 2026