FACTORS AFFECTING THE EFFECTIVENESS OF IMPLEMENTATION WAREHOUSE MANAGEMENT SYSTEMS (WMS): A SYSTEMATIC LITERATURE REVIEW

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Abstract: This study aims to identify and analyze the key factors affecting the effectiveness of Warehouse Management System (WMS) implementation and to develop an integrated framework for understanding successful WMS implementation. A Systematic Literature Review (SLR) was conducted on relevant peer-reviewed journal articles and conference proceedings published between 2020 and 2024. Literature was collected from several academic databases, including Google Scholar, IEEE Xplore, ScienceDirect, SpringerLink, and Emerald Insight. Following a structured screening and selection process based on PRISMA guidelines, 63 articles were analyzed using content and thematic analysis. The findings indicate four major factors influencing WMS implementation effectiveness: technology integration (35%), operational factors (29%), organizational support (29%), and financial considerations (8%). Effective WMS implementation is associated with technological compatibility, process alignment, management commitment, employee competence, training, and adequate resource allocation. Organizations should adopt phased implementation, strengthen employee training and change management, align the WMS with operational processes, and conduct appropriate financial planning. Contribution & Value Added: This study contributes a comprehensive framework that integrates technological, organizational, operational, and financial perspectives to explain WMS implementation effectiveness, 63addressing the limitation of previous studies that tend to emphasize technological aspects.

Keywords: Warehouse Management System, Supply Chain Management, Manufacturing Industry, Systematic Literature Review, Implementation Effectiveness, Organizational Factors, Technological Integration, Financial Considerations.

INTRODUCTION

Warehousing plays a critical role in supply chain management by supporting inventory control, material handling, order processing, and the timely movement of goods. Increasing demands for operational efficiency, inventory visibility, and reliable order fulfillment have encouraged organizations to use digital technologies to manage warehouse activities. One such technology is the Warehouse Management System (WMS), which supports recording, monitoring, and coordinating warehouse transactions. When effectively implemented, WMS can improve inventory information, facilitate coordination across warehouse processes, and support operational decision-making. However, having a WMS does not

necessarily guarantee its intended benefits. Implementation effectiveness may depend on technological compatibility, organizational readiness, operational processes, financial resources, and external conditions. Understanding these factors is therefore important for explaining variations in WMS implementation outcomes across organizations.

WMS implementation effectiveness needs to be distinguished from technology adoption and system availability. Technology adoption primarily concerns an organization's decision to introduce or accept a technology. In contrast, implementation effectiveness concerns the extent to which the system is deployed and used to support intended organizational objectives. Depending on the research context, effectiveness may be assessed through indicators such as inventory accuracy, order-processing time, warehouse productivity, order-fulfillment performance, and cost efficiency. These indicators represent potential outcomes of implementation rather than necessarily being factors that cause implementation success. Similarly, employee training, system integration, process redesign, and operational standardization may represent implementation practices, while inadequate resources, employee resistance, and technological incompatibility may function as barriers. Distinguishing these concepts is essential because studies may report different types of factors without assigning them the same conceptual role. A systematic review of WMS implementation effectiveness should therefore identify not only which factors are reported but also whether they represent implementation conditions, practices, barriers, or outcomes.

Previous literature reviews have examined warehouse technologies from related but distinct perspectives. Cupido and Jokonya (2024), in Exploring the Factors Affecting the Adoption of Emerging Technologies in Warehouse Management, apply the Technology–Organization–Environment (TOE) framework to examine factors associated with adopting emerging warehouse technologies. Their findings identify relative advantage, management, and market structure as prominent factors within the technological, organizational, and environmental contexts, respectively. Perotti et al. (2022) In Logistics 4.0 in Warehousing: A Conceptual Framework of Influencing Factors, Benefits and Barriers, 56 documents are reviewed, and a conceptual framework is developed that encompasses factors influencing Logistics 4.0, along with its potential benefits and barriers. These studies provide valuable foundations for understanding technology-related decisions and implementation in warehouse environments. Nevertheless, their emphasis on emerging technology adoption and the broader Logistics 4.0 domain creates a different analytical scope from a review focused specifically on WMS implementation effectiveness.

Table 1. Systematic Comparison of Previous Literature Reviews and Present Study.

Author(s) & Year	Scope of Review	Methodology	Identified Factors	Scope Limitations and Gaps Identified in the Present Review
Perotti et al. (2022)	Broad domain of Logistics 4.0 applications and digital technologies in warehousing.	Literature review and conceptual framework development (n = 56 documents).	Technological drivers, digital readiness, general organizational benefits, and adoption barriers.	Broad scope on Industry 4.0; does not isolate WMS-specific implementation effectiveness or differentiate operational outcomes from implementation practices.
Minashkina & Happonen (2023)	Research trends, bibliometric mapping, and deployment considerations of WMS.	Systematic literature mapping and bibliometric analysis.	Technological deployment trends, Industry 4.0 integration patterns, and publication demographics.	Focuses on descriptive bibliometric trends rather than synthesizing internal organizational, operational, and financial determinants of post-implementation success.
Cupido & Jokonya (2024)	Adoption factors of emerging warehouse management technologies grounded in the TOE framework.	Systematic literature review and thematic synthesis.	Relative advantage (Technological), top management support (Organizational), and market structure (Environmental).	Emphasizes the initial *technology adoption decision* stage rather than evaluating *implementation effectiveness*, operational alignment, and post-adoption performance outcomes.

To explicitly establish the novel position and theoretical contribution of this study, Table 1 provides a systematic comparison between previous literature reviews in warehouse technology and the present study. While existing reviews focus either on broad Logistics 4.0 frameworks (Perotti et al., 2022) bibliometric trend mapping (Minashkina & Happonen, 2023)or initial technology adoption decisions (Cupido & Jokonya, 2024), this review specifically isolates WMS implementation effectiveness. It also addresses key research gaps by categorizing identified factors into analytical dimensions and explicitly delineating their conceptual roles as implementation conditions, practices, barriers, or operational outcomes.

The distinction between these research scopes provides the starting point for the present study. Findings concerning emerging technology adoption or Logistics 4.0 may be relevant to WMS implementation, but they cannot automatically be interpreted as evidence of implementation effectiveness. Furthermore, factors reported across studies may represent different stages or aspects of implementation. For example, management support may be an enabling condition, employee training may be an implementation practice, technological incompatibility may be a barrier, and inventory accuracy may be an outcome. Treating these elements as equivalent factors may obscure their conceptual relationships and limit comparability across studies. Accordingly, this study addresses the need for a structured synthesis that focuses on factors associated with WMS implementation effectiveness while explicitly distinguishing the conceptual roles of the

identified factors. The extent to which this approach differs from previous reviews must be established through a systematic comparison of their research scopes, analytical classifications, and treatment of implementation outcomes.

To address this gap, the study adopts the Technology–Organization–Environment (TOE) framework as its principal theoretical foundation. TOE explains organizational technology adoption and implementation through three contextual dimensions. The technological context concerns the technology's characteristics, compatibility, and capabilities. The organizational context encompasses internal resources, management commitment, employee competence, organizational readiness, and related capabilities. The environmental context concerns external conditions that may influence technology-related decisions and implementation, including customer requirements, competitive pressure, regulatory conditions, market developments, and relationships with external stakeholders. These dimensions provide a theoretical basis for interpreting the contexts in which WMS implementation takes place. However, not every factor identified in WMS-related studies corresponds directly to a single TOE dimension. Operational and financial considerations, in particular, may represent internal conditions, implementation practices, constraints, or outcomes rather than additional theoretical dimensions. TOE is therefore used to interpret the contextual origins of the factors, rather than to force every finding into a predetermined classification.

Building on this theoretical foundation, the present study organizes the identified factors into four analytical categories derived from the literature synthesis: technology integration, organizational support, operational factors, and financial considerations. These categories are intended to organize and compare the evidence reported in the reviewed studies; they are not proposed as four independent dimensions of TOE. Technology integration primarily relates to the technological context, whereas organizational support primarily relates to the organizational context. Operational factors should be classified according to their conceptual roles. Warehouse process configuration and workflow complexity may represent internal conditions, while process redesign and standardization may represent implementation practices. Inventory accuracy and order-processing time, in contrast, may represent implementation outcomes. Financial considerations also require differentiation. Implementation budgets and investment capacity generally concern internal organizational resources, whereas external financing constraints or broader economic pressures may relate to the environmental context when supported by the reviewed evidence. Cost reduction should likewise be distinguished from the financial resources required to implement WMS because it represents a potential outcome rather than an implementation input. This approach allows the review to retain its four analytical categories while preserving the TOE framework's three-dimensional structure.

The proposed synthesis consequently combines two complementary levels of analysis. First, the four analytical categories provide a structure for organizing the factors identified in the literature. Second, a role-based classification distinguishes implementation conditions, practices,

barriers, and outcomes, while TOE provides the theoretical lens for interpreting their technological, organizational, and environmental contexts. This distinction matters when examining the environmental dimension. Although external conditions are theoretically relevant to technology implementation, their empirical relevance cannot be assumed without supporting evidence from the reviewed studies. Environmental factors are therefore included in the synthesis only when substantiated by the included literature. Similarly, operational and financial considerations are not automatically treated as separate TOE dimensions. By combining analytical categorization with role-based interpretation, this study seeks to improve conceptual consistency and provide a clearer account of the factors associated with WMS implementation effectiveness.

Accordingly, this study aims to systematically review the literature on factors associated with WMS implementation effectiveness and develop an integrated analytical interpretation grounded in the TOE framework. The review addresses the following research questions:

RQ1: What factors associated with WMS implementation effectiveness are reported in the reviewed literature?

RQ2: How can the identified factors be classified as implementation conditions, practices, barriers, or outcomes, and how do they relate to the technological, organizational, and environmental dimensions of TOE?

RQ3: What theoretical and practical implications can be derived from the synthesis for understanding and improving WMS implementation effectiveness?

This study has three intended contributions. First, it synthesizes factors reported in the reviewed literature into four analytical categories: technology integration, organizational support, operational factors, and financial considerations. Second, it maps these categories onto the TOE framework while distinguishing implementation conditions, practices, barriers, and outcomes. This distinction is intended to improve conceptual consistency when interpreting findings that might otherwise be grouped despite representing different roles in the implementation process. Third, the study provides a structured basis for managerial assessment by connecting technological compatibility, organizational readiness, operational process alignment, financial resource requirements, and relevant external influences with the evaluation of WMS implementation. These contributions are intended to support a more systematic interpretation of implementation challenges rather than assuming that technology availability alone guarantees effective results.

The novelty or originality of this study is positioned in the combination of a specific focus on WMS implementation effectiveness, four literature-derived analytical categories, and an explicit interpretation of the factors' conceptual roles through the TOE framework. Rather than claiming the first application of TOE to warehouse technologies or proposing a new technology-adoption theory, the study clarifies how factors reported in WMS-related research can be organized and interpreted by both analytical category and role in the implementation process. Its distinctiveness from previous reviews must be demonstrated through a systematic comparison of their scope and analytical approaches, supported by transparent coding of the included studies. The resulting synthesis is

intended to provide a more conceptually consistent interpretation of WMS implementation effectiveness and a practical basis for identifying the conditions, practices, barriers, and outcomes relevant to its improvement.

The research questions were structured using the PICOS framework (Population, Intervention, Comparison, Outcome, and Study Design) to clarify the scope of the systematic literature review.

- **Population (P)**: Organizations implementing or using Warehouse Management Systems (WMS), subject to the eligibility criteria established for this review.
- **Intervention (I)**: The implementation, integration, or use of WMS.
- **Comparison (C)**: Where reported in the included studies, differences in implementation approaches, organizational contexts, or implementation outcomes.
- **Outcome (O)**: Factors associated with WMS implementation effectiveness, including relevant enabling conditions, implementation practices, barriers, and reported outcomes.
- **Study Design (S)**: Empirical studies and other eligible research designs specified in the review protocol.

The PICOS framework was used to guide the formulation of the research questions and the definition of the review scope. The final selection of studies was determined by the predefined search strategy and eligibility criteria.

This review has several limitations. First, the findings may be affected by the coverage of the selected databases, the search strategy, and the eligibility criteria applied. Second, differences in research designs, organizational contexts, and measures of WMS implementation effectiveness may limit direct comparisons across studies. Therefore, interpret the findings in light of the review's scope; they may not be generalizable to all industries or organizational settings.

The remainder of this article presents the review methodology, reports and discusses the findings, and concludes with the study's implications and limitations.

CONCEPTUAL FRAMEWORK / RESEARCH METHODOLOGY

CONCEPTUAL FRAMEWORK

WMS Implementation Effectiveness

A Warehouse Management System (WMS) is an information system that supports warehouse activities, including inventory management, storage, order processing, and goods movement. Its implementation should be considered in relation to both technological capabilities and the operational context in which the system is used. Perotti et al. (2022) Identify warehouse management practices, digital readiness, employee capabilities, and implementation barriers as key considerations in adopting Logistics 4.0 technologies. Similarly, Cupido & Jokonya (2024) apply the Technology–Organization–Environment (TOE) framework to examine factors associated with the adoption of emerging warehouse technologies.

In this study, WMS implementation effectiveness refers to the extent to which a WMS supports warehouse performance objectives, such as inventory accuracy, productivity, order fulfillment, and operational efficiency. This conceptualization is consistent with the broader information systems success perspective, which considers system quality, information quality, service quality, use, user satisfaction, and net benefits. (DeLone & McLean, 2016) . Accordingly, this review distinguishes implementation-related conditions from

implementation practices, barriers, and performance outcomes.

Technology–Organization–Environment (TOE) Framework

The Technology–Organization–Environment (TOE) framework, introduced by Tornatzky and Fleischer (1990), explains organizational technology adoption through three contextual dimensions: technology, organization, and environment. The technological context concerns the characteristics and availability of relevant technologies; the organizational context includes resources, managerial support, and internal capabilities; and the environmental context concerns external conditions that affect organizational decisions.

In the WMS context, the technological dimension may include system compatibility, integration, and information-system capabilities. The organizational dimension may include management commitment, employee competence, training, and resource allocation. The environmental dimension may include external influences such as customer requirements, regulations, market competition, and supply-chain partners, provided that these factors are explicitly supported by the reviewed studies. This application is consistent with research applying TOE to emerging technologies in warehouse management. (Cupido & Jokonya, 2024).

In this review, TOE serves as an interpretive framework for organizing and discussing the evidence rather than as a statistical model. Operational and financial considerations are treated as analytical categories, not as additional TOE dimensions. Their relationship with TOE is determined by the nature of the evidence reported in each study.

Analytical Categories

The literature is synthesized into four analytical categories: technology integration, organizational support, operational factors, and financial considerations. These categories provide a practical structure for comparing findings across studies. Their relevance is supported by research on technology adoption and digital transformation in warehousing, which identifies technological, organizational, operational, and economic considerations in implementation decisions. (Cupido & Jokonya, 2024; Perotti et al., 2022).

Technology integration concerns system compatibility, connectivity, and information exchange. Organizational support covers management commitment, employee competence, training, and available organizational resources. Operational factors relate to warehouse processes, workflow alignment, and integrating system functions with daily operations. Financial considerations include implementation costs and available financial resources.

The analysis also distinguishes four conceptual roles: enabling conditions, implementation practices, barriers, and outcomes. Enabling conditions facilitate implementation; implementation practices describe activities undertaken during implementation; barriers hinder adoption or effective use; and outcomes represent the resulting operational or organizational effects. This distinction supports a clearer synthesis of the different types of evidence reported in the literature.

RESEARCH METHODOLOGY

Research Design

This study employs a Systematic Literature Review (SLR) to identify and synthesize factors associated with WMS

implementation effectiveness. An SLR provides a structured and transparent approach to identifying, selecting, and synthesizing relevant research. (Snyder, 2019) .

Qualitative content and thematic analyses are used to identify recurring concepts and classify the findings, while descriptive frequency analysis summarizes the distribution of identified themes across the reviewed studies. These methods support the research questions presented in the Introduction. The analysis describes patterns in the literature and does not, by itself, establish causal relationships.

Search Strategy and Eligibility Criteria

The review focuses on publications published from 1 January 2020 to 31 December 2024. The manuscript reports search sources from Google Scholar, IEEE Xplore, ScienceDirect, SpringerLink, and Emerald Insight. Search terms include "Warehouse Management Systems," "WMS implementation effectiveness," "Factors affecting WMS," and "Digital transformation in warehousing."

Studies are eligible for inclusion when they address WMS implementation or use and report relevant implementation factors, barriers, or outcomes in a warehouse or supply-chain context. Publications that do not address the research focus or do not meet the predefined eligibility criteria are excluded.

For reproducibility, the final manuscript should report the exact search strings used for each database, the date each search was conducted, language and publication-type restrictions, and the detailed inclusion and exclusion criteria. The search sources and eligibility rules reported in the text must match the actual search records and the study-selection table.

Study Selection and Data Extraction

The manuscript reports 3,218 initial records, 1,671 records after title screening, 476 after abstract and keyword screening, and 63 articles in the final review. These figures should be verified against the original screening records before submission. The study-selection process should be presented in a PRISMA 2020 flow diagram, including duplicate removal, records assessed at each stage, full-text exclusions, and reasons for exclusion where applicable (Page et al., 2021).

Data extracted from each included study comprise the author(s), publication year, research context, study design, factors identified, and relevant findings. The extracted evidence is then classified into the four analytical categories and interpreted using the TOE framework. The final dataset should contain unique studies, with duplicate records identified and removed before synthesis.

Data Analysis

Content and thematic analyses are used to identify recurring factors and classify their conceptual roles. Descriptive frequency analysis summarizes the number of included studies in which each category is reported. The coding procedure should specify whether each article may be assigned to more than one category and whether frequencies are calculated using unique articles or individual factor occurrences.

The current manuscript reports 22 articles for technology integration, 18 for organizational support, 18 for operational factors, and 5 for financial considerations. These counts and their corresponding percentages must be verified against the

final set of 63 unique articles before they are reported as definitive results. If categories overlap, the manuscript should explicitly state that the percentages may not sum to 100%.

The frequency of a theme indicates how often it appears in the reviewed literature; it does not, on its own, demonstrate that the factor has a stronger causal effect on WMS implementation effectiveness. The findings are therefore interpreted as patterns in the reviewed evidence, with conclusions limited to what the included studies support. The PRISMA 2020 reporting guideline is used to improve transparency in documenting the identification, selection, and inclusion of studies (Page et al., 2021).

We have thus far synthesized the findings from the reviewed literature to offer a comprehensive overview of the factors that affect the effectiveness of WMS. This synthesis not only identifies each study's contributions but also highlights gaps in the literature that require further exploration. As noted by Tranfield et al. (2003), synthesizing findings from multiple studies can lead to new insights and a deeper understanding of the research topic.

The process of selecting this article was carried out in stages, namely:

a. Stage 1: identify from the source database based on search criteria, at this stage, the number of articles that can be identified is 3218 articles.
b. Stage 2: identify the selected articles in the first stage based on the article titles relevant to the research topic; at this stage, 1671 articles can be identified.
c. Stage 3: selection of articles based on the suitability of abstract content and keywords, resulting in 476 articles.
d. Stage 4: is the final stage of removing a number of articles that are not eligible based on the search criteria, at this stage 63 articles can be identified. The distribution of the number of articles from 2020-2024 can be shown in Table 2.

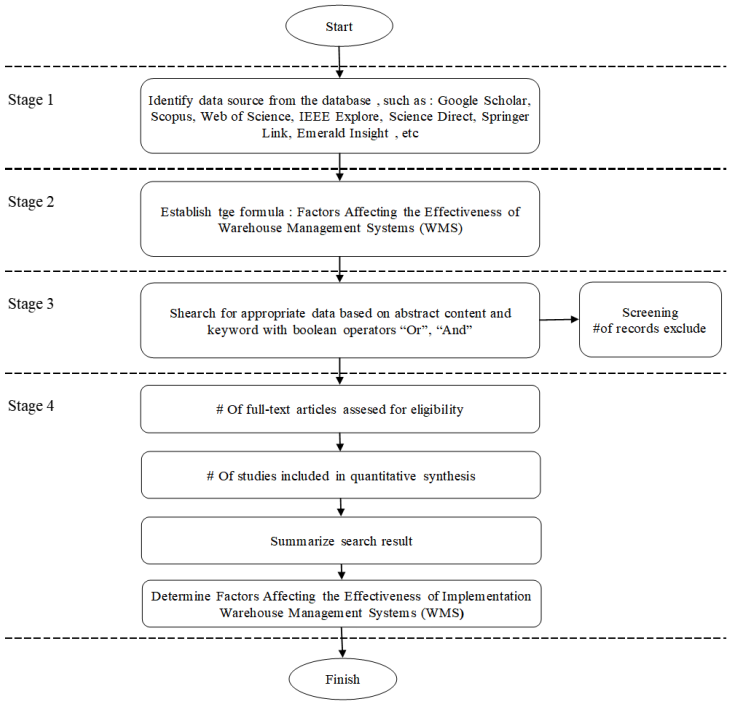

Figure 1 The steps used in systematic literature review (SLR)

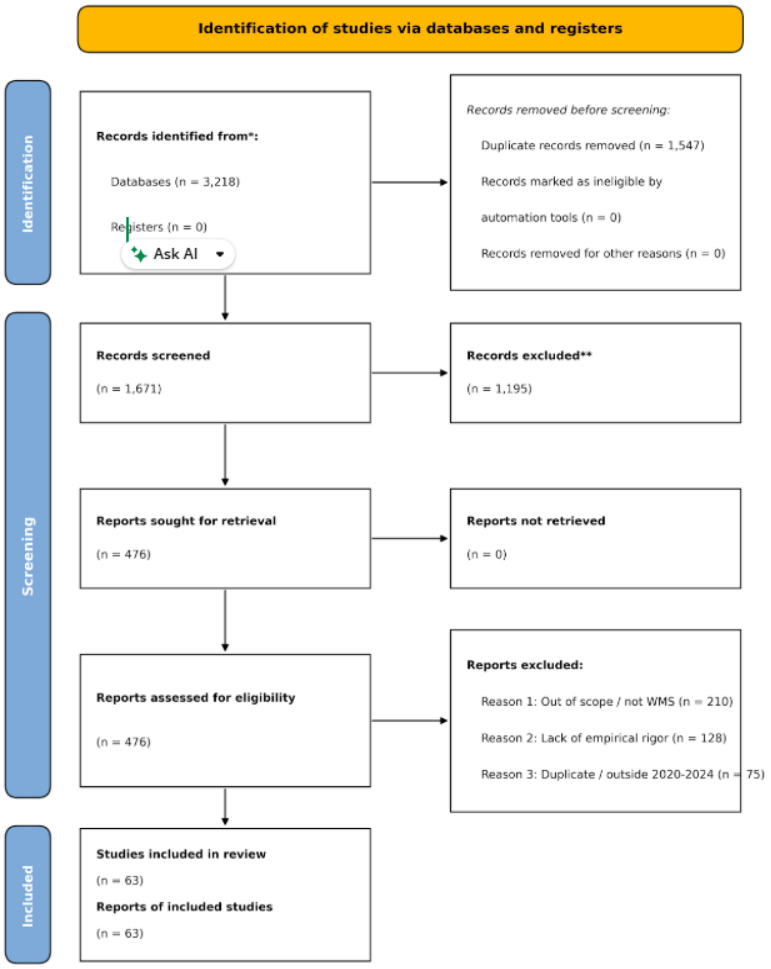

Figure 2 The steps used in systematic literature review (SLR)

Table 2. Number of publications by database sources.

No	Source of Database	# of Papers (Stage 1)	# of Titles (Stage 2)	# of Abstracts & Keywords (Stage 3)	Selected for the Final Review (Stage 4)
1	Google Scholar	668	75	57	14
2	IEEE Xplore	325	159	90	7
3	ScienceDirect	1426	950	290	35
4	SpringerLink	210	89	20	3
5	Emerald Insight	589	398	19	4
Total		3218	1671	476	63

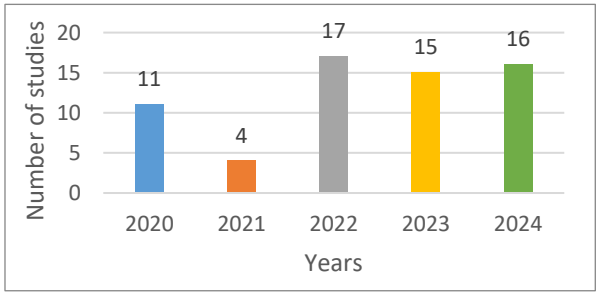

Figure 3 Number of studies across Warehouse Management System Analise the years

A Warehouse Management System (WMS) is specialized software that supports warehouse operations and information management. Its implementation can improve warehouse productivity, although results may depend on operational changes and the implementation context. Wicki (2020)For example, one study examined WMS implementation in three distribution warehouses and reported productivity improvements following implementation. Andiyappillai (2020b) Also discussed factors associated with successful WMS implementation, emphasizing the importance of considering the conditions required for effective system deployment.

This study adopts a Systematic Literature Review (SLR) to identify and

synthesize factors associated with WMS implementation effectiveness. The review follows a structured process involving literature identification, eligibility screening, data extraction, and thematic synthesis. Previous WMS reviews have applied systematic literature mapping and bibliometric analysis to examine research trends and deployment considerations (Minashkina & Happonen, 2023). However, the present review focuses on synthesizing factors associated with WMS implementation effectiveness in publications from 2020 to 2024.

RESULT AND DISCUSSION

In this section, the results of the article selection process based on the SLR (systematic literature review) mechanism will be explained. The final number of selected articles was 63 (sixty-three) articles relevant to Factors Affecting the Effectiveness of Implementing Warehouse Management Systems (WMS). The search for relevant articles was summarised into its main groups, namely: State-of-the-art for the implementation of warehouse management systems (WMS). Based on the categories mentioned above, the results are briefly explained by publication year, along with further analysis of the factors that affect the Effectiveness of implementing warehouse management systems (WMS).

Publication Year

The results of the selection of articles that have been collected based on this objective SLR (systematic literature review) are 63 (sixty-three) articles. The distribution of the number of articles related to factors affecting warehouse management system (WMS) implementation from 2020 to 2024 in detail is shown in Table 3 below:

From the data above, it can be seen that the trend in the number of articles is from 2020-2024 related to the factors affecting the effectiveness of Warehouse Management Systems (WMS)

RQ1. What are the key factors influencing the effectiveness of WMS implementation in the manufacturing industry?

The extensive, systematic analysis revealed four primary categories of determinants that significantly affect the efficacy of Warehouse Management System (WMS) implementation technological, organizational, operational, and financial. Each category is instrumental in determining the success or failure of WMS adoption in the manufacturing sector.

1. Technological Factors

Technology integration was identified in 22 studies (34.92%). This category includes system compatibility, integration with existing information systems, and the use of digital technologies in warehouse operations.

The reviewed studies indicate that WMS needs to be compatible with existing systems, such as Enterprise Resource Planning (ERP), to support accurate and timely data exchange. The use of technologies such as the Internet of Things (IoT), barcode systems, and automation can also support inventory monitoring and warehouse activities (Amanda Istiqomah et al., 2020; Andiyappillai, 2020b; Ngaboyimbere et al., 2021).

These findings suggest that technology integration is an important consideration in WMS implementation. The system should not only provide the required functions but also support the organization's existing information

technology infrastructure and warehouse requirements.

2. Organizational Factors

Organizational support was identified in 18 studies (28.57%). The main factors in this category include management commitment, resource allocation, employee training, and change management.

Management support is important for providing direction and ensuring the implementation process receives adequate resources. Employee training is also necessary to help users understand and operate the system. In addition, employee involvement and clear communication can help reduce resistance to technological changes (Andiyappillai, 2020a; Febriani Samsudin et al., 2023; Shaikh & Poonawala, 2022) .

The findings indicate that WMS implementation requires support from both management and employees. Without adequate organizational support, implementation may face difficulties related to limited resources, employee readiness, and system utilization.

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3. Operational Factors

Operational factors were identified in 18 studies (28.57%). This category relates to the alignment between WMS functions and warehouse activities, including warehouse layout, inventory tracking, workflow standardization, and order processing.

The reviewed studies indicate that WMS should support the actual needs of warehouse operations. A mismatch between system functions and operational processes may reduce system effectiveness. In contrast, aligning warehouse processes with WMS capabilities can support inventory control, order processing, and operational coordination (Ambrosio-Flores et al., 2022; Duque-Jaramillo et al., 2024; Kurniawan et al., 2024).

Some studies also highlight pilot testing and phased implementation as practices that can help organizations identify operational problems before full implementation. These findings suggest that operational readiness and process alignment are important considerations in WMS implementation.

4. Financial Considerations

Financial considerations were identified in 5 studies (7.94%). This category includes software, hardware, system integration, training, maintenance, and system upgrade costs.

WMS implementation requires sufficient financial resources, not only during initial installation but also throughout system operation. Limited budgets may affect implementation activities, employee training, and system maintenance. Cost-benefit analysis and return on investment (ROI) can also be used to assess the feasibility of WMS investment (Hanum et al., 2020; Tikwayo & Mathaba, 2023).

These findings indicate that financial planning is necessary to support both WMS implementation and long-term use.

Technology Integration was the most frequently discussed category, while Financial Considerations received the least attention. However, these percentages reflect discussion frequency in the reviewed studies and do not indicate the relative effect or causal influence of each category on WMS implementation effectiveness.

Overall, the findings answer RQ1 by identifying four categories of factors associated with WMS implementation effectiveness.

RQ2. How do these factors contribute to the success or failure of WMS implementation?

The effectiveness of WMS implementation is determined by the scope to which organizations consider technological, organizational, operational, financial, and human-related elements in a comprehensive approach. Successful implementation is observed when organizations ensure seamless technological integration, provide adequate training, and establish strong leadership support.

Conversely, failure often stems from resistance to change, low employee engagement, and misalignment between system functionality and warehouse operations. The investigation carried out by Smith (2024) underscores that organizations that invest in intuitive user interface design and robust information technology infrastructure achieve more successful Warehouse Management System (WMS) implementations. Furthermore, N. Khan et al. (2023) highlight the importance of customizing smart warehouse management systems to accommodate the operational requirements of large-scale production industries.

Additionally, organizations that neglect proper financial planning and underestimate system maintenance costs often face implementation delays or

interoperability and best practices across different manufacturing sectors.

decreased operational efficiency. These findings emphasize that successful WMS implementation requires aligning technological investments with structured training programs, clear leadership commitment, and strategic financial planning.

inefficiencies. Companies that lack structured change management strategies may experience high employee resistance, leading to slow adoption rates and

RQ3. What are the implications of these findings for the development of future WMS implementation strategies?

From a theoretical viewpoint, this investigation enriches the understanding of Warehouse Management System (WMS) adoption by combining viewpoints from various disciplines, including supply chain management, information systems, and organizational behavior. It provides a comprehensive framework for assessing WMS effectiveness and bridges gaps in the fragmented literature.

Practically, the findings highlight the need for a structured WMS deployment strategy that incorporates change management, employee engagement, and continuous system evaluation. Organizations should focus on phased implementation approaches, ensuring that end-users are adequately trained and that the system is fine-tuned to align with warehouse-specific requirements. Financially, organizations must adopt long-term budgeting strategies to accommodate system upgrades, maintenance, and employee training. Furthermore, policymakers and industry leaders should establish standardized guidelines for WMS adoption, promoting

Analysis State-of-the-art for the factors that Affecting of implementation warehouse management systems (WMS).

Survey and literature findings highlight system integration challenges (Mulla, 2024a; Rana, 2023), skilled personnel and resistance to change

(Febriani Samsudin et al., 2023), and cost and resource allocation (Tikwayo & Mathaba, 2023). The results of a survey conducted by Edirisinghe & Liyanage (2022), explain the combination of quantitative and qualitative research methods to evaluate the problem findings. Real-world case studies provide valuable insights into the challenges and practical solutions associated with implementing and evaluating the impact of Extended Warehouse Management System (EWMS) on warehouse operational performance in the Fast-Moving Consumer Goods (FMCG) industry. As Hanum et al. (2020) emphasize, hands-on training for WMS users is essential. This ensures that users are adequately equipped to use the system effectively, minimize human error, provide accurate real-time data, and improve overall efficiency Amanda Istiqomah et al. (2020). In addition, the results of a survey conducted by Wahyuni et al. (2021) , top management support plays a crucial role in the successful implementation of a Warehouse Management System (WMS). Rabe & Stadler (2022) also explain that a company's lack of knowledge about its own processes leads to high capacity and cost burdens. Veronika Tiupysheva et al. (2023) explain that top management support is not only about providing financial resources but also about active commitment in the implementation process and strategic decision-making (Andiyappillai, 2020b).

Based on Table 2, which is explained in Part 2, namely, the number of search results, 63 articles were identified that were relevant to the search topic Factors Affecting the Effectiveness of Implementation Warehouse Management Systems (WMS). Result of analysis based on the state of the art in the selected articles.

Table 3. Number of publications by database sources.

No	Author	Article title	Conclution
1	Febriani Samsudin et al. (2023)	Attributes And Effect Of Implementation Of Warehouse Management System (WMS) For Company Sustainability	This research identifies the integration of WMS with other systems and the management of goods in the warehouse.
2	Alamsah et al. (2024)	The Effectiveness Of Implementing Warehouse Management System On Productivity Improvement And Stock Accuracy (A Case Study On FMCG Logistic Service Companies In Palembang, Indonesia)	This study investigates the effectiveness of implementing Warehouse Management Systems (WMS) on productivity improvement and stock accuracy
3	Mulla (2024b)	Optimizing E-Commerce Fulfillment: The Strategic Role Of Warehouse Management Systems (WMS)	This research identified integration with other systems, real-time data, and the ability to automate workflows.
4	Shanmugaman i & Mohamad (2023)	The Implementation Of Warehouse Management System (WMS) To Improve Warehouse Performance In Business To Business (B2B)	This research identified inventory management, technology integration, and the need for precise and fast communication.

No	Author	Article title	Conclution
5	Rana (2023)	An Analysis Of Warehouse Management Systems	The research identifies the need for skilled personnel, data security concerns, and system integration challenges.
6	Edirisinghe & Liyanage (2022)	Impact Of Extended Warehouse Management System Implementation On Warehouse Operational Performance: A Case Study Of Fast Moving Consumer Goods Industry	This research identifies the importance of advanced features and their impact on operational performance metrics
7	Shaikh & Poonawala (2022)	Warehouse Automation	The research identifies the necessity of a corporate culture, integration of business processes, and ongoing training for staff .
8	Sied (2024)	Advancing Warehouse Management Systems: Optimizing Loading-Unloading, Conditioning, Packing And Marking Processes With Adaptive Ai Technology	The research identifies integrates adaptive technologies such as IoT, robotics, and AI, which improve efficiency and accuracy
9	Andiyappillai (2020b)	Factors Influencing The Successful Implementation Of The Warehouse Management System (WMS)	This research selecting a skilled team and making the necessary training to users.
10	Ptytsia & Kovtsur (2022)	Features Of Logistics Management Of Warehouse System Of The Express Delivery	The paper identifies the efficient use of usable area and capacity, and the time of circulation of goods.
11	Vatumalae et al. (2020)	Warehouse Management System Of A Third Party Logistics Provider In Malaysia	This study highlights effective human resource training management
12	Saleet (2020)	Smart Solution For Enhancing Storage Location Assignments In WMS Using Genetic Algorithm	This paper highlights the optimal siting of stock keeping units (SKUs).
13	Mulla (2022)	Challenges And Strategic Best Practices For Successful Implementation Of Warehouse Management Systems (WMS)	This study highlights the importance of aligning WMS implementation with effective training and change management strategies.
14	Ngaboyimbere et al. (2021)	Development Of RFID Based Automatic Warehouse Management System: A Case Study Of Rok Industries Limited Kenya	The paper discusses the application of RFID technology in WMS to automate storage and inventory management
15	Živicnjak et al. (2022)	Case-Study Analysis Of Warehouse Process Optimization	The study emphasizes simple methods and tools.
16	Fitria Murad et al. (2020)	Warehouse Management System For Smart Digital Order Picking Systems	This paper identifies the availability of human resources.

No	Author	Article title	Conclution
17	Aravindaraj & Rajan Chinna (2022)	A Systematic Literature Review Of Integration Of Industry 4.0 & Warehouse Management To Achieve Sustainable Development Goals (Sdgs)	This paper identifies the need for a defined structure in warehouse management to integrate Industry 4.0 technologies.
18	Affum (2022)	Exploring The Value Of Ict In Warehouse Management At The Electricity Company Of Ghana, Takoradi	The study identified Ensuring that training for staff compliance with stock control rules is established.
19	Yan & Zhihua (2023)	Research On Optimization Of Warehousing System Based On Analytic Hierarchy Process And Order Index Method	This research identifies the WMS can automatically determine the optimal location for goods
20	Ali & Kaur (2022)	Exploring The Impact Of Technology 4.0 Driven Practice On Warehousing Performance: A Hybrid Approach	The study identifies integration of smart systems for reverse logistics & the ability to reduce downtime are crucial.
21	Amriyanto & Widyastuti (2024)	Perancangan Warehouse Management System Pada Toko Brayan Maju	the accuracy of stock data, the design of the warehouse layout, and the ease of use of data management systems.
22	Kudelska & Niedbał (2020)	Technological and organizational innovation in warehousing process – research over workload of staff and efficiency of picking stations	The study highlights that technological and organizational innovations can enhance warehouse productivity and efficiency
23	Zhai (2024)	Visualizing Walmart'S Supply Chain Management: A Case Study On Detailed Warehouse Management Practices	The paper highlighting the use of visualization techniques to optimize processes.
24	Duque-Jaramillo et al. (2024)	Warehouse Management Optimization Using A Sorting-Based Slotting Approach	The paper emphasizes the importance of integrating various slotting and picking strategies to enhance logistics systems.
25	Malini Lubis et al. (2023)	Comparison Of Lean Warehouse Implementation In Several Companies In Indonesia	The study emphasized the use of labels, layout, policy and procedure standardization, and ongoing training.
26	Shashidharan & Anwar (2021)	Importance Of An Efficient Warehouse Management System	The paper concludes that effective warehouse management processes are essential in a competitive environment.
27	Shashidharan & Anwar (2021)	Effect Of Warehouse Management Systems On Supply Chain Performance Of Fast-Moving Consumer Goods Manufacturers In Kenya	This paper analyses the role of companies to ensure their WMS is up-to-date, embrace modern technology, and provide employee training.
28	Wahyuni et al. (2021)	Modelling Operation Of Logistics Management In Modern Market: A Case Study In Indonesian Retail Company	The implementation of a logistics management operation model using the System Development Life Cycle (SDLC) is necessary for improved efficiency.

No	Author	Article title	Conclution
29	N. Khan et al. (2024)	Time Optimization Of Warehouse Operations Through Industry 4.0 Technology Implementation: Case Study From A Spare Parts Warehouse In The Oil And Gas Industry	The findings indicate that a combination of limited automation tools and high interoperability yields the most efficient operations, suggesting further cost and sustainability analyses for future work.
30	Tikwayo & Mathaba (2023)	Applications Of Industry 4.0 Technologies In Warehouse Management: A Systematic Literature Review	This paper discusses the significant impact of warehouse management costs on overall logistics costs.
31	Veronika Tiupysheva et al. (2023)	Modern Condition And Direct Development Of Warehouse Logistics	The optimization of warehouse operations, the cost of automation technology, and the training of employee capabilities.
32	Maleshkov et al. (2024)	Blockchain-Based Model For Warehouse Management Systems For Artworks And Collectibles	The integration of technology, focus on security, real-time monitoring, reduction of human error, and accountability are essential elements
33	Kurniawan et al. (2024)	Use Case Diagram For Enhancing Warehouse Performance At Pt. Mda Through The Implementation Of 5S, Economic Order Quantity, Safety Stock, And Warehouse Management System	the utilization of the Probabilistic Economic Order Quantity (EOQ) method supported by the 5S concept to enhance decision-making accuracy in inventory management.
34	Azzahra & Fauziah (2023)	Efektivitas Penerapan Warehouse Management System (WMS) Pada Gudang Pt XYZ	This study emphasizes resource factors and technological capabilities
35	Wanjari (2020a)	Analyzing The Impact Of Human And Technological Factors On Warehouse Productivity	This paper discusses human factors and technology.
36	Ambrosio-Flores et al. (2022)	Warehouse Management Model Integrating Bpm-Lean Warehousing To Increase Order Fulfillment In Sme Distribution Companies	The paper is highlights issues such as lack of standardization, organization, and methodology in warehouse logistics, which can impact WMS effectiveness.
37	Youssef et al. (2022)	Brief Survey On Industry 4.0 Warehouse Management Systems	This paper conducts a comprehensive study of the features and parameters of Warehouse Management Systems (WMS)
38	Wanjari (2020b)	Measuring The Turnaround In Business Performance Due To WMS And Mes Implementation In A Process Manufacturing Client	This paper discusses system collaboration to improve productivity and efficiency in the process manufacturing industry.
39	Andiyappillai (2020a)	Digital Transformation In Warehouse Management Systems (WMS) Implementations	The paper discusses The integration of digital technologies with WMS applications has significantly improved logistics operations

No	Author	Article title	Conclution
40	Ricardo S. Jimenez et al. (2024)	The Effectiveness Of Implementing Emerging Warehouse Technologies On Warehouse Operations	This paper identifies implementation costs, technical issues, and regulatory compliance.
41	Kodithuwakku et al. (2022)	Impact Of Warehouse Management Factors On Performance Improvement Of 3Rd Party Logistics Industry	to warehouse performance criteria and management factors.
42		Rancang Bangun Warehouse Management System (WMS) Berbasis Aplikasi Appsheet Pada PT ABC	this paper focuses on designing a WMS application for PT ABC to manage inventory more effectively and affordably.
43	Shreyas Gawande et al. (2023)	Review Of Warehouse Management System	This research discusses inventory management, technology adoption, and the role of warehouse specialists.
44	N. Khan et al. (2023)	Customizing Smart Warehouse Management For Large Scale Production Industries	the paper emphasizes the importance of customizing WMS to align with the unique operational requirements of large-scale production industries
45	ZAVALETA SAENZ et al. (2024)	Web/Mobile System Innovation: An Efficient Revolution In Warehouse Management.	This research explores methodology, technology, training, clear goals, and a focus on continuous improvement.
46	Perotti et al. (2022)	Logistics 4.0 in warehousing: a conceptual framework of influencing factors, benefits and barriers	Broad domain of Logistics 4.0 applications and digital technologies in warehousing.
47	Alamsah et al. (2024)	The Effectiveness Of Implementing Warehouse Management System On Productivity Improvement And Stock Accuracy (A Case Study On FCMG Logistic Service Companies In Palembang, Indonesia)	The research identifies employee engagement and training can also play a role in optimising warehouse operations and improving overall efficiency.
48	Tulaskar et al. (2022)	An Automated Warehouse Management System	This paper analyses the optimization of facility layout and integration of production
49	Chen et al. (2024)	Warehouse Management Information System Technology Review	This paper summarizes the importance of warehouse management information systems and the impact of technological advances.
50	Tong et al. (2023)	Construction of a Sustainable Digital Factory For Automated Warehouse Based On Integration Of ERP And WMS	The paper emphasizes the proper distribution and use of personnel skills, as well as the integration of WMS, which play crucial roles.

No	Author	Article title	Conclution
51	Hanum et al. (2020)	The Analysis Of Implementation Of Enterprise Resource Planning In The Warehouse Division Of Trading And Service Companies, Indonesia	The effectiveness of implementing Warehouse Management Systems (WMS) is influenced management support, user involvement, and clear project objectives.
52	Luft (2022)	Evaluation Of The Effectiveness Of Information System In Optimizing Warehouse Processes	the paper highlights the importance of organizational readiness and the alignment of WMS functionalities with specific warehouse operations to optimize performance.
53	Budiman & Purwaningsih (2023)	Inventory Management Through Information Systems Design And Warehouse Layout In Sans Boxer	The research highlights the importance of an effective inventory information system and proper storage layout design, which can influence inventory control
54	Larutama et al. (2022)	Implementation Of Warehouse Management System Planning In Finished Goods Warehouse	This paper highlights requiring a structured management approach.
55	M. G. Khan et al. (2022)	Smart Warehouse Management System: Architecture, Real-Time Implementation And Prototype Design	Effectiveness of system implementation is influenced by architectural design and integration capabilities with existing systems
56	Fathima Thahiba et al. (2022)	Automated Warehouse Control System Design	The paper discusses the significance of Warehouse Management Systems (WMS) in managing daily warehouse operations
57	Minashkina (2024)	A Review And Research Agenda For Recent Socially And Environmentally Sustainable Practices For Warehouse	The research article explores recent developments and future directions in socially and environmentally sustainable practices for WMS
58	Haasanah et al. (2024)	Warehouse Management System Analysis	there is a positive perception among employees regarding the effectiveness of the Warehouse Management System (WMS) and adherence to Standard Operating Procedures (SOP)
59	Amanda Istiqomah et al. (2020)	The Implementation Of Barcode On Warehouse Management System For Warehouse Efficiency	The research highlights that integrating barcode technology into the warehouse management system improves efficiency by streamlining processes
60	Ahmadi (2024)	Examining The Standardization Of Solutions For The Integration Of Implementation Of Warehouse Management Systems	The paper investigates the necessity of standardizing integrated system solutions for the implementation of warehouse management systems (WMS) in logistics
61	Rahayu et al. (2022)	Sistem Informasi Warehouse Management System (WMS) Pada PT. Citra Banjar Abadi	This research addresses data processing accuracy, security measures, and business process efficiency.

No	Author	Article title	Conclution
62	Minashkina & Happonen (2023)	Warehouse Management Systems for Social and Environmental Sustainability: A Systematic Literature Review and Bibliometric Analysis	Research trends, bibliometric mapping, and deployment considerations of WMS.
63	Cupido & Jokonya (2024)	Exploring the factors affecting the adoption of emerging technologies in warehouse management	Adoption factors of emerging warehouse management technologies grounded in the TOE framework.

Table 3 above states the title of the research article, author, and summary of the conclusions of each article reviewed. From the results of the review of these articles, it can be seen that there is uniformity or similarity in the research results, and this is the key in research using the SLR method.

Table 4 Influence factors based on state-of-the-art result.

Factors	Author	Total
Technology Integration	(Amanda Istiqomah et al., 2020; Amriyanto & Widyastuti, 2024; Andiyappillai, 2020a, 2020b; Chen et al., 2024; Febriani Samsudin et al., 2023; N. Khan et al., 2024; Luft, 2022; Maleshkov et al., 2024; Minashkina, 2024; Mulla, 2024; Ngaboyimbere et al., 2021; Shanmugamani & Mohamad, 2023; Shashidharan & Anwar, 2021; Shiamia & Waluyo, 2023; Sied, 2024; Tong et al., 2023; Wanjari, 2020b; Yanovsky & Graf, 2024; Zhai, 2024; 沤 ivicnjak et al., 2022; Zunic et al., 2020)	22
Organizational Support	(Affum, 2022; Ahmadi, 2024; Alamsah et al., 2024; Azzahra & Fauziah, 2023; Edirisinghe & Liyanage, 2022; Eric Jepherson et al., 2021; Kodithuwakku et al., 2022; Kudelska & Niedba 艂, 2020; Larutama et al., 2022; Mulla, 2022; Rana, 2023; Ricardo S. Jimenez et al., 2024; Shaikh & Poonawala, 2022; Vatumalae et al., 2020a; Veronika Tiupysheva et al., 2023; Wahyuni et al., 2021; Youssef et al., 2022; Zavaleta Saenz et al., 2024)	18
Operational Factors	(Ali & Kaur, 2022; Ambrosio-Flores et al., 2022; Aravindaraj & Rajan Chinna, 2022; Budiman & Purwaningsih, 2023; Duque-Jaramillo et al., 2024; Fitria Murad et al., 2020; M. G. Khan et al., 2022; N. Khan et al., 2023; Kurniawan et al., 2024; Malini Lubis et al., 2023; Ptytsia & Kovtsur, 2022; Rabe & Stadler, 2022; Rahayu et al., 2022; Saleet, 2020; Shreyas Gawande et al., 2023; Tulaskar et al., 2022; Wanjari, 2020a; Yan & Zhihua, 2023)	18
Financial Considerations	(Co et al., 2023; Fathima Thahiba et al., 2022; Haasanah et al., 2024; Hanum et al., 2020; Tikwayo & Mathaba, 2023)	5

From Table 4, we can find out some of the factors affecting the effectiveness of Warehouse Management Systems (WMS) Implementation:

a. Technology Integration

Integrating innovative technology and automation is critical to optimizing warehousing operations. This includes the use of an advanced WMS to lean out processes and reduce manual errors.

b. Organizational Support

Proactive participation and support from top management are important for successfully implementing a WMS. This includes providing the necessary resources and fostering a culture that accepts technological change. In addition, providing appropriate training to empower employees to use the new system effectively is essential.This helps minimize resistance and accelerate system adoption.

c. Operational Factors

Aligning the WMS implementation with the company's broader strategic business objectives, such as improving customer satisfaction and operational efficiency. The company also hopes that by adopting the WMS, it can meet market demands and overcome operational challenges by improving effectiveness and gaining a competitive advantage.

d. Financial Considerations

Conducting a comprehensive cost-benefit analysis to justify the investment in the WMS and ensuring that the expected benefits outweigh the costs is common practice. Appropriate allocation of financial resources is required to support the implementation process and address any challenges that arise.

CONCLUSION

This systematic literature review analyzed factors associated with Warehouse Management System (WMS) implementation effectiveness based on 63 studies published between 2020 and 2024. The findings identified four analytical categories: technology integration (22 studies; 34.92%), organizational support (18; 28.57%), operational factors (18; 28.57%), and financial considerations (5; 7.94%). These frequencies reflect the emphasis of the reviewed literature rather than the relative causal effects of each category.

The synthesis addressed the second research question by classifying the identified factors and mapping them to the Technology–Organization–Environment (TOE) framework. The four categories serve as analytical groupings, not additional TOE dimensions. Distinguishing implementation conditions, practices, barriers, and outcomes clarifies the roles of individual factors, while TOE provides the overarching framework for interpreting technological, organizational, and external environmental influences.

Regarding the third research question, this review offers a structured synthesis that links WMS implementation factors to their conceptual roles and relevant TOE dimensions. Practically, organizations should consider system compatibility and integration, management commitment, employee competence, operational requirements, and financial resources when planning WMS implementation. Evaluate these factors in the context of each organization rather than ranking them solely by their frequency in the literature.

This review is limited to studies published between 2020 and 2024 and is subject to the coverage and methodological diversity of the included literature. Its frequency-based synthesis

also does not establish causal relationships or quantify the effects of individual factors. Future research should empirically test these relationships using measurable implementation outcomes, compare different organizational and industry contexts, and investigate how implementation conditions and outcomes evolve.

Overall, this review strengthens the conceptual understanding of WMS implementation effectiveness by organizing reported factors into four analytical categories and interpreting them through the TOE framework. The synthesis provides a basis for further empirical research and more context-sensitive implementation decisions.

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