



Optimizing E-Commerce Productivity through Warehouse Management Systems: Evidence from Malaysia's Retail Industry

Yusri Arshad¹, Qistina Erika Ismail², Sharifah Norhafiza Syed Ibrahim³

^{1,2}Faculty of Technology Management and Technopreneurship, Universiti Teknikal Malaysia Melaka

³Faculty of Accountancy, Universiti, Teknologi MARA Melaka Branch

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ABSTRACT

The rapid growth of e-commerce has transformed Malaysia's retail industry, intensifying the need for efficient warehouse operations to sustain competitiveness and customer satisfaction. Warehouse Management Systems (WMS) have emerged as critical tools for optimizing logistics processes, including inventory tracking, order fulfilment, automation, cost management, and system integration. This study investigates the role of WMS in enhancing e-commerce productivity within Malaysia's retail sector, guided by the DeLone and McLean Information System (IS) Success Model as the theoretical framework. A quantitative research design was employed, with data collected from 200 respondents representing retail businesses that actively use WMS. Structured questionnaires measured perceptions of WMS effectiveness across five independent variables—real-time data accuracy, order fulfilment, warehouse automation, cost reduction, and system integration—against the dependent variable, e-commerce efficiency. Reliability testing confirmed strong internal consistency. Descriptive analysis indicated high mean values across all variables, reflecting broad agreement on the importance of WMS functions. Pearson's correlation analysis revealed positive and significant relationships between all independent variables and e-commerce efficiency, with system integration showing the strongest correlation. Multiple regression analysis demonstrated that the model explained 80.9% of the variance in e-commerce efficiency. Order fulfilment, cost reduction, and system integration were significant predictors, while real-time data accuracy and warehouse automation did not show significant effects. These findings suggest that integrated systems, effective cost management, and streamlined order fulfilment are the primary drivers of e-commerce productivity in Malaysia's retail industry. The study contributes theoretically by extending the IS Success Model to logistics and retail e-commerce, and practically by offering insights for retailers and policymakers on leveraging WMS to enhance efficiency, profitability, and customer satisfaction in the digital economy.

Keywords: Warehouse Management System (WMS), E-commerce Productivity, Order Fulfilment, System Integration, Cost Reduction

INTRODUCTION

The rapid expansion of e-commerce has transformed Malaysia's retail industry, reshaping supply chain operations and intensifying the need for efficient warehouse management. Warehouse Management Systems (WMS), software platforms designed to optimize processes such as inventory tracking, order processing, and space utilization, have emerged as critical tools in supporting this transformation. By integrating WMS with e-commerce platforms, retailers can achieve real-time data visibility, automate warehouse activities, and strengthen customer satisfaction through timely order fulfilment and cost reduction.

Despite these advantages, many Malaysian retailers continue to face challenges in warehouse operations. Manual processes often lead to human error, inaccurate inventory tracking, and delays in fulfilling customer orders. Poor integration of WMS further exacerbates these issues, resulting in higher operating costs, stock imbalances, and reduced productivity. Without robust WMS adoption, retailers struggle to meet rising consumer expectations and remain competitive in the digital marketplace.



This study investigates the role of WMS in enhancing e-commerce productivity within Malaysia's retail sector. Specifically, it examines the relationships between real-time data accuracy, order fulfilment, warehouse automation, cost reduction, and system integration, and their collective impact on operational efficiency of e-commerce. The objectives are to analyze how these factors influence e-commerce performance and to provide insights into effective WMS adoption strategies.

The significance of this research lies in its contributions to multiple stakeholders. For scholars, it offers empirical evidence on the role of WMS in driving e-commerce productivity. For practitioners, it provides guidance to retailers on improving inventory control, reducing costs, and strengthening customer satisfaction. For policymakers, it highlights the importance of WMS in supporting Malaysia's digital economy, informing decisions on technology adoption, logistics development, and workforce training.

The scope of this study is limited to Malaysia's retail industry, focusing on four key WMS functions—real-time data accuracy, order fulfilment, automation, and cost reduction. Data were collected from 200 respondents representing retailers who actively use WMS, through questionnaires distributed online over a four-week period. By situating the analysis within this context, the study provides practical insights into how WMS adoption can enhance competitiveness and support sustainable growth in Malaysia's retail sector.

LITERATURE REVIEW

This study draws on prior research to establish a solid theoretical and empirical foundation for examining the role of Warehouse Management Systems (WMS) in enhancing e-commerce productivity within Malaysia's retail industry. The dependent variable is e-commerce productivity, while the independent variables include real-time data accuracy, order fulfilment, warehouse automation, cost reduction, and system integration.

The DeLone and McLean IS Success Model (1992, 2003) provides a comprehensive framework for evaluating the effectiveness of information systems, encompassing dimensions such as system quality, information quality, service quality, use, user satisfaction, and net benefits. In logistics and e-commerce contexts, this model has been widely applied to assess system success, particularly in ensuring inventory accuracy, real-time data visibility, and customer satisfaction. Studies such as Petter, DeLone, and McLean (2008) and Angelina et al. (2019) confirm the model's relevance, highlighting the importance of system and service quality in driving user satisfaction and operational benefits. Its adaptability makes it a suitable theoretical lens for evaluating WMS effectiveness in Malaysia's retail sector.

E-commerce has grown rapidly in Malaysia, accelerated by the COVID-19 pandemic and supported by initiatives from the Malaysia Digital Economy Corporation (MDEC). Operations in this sector involve complex logistics, including order processing, inventory management, and returns handling. Efficient warehouse systems are critical to meeting consumer expectations for speed, accuracy, and reliability. Ying Yu et al. (2017) emphasizes the role of WMS and related technologies in supporting seamless e-commerce logistics.

WMS are software platforms designed to optimize warehouse operations, from receiving goods to shipping orders. They provide real-time inventory visibility, streamline workflows, and reduce costs. Existing studies highlight the use of technologies such as RFID and automation to improve accuracy and efficiency (Ramaa et al., 2012; Saleh Alyahya et al., 2016). Advanced WMS solutions also leverage analytics and optimization algorithms to enhance order fulfilment and minimize inefficiencies (Diana Ailyn, 2024).

E-commerce productivity is measured through indicators such as order fulfilment speed, inventory accuracy, return processing efficiency, and customer satisfaction. Research shows that WMS adoption significantly improves these outcomes, reducing human error and enabling real-time monitoring of stock and orders (Shanmugamani & Mohamad, 2023; Rahman & Kirby, 2024). By supporting operational excellence, WMS contributes to sustainable growth and competitiveness in the digital marketplace.

Based on existing studies, this paper investigates the relations between four functions related to WMS and e-commerce productivity. First, for real-time data accuracy, the WMS enables precise inventory tracking and reduces human error, allowing businesses to make informed decisions and avoid stock imbalances (Faiz

Mohammad Mulla, 2023; Atieh et al., 2015). Second, the order fulfilment is crucial for e-commerce productivity as automation of picking, packing, and shipping processes improves speed and accuracy, directly enhancing customer satisfaction (Ahmad, 2025; Halim et al., 2024). Third, the warehouse automation changes the way e-commerce performs in which algorithms optimize picking routes and replenishment, reducing delays and ensuring product availability (Lorenc & Burinskienė, 2021; Raam, 2025). Forth, financial implication matters and thus cost reduction is another factor to consider as WMS lowers labour costs, minimizes stockouts and overstock, and improves purchasing strategies through accurate demand forecasting (Halim et al., 2024; Akbar & Fajar, 2024). Last, the System Integration represents integration of WMS with ERP systems enhances operational efficiency, reduces errors, and supports faster order fulfilment (Tong et al., 2020; Ng & Dazki, 2024). Figure 1 illustrates the potential relations between these factors and e-commerce productivity.

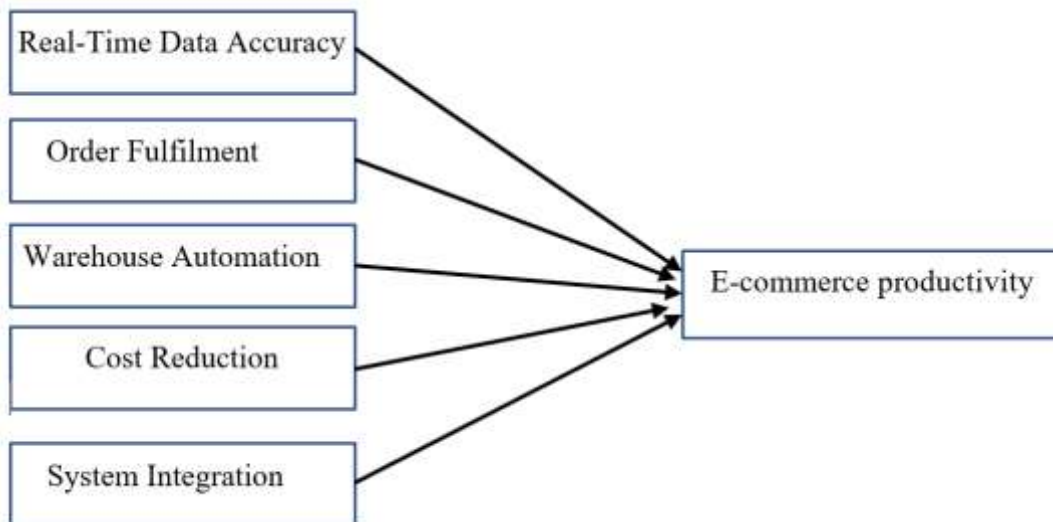


Figure 1: The Research Framework

The research framework illustrates the proposed relationship between the independent variables—real-time data accuracy, order fulfilment, warehouse automation, cost reduction, and system integration—and the dependent variable, e-commerce productivity in Malaysia’s retail industry. Each independent variable represents a critical dimension of warehouse management that directly influences operational efficiency and customer satisfaction. Real-time data accuracy ensures precise inventory control, order fulfilment guarantees timely delivery, automation streamlines warehouse processes, cost reduction enhances profitability, and system integration supports seamless coordination across platforms. Collectively, these factors provide a structured basis for analyzing how WMS adoption contributes to improved e-commerce productivity, aligning with the study’s objectives and research questions.

RESEARCH METHODOLOGY

This study adopts a quantitative research design to examine the role of Warehouse Management Systems (WMS) in enhancing e-commerce productivity within Malaysia’s retail industry. A survey method was employed, as it allows for systematic data collection from a large sample and supports statistical analysis of relationships between independent and dependent variables.

Population and Sample

The target population consists of retail businesses in Malaysia that actively utilize WMS in their operations. A total of 200 respondents were selected using purposive sampling, ensuring that participants had direct experience with WMS implementation. This approach strengthens the relevance of the findings to the research objectives. According to Kibuacha (2021), sample size refers to the number of participants selected to represent a population, and determining an appropriate size is crucial in statistical analysis. In this study, G*Power calculated a required sample size of 138. To account for potential incomplete responses, 200 self-administered questionnaires will be distributed via Google Forms.



Data Collection

Data were collected through structured questionnaires distributed online via Google Forms over a four-week period. The questionnaire was designed to capture respondents' perceptions of WMS effectiveness across key dimensions: real-time data accuracy, order fulfilment, warehouse automation, cost reduction, and system integration. Items were measured using a five-point Likert scale, ranging from "strongly disagree" to "strongly agree."

Variables and Measurement

The dependent variable is e-commerce productivity, which is measured through indicators such as order fulfilment speed, inventory accuracy, cost efficiency, and customer satisfaction. On the other hand, the independent variables are real-time data accuracy, order fulfilment, warehouse automation, cost reduction, and system integration. Each variable was operationalized based on established measures from prior studies to ensure validity and reliability.

Data Analysis

The collected data were analyzed using multiple regression techniques to assess the relationships between independent variables and e-commerce productivity. Statistical analysis was conducted with SPSS, enabling hypothesis testing and evaluation of the strength and significance of each relationship. Reliability was tested using Cronbach's alpha, while validity was assessed through factor analysis.

Hypotheses Testing

Based on the literature review and conceptual framework, this study proposes the following hypotheses to examine the relationship between Warehouse Management Systems (WMS) and e-commerce productivity in Malaysia's retail industry:

H₁: Real-time data accuracy has a positive effect on e-commerce productivity.

H₂: Order fulfilment efficiency has a positive effect on e-commerce productivity.

H₃: Warehouse automation has a positive effect on e-commerce productivity.

H₄: Cost reduction through WMS has a positive effect on e-commerce productivity.

H₅: System integration has a positive effect on e-commerce productivity.

These hypotheses are grounded in prior studies that emphasize the importance of accurate inventory management, streamlined order fulfilment, automation-driven efficiency, cost savings, and seamless integration in enhancing operational performance. Testing these hypotheses through multiple regression analysis will provide empirical evidence on how WMS adoption contributes to the competitiveness and sustainability of Malaysia's retail e-commerce sector.

RESULTS AND DISCUSSION

Reliability and Pilot Test

The pilot test confirmed that the research instrument was reliable, with Cronbach's Alpha at 0.860 for 30 items, indicating strong internal consistency. The full survey achieved an even higher reliability score of 0.955, demonstrating that the questionnaire items consistently measured the intended constructs.

Respondent Profile

The sample consisted of 200 respondents, all of whom reported using WMS in their organizations. The majority were male (63%), aged between 26–30 years (44%), and primarily employed as warehouse staff (34%). Most



respondents had 1–3 years of working experience (59%), reflecting a workforce actively engaged in adopting and applying WMS in daily operations.

Descriptive Analysis

Mean values for all independent variables—real-time data accuracy ($M = 4.53$), order fulfilment ($M = 4.57$), warehouse automation ($M = 4.57$), cost reduction ($M = 4.53$), and system integration ($M = 4.55$)—were high, indicating strong agreement among respondents on the importance of these factors. The dependent variable, e-commerce efficiency, also recorded a high mean ($M = 4.55$), suggesting that WMS is widely perceived as enhancing productivity in Malaysia's retail sector.

Correlation Analysis

Pearson's correlation results revealed positive and statistically significant relationships between all independent variables and e-commerce efficiency ($p < 0.01$). System integration showed the strongest correlation ($r = 0.846$), followed by cost reduction ($r = 0.796$), order fulfilment ($r = 0.759$), automation ($r = 0.716$), and real-time data accuracy ($r = 0.620$). These findings highlight the critical role of integrated systems and cost management in driving operational efficiency.

Multiple Regression Analysis

Multiple regression analysis demonstrated that the model explained 80.9% of the variance in e-commerce efficiency ($R^2 = 0.809$), confirming the robustness of the predictors. These results are reported in Table 1 below.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.900 ^a	.809	.804	.65929
a. Predictors: (Constant), System Integration, Real Time Data Accuracy, Automation Warehouse Management, Order Fulfilment, Cost Reduction				

Table 1: Model Summary for the Multiple Regression

Table 2 presents the coefficients for each independent variable. Among the independent variables, system integration ($\beta = 0.393$, $p < 0.001$), cost reduction ($\beta = 0.331$, $p < 0.001$), and order fulfilment ($\beta = 0.330$, $p < 0.001$) were significant predictors of e-commerce efficiency at 5% confidence level. In contrast, real-time data accuracy ($\beta = -0.108$, $p = 0.045$) and warehouse automation ($p = 0.450$) were not significant, suggesting that while these factors are important in theory, their practical impact may be limited without effective integration and cost management strategies.

Table 2: The Coefficients of Independent Variables

Based on the multiple regression analysis, the linear regression equation is expressed as follows:

$$Y = 2.650 + 0.374X_1 + (-0.107) X_2 + 0.056X_3 + (-0.023) X_4 + 0.180X_5$$

Where:

Y= E-Commerce Efficiency

X_1 = Real Time Data Accuracy



X_2 = Order Fulfilment

X_3 = Automation Warehouse Management X_4 = Cost Reduction

X_5 = System Integration

For the hypothesis testing, Table 2 shows that there is sufficient statistical evidence to accept the H_2 , H_4 and H_5 . Order fulfilment, cost reduction and system integration are significantly related to the e-commerce efficiency. However, this study finds inadequate statistical evidence to accept H_1 and H_3 , suggesting no significant relations between real-data accuracy and warehouse automation against e-commerce efficiency. These results indicate that operational efficiency in Malaysia's retail e-commerce sector is primarily driven by effective order fulfilment, cost management, and integrated systems, while data accuracy and automation alone do not guarantee improved performance.

The findings reinforce the importance of WMS as a strategic tool for enhancing e-commerce productivity. System integration emerged as the most influential factor, underscoring the need for seamless coordination between WMS and other enterprise systems to ensure real-time visibility and efficient workflows. Cost reduction and order fulfilment also proved critical, reflecting the competitive pressures in e-commerce where profitability and customer satisfaction depend on efficient operations.

Interestingly, real-time data accuracy and automation did not show significant effects, suggesting that these capabilities may only yield benefits when embedded within integrated systems and supported by effective cost management. This highlights a practical insight for retailers: technology adoption must be holistic, combining integration, efficiency, and cost control, rather than relying on isolated improvements.

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

This study examined the role of Warehouse Management Systems (WMS) in enhancing e-commerce productivity within Malaysia's retail industry. The findings demonstrate that order fulfilment, cost reduction, and system integration are the most influential predictors of efficiency, whereas real-time data accuracy and warehouse automation exert limited impact when considered independently. These results underscore the need for a holistic approach to WMS adoption, where technological features are embedded within broader strategies of integration and cost management.

From a theoretical perspective, the study indirectly extends the DeLone and McLean IS Success Model into the logistics and retail e-commerce domain, affirming the relevance of system quality, service quality, and integration in driving operational success. Practically, the evidence highlights that Malaysian retailers can strengthen competitiveness and profitability by prioritizing integrated WMS solutions that streamline order fulfilment and reduce costs. Policymakers, in turn, play a pivotal role in enabling this transformation through training initiatives, incentives, and infrastructure development, thereby advancing Malaysia's digital economy and reinforcing supply chain resilience.

This study is subject to several limitations. Its focus on Malaysia's retail industry restricts the generalizability of findings to other sectors or regions, while the cross-sectional design captures relationships only at a single point in time. Reliance on survey-based measures may also introduce perceptual bias, as managerial assessments may not fully reflect operational realities. Moreover, the study concentrated on technological and operational determinants, leaving broader dimensions such as customer experience, supply chain collaboration, and organizational culture unexplored.

Future research should therefore adopt longitudinal approaches to assess the sustained impact of WMS adoption on productivity and competitiveness. Comparative studies across industries and countries could illuminate contextual variations, while investigations into emerging technologies—such as artificial intelligence, predictive analytics, and blockchain—would enrich understanding of WMS integration in digital supply chains. Expanding the scope to include customer experience, collaboration, and organizational readiness would further refine the



IS Success Model and provide practical guidance for businesses navigating digital transformation in diverse environments.

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