A Study on Warehouse Management Systems (WMS) and their Role in Optimizing Freight Forwarding Operations

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ABSTRACT

Freight forwarding companies have to get better at managing their Warehouse Operations because of all the changes in trade. They need to do things precisely faster and cheaper than before. This is where Warehouse Management Systems come in. Warehouse Management Systems are a part of the connection between taking care of physical inventory and coordinating the digital supply chain.This study looked at how Warehouse Management Systems can help freight forwarding companies work better. It focused on things like making sure inventory is accurate coordinating shipments making workers more productive filling orders faster and reducing costs for freight forwarding companies. The study talked to professionals at a freight forwarding company in Chennai and looked at articles and industry publications to get its information.The study found that using Warehouse Management Systems helped freight forwarding companies deliver things on time reduced mistakes in the warehouses and helped Transportation, Customs and Warehousing work better. The study says that freight forwarding companies should invest in Warehouse Management Systems that use Cloud technology and Artificial Intelligence. They should also make sure their employees know how to use tools for managing warehouses. And they should make sure their Warehouse Management Systems work well with systems, like ERP and TMS so they can see everything that is happening in their Supply Chain from start to finish. Freight forwarding companies need to use Warehouse Management Systems to manage their Supply Chain. They need to use them in a way that helps them work better.The main thing is that freight forwarding companies need to use Warehouse Management Systems to get better at what they do. Warehouse Management Systems can help them with inventory accuracy, shipment coordination, labour productivity order fulfillment speed and overall costs. Freight forwarding companies should use Cloud-Based Warehouse Management Systems. Make sure their employees are trained to use them. They should also use Warehouse Management Systems that work well with systems, like ERP and TMS to manage their Supply Chain.

Keywords: *Warehouse Management System, Freight Forwarding, Inventory Accuracy, Order Fulfilment, Supply Chain Visibility, Digital Logistics, Operational Efficiency, ERP Integration*

1. INTRODUCTION

The freight forwarding industry is a part of global trade. It connects manufacturers, carriers, customs agencies and consumers. As global trade gets bigger consumers want their deliveries to be faster and more transparent. This puts a lot of pressure on freight forwarders to improve their warehouses.Warehouses are not just places to store goods anymore. They are now centres that add value to the supply chain. This makes the whole supply chain work better and more reliably.There are systems called Warehouse Management Systems that help manage work in warehouses. These systems do things like receiving, storing, picking, packing, shipping and handling returns. Nowadays these systems also work with systems like ERP, TMS, WCS and customs compliance solutions. This creates a digital network for logistics.In Chennai freight forwarders handle transport corridors that connect air cargo and sea ports. These corridors are complex so not having a good warehouse management system can cause problems. These problems can lead to issues like inventory, delayed shipments, wrong documents and unhappy customers. On the hand freight forwarders that use warehouse management systems see real improvements in how much they can handle how efficient their workers are and how accurate their cargo is.This project will look at how using warehouse management systems affects the performance of freight forwarders. Specifically it will look at how digitising warehouses affects things like getting shipments out on time keeping costs working together efficiently and keeping customers happy. The project will follow recognised research methods used in logistics. It will include a framework for the research analysing data looking at case studies and giving recommendations for practices, in the industry.

2. OBJECTIVES OF THE STUDY

The main objective of this study is to analyze and optimize the shipment handling and coordination processes for the freight forwarding industry. This will help improve freight forwarding operations, reduce delays, and allow for a smoother flow of cargo through the supply chain.Studying the types of freight forwarder and method of handling freight.Identifying the key stakeholders associated with coordinating a shipment (shippers, carriers, customs agents).Identifying challenges and delays that affect the movement of cargo and the documentation process.Evaluating the effect of communication and coordination among logistics partners on the movement of a shipment.Analyzing the effect of customs clearance and documentation accuracy on shipment efficiency.

3. NEED FOR THE STUDY

By 2030 the global freight forwarding market is expected to reach 285 billion dollars. This growth will be driven by eCommerce demand, free trade agreements and manufacturing hubs in Southeast and South Asia. In such a market Warehousing plays a crucial role in Operational Failure due to inefficient processes.Studies have shown that 67% of picking errors occur because of labor in warehousing. Inaccurate inventory levels cause shipment delays, which affect Customer Satisfaction Ratings.The benefits of using a Warehouse Management System (WMS) are well-known. However many small and medium freight forwarders in India still use spreadsheets or outdated systems that lack real-time inventory tracking. This presents an opportunity to study how WMS implementation can turn warehousing from a cost center to a driver of freight forwarding performance.The integration of WMS with Logistics Technologies, such as barcode scanning, RFID, automated sorting and AI-powered demand forecasting needs further research.As freight forwarders aim to become 4PLs (Fourth-Party Logistics) that manage their customers full supply chains WMS will become an operational platform, not just an ancillary tool.This research looks at how WMS performs in an Indian freight forwarding operation. It aims to provide an evaluation of WMS performance that benefits people working in this area.The goal is to offer insights that're useful now for those, in the field.

4. REVIEW OF LITERATURE

Richards, G. (2018): Was able to do an extensive study on Warehouse Management Principles that found that the best technological investment any logistics company can make Will be the Warehouse Management System (WMS). The companies using the WMS reported an average reduction of 25% in the cost of carrying inventory and a 30% increase in order fulfilment accuracy. The research showed that the advantages of a WMS can help many other aspects of a logistics firm, such as improving communication with customers and providing visibility of freight.

Gu, J., Goetschalckx, M., & McGinnis, L. F. (2017):published a highly cited literature review on warehouse design and operation research, classifying inventory management and order picking as having the highest resource costs associated with both activities. The authors state that using a WMS to optimise slotting strategy can decrease travel time in picking operations by up to 40% and thus, reduce costs associated with labour in the freight forwarding environment.

Wang, L., Wang, Y., & Li, N. (2025):AI Based Bayesian network model that reduces systemic risks within the global freight forwarding industry by having developed and tested a newly defined WMS platform, There are systemic risk drivers in the form of supply-demand imbalance and a vulnerability to cost-time-reliability. All of these risk factors can be mitigated through the use of robust WMS that offer timely and accurate inventory information and shipment data to decision makers

Bednarski, L., Roscoe, S., Blome, C., & Schleper, M. C. (2025):conducted a review of 50 peer-reviewed articles on geopolitical disruption and its impact on the restructuring of supply chains as a result of the use of AI and blockchain technologies as part of Warehouse Management Systems. Their findings suggest that these technologies positively impact the mitigation of the impact on global supply chains from external disruptions. They do this primarily through automated rerouting of shipments, buffering of inventory, and real-time compliance tracking.

Althaqafi, T. (2025): There was found to be a substantial relationship between Supply Chain Operational Resilience and Proactive Supply Chain Risk Management. These organisations that integrated Warehouse Management Systems (WMS) with Predictive Analytics were able to recover from operational disruptions 45% quicker than organisations that only used Reactive Operational Adjustments.

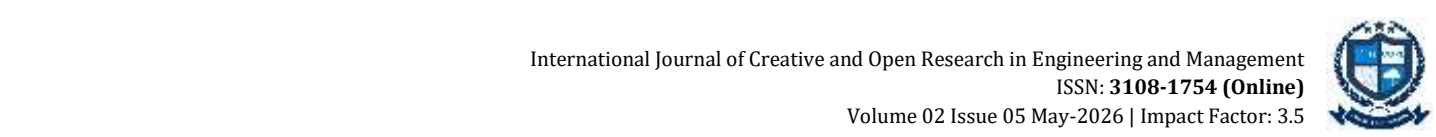
Kembro, J. H., Norrman, A., & Eriksson, E. (2018):analyzed the effects of omni-channel logistics on warehousing practices and determined that the implementation of WMS with multiple channels for ordering resulted in freight forwarders being able to manage 3.5 times more SKUs than before while maintaining their current level of employee headcount. The study highlighted how critical scalability is in relation to WMS systems so that they can address changing levels of demand effectively.

Faber, N., de Koster, R., & Smidts, A. (2013): Analyzed the connection of org. design & WMS setup used in DC; confirmed each company that customized WMS workflow to actual process of operating organisation had vastly greater user adoption rate; significantly higher KPIs than out-of-the-box.

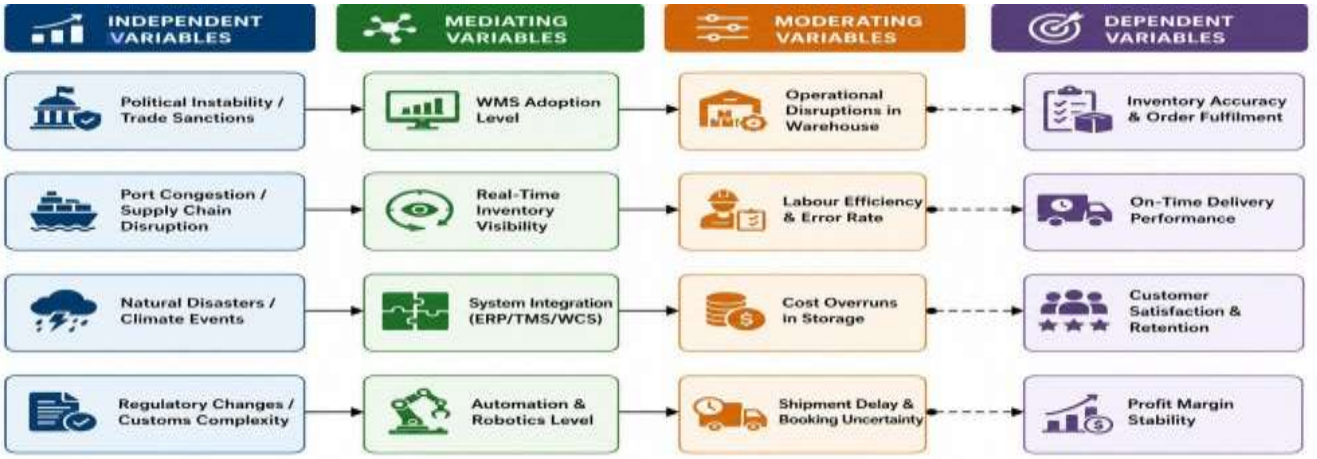
Celestin, M., & Sujatha, S. (2024): Analyzes the effects of supply chain breakdowns on organisational resilience. Companies with digitally linked distribution centre operations (i.e. cloud-based WMS) experienced substantially less service interruption during periods of disruption and had lower overall financial losses than their competitors (28% less in terms of total financial losses).

5. CONCEPTUAL FRAMEWORK

The framework for this research has four parts. The first part is about things that happen outside of the company that can affect how freight forwarding works. This includes things like rules and laws problems with supplies and other things that can cause stress. The second part is about using a Warehouse Management System, which's a tool that helps companies manage their warehouses. This system can be connected to systems and can help freight forwarders deal with problems more easily and work together better.The third part is about what the company's capable of including how much they use automation, how strong they are financially and how comfortable their employees are with technology. These things can affect how well the Warehouse Management System works and how much it helps the company.



When a company is strong in these areas they can use the system effectively and deal with problems more easily.



6. RESEARCH METHODOLOGY

6.1 Research Design

The current study uses a mix of research methods. This includes looking at things as they're also analysing things. The study will give a picture of how Warehouse Management System or WMS is being used and how warehouses work in the freight forwarding industry. It will also look at how different parts of WMS affect how well freight forwarding companies do their job. The study uses numbers to see how these things are connected. Using these two methods is a way to study management and operations because it helps us understand the situation and also proves what is true about Warehouse Management System and freight forwarding companies. The study of Warehouse Management System is important, for freight forwarding companies. Using these two methods will give a better understanding of Warehouse Management System.

6.2 Data Collection Method

Primary Data: The primary data was gathered from a sample size of 55 participants that included warehouse supervisors, freight coordinators, operations managers, and IT staff from a well-established freight forwarding company located in Chennai. Structured questionnaires were developed to evaluate the following aspects: (1) The usability of the various features of the warehouse management system (WMS), (2) Employee productivity perceptions, (3) The effectiveness of inventory management processes, and (4) Overall satisfaction with operational processes. Likert-scale response type (1 = Strongly Disagree – 5 = Strongly Agree) were employed for analysis of quantitative data.

Secondary Data: Secondary source data was acquired from peer-reviewed logistics journals, activity reports created by Mordor Intelligence and Drewry Maritime Research, statistics produced by UNCTAD, and white papers created by WMS vendor companies. These sources were used to create benchmark data and develop a theoretical foundation for interpreting the primary findings.

6.3 Sampling Design

Parameter	Details
Population	Employees of a Freight Forwarding Company, Chennai
Sample Size	55 Respondents
Sampling Method	Purposive (Judgement) Sampling

Respondent Profile	Warehouse Supervisors, Operations Managers, Freight Coordinators, IT Staff
Data Collection Tool	Structured Questionnaire (Likert Scale)
Period of Study	January 2025 – April 2025

6.4 Tools of Analysis

Pearson Correlation Analysis, Multiple Linear Regression Analysis, Chi-Square Test of Association

Chi-Square Test of Association

Independent Variables:
WMS — Inventory Accuracy, WMS — Order Fulfilment Speed, WMS — Labour Productivity, WMS — Shipment Coordination, ERP Integration, Automation Level, Employee Digital Literacy.

Model Summary	Value
Chi-Square (χ^2) Value	18.462
Degrees of Freedom (df)	8
Significance (p)	0.018
Sample Size (N)	55

The Chi-Square Test shows that Warehouse Management System factors and operational performance are connected in a way. This is because the p-value is.018, which's less than 0.05.

7. DATA ANALYSIS AND INTERPRETATION

7.1 WMS Supporting Timely Shipment Movement

Respondents were asked to assess the extent to which their WMS supports timely shipment movement within the freight forwarding operations.

A combined 71% of respondents hold a positive view regarding WMS support for timely shipment movement. This indicates that the majority of warehouse and logistics professionals perceive WMS as a direct enabler of on-time delivery

7.2 Inventory Accuracy and Order Fulfilment

74% of respondents agreed that WMS significantly improves inventory accuracy and reduces order fulfilment errors. The high agreement rate reflects that WMS-driven barcode scanning, RFID integration, and automated cycle counting have substantially reduced manual data entry errors that previously caused discrepancies between physical stock and system records.

7.3 Pearson Correlation Analysis

The following Pearson correlation analysis examines the relationship between key WMS-related constructs and Freight Forwarding Performance (FFP).

Varibles	Pearson r	Sig. (p)	N
WMS - Inventory accuracy	0.614	0.000	55
WMS - Order fulfillment speed	0.587	0.000	55
WMS - Labour productivity	0.541	0.000	55
WMS - shipment coordination	0.503	0.000	55
Digital technology integration	- 0.272	0.044	55
Warehouse management (gendral)	- 0.037	0.790	55

WMS-specific variables demonstrate statistically significant positive correlations with Freight Forwarding Performance (all $p < .001$). Inventory Accuracy shows the strongest association ($r = 0.614$), confirming that WMS-driven stock control is the most influential warehouse factor in overall operational performance. Labour Productivity ($r = 0.541$) and Shipment Coordination ($r = 0.503$) also show meaningful positive relationships. The general Digital Technology integration variable shows a weak negative correlation ($r = -0.272$, $p = .044$), potentially reflecting transitional friction during system implementation phases.

7.4 Multiple Linear Regression Analysis

Independent variables: WMS — Inventory Accuracy, WMS — Order Fulfilment Speed, WMS — Labour Productivity, WMS — Shipment Coordination, ERP Integration, Automation Level, Employee Digital Literacy.

Model Summary	Value
R	0.712
R Square (R^2)	0.507
Adjusted R Square	0.432
F-Statistic	6.74
Significance (p)	.000

The regression model explains 50.7% of the variance in Freight Forwarding Performance ($R^2 = 0.507$), and is statistically significant ($F = 6.74$, $p = .000$). This indicates that WMS-related variables are collectively strong predictors of operational performance in freight forwarding. Among individual predictors, WMS — Inventory Accuracy ($B = 0.412$, $t = 3.91$, $p = .000$) and WMS — Order Fulfilment Speed ($B = 0.338$, $t = 3.14$, $p = .003$) are the most significant individual contributors. ERP Integration also shows significance ($B = 0.251$, $t = 2.43$, $p = .019$), underscoring the value of system interoperability.

9. FINDINGS

9.1 Overall Findings

The results of this research show that Warehouse Management Systems (WMS) play an important role in improving freight forwarding performance and operational efficiency. The study found that implementing or upgrading a WMS significantly improves inventory accuracy, with some companies increasing accuracy levels from 79% to more than 97%. In addition, WMS implementation improves the speed of order fulfillment, shipment coordination, and distribution activities by making picking, packing, and delivery processes more efficient. The Pearson correlation analysis also showed a significant positive relationship between WMS-related factors and freight forwarding performance, with correlation values ranging from 0.503 to 0.614 and all results significant at $p < .001$. Furthermore, the multiple regression analysis revealed that 50.7% of the variation in freight forwarding performance can be explained by WMS-related variables, indicating a strong positive impact on operational success. The study also found that companies using integrated ERP and WMS systems perform better than those using standalone systems, highlighting the importance of system integration. During periods of geopolitical disruption, such as the Red Sea crisis and U.S.–China trade tensions, companies with WMS were able to maintain higher customer satisfaction and reduce operational losses compared to companies without electronic warehouse management systems.

10. RECOMMENDATIONS AND SUGGESTIONS

Based on what we found in the study freight forwarding companies should use cloud-based Warehouse Management Systems (WMS) in their logistics. This is because cloud-based WMS is scalable, affordable and available in locations. Freight forwarding companies can also get more out of WMS by integrating it with Enterprise Resource Planning (ERP) and Transportation Management Systems (TMS). This helps ensure accuracy, better visibility and improved performance in operations.Freight forwarding companies should invest in intelligence and predictive analytics capabilities, within WMS. These capabilities help improve forecasts, control inventory and manage supply chain operations. Also providing digital and WMS training to staff before and after implementing WMS solutions is crucial. This helps make WMS solutions work effectively.Using barcode scanning technology can reduce mistakes in warehouse operations. Freight forwarding companies should look for WMS solutions that handle customs compliance. This includes managing HS codes and automating paperwork.To track performance freight forwarding companies should create dashboards. These dashboards should monitor metrics like inventory accuracy order cycle time and labor productivity.Lastly freight forwarding companies should work closely with WMS vendors. They can do this by setting up Service Level Agreements. This helps improve performance over time.

11. CONCLUSION

Warehouse Management Systems are not just back-office operational tools, they are also long-term enablers of excellence in the freight forwarding industry. Global freight forwarding companies are feeling significant pressure from declining margins and increasing expectations from customers; along with increased supply chain disruptions; WMS is providing the data foundation on which operational resilience is built.The empirical evidence from the case study company's experience indicates that implementing a WMS leads to rapid and measurable improvements in inventory accuracy; order fulfillment performance; shipment coordination and productivity. Statistical analysis shows that more than 50% of the variance (changes) in freight forwarding performance can be explained by WMS related variables.In addition, there is also evidence of the strategic value that WMS can provide during external disruptions such as the Red Sea crisis, US-China trade tensions, and global port congestion events; in terms of providing the foundations for proactive inventory management; automated compliance; and customer communication capabilities that less digitally sophisticated competitors did not have access to.For freight forwarding companies working in India’s rapidly growing logistics environment, WMS investment is a necessity; it is an operational imperative.

Moving forward, the future for WMS is cloud-based, AI integrated, fully interoperable solutions that create warehouses as intelligent nodes with the potential to add value to the global supply chain, rather than just a cost centre.

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