Enhancing Logistics Efficiency for Customer Satisfaction in E-commerce

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Abstract

This research investigates customer satisfaction in e-commerce logistics, with a focus on enhancing efficiency. The objectives of this study are to examine the impact of e-commerce on supply chains and logistics, identify efficiency and cost-reduction strategies, explore last-mile and technology innovations, and assess the role of data analytics and automation. Using a comprehensive approach, the study explores key factors including supply chain management, inventory management, warehousing, customer communication, returns management, and customer data analysis. Data were collected through a structured questionnaire administered via Google Forms to 392 Thai respondents with access to the internet and mobile devices who use online shopping services.

The data were analyzed using descriptive statistics, including frequency, percentage, mean, and standard deviation. The results indicated that most online shoppers were female, employed, and frequently engaged in online shopping. Key factors influencing customer satisfaction included technology utilization, efficient delivery, and responsive customer service.

The findings indicate that customer satisfaction with e-commerce logistics is high to very high, highlighting the importance of logistics efficiency. Fast and accurate delivery, product quality, inventory availability, technology integration, and effective returns management were identified as key factors influencing customer satisfaction and trust in e-commerce services.

Keywords: E-commerce, logistics efficiency, customer satisfaction, supply chain management, last-mile delivery

Introduction

E-commerce involves the buying and selling of goods and services through digital platforms and has become a vital component of modern business due to its ability to expand

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market reach, reduce operational costs, and enhance efficiency (McKinsey & Company, 2023; Stanford Institute for Economic Policy Research [SIEPR], 2023; TatvaSoft, 2022). From the consumer perspective, e-commerce offers convenience, wider product choices, and real-time price comparisons, supporting the growth of the digital economy (Amazon, 2024; The Academic, 2024).

The rapid expansion of e-commerce has significantly increased customer expectations for fast, accurate, and reliable delivery services. As a result, logistics efficiency has become a critical factor influencing customer satisfaction and competitive advantage. Customer satisfaction in e-commerce is shaped by multiple logistics-related dimensions, including supply chain management, last-mile delivery, technology integration, communication, and returns management. Inefficient logistics operations can negatively affect service quality and customer loyalty (Moschidis et al., 2018; Ramanathan, 2010).

Although advanced technologies such as automation, IoT, and data analytics have the potential to enhance logistics performance, empirical evidence examining their combined impact on customer satisfaction remains limited (Gajewska & Zimon, 2018). Therefore, this study aims to evaluate customer satisfaction with logistics efficiency in the e-commerce sector and identify key factors that influence customer perceptions, providing insights for improving logistics strategies in response to evolving customer expectations.

Research Objectives

This study aims to examine the impact of e-commerce on logistics and fulfillment, focusing on strategies to enhance efficiency and customer satisfaction. The objectives are:

1. To analyze how e-commerce transforms traditional supply chains and logistics.
2. To identify strategies for improving logistics efficiency and reducing costs.
3. To explore innovations in last-mile delivery and technology integration.
4. To assess the use of data analytics and automation to optimize e-commerce operations.

Literature Review

This study reviews key literature on strategies enhancing e-commerce efficiency and customer satisfaction. It explores how logistics, technology, and management practices contribute to organizational competitiveness in the digital marketplace.

E-commerce Overview

E-commerce involves electronic transactions of goods and services via digital platforms (Singh, 2016). Major models include B2B, B2C, C2C, and C2B, each differing by participants and interaction scope (Taher, 2021). B2C and B2B dominate the sector, emphasizing digital communication, service quality, and technology-driven operations (Nica, 2015).

Logistics and Supply Chain Management

E-commerce logistics significantly influences total costs and customer satisfaction (Bayles & Bhatia, 2000). Two primary distribution models exist: self-support (in-house) and outsourcing (3PL), both balancing cost, control, and efficiency (Hertz & Alfredsson, 2003). Effective supply chain management integrates information, financial, and logistics flows through digital platforms to ensure transparency and coordination (Qi & Tao, 2018).

Last-Mile Delivery

Last-mile delivery, the final transport stage to customers, critically affects satisfaction and environmental efficiency. Optimization reduces costs, emissions, and enhances service quality (Kum et al., 2018).

Omnichannel Integration

Integrating online and offline channels enhances customer experience, loyalty, and market coverage (Verhoef et al., 2015). Retailers like Tesco exemplify successful omnichannel strategies through synchronized web, app, and store services (Savisaari, 2016).

Inventory and Fulfilment Management

Efficient stock management via pre-purchase, post-purchase, drop-shipping, or hybrid models ensures responsiveness and minimizes risk (Patil & Divekar, 2014). E-fulfilment requires automated, flexible systems to handle orders efficiently from warehousing to delivery (Krueger, 2000).

Warehousing and Returns Management

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Modern fulfillment centers use integrated systems (WMS, ERP, SCM) for real-time control (Tarn et al., 2003). Returns or reverse logistics remain vital for sustaining trust and operational balance (Cooke, 2000).

Technology Integration

IoT enables real-time tracking, personalized marketing, and process optimization (Griffith & Colon, 2019). AI supports chatbots, recommendation engines, and intelligent logistics, enhancing efficiency and service (Song et al., 2019).

Customer Communication and Data Analytics

Effective communication via user-friendly design, tracking, personalization, and reviews builds trust. Big Data analytics empowers e-commerce to understand consumer behavior, personalize offers, and improve decision-making (Alyoubi, 2019).

Challenges and Opportunities

Key challenges include data security, logistics reliability, and privacy concerns. However, personalization, technology integration, and post-purchase engagement create opportunities for growth and loyalty.

The e-commerce success relies on the seamless integration of logistics efficiency, technological innovation, and effective customer engagement. The convergence of digital transformation and supply chain optimization has redefined how businesses deliver value and sustain competitiveness in the digital era. Despite persistent challenges such as data security, delivery efficiency, and sustainability, emerging technologies like AI, IoT, and Big Data analytics present unprecedented opportunities to enhance customer satisfaction and operational agility. Ultimately, the synergy between logistics excellence, intelligent technology, and customer-centric strategies forms the foundation for sustainable growth and long-term success in the e-commerce ecosystem.

Previous Research

Previous studies on e-commerce logistics and customer satisfaction have predominantly focused on specific dimensions rather than providing an integrated perspective. For instance, Bayles and Bhatia (2000) examined the cost implications of logistics operations in e-commerce, emphasizing their influence on overall customer satisfaction. Similarly, Hertz and Alfredsson (2003)

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compared self-support and outsourcing logistics models, highlighting trade-offs between cost efficiency and service quality. While these studies contribute valuable insights, they tend to address logistics efficiency without examining its cumulative effect on customer experience.

Research on last-mile delivery, such as that by Kum et al. (2018) and Viu-Roig and Alvarez-Palau (2020), underscores the importance of timely delivery and environmental sustainability. However, these studies often neglect how customer perceptions of delivery performance shape long-term satisfaction and loyalty. Meanwhile, investigations into omnichannel retailing (Verhoef et al., 2015; Savisaari, 2016) have revealed how integrating physical and digital channels can enhance customer experience, though few studies explicitly connect these omnichannel logistics strategies with measurable satisfaction outcomes.

From the technological standpoint, scholars such as Griffith and Colon (2019) and Song et al. (2019) explored the role of IoT and Artificial Intelligence in optimizing logistics processes and personalization. Despite their significance, these works generally focus on technological efficiency rather than its human-centered effects, particularly how customers perceive technology-driven logistics services.
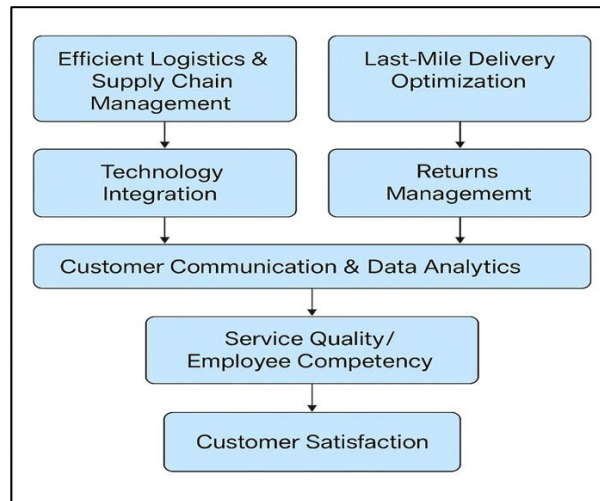
In the context of inventory and fulfillment, Patil and Divekar (2014) demonstrated that efficient stock and fulfillment management enhances operational performance. Yet, there remains a limited understanding of how these operational factors collectively influence customer satisfaction across the e-commerce journey. Similarly, studies on reverse logistics (Cooke, 2000) have addressed return management efficiency but seldom evaluated its impact on customer trust and retention.

Furthermore, previous literature has seldom examined employee competency, training, and service quality within the logistics chain, even though these human factors play a vital role in ensuring positive customer experiences. This omission leaves an empirical gap in understanding how workforce development contributes to customer satisfaction in e-commerce logistics.

In summary, while existing research provides a solid foundation for understanding individual elements of e-commerce logistics, it lacks an integrative model linking logistics operations, technology adoption, and human factors with customer satisfaction outcomes. The present study, therefore, extends prior research by addressing these overlooked interconnections,

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offering a comprehensive perspective on how logistics efficiency, technological innovation, and service quality collectively enhance customer satisfaction in e-commerce environments.

Research Framework

Figure1: Research Framework showing the relationship between logistics efficiency factors and customer satisfaction in e-commerce.

The research proposes that improvements in logistics efficiency through better management of supply chains, last-mile delivery, technology, communication, and returns positively influence service quality, which in turn enhances customer satisfaction. Employee competency and training strengthen this relationship by ensuring consistent, high-quality logistics performance.

Research Methodology

Research Design

This study employed a quantitative survey design to examine the relationship between logistics efficiency and customer satisfaction in e-commerce. A structured questionnaire was used to collect data on factors such as supply chain management, last-mile delivery, technology integration, returns management, and customer communication. The research design followed a systematic approach emphasizing reliability, validity, and ethical considerations.

Population and Sample

The population of this study consisted of individuals with experience in online shopping and e-commerce logistics. Random sampling was used to reduce selection bias and ensure equal participation opportunities. Inclusion criteria were individuals who owned a smartphone with internet access and had at least one experience of online shopping. Exclusion criteria included individuals with no prior online shopping experience and those who provided incomplete questionnaire responses.

Data were collected via an online questionnaire distributed through Google Forms. The sample comprised 392 respondents, which was considered sufficient to represent diverse consumer experiences and to support descriptive statistical analysis in accordance with prior survey-based e-commerce studies.

Research Instrument

The research instrument was a structured questionnaire divided into six key sections, each designed to assess specific elements of logistics performance and their impact on customer satisfaction:

1. Fundamental Details of Respondents – demographic information and online shopping experience (4 items).
2. Efficient Logistics and Supply Chain Management – evaluating logistics and warehousing performance (7 items).
3. Last-Mile Delivery Optimization – measuring satisfaction with delivery efficiency and accessibility (7 items).
4. Technology Integration – assessing satisfaction with the use of digital tools and automation in logistics (5 items).
5. Returns Management – focusing on customer perceptions of return and refund processes (5 items).
6. Customer Communication and Data Analysis – evaluating communication quality, data security, and responsiveness (5 items).

Responses were measured using a five-point Likert scale, ranging from Strongly Disagree (1) to Strongly Agree (5), allowing quantitative interpretation of customer satisfaction levels.

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Creation and Testing of Tools

The questionnaire was developed based on a review of relevant theories on customer satisfaction and logistics efficiency in e-commerce. Expert consultation ensured clarity, content validity, and alignment with research objectives. All items achieved an IOC score of 1.00, exceeding the minimum threshold of 0.50. A pilot test with 30 respondents was conducted, and the Cronbach's Alpha value of 0.814 confirmed strong reliability and internal consistency. Thus, the instrument was deemed valid and reliable for use in this study.

Data collection

Data were collected using a structured questionnaire distributed via Google Forms through social media platforms such as Facebook, Instagram, WhatsApp, and email. Responses were evaluated using a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree to measure customer satisfaction levels. From using the Class Interval frequency distribution formula to interpret the meaning

Data analysis

The collected data were analyzed using Google Forms' automated system to obtain descriptive statistics. The analysis included calculations of the mean ($\bar{x}$), standard deviation (SD), and percentage (%). The results were then interpreted and categorized into satisfaction levels based on the Class Interval Frequency Distribution method, dividing responses into five levels of satisfaction.

Results

This study investigated customer satisfaction regarding efficient logistics in E-commerce. The researcher has organized the analysis results into two distinct sections as follows.

Section 1: Findings from the analysis of general information provided by respondents in the questionnaire, encompassing gender, occupation, experience in online purchasing, and the frequency of utilizing online purchasing systems.

Section 2: Results of analysis of customer satisfaction data regarding transportation and distribution of goods. And various related aspects

Section 1: **Results of analysis of general data for the respondent**

Table **1: Quantity** and percentage of general information of questionnaire respondents.

Information		Quantity	Percentage
Gender	Male	98	25
	Female	294	75
	Overall	**392**	**100**
Occupation	Student	112	28.6
	Employee	175	44.6
	Others	91	23.2
	Overall	**392**	**100**
Shopping experience through the online system	Less than 1 year	21	5.4
	2–5 years	161	41.1
	5–10 years	168	42.9
	10 years and up	42	10.7
	Overall	**392**	**100**
Frequency of participation in online shopping	Infrequently (once a month or less)	140	35.7
	Occasionally (2-3 times a month)	105	26.8
	Regularly (over 3 times a month)	147	37.5
	Overall	**392**	**100**

In Table 1, it is evident that the predominant demographic consists of female customers, comprising 75 percent, with male customers following at 25 percent. The primary occupation reported by respondents is employment, constituting 44.6 percent, trailed by student occupations at 28.6 percent, and other occupations at 23.2 percent. The highest percentage of respondents, 42.9 percent, reported having online shopping experience between 5-10 years, closely followed by those with 2-5 years of experience at 41.1 percent. Meanwhile, individuals with experience

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exceeding 10 years accounted for 10.7 percent, and those with less than 1 year of experience represented 5.4 percent, respectively. Moreover, the most common frequency of online shopping among respondents is over three times a month, constituting 37.5 percent. This is followed by those who shop online only once a month at 35.7 percent, and lastly, those who shop online 2-3 times a month, accounting for 26.8 percent.

Section 2: **Results of analysis of customer satisfaction data**

Table 2: Efficient Logistics and Supply Chain Management

Questions	Meen	SD	Meaning
1. Getting a product of good quality at a reasonable price affects satisfaction.	4.59	0.68	very high satisfaction
2. Ordering in-stock products has a positive impact on satisfaction.	4.39	0.72	very high satisfaction
3. Buying products with a distribution center nearby affects satisfaction.	4.20	0.89	high satisfaction
4. Receiving the correct and undamaged product affects satisfaction.	4.84	0.45	very high satisfaction
5. Fast and punctual delivery is important for satisfaction.	4.75	0.57	very high satisfaction
6. If the company uses a 3PL to transport the goods to the customer. will affect their satisfaction in bad ways.	3.21	1.05	moderate
7. Does shipping marketing influence the purchasing decisions, such as free shipping?	4.50	0.76	very high satisfaction
Overall	**4.35**	**0.73**	**very high satisfaction**

From Table 2, Efficient Logistics and Supply Chain Management is found to have an effect on customer satisfaction at a very high satisfaction level ($\bar{x} = 4.35$, SD=0.73). The highest level of customer satisfaction is influenced by factors such as obtaining quality products at

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affordable prices, having products readily available in stock for prompt shipping, and receiving accurate and undamaged items swiftly and on time. Additionally, transportation-related marketing strategies, such as free delivery, play a crucial role in shaping customer satisfaction ($\bar{x}$ = 4.24 - 5.00). Subsequently, products with a nearby distribution center contribute significantly to a high level of customer satisfaction ($\bar{x}$ = 3.43 - 4.23). However, the utilization of 3PL services by the company does not show a discernible positive or negative impact on customer satisfaction. ($\bar{x}$ = 2.62 - 3.42).

Table 3: Last-Mile Delivery Optimisation.

Questions	Mean	SD	Meaning
1. Can real-time shipment status through a platform positively influence satisfaction?	4.50	0.63	very high satisfaction
2. Is same-day shipping better than regular shipping, even though there is a slightly higher service charge?	3.36	1.20	moderate
3. Do the personality/services of shippers affect company image and customer decision?	3.82	0.93	high satisfaction
4. Does a multi-channel ordering affect customer purchasing decisions?	4.36	0.74	very high satisfaction
5. Does an easy-to-use ordering platform and other significant aspects of the application influence the customer's decision in choosing a service?	4.45	0.65	very high satisfaction
6. Is notification of product status via the App a satisfactory service?	4.41	0.65	very high satisfaction
7. Making payments and providing ratings orders through the platform is a task that customers feel comfortable with and find effortless.	4.20	0.74	high satisfaction
Overall	4.16	0.79	high satisfaction

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From Table 3, Last-Mile Delivery Optimization has a high effect on customer satisfaction. ($\bar{x} = 4.16$, SD=0.79). Having an application that enables customers to track the real-time status of last-mile transportation, ensuring user-friendly functionality, coupled with a prompt notification system and diverse alternative channels for convenient product access (multi-channel), is a paramount factor that significantly influences customer satisfaction ($\bar{x}$ = 4.24 - 5.00). Furthermore, customers perceive that the personality and service of the delivery personnel, along with the capability to make online payments directly on the platform, exert a high level of satisfaction. The majority of customers find leaving online product reviews is effortless ($\bar{x}$ = 3.43 - 4.23). And, customers believe that as long as transportation ensures the delivery of the correct and undamaged product, the choice between same-day delivery and regular delivery brings equal satisfaction depend on the particular customer. The distinction between these two delivery types does not affect customer satisfaction ($\bar{x}$ = 2.62 - 3.42).

Table 4: Technology Integration.

Questions	Mean	SD	Meaning
1. Can employing technology, such as AI systems or potential drone utilisation in the future, by the company elevate customer satisfaction?	3.64	1.03	high satisfaction
2. Is it appropriate for the company to utilise technology to gather information about customer purchasing behaviour for the purpose of enhancing future services?	3.66	1.04	high satisfaction
3. How crucial for the company to employ technology that efficiently oversees the entire product delivery process, ensuring accuracy in terms of location, product, and timing without errors?	4.20	0.74	high satisfaction
4. Is it important for the company to have technological applications that cater to your fundamental requirements?	4.41	0.73	very high satisfaction

Questions	Mean	SD	Meaning
5. Is a company utilising high-quality technology perceived as highly reliable?	3.91	0.79	high satisfaction
Overall	3.96	0.86	high satisfaction

From Table 4 Technology Integration, it is found that it has a high effect on customer satisfaction ($\bar{x} = 3.96$, SD = 0.86). If the company possesses technology that addresses fundamental customer services, such as tracking status and making payments, it is the paramount factor contributing to customer satisfaction ($\bar{x}$ = 4.24 - 5.00). While using AI or drones to provide services in the future, using technology to collect sales data and use it to develop services in the future, so that there are no errors. Makes customers view the company as a trustworthy company ($\bar{x}$ = 3.43 - 4.23).

Table 5: Returns Management.

Questions	Mean	SD	Meaning
1. The company that has policies in place to support the return of damaged products and effectively takes responsibility in such instances contributes significantly to customer satisfaction.	4.7	0.50	very high satisfaction
2. The company that has policies in place to support the return of damaged products, and effectively takes responsibility in such instances influences customer decisions to continue purchasing from them in the future.	4.55	0.62	very high satisfaction
3. How important do customers consider the speed of the product return process?	4.64	0.58	very high satisfaction
4. When opting for a return instead of a replacement, the prompt verification and issuance of refunds are crucial.	4.63	0.55	very high satisfaction

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Questions	Mean	SD	Meaning
5. Conversely, if the issue or product return is not resolved satisfactorily, the customer may choose not to engage with the company or may share the drawbacks more widely.	4.52	0.60	very high satisfaction
Overall	4.61	0.57	very high satisfaction

From Table 5, Returns Management is found to be a factor that affects customer satisfaction at a very high level ($\bar{x} = 4.61$, SD=0.57). The presence of a company policy that effectively aids in resolving issues, expedites the return process, and ensures swift refunds has a profound impact on customer satisfaction. Customers express a willingness to return and use the service again when they receive adequate assistance. Conversely, a lack of responsibility on the company's part significantly increases the likelihood that customers will refrain from future purchases and potentially share this disadvantage with a broader audience ($\bar{x}$ = 4.24 - 5.00).

Table 6: Customer Communication and Customer Data Analysis.

Questions	Mean	SD	Meaning
1. How much timely communication with a company when issues arise significantly influences customer satisfaction.	4.64	0.61	very high satisfaction
2. Does the presence of multiple and easily accessible contact channels impact customer satisfaction with the company?	4.54	0.76	very high satisfaction
3. Is a company that follows up on complaints, either during or after resolving issues, considered to provide impressive service?	4.68	0.54	very high satisfaction
4. If the company remembers previous purchases, then facilitating future transactions by recalling details influences the satisfaction.	4.34	0.79	very high satisfaction

Questions	Mean	SD	Meaning
5. Does the secure protection of information impact customer trust in the company for future purchases?	4.73	0.48	very high satisfaction
Overall	4.59	0.63	very high satisfaction

From Table 6, Customer Communication and Customer Data Analysis found that it plays a very high role in customer satisfaction ($\bar{x} = 4.59$, SD = 0.63). Customers perceive that a company offering efficient customer communication, streamlined issue tracking, easy accessibility, multiple contact channels, information gathering for future orders, and robust security measures for personal and financial details, such as customer personal information and credit card numbers, will garner maximum satisfaction from them ($\bar{x}$ = 4.24 - 5.00).

Linking Research Findings to the Study Objective

The findings of this study provide empirical evidence that directly addresses the research objectives by demonstrating how logistics efficiency and technology integration influence customer satisfaction in e-commerce. Based on data from experienced online shoppers, the results highlight the transformation of supply chains, strategies for logistics efficiency, innovations in last-mile delivery, and the growing role of data-driven operations. The following discussion explains how the findings respond to each research objective.

Objective 1: To analyze how e-commerce transforms traditional supply chains and logistics

The findings show that e-commerce has transformed traditional supply chains into customer-centered and time-sensitive logistics systems. High customer satisfaction is closely associated with product availability, accurate order fulfillment, fast delivery, and proximity of distribution centers. These results indicate a shift from linear supply chains toward more flexible, responsive, and service-oriented logistics networks.

Objective 2: To identify strategies for improving logistics efficiency and reducing costs

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The results suggest that logistics efficiency can be improved by ensuring in-stock availability, strategically locating distribution centers, and using logistics-related marketing strategies such as free shipping. The limited impact of third-party logistics providers on customer satisfaction implies that 3PLs may be used primarily to enhance cost efficiency rather than customer experience.

Objective 3: To explore innovations in last-mile delivery and technology integration

The findings highlight the importance of last-mile innovations, particularly real-time tracking, user-friendly platforms, automated notifications, and multi-channel ordering. Customers value reliability and transparency more than delivery speed alone, as same-day delivery does not significantly increase satisfaction when standard delivery is accurate and timely.

Objective 4: To assess the use of data analytics and automation to optimize e-commerce operations

The study demonstrates that data analytics and automation are essential for optimizing e-commerce operations. Technologies that support delivery monitoring, personalized services, and secure data management significantly enhance customer trust and satisfaction. Although advanced technologies such as AI and drone delivery are still emerging, they are viewed positively as future tools for improving operational efficiency.

Discussion

The findings indicate that most online shoppers are female, employed, and have 2–10 years of experience in online purchasing, suggesting that respondents are familiar with e-commerce systems and able to evaluate logistics performance effectively. Overall customer satisfaction ranged from high to very high, confirming that logistics efficiency plays a critical role in shaping consumer perceptions in the e-commerce context.

Consistent with previous studies, fast and accurate delivery, product quality, and service reliability were identified as key determinants of customer satisfaction. These findings align with Kum et al. (2018) and Viu-Roig and Alvarez-Palau (2020), who emphasized the importance of delivery speed and reliability in online retail. In addition, high satisfaction with multi-channel ordering and user-friendly platforms supports Verhoef et al. (2015), who highlighted the role of omnichannel integration in enhancing convenience and customer loyalty.

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The results also corroborate Song et al. (2019), demonstrating that technology adoption—such as real-time tracking, digital payments, and secure data systems—strengthens customer trust. Furthermore, effective return management was found to significantly increase satisfaction, consistent with Cooke (2000), reinforcing the importance of post-purchase services in long-term customer relationships.

Overall, the findings confirm that logistics efficiency, technology integration, and service quality collectively drive customer satisfaction and competitive advantage in the e-commerce sector.

Recommendation

Recommendation for research Utilization

Based on the findings, e-commerce businesses should optimize supply chain management by maintaining product availability, improving delivery accuracy, and integrating user-friendly digital platforms with real-time tracking and secure payment systems. Logistics providers should enhance last-mile delivery efficiency through timely and reliable delivery services, supported by professional delivery personnel. Technology and data management teams should apply data analytics and automation to personalize services, improve operational efficiency, and strengthen data security. Customers are encouraged to provide accurate delivery information and constructive feedback to support continuous service improvement.

Recommendation for Future research

Based on the findings of this research, for anyone considering further development, the researcher suggests implementing the enhancements within an e-commerce company and assessing whether customers indeed experience increased satisfaction following the implementation.

Research Limitation and Critique

This study successfully collected valuable insights to enhance logistics efficiency and customer satisfaction in e-commerce through eight key factors: supply chain management, last-mile delivery, inventory and warehousing, technology integration, customer communication, returns management, and data analysis.

Although the questionnaire, administered to 3 9 2 respondents via Google Forms, demonstrated satisfactory reliability (tested using SPSS), certain limitations were encountered. These included limited opportunities for direct academic supervision and reliance on online platforms for data collection. Minor discrepancies in responses were also observed but remained within acceptable research standards.

Despite these constraints, the findings provide meaningful implications for practical application in e-commerce logistics. Future research should expand the sample size and incorporate comparative or longitudinal studies to further validate and strengthen the model's applicability in real-world operations.

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