Topic: Critical Factors towards Implementing Sustainable Last-mile Delivery of Urban E-commerce Logistics in Vietnam - Expert Perspectives

Bachelor Of International Business Thesis

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Sincerely,

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ABSTRACT

According to Vietnam E-commerce and Digital Economy Agency, Vietnam has emerged as the world's second-fastest-growing digital economy, following India, with the highest E-commerce development rate in Southeast Asia. Urban E-commerce also plays a pivotal role in the economic development of Vietnam. This emphasizes the importance of last-mile delivery (LMD) in the success of E-commerce businesses. While there are still many problems in Vietnam's urban LMD such as poor service quality, significant high cost, and outdated technology, there is a limited focus on sustainability in existing research.

To address this research gap, this study proposes a comprehensive analysis of LMD in urban Vietnam, incorporating economic, environmental, and social sustainability factors alongside service criteria. This study aims to analyze expert perspectives and professional opinions through the Analytical Hierarchical Process (AHP) model to assess the impact of all these factors on LMD services. A comprehensive set of criteria encompassing key considerations for sustainable logistics development in Vietnam is ebstalished, consist of six primary criteria: Service Convenience (M1), Service Responsiveness (M2), Service Reliability (M3), Economic Aspect (M4), Environmental Aspect (M5), and Social Aspect (M6), which in turn comprise a set of 21 sub-criteria. The study delineates strategic objectives pertinent to sustainability within the logistics sector's LMD domain. The outcome of this research is a rank of a set of strategies to enhance LMD service quality are prioritized based on their efficacy. Each main criterion plays a distinct role in mitigating and addressing inefficiencies in the customer delivery process, and served as a valuable reference for companies to enhance logistical, operational, and strategic directions.

The research, though insightful, reveals limitations warranting further exploration. It exclusively concentrates on urban areas in Vietnam, overlooking significant distinctions in rural regions. Additionally, the study's primary focus on the logistics of the "last-mile of E-commerce deliveries" implies limited universality to other logistic domains, like express delivery, which possess distinct characteristics. Moreover, in-depth investigations into the impact of criteria such as costs and integrity of goods on sustainable LMD in urban E-commerce logistics in Vietnam are crucial to understanding the intricate mechanisms influencing the LMD landscape more comprehensively.

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LMD	Last-mile Delivery
LSQ	Logistics Service Quality
LSPs	Logistics Service Providers
MCDM	Multi-criteria Decision-making Model
AHP	Analytical Hierarchical Process
WCED	World Commission on Environment and Development
TBL	Triple Bottom Line
B2C	Business to Consumer
CAGR	Compound Annual Growth Rate
B2B2C	Business to Business to Customer
CR	The Consistency Ratio
CI	The Consistency Index
RI	Random Index
ISM	Interpretative Structural Model
FSC	Forest Stewardship Council
SEVQUAL	Service Quality
MADM	Multi-attribute decision making

CHAPTER 1: INTRODUCTION

1.1 Topic background

1.1.1 E-commerce in Vietnam

Electronic commerce is known as online trade, paperless commerce, or e-business; nevertheless, the term E-commerce is the most commonly used, well-known, and nearly regarded as a common convention to call a form of commerce that buys and sells goods or services via the internet (Aggarwal and Anchal, 2023). The impact of e-commerce on a country's economy is quite significant. It not only facilitates commercial activities but also brings forth new values that cater to the changing needs of enterprises and customers (Tsagkias et al., 2021). This is the reason why every country in the world is eager to promote and expand E-commerce. E-commerce plays several critical functions, including changing the nature of each country's economy and the global economy, increasing knowledge in the economy, opening up opportunities for development, and shortening the gap in knowledge levels between developed countries and developing countries (Terzi, 2011).

In the global context, with over five billion internet users, the number of individuals making transactions online is growing at a rapid pace. In terms of gross merchandise value (GMV), the top 3 world market leaders include the top 2 Asian online commerce providers from China, which are Taobao and Tmall, followed by Amazon from US (Koen van Gelder, 2023). And Stephanie Chevalier (2022) expected retail E-commerce sales to reach USD 6.31 billion by 2023 and continute to grow steadily each year, from 2014 to 2026 (Chart 1.1). According to Statista Market Insights (2023), it predicts user penetration will reach 57.2% by 2023 and increase to 66.6% in 2027. These numbers highlight the strong attraction of E-commerce platforms to the shopping behavior of people around the world.

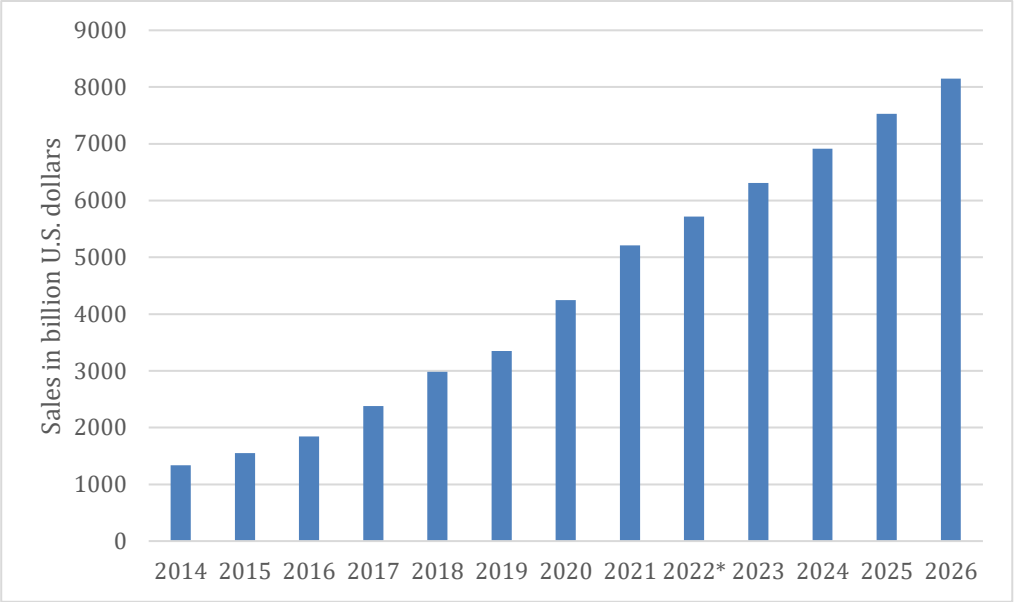

Chart 1.1 Retail E-commerce sales worldwide from 2014 to 2026 *(Stephanie Chevalier, 2022)*

Vietnamese E-commerce in recent years has recorded strong growth. Vietnam has a rate of internet users shopping for goods online weekly at 60.7%, which is higher than the global average of 57.6% (Chart 1.2)

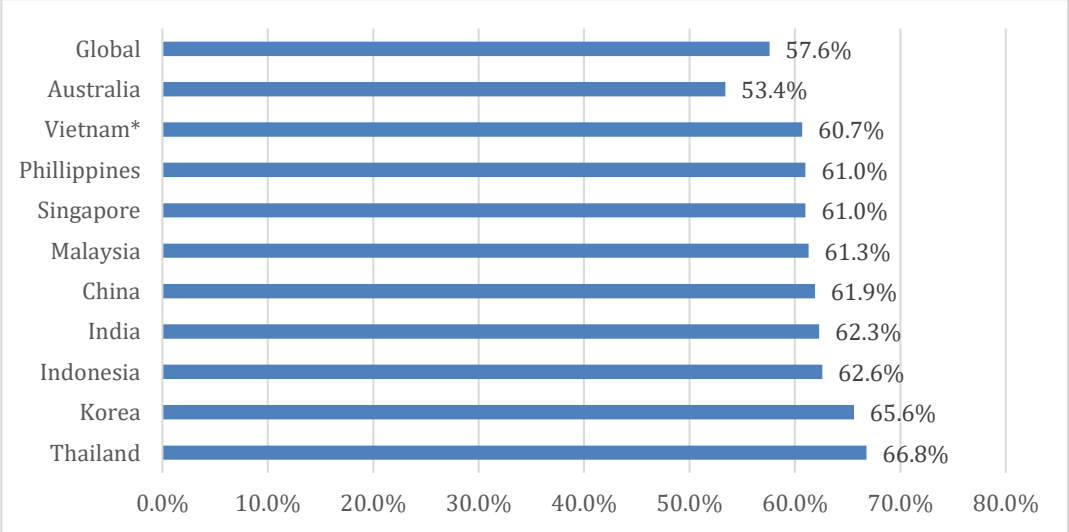

Chart 1.2 Propotion of internet users who shop online weekly in some countries

(Vietnam E-commerce and Digital Economy Agency, 2023b)

Vietnam's B2C E-commerce revenue only reached about 8 billion USD in 2018, but it has reached 16.4 billion USD in 2022 (Chart 1.3). It is estimated that in 2023 E-commerce in Vietnam will reach a revenue of 20.5 billion USD with a growth rate of 25% (Lam Nguyen,

2023). The proportion of B2C E-commerce revenue accounts for about 7.8-8% of the total retail sales of goods and consumer service revenue nationwide (Table 1.1). eMarketer has ranked Vietnam among the top 5 countries with the world's leading E-commerce growth rates, which is in line with reports from Google, Temasek, and Bain & Company. These reports state that the impressive growth of Vietnam's digital economy in recent years has largely come from the boom of the E-commerce sector when this industry accounts for more than 60% of the value of the economy (Lam Nguyen, 2023).

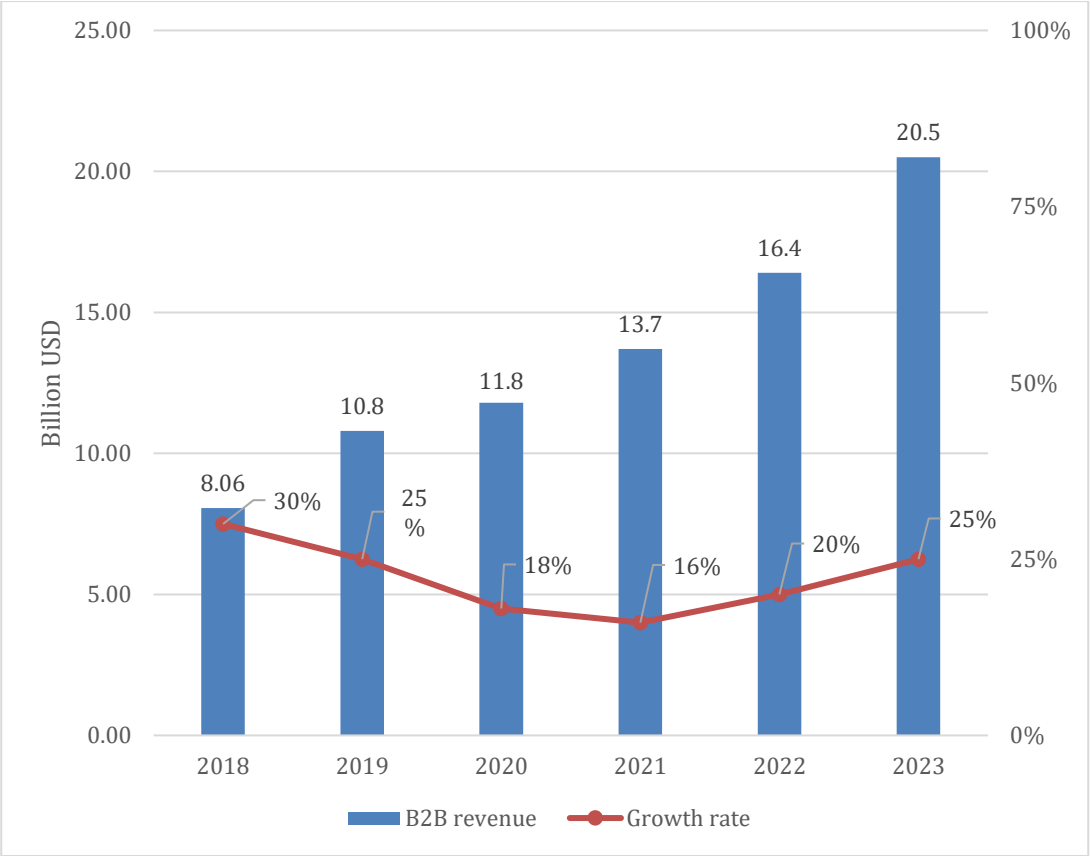

Chart 1.3 Vietnam B2C E-commerce revenue in 2018 – 2023 *(Vietnam E-commerce and Digital Economy Agency, 2023b)*

Table 1.1 Retail E-commerce market scale in Vietnam *(Vietnam E-commerce and Digital Economy Agency, 2023b)*

	2018	2019	2020	2021	2022	Forecast 2023
Estimated number of consumers shopping online (millions)	39.9	44.8	49.3	54.6	57	59 - 62

Estimated value of one person's online shopping (USD)	202	225	240	251	288	300 - 320
Proportion of B2C E-commerce revenue compared to total retail sales of goods and consumer service revenue nationwide	4.2%	4.9%	5.5%	7.0%	7.5%	7.8 - 8%
Proportion of people using the Internet	60%	66%	70%	73%	73%	74%

Based on the Metric's E-commerce report for the first half of 2023, the revenue determined by the total value of all successfully delivered orders in the Vietnam market of Shopee, Lazada, Tiki, Tiktok shop, and Sendo hits almost 93,000 billion VND, representing a 46% increase over the previous year (Metric, 2023). In particular, revenue in the first and second quarters of 2023 was 43,000 and 50,000 billion VND, respectively (Metric, 2023). Vietnam's online shopping market is considered a vibrant market with great potential for development in the following periods.

Assessing the growth rate of the E-commerce market in Vietnam, the Vietnam E-commerce Association (VECOM) stated that 2023 will be a flourished year for TikTok shop. Since then, the new shopping term "Shoppertainment" (online shopping trend combined with entertainment) has become one of the prominent trends in 2023 (Ngoc Cham, 2023b). Besides, the explosion of Live Commerce - a form of sales and promotion via livestream in the past year is also considered a new bright spot in the development of E-commerce in Vietnam (Ngoc Cham, 2023a).

There are many positive signs about the development of E-commerce in 2023 and the following years. However, E-commerce will also have to deal with huge challenges. The first to mention is infrastructure limitations. As the E-commerce sector expands, particularly when customers are located at a significant distance, managing a high volume of orders with the demand for expedited delivery adds complexity to the logistics process. (Vietnam E-commerce and Digital Economy Agency, 2023a). The costs entailed by logistics intermediaries make the prices applied to online shoppers not much lower than those of purchasing by traditional methods. (Vietnam E-commerce and Digital Economy Agency, 2023a). Competition among LSPs leads to the need to provide additional value-added services to meet the demands for faster, safer, more economical delivery and better service for customers. In addition, logistics solutions in domestic E-commerce still have many

limitations in terms of technology, information security or payment security. Technology solutions for handling post-delivery operations such as reverse e-logistics are not well controlled, also creating challenges for delivery companies (Vietnam E-commerce and Digital Economy Agency, 2023a).

1.1.2 Urbanization in Vietnam

In Vietnam, urbanization is experiencing significant growth, marked by the burgeoning emergence of increasingly sizable metropolitan areas within pivotal economic nuclei. In Vietnam, urban areas are contributing 70% of the country's GDP. Although five big cities only account for 2.9% in the area and about 22% of the population, they contributed 46% of the total GDP in 2020 (Lan Anh, 2022). According to Statista (2023), the urbanization rate in Vietnam is increasing over the years (Chart 1.4). The government's resolution also sets out targets for urban development in Vietnam, the urbanization rate will be about 45% by 2025 and over 50% by 2030. In 2050, it is predicted that Vietnam's urban population will exceed its countryside (Minh-Ngoc Nguyen, 2022).

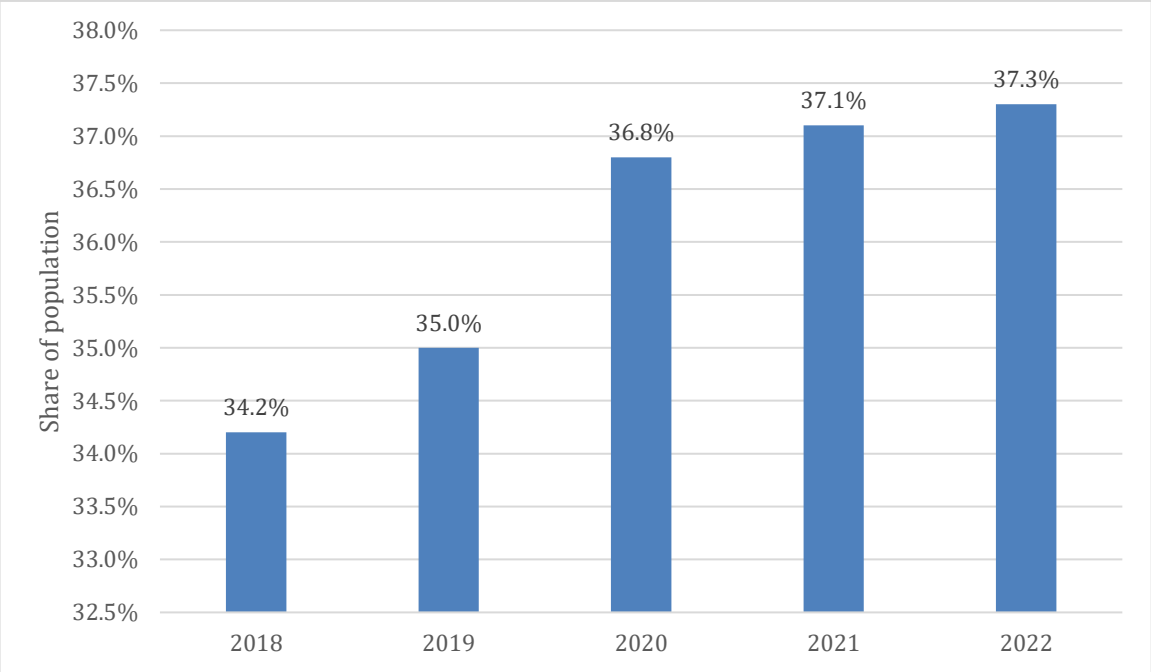

Chart 1.4 Share of the urban population in Vietnam from 2018 to 2022 (Statista, 2023)

Current rapid urbanization has also generated favorable conditions for socio-economic growth, promoting economic and labor restructuring towards industrialization and modernization (Lan Anh, 2022). According to the Ministry of Construction of Vietnam,

urbanization has created urban areas with expanded economic space and a favorable business and investment environment, developed infrastructure, abundant labor resources and larger markets. These conditions facilitate the development of industries and services, attract FDI, promote economic, resructure towards industrialization, and improve productivity and quality of economic growth (Lan Anh, 2022). The economic prosperity fostered by Vietnam's urbanization has then led to an increase in consumer purchasing power, which is beneficial for E-commerce. Besides, steady inflows of foreign investment into the country's digital economy has also been a result encouraged by the high urbanization rate (Acclime Vietnam, 2022). Furthermore, the shipment of urbanization often accompanied with improved infrastructure E-commerce, including logistics and LMD systems.

On the other hand, according to World Cities, Vietnam has recently experienced the adverse effects of urbanization, including polluted environments, poor service delivery, insufficient service provision, and heavy traffic (World Cities, 2018). The Vietnam Ministry has also expressed concern about addressing these long-term effects by utilizing integrated Sustainable Development Strategies, i.e., the *"*Vietnam Urban Green Growth Development Plan to 2030*"* was adopted in 2018 to guide the transformation of the urban economic growth model toward sustainable development and climate change adaptation (Global Platform for Sustainable Cities, 2021). Vietnam's digital economy, especially in urban areas, has recently adapted to a flourishing E-commerce sector and is now focusing on creating and putting into action such sustainable development strategies. Given that E-commerce sectors will be predicted to reach 65% of the entire digital economy by 2025 (VNA, 2023), the country is getting more serious about adopting sufficient practices of sustainability in urban E-commerce.

1.1.3 Logistics market in Vietnam

In order to fulfill the increasing demand for urban E-commerce, the urban logistics sector must be under tremendous pressure to improve their efficiency and competitiveness while also guaranteeing the long-term growth of urban cities (Taniguchi, 2014). Logistics, as the connecting and cooperating factor in a market economy, is becoming increasingly vital and indispensable in the production, distribution, and circulation of goods, especially in establishing a favorable environment for business to improve the efficiency of production as well as company operations in all fields.

Vietnam is considered as a potential market for the the logistics service industry development. According to Agility (2023), the Vietnam Logistics industry is placed 10th among 50 rising logistics markets worldwide. The Vietnam Freight and Logistics Market is anticipated to be valued 45.19 billion USD by 2023 and 65.34 billion USD in 2029, growing at a CAGR of 6.34% from 2023 to 2029 (Vietnam Freight and Logistics Market Insights, 2023).

Vietnam offers numerous favorable conditions for the development of the logistics business such as ideal geographical location with a long length of coast, government and authorities active support (Thanh and Dung, 2021), a variety of regional free trade agreements (FTAs) such as the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), the Regional Comprehensive Economic Partnership (RCEP), the EU-Vietnam FTA, the UK-Vietnam FTA (ARC's report, 2023). Furthermore, given the close relationship between E-commerce and the logistics industry, Vietnam logistics industry can take advantage of the booming of E-commerce. Logistics serve an essential part in the trade chain from vendor to consumer, including order fulfillment processes such as packaging, transportation, and collection of payments. Therefore, the emergence of Vietnam E-commcerce is projected to fuel the logistics industry's robust development in the future (VIRAC's Report, 2023).

According to the aforementioned study, the logistics business in Vietnam is rapidly expanding. However, in current circumstances, Vietnam's logistics business confronts several challenges in realizing its full potential. High costs and a lack of high-quality infrastructural components have a significant negative impact on logistics activities in Vietnam. Furthermore, defective information technology applications and inadequate transportation infrastructure raise the cost of delivery services. Data shows that Vietnam logistics costs are substantially higher than the other countries. (Banomyong, Hng, & Ha, 2017). In ASEAN, some countries have lower logistics costs such as Thailand and Singapore while Vietnam has maintained high expenses. According to the World Bank, Vietnam logistics costs represent around 20.9-25% of GDP which is 6% more than Thailand, 12% more than Malaysia, and three times more than Singapore (Chart 1.5) (WB, 2018). In Vietnam, transportation expenses represent around 50% - 60% of the total logistics cost, which is excessive in comparison to other nations. Therefore, the overall operating expenses of delivery services in Vietnam remain expensive, and a lack of technology also hampers the expansion of the logistics business (VIRAC's Report, 2023).

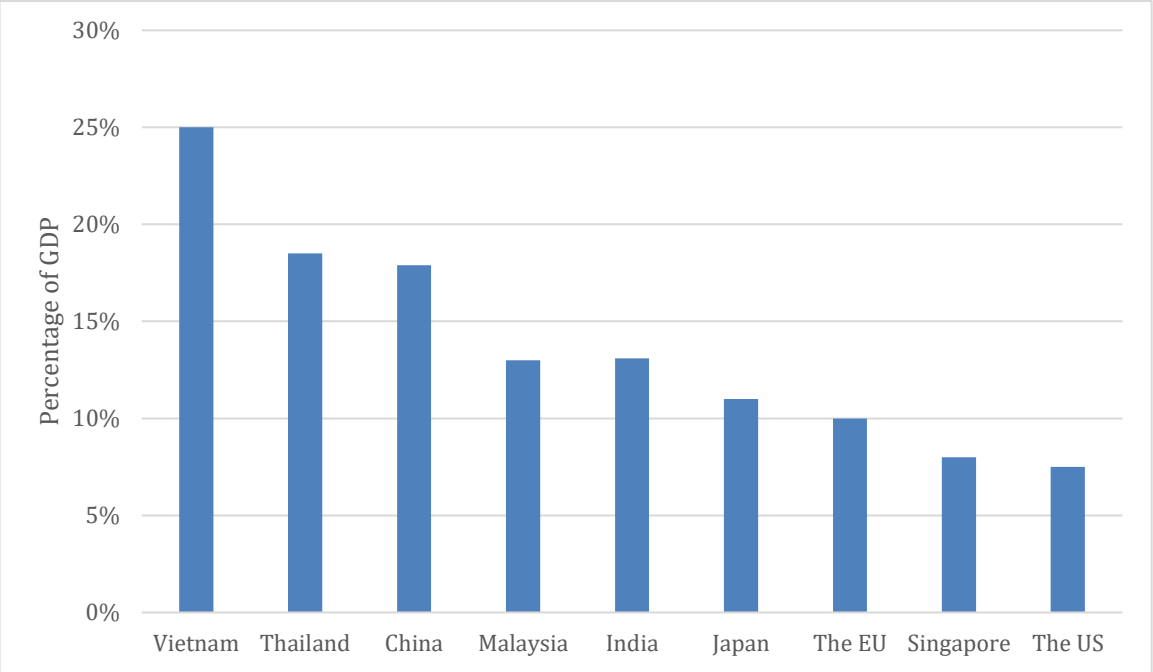

Chart 1.5 Logistics cost as percentage of GDP *(WB, 2018)*

As the globe enters a new economic cycle, new trends appear shaping the operation of the logistics and supply chain and and Sustainable Logistics is in the top 4 trends, acording to Vietnam Report's study (Vietnam Report, 2022). In this study, the authors focus on researching the Sustainable Logistics, specifically LMD.

1.1.4 Last-mile delivery in Vietnam

LMD denotes the conclusive stage of the delivery procedure, wherein the package transitions from the transportation hub to the customer, encompassing diverse delivery locations such as residential addresses, workplaces, or other designated destinations for product receipt (Vrhovac et al., 2023). The term "last-mile" describes the actual physical movement of a good or service from its point of origin to its ultimate destination, or from the supply side to the demand side (Olsson, Hellström and Pålsson, 2019). Because of this, it does not correspond to a precise mile (or km), but rather relies heavily on the supply chain's location and geographic structure (Ji and Liu, 2011). LMD often holds significant importance within supply chain management. However, it is simultaneously considered the most costly and least efficient segment in logistics and E-commerce (Van Duin et al., 2020). According to Van Duin et al., (2020), this inefficiency accounts for a substantial portion of the overall delivery cost, approximately 28%, thereby creating the financial burden of both businesses and customers.

Particularly in the context of Vietnam, due to the rapid growth of E-commerce during COVID period, delivery service has become a key factor in online shopping and is a tool for online platforms to grow their images. Evidences below also show that online consumers rely on delivery service in a regular basis. According to recent research, more than 85% of the population uses delivery services once, and half of them use it between 1 to 3 times every month (Thao Vy et al, 2021). 95% of customer care about delivery service when purchasing online, whose satisfaction is dependent on multiple factors such as delivery speed and cost (Giang et al., 2020). Those factors incentivize buyers' decision-making and reliability in online shopping. On the other hand, visibility on delivery progress and timeliness is also a high demand in Vietnam as it adds to consumers a good sense of trust and safety (Ha Anh et al, 2022). These are strong statistics to show that LMD plays an important role in urban economic system in Vietnam. E-commerce growth is strongly influenced and tight to customer satisfaction on LMD.

Key business challenges associated with expensive and inefficient LMD give rise to a multitude of problems. These issues encompass not only the financial aspects but also environmental concerns, customer satisfaction, and the overall reputation of businesses. Resources are wasted, and there's a resultant increase in environmental pollution due to unnecessary mileage and fuel consumption. Additionally, the suboptimal LMD processes often lead to unsatisfied customers, adversely affecting their shopping experience and eroding their trust in E-commerce companies. Research found that there is room for improvement in delivery customer service (Tram and Giang, 2023). The negative repercussions extend further to the businesses, as they risk damaging their reputation and potentially losing out on loyal clientele. Therefore, addressing these challenges in LMD is imperative to ensure more efficient, cost-effective, and environmentally sustainable E-commerce and logistics operations in Vietnam (Hoang Ha, 2022).

1.2 Problem statement

1.2.1 Practical problem

Vietnam now boasts the world's second-highest rate of digital economic growth, following India, and holds the top position for E-commerce development in Southeast Asia, which was shared by Deputy Prime Minister Tran Luu Quang at the Vietnam Development Bridge 2023 Conference held in Da Nang City (Tan Luc, 2023). Nevertheless, according to Vietnam

Ministry of Industry and Trade (2021), despite the growth prospects, the E-commerce sector in Vietnam encounters numerous challenges in establishing a robust and enduring market. The success of E-commerce is significantly influenced by LMD. LMD is considered the most important link between logistics companies and customers (Liu et al., 2019). B2B2C delivery services in general and LMD, in particular, play a decisive role in winning and retaining customers, as the supply chain environment changes rapidly and customer demands become increasingly high (Ha Yen, 2022). However, LMD posing a huge challenge for sustainable development of logistics industry and E-commerce (Binh and Huong, 2021).

As outlined in the Vietnam E-commerce Index Report 2023, the online retail sector identifies two key stages that have detrimental environmental effects, including delivery (related to vehicles running on the road emitting large amounts of carbon emissions) and packaging (Carton boxes, packaging nylon, bubble wrap, foam boxes, disposable plastic items) (Khac Kien, 2023). A 2020 study published by the World Economic Forum (WEF) revealed that the substantial expansion of LMD in E-commerce has the potential to exacerbate traffic congestion and elevate carbon emissions in major cities globally (Duy Khang, 2023). The World Bank report shows that the transportation industry causes up to 10% of Vietnam's greenhouse gas emissions (Lam, Sriram and Khera, 2019). Citing a report from the Ministry of Natural Resources and Environment, Ho Chi Minh City holds the highest greenhouse gas emissions in Vietnam, amounting to 38.5 million tons of CO2. This constitutes approximately 16% of the country's total emissions, with 45% attributed to gas emissions from traffic and transportation activities (Tuan Phong, 2021). According to a report from the Ministry of Industry and Trade of Vietnam, Ms. Lai Viet Anh, Deputy Director of the Department of E-Commerce and Digital Economy, asserted that the amount of waste generated during online shopping is seven times greater than that produced when shopping in physical stores (Nguyen Quynh, 2023).

Furthermore, logistics costs at retail businesses account for a large proportion of the price, ranging from 10 - 20% (Nguyen Quynh, 2023). In the 2019 report of the World Bank (WB), logistics costs in Vietnam are equivalent to 21% of GDP, and Vietnam ranks among the countries with the highest logistics costs globally (Lam, Sriram and Khera, 2019). LMD costs account for about 28% of total shipping costs and can be up to 53% in the case of on-demand delivery (Viet Dung, 2023). This is a significant cost that not only increases the final price of the product purchased by consumers but also shows ineffectiveness in organizing the distribution system.

Additionally, the inadequate technological infrastructure poses challenges for Vietnam's E-commerce sector to compete with other developed nations, leading to unforeseen incidents and cybersecurity challenges. (Ha Yen, 2022). Sharing about the current situation of the E-commerce market, Deputy Minister of Science and Technology Tran Van Tung commented on the challenges of delivery activities, safety, network security and personal security in E-commerce transactions poses significant challenges for businesses (Department of Industry and Trade, 2023). According to a survey of the Vietnam Logistics Service Business Association (2018), in the field of e-logistics, only about 10.8% of businesses are using basic IT related to tracking and tracing, delivery, and warehouse management systems (Binh and Huong, 2021). Technology also faces challenges with technology infrastructure to meet E-commerce requirements for processing huge data or when many orders are placed simultaneously (Ha Yen, 2022).

Vietnam's E-commerce also witnesses disparity in development between large cities and other localities. In 2022, Hanoi and Ho Chi Minh City account for 22% of the population but account for over 75% of the country's E-commerce transactions. This means that the remaining 61 localities account for 78% of the population, but only contribute less than 25% of the E-commerce scale (Lam Nguyen, 2023). This shows that, in the Vietnamese E-commerce market, urban E-commerce plays a large role in E-commerce businesses.

Facing the challenges mentioned above, businesses providing LMD services in urban E-commerce in Vietnam need to make changes in accordance with industry trends, thereby leading to sustainable development. Sustainable development gives businesses, logistics, and supply chain networks a system of service, economic, environmental and social development while contributing to sustainable development of the economy and society.

Therefore, the research team decided to conduct research on this topic to identify factors facilitating the sustainable development of LMD services in Vietnam, contributing to achieving development sustainability of LMD service, and adapting to the rapid development trend of E-commerce.

1.2.2 Theoretical problem

Sustainability is the global industry development trend today. In Vietnam, sustainable economic development is an issue of special concern with the determination to innovate the growth model from breadth to depth associated with labor productivity, science and

technology, and innovation. Along with the E-commerce industry's exceptional growth rate, one of the key trends in the near future is the development of a sustainable E-commerce ecosystem and investment in logistics (Anh Dung et al., 2021). Creating a sustainable logistics platform allows firms to control costs while preserving economic growth and environmental preservation (Van Su and Dieu Anh, 2021). Specifically, implementing sustainability in LMD is the dominant trend (Nguyen, 2022).

Nevertheless, many research publications pertaining to LMD in urban Vietnam primarily focus on the evaluation of service-related characteristics. Recognizing the significance of implementing sustainability in LMD due to the recent changes mentioned above. Alongside service quality criteria, the authors present the inclusion of the following sustainable factors: economic aspect, environmental aspect, and social aspect in order to assess the logistics of LMD. However, service quality management is regarded as one of the most critical parts of a company for improving business performance and adding value (Sebhatu and Enquist, 2007). Therefore, this research aims to comprehensively analyze the service aspect, dividing it into convenience, responsiveness, and reliability.

1.3 Research objectives

This study examines the factors that tend to influence the sustainable development of LMD services in urban Vietnam, namely evaluates the importance of factors that contribute to the sustainability of the business provides LMD services in the aspects of Service Convenience, Service Responsiveness, Service Reliability, Economic Aspect, Environmental Aspect, Social Aspect. The authors selected relevant aspects with widely recognized significance, a determination informed by a comprehensive literature review of specialized articles published in reputable journals. Additionally, insights were sought through consultations with experts possessing considerable experience in the field.

This study aims to promote theoretical discussions on the important factors that tend to influence the sustainable development of LMD services in urban areas of Vietnam. Specifically, the aims can be classified into specific objectives:

Objective 1: Contribute to clarifying the development trends of LMD in Vietnam urban areas.

Objective 2: Present a conceptual framework including a set of 21 sub-criteria with priority ranking for LMD companies to evaluate their sustainable performance.

Objective 3: Provide valuable recommendations to help companies providing LMD services improve their services and develop sustainably in accordance with Vietnam's development trends.

1.4 Research questions

The outlined objectives lead to the formulation of specific research questions as follows:

Research question 1: What are the trends in the development of LMD in Vietnam?

Research question 2: What are the most important factors affecting sustainability in urban E-commerce LMD?

Research question 3: How can companies providing LMD services in Vietnam improve their services and grow sustainably?

1.5 Research scope

In this study, the authors focus on factors implementing the sustainability of LMD services in urban areas of Vietnam. Experts are selected based on the main criteria: people with high professional qualifications; with degrees recognized by competent authorities; having more than 5 years of working experience and professional capacity in the domain of logistics and supply chain, particularly preffered on Last-Mile Delivery (LMD*).*

- Number of respondents: 10 experts
- Type of survey: Face-to-face questionnaire.

1.6 Methodology and data review

The study employed a diverse range of data collection and analysis methods in this study. Preliminary research is based on a combination of both qualitative and quantitative research, collected through direct questionnaire with experts and analyzed using the AHP method. The AHP method determines the weights of the criteria and evaluates the impact of the criteria on sustainability in LMD services.

Primary data is collected from experts' evaluation through questionnaire. Secondary data is taken from specialized studies on sustainability in LMD services in reputable specialized journals, books, magazines, articles of Vietnam and international.

1.7 Conclusion

This thesis introduces the implementing factors and overview of the sustainable development model of LMD in urban Vietnam. This article explores the mentioned problem and identifies the research object, research purpose, research scope and proposed research questions.

1.8 Thesis outline

The thesis content is organized into distinct sections (excluding the abstract, appendix, references, list of tables and figures, abbreviations, and acronyms list) and is presented as follows:

Chapter 1: Introduction

In Chapter 1, a concise presentation offers foundational details introducing the research. This includes an overview of the research topic, problem statement, research objectives, research questions, research scope, methodology, data review, and an outline of the thesis.

Chapter 2: Literature review

Chapter 2 delves into pertinent theories, serving as the foundation for developing the research questions. It further describes and evaluates factors influencing the sustainability of Last-Mile Delivery (LMD) services and introduces the chosen research methods.

Chapter 3: Methodology

In Chapter 3, the thesis presents the research methods, detailing the chosen approaches for data collection and analysis.

Chapter 4: Findings and Analyses

Chapter 4 presents step-by-step the analysis and application of the model and method proposed in Chapter 3 to calculate and evaluate factors affecting the sustainability of LMD services in urban Vietnam.

Chapter 5: Conclusions and Implications

Chapter 5 is the final chapter of the thesis. This chapter answers the research questions by presenting research results and proposing appropriate solutions for companies providing LMD service to have a better direction in the sustainable development process. The limitations and significance of this study are also mentioned to apply the results of this study to other future studies.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This section provides a review of research findings valuable to the sustainability context and how they relate to suggestions for a more integrated last-mile logistic approach. It includes Service Convenience, Service Responsiveness, Service Reliability, Economic Aspect, Environment Aspect, and Social Aspect; then showcase 21 supplied sub-criteria, which have been gathered from a selection of recent empirical research and professional consultation.

2.2 Sustainability

2.2.1 The importance of sustainability in logistics

The concept of sustainability has been emphasized under the spotlight from its first creation till now by the increasing global concerns for environmental and climate change. There are multiple forms of its definition that demonstrate its widespread importance and based on those theories, sustainability in logistics has also been developed for impactful research for further practices.

A significant shift from conservation to sustainability was initiated by Brundtland (1987) of the WCED, in which the notion of sustainable development or sustainability represents an effort to link the environment with development. Brundtland (1987) also stated that sustainable development involves satisfying present demands without hampering future generations' capacity to fulfill their own needs. Besides, by Johnson et al. (2023), sustainability is defined recently as an organizing principle that seeks to achieve human development goals while also allowing natural systems to provide human beings with essential natural resources and ecosystem services. On the foundation of sustainable approaches, according to Kajikawa (2008), while conservation is for protection purposes, sustainability directly refers to a state with many processes that can be sustained at a particular level or environmental sustainability with the ability to maintain it. In other words, it refers to preserving the well-being of the ecosystem's recoverable capacity. Balancing among economic, environmental, and social aspects are frequently described as three pillars of sustainability by many studies (Purvis, Mao and Robinson, 2019). This involves ensuring

the perpetuity of natural resources and ecosystems while maintaining equal status and social well-being for generations to come.

In the context of logistics, there are strong connections among logistics operations, environment, and sustainability (Kleindorfer, Singhal and Van Wassenhove, 2005), in which business concerns of profitability in the long term can be tackled by implementing the mentioned 3Ps (Profit, People, Planet) theories to practice. Further research by (Björklund and Forslund, 2018) also stated that sustainable logistics practices should encompass environmental, economic, and social dimensions of sustainability, how supply chain and logistics management involves sustainable development to provide economic and environmental benefits and incorporate social responsibility into its operations. Those adoptions to sustainable logistics practices offer numerous benefits i.e., cost efficiency, and lean operation, thus creating a competitive advantage for businesses in long-term development (Wichaisri and Sopadang, 2017).

In E-commerce sector, LMD plays an essential role, accounting for approximately 28% of total shipping costs (Viet Dung, 2023). The growth of E-commerce has caused an demanding impact in congestion, traffic accidents, air and noise pollution, and greenhouse gas emissions. LMD is therefore regarded as the most polluting, inefficient and costly element in the logistics system (Ha et al., 2023). Hence, in order to promote sustainability within E-commerce logistics, it is necessary to initially establish sustainability in LMD.

In Vietnam, sustainability also assumes a significant role within the logistics sector, necessitating a prioritization of sustainable development by logistics service providers. Logistics companies may adopt sustainability as a major driver for profit enhancement. When logistics businesses implement sustainability options inside their operations, they must develop optimal and innovative technological solutions. As a result, the efficiency of their operational procedures will be enhanced, leading to increased profitability and decreased expenditures. According to Hong Thao (2022), By incorporating technology into logistics systems, organizations may save 14% on LMD costs while increasing the number of deliveries per vehicle by 13%. Moreover, artificial intelligence and automation-based logistics operations management systems can speed up shipment processing by 56%. At the same time, technology assists in reducing shipping operations' stages by 77% and reducing manual data entry by 65%. The investment in technology by companies in this area not only facilitates the development of the E-commerce market and enhances corporate production

and commercial activities but also contributes to the expansion and integration of the Vietnamese economy, enabling it to access the global market (My Phuong, 2022).

Another compelling motivation for logistics firms to practice sustainability is to attract greater investment funding. Hua Chung (2023) stated that, in September 2023, the ten most significant investments accounted for 45.8% of the net asset value of Dragon Capital's DC Leading Business Investment Fund (DCBC) have up to 7 stocks in the basket of 20 stocks with the best Vietnam Sustainability Index (VNSI) on HOSE. Similarly, at VinaCapital, the top ten stocks in the portfolio of Hung Thinh VinaCapital Stock Investment Fun in September included up to six VNSI stocks. Besides the above two funds, an analysis of the investment portfolios of foreign investment funds actively investing in the Vietnamese stock market also reveals that the VNSI basket predominantly comprises stocks. The inclination towards stocks within this collection indicates a growing trend among these funds to prioritize sustainable development in their investing decisions. By implementing sustainability practices, LMD companies can position themselves as attractive investment opportunities, attracting funding from ESG-focused investors (Le Quan, 2023). This not only provides financial support but also enhances the company's reputation and credibility in the market. Therefore, Vietnamese LMD companies need to apply sustainability development standards to enhance their competitive strength when participating in global green supply chains.

The shift in customer awareness regarding environmental protection is also a decisive factor in Vietnamese logistics companies' decision to implement sustainability. In May 2021, Cimigo polled 1,500 Vietnamese citizens between the ages of 16 and 29 as part of a national study on the digital generation in Vietnam (Cimigo, 2022). This study suggests that the digital generation is highly concerned with social issues. Environmental protection and pollution are important to them. According to a research by Thuy Hang (2022), companies must work to satisfy customers' demands since they use environmental protection actions as a consideration for choosing logistics providers. From that, cooperation on environmental conservation with customers has a good impact on economic results. Accordingly, by implementing sustainable practices and showcasing their environmental efforts, delivery companies can attract and retain environmentally-conscious customers. This not only leads to increased business opportunities but also improves customer satisfaction and loyalty. Meeting customer demands for environmental responsibility is not just a moral obligation but also a strategic advantage for LMD companies in Vietnam.

The Prime Minister (2021) of Vietnamese government also offers guidance and promotes the sustainability of logistics companies as putting forth a comprehensive plan consisting of 61 recommended actions aimed at fostering the sustainability of the logistics service industry. These activities are designed to address six specific objectives. The policies and directives aimed at promoting and enhancing sustainability not only serve as obligatory tasks but also present ideal conditions and opportunities for the logistics industry in Vietnam to undergo significant transformation and robust development in the foreseeable future.

In summary, the significance of sustainability in the logistics industry of Vietnam cannot be overstated. Logistics organizations may strategically capitalize on technological improvements, secure investment funding, fulfill customer expectations, and align with governmental efforts by placing sustainability as a top priority. The adoption of sustainable practices not only guarantees the achievement of long-term success but also enhances the overall growth and competitiveness of the logistics sector in Vietnam. Embracing sustainability is not an option, but a need for logistics firms in Vietnam to flourish in an ever-changing economic landscape and have a positive impact on the environment and society.

2.2.2 Theory of service quality and triple-bottom-line in logistics research

The concept of logistics service quality was adopted very soon in many research due to its importance in the service industry, which refers to the ability of a logistics and supply chain management system to meet the requirements and expectations of its customers. According to Parasuraman et al. (1991), service quality was initially measured by a quantitative approach including 5 aspects of tangible, reliability, responsiveness, assurance and empathy. In testing this measurement's applicability to logistics, it is said to scarcely use the construct of assurance and empathy (Franceschini and Rafele, 2000). The aspects of assurance and empathy are more related to the emotional and psychological interactions between service providers and customers, which might be less prominent or harder to quantify in a logistics context. Assurance involves building trust and confidence, while empathy involves understanding the customer’s needs and providing individualized attention (Ramadass and Swarnalatha, 2013). However, combining tangible, assurance, and empathy aspects can provide a more holistic view of service quality. Tangible gives a concrete measure of service delivery, assurance can help build trust and confidence in the service provider, and empathy can help tailor services to individual customer needs. Even in logistics, these aspects could be relevant in certain contexts or for certain types of customers. As necessary to develop

more service quality measurements, they may need to be adapted based on the specific context or industry (Franceschini, Di Torino and Rafele, 2000). Therefore, by the above commanding E-commerce development of Vietnam's LMD basis, the tangible, assurance, and empathy have been defined as the service responsiveness aspect.

In the more qualitative research technique of Arabelen and Kaya, 2021, LSQ has been increasingly demanding aspect for LSPs and logistics service customers of the increased universality of logistics services' importance. The increasing structured service quality dimensions over time have proved for those provider concerns as the high level of LSQ increases logistics providers' competitive advantage among compelling business environments (Wang et al., 2016).

The Triple Bottom Line (TBL), a well-known sustainable concept, examines the link between economics, the environment, and social performance (Norman and MacDonald, 2004). It is often mentioned at the same time with sustainability, in which firms should commit to measuring their social and environmental impact - in addition to their financial performance - rather than solely focusing on generating profit (Kelsey Miller, 2020). This framework has also been applied in studies for contributing business strategies, in which managements can utilize these categories to identify any undesirable societal effects and to develop their environmental responsibilities into their contribution, and finalize economic developments (Nogueira, Gomes and Lopes, 2022). Being effectively using these indicators, businesses or organizations can respond to the questions of seeking a path towards sustainability (Yun et al., 2019).

Besides, according to a research of Ali et al., (2021), sustainable service quality and LSQ concepts are the basis of developing new sustainable logistics service qualities (SLSQ) that both overlap and distinguish factors. Particularly in the business environment of circular economy, sustainable service quality contributes significantly to business performance in which sustainability dimensions and service quality have a strong correlation (Gupta, Singh and Mangla, 2022). While all parts of the logistics process are important, LMD plays a particularly crucial role in determining logistics service quality that impacts the overall shopping experience (Russell Simmons, 2023). Especially in the rising importance of E-commerce activities, businesses have forefront insights to improve their LMD network toward more sustainability (Klein and Popp, 2022). Combining LSQ dimensions with TBL sustainability dimensions can lead to significant benefits for logistics providers, including

improved service delivery, increased trade volume, growth opportunities, and enhanced environmental sustainability (An et al., 2021). Finally, those approaches can help businesses and policymakers develop sustainable logistics systems in general and LMD in particular, which meet the needs of all stakeholders and also compromise further approaches to identify key concepts in each dimension for the validity of sustainable indicators.

2.3 Proposed factors

The primary process of research is the collection of factors affecting sustainable development, which serves as the foundation for later analysis. To investigate influential elements, the study employs approaches that include a literature review and experts' consultation. Initially, the authors evaluated the existing literature, resulting in a preliminary list of 31 sub-criteria distributing in 8 main criteria (Appendix 2). After that, through discussions with experts, a refined set of 21 sub-criteria was determined and effectively developed. The following criteria has been defined in conjunction with the development status and characteristics of urban E-commerce logistics services.

Table 2.1 Proposed factors

Main criteria	**Sub-criteria**	**References**
M1. Service Convenience	S1. Convenience of Payment	Wang et al., 2021
	S2. Convenience of Setting The Parcel Receiving Time	Ignat & Chankov, 2020; Wang et al., 2021
	S3. Convenience of Delivery Location	Siegfried, 2021; Silva et al., 2023; Wang et al., 2021
	S4. Convenience of Returning Goods	Bosona, 2020; Ali et al., 2021
M2. Service Responsiveness	S5. Timeliness of Customer Service Response	Ali et al., 2021; Wang et al., 2021
	S6. Timeliness of Goods Delivery	Ali et al., 2021; Kiba-Janiak et al., 2021; Wang et al., 2021
M3. Service Reliability	S7. Integrity of Goods	Ali et al., 2021b
	S8. Accuracy of Goods Arrival	Siegfried, 2021; Wang et al., 2021
	S9. Accuracy of Logistics Information	Ali et al., 2021; Siegfried, 2021; Wang, et al., 2021
M4. Economic Aspect	S10. Costs	Bosona, 2020; Siegfried, 2021; Wang et al., 2021

	S11. Technology Capability	Bosona, 2020; Viu-Roig and Alvarez-Palau, 2020; Kiba-Janiak et al., 2021
	S12. Urban Distribution System	Ali et al., 2021; Siegfried, 2021; Silva, Amaral and Fontes, 2023
M5. Environmental Aspect	S13. Green Vehicle	Ali et al., 2021; Mohamed Awwad et al., 2018; Silva et al., 2023
	S14. Green Packaging	Ali et al., 2021; Silva et al., 2023; Wang et al., 2021
	S15. Green Warehouse	Bosona, 2020
	S16. Green Management Systems	Viu-Roig and Alvarez-Palau, 2020; Ali et al., 2021b; Siegfried, 2021
M6. Social Aspect	S17. Health and Safety	Ali et al., 2021; Wang et al., 2021
	S18. Government Regulations	Kiba-Janiak et al., 2021; Mohamed Awwad et al., 2018; Ranieri et al., 2018
	S19. Customer Satisfaction	Ali et al., 2021; Kiba-Janiak et al., 2021; Wang et al., 2021
	S20. Employee Satisfaction	Ignat and Chankov, 2020; Ali et al., 2021b; Siegfried, 2021
	S21. Cooperation Among Stakeholders to Adapt Change in Customer Behavior	Viu-Roig and Alvarez-Palau, 2020; Ali et al., 2021b; Kiba-Janiak et al., 2021

2.3.1 Main criteria

[M1] Service Convenience

A convenience service is the quality of being useful, easy or suitable for online browsing, ordering, payment and customer service (Jiang et al., 2019). Compared with physical stores, online products are all virtual in the E-commerce purchasing process providing diversity, convenience, and time efficiency, which are the reasons why consumers prefer online shopping. In addition, the payment method can be online payment by bank card, e-wallet, or cash on delivery (Department of E-commerce and Digital Economy, 2022). Moreover, online shopping also provides door-to-door delivery services, some E-commerce platforms also allow customers to choose delivery time and return goods if the product has a manufacturing defect, and other convenient services (Jiang et al., 2019a). Thus, the term

"tangibility" used in this study would be better replaced by "convenience". “Service Convenience”, including convenience in receiving and returning goods, is a top priority in customers' attitudes and beliefs toward LMD services, driving purchase demand (Jiang et al., 2019a).

In this study, the experts have reviewed and evaluated the overall Service Convenience criteria based on the following sub-criteria: [S01] Convenience of Payment [S02] Convenience of Setting The Parcel Receiving Time [S03] Convenience of Delivery Location [S04] Convenience of Returning Goods.

[M2] Service Responsiveness

Responsiveness refers to the timeliness of customer service in responding to customer questions and requests, and speed of delivery processing (Jiang et al., 2019). Customers expect E-commerce and logistics companies to respond and resolve issues they unfortunately encounter during this online shopping process in a timely manner (Hong et al., 2019). A research of Gulc (2021) shows that the Timeliness of Customer Service Response factor is the decisive criterion and Timeliness of Goods Delivery is the priority measure for customers in choosing to use delivery services when purchasing goods on E-commerce platform. Therefore, Service Responsiveness is also considered an important criterion.

This study examines the assessment of Service Responsiveness based on two sub-criteria that LMD providers should pay attention to, including [S05] Timeliness of Customer Service Response and [S06] Timeliness of Goods Delivery.

[M3] Service Reliability

In the SEVQUAL model, reliability is defined as the ability of a LMD provider and its employees to guarantee and deliver service promises reliably and accurately (Parasuraman et al., 1988). In addition, the term guarantee refers to whether the skills, professional quality and level of service delivery of employees are worthy of customers' trust and expectations (Jiang et al., 2019). Businesses that prioritize reliability and assurance are more likely to succeed. Jiang et al. (2019) also stated that reliability is crucial for ensuring consistent service, while assurance provides customers with the confidence they need to trust a business. Hence, this study suggests that it is possible to merge the two aspects into a single dimension.

The reliability of LSQ refers to the completeness, integrity, and accuracy of goods, while also considering the accuracy of information and time of shipment that the delivery company has provided (Uzir et al., 2021). When consumers conduct online shopping, in many cases, they have outlined plans for delivery time providing by the logistic information and the purpose of using the product or service, especially when there is an important event. If the goods are not received on time as promised, consumers will be disappointed and lose trust in the delivery company (Thi Hoi, 2023). According to a survey by Department of E-commerce and Digital Economy (2022), up to 30% of customers think that the quality of LMD service is a concern when using E-commerce. Therefore, it can be seen that service quality is affected by the reliability of the business and its employees (Jiang et al., 2019).

According to research and experts' perspectives, the study evaluates Service Reliability based on 3 sub-criteria including: [S07] Integrity of Goods, [S08] Accuracy of Goods Arrival, and [S09] Accuracy of Logistics Information.

[M4] Economic Aspect

According to the European Science Foundation, the impact of the Economic aspect can be defined as the contribution to the micro level of the economy such as selling price, costs, and revenue of products of a company; and contribution to the macro level of the economy which is economic profit through economic growth or productivity growth (Janson, 2012). The economy is an important factor affecting the sustainable development of urban E-commerce logistics. Logistics costs may be incurred not only during distribution operations but also during returns and replacements (Jiang et al., 2019). Besides, optimizing technology or building distribution systems to optimize the delivery process all contribute to economic benefits for the company.

In this research, three influencing sub-criteria namely [S10] Costs, [S11] Technology Capability, and [S12] Urban Distribution System have been selected.

[M5] Environmental Aspect

The environmental viewpoint within a sustainable logistics system comprises the consequences of energy consumption, waste disposal, pollution and emissions (Wichaisri and Sopadang, 2014). Logistical operations can also have a number of harmful influences on the environment. Many studies have shown the environmental impacts in cities due to the increase in LMD (Viu-Roig and Alvarez-Palau, 2020). For example, they continue to rely

on fossil fuels and nonrenewable natural resources, resulting in air, land, water, noise, and visual pollution (Abbasi and Nilsson, 2016). Efforts such as using electric vehicles (Mohamed et al., 2018), remote control vehicles (Silva, Amaral and Fontes, 2023) to replace conventional vehicles; and eco-packaging (Ali et al., 2021) has significantly reduced energy consumption, greenhouse gas, and CO2 emissions. In addition, orienting management towards environmental protection such as green warehouse systems and using clean energy equipment also brings benefits to reduce pollution (Kiba-Janiak et al., 2021).

To have a detailed perspective at the Environmental Aspect, the study considers 4 sub-criteria that LMD companies should consider, which are: [S13] Green Vehicle, [S14] Green Packaging, [S15] Green Warehouse, [S16] Green Management Systems.

[M6] Social Aspect

The social perspective is one of the aspects of a sustainable logistics system which is based on the human resources component found in traditional logistics systems and focuses on the needs of both intra-organizational stakeholders (employees in an organization) and inter-organizational stakeholders (suppliers, customers, and communities) (Wichaisri and Sopadang, 2014). In this paper, the social perspective was also divided into two criteria: quality of life and health and safety. The strong growth of E-commerce has led to a change in consumer habits and behavior, and LMD companies must strive to improve their services to be able to meet the demand. At the same time, another task is that they must both ensure customer satisfaction and introduce appropriate policies to enhance employee benefits.

5 sub-criteria were selected by the authors to evaluate the Social Aspect: [S17] Health and Safety, [S18] Government Regulations, [S19] Customer Satisfaction, [S20] Employee Satisfaction, [S21] Cooperation Among Stakeholders to Adapt Change in Customer Behavior.

2.3.2 Sub-criteria

[S01] Convenience of Payment

The increasing number of mobile devices connected to the Internet in urban areas has led to a growing demand for online payment methods (Li, 2023). This development can enhance efficiency and convenience for both LMD staffs and customers, while mitigating the risks associated with cash transactions, such as theft and confusion (Nhu Binh, 2020).

The concept of "Convenience of Payment" refers to the necessity for LMD providers to offer a diverse range of payment options, including online payment and cash on delivery, in order to accommodate the varying payment preferences of their customers (Tapchitaichinh, 2022).

Today, customers in urban areas of Vietnam are gradually switching to online payment instead of paying in cash as before. The LMD companies now enable their customers to pay with a variety of methods, including bank transfers, mPOS, and etc. After that point, payment is becoming more convenient and less risky (Nhu Binh, 2020).

[S02] Convenience of Setting The Parcel Receiving Time

In urban areas, busy lifestyles have become the norm. A greater percentage of people are not at home to receive deliveries during the working day (ProLogis, 2008). Unsuccessful deliveries incur significant costs and take valuable time for both retailers and carriers, while also causing inconvenience for consumers. Moreover, these failed deliveries have an adverse impact on the environment (Ben Webster, 2007). According to Edwards et al. (2009), when just evaluating the freight aspect of an unsuccessful delivery, it was seen that the subsequent effort resulted in an increase in CO2 emissions per drop ranging from 9% to 75%. Hence, it is essential for LMD providers to proactively incorporate the feature of scheduling parcel receiving time within their system.

The Convenience of Setting The Parcel Receiving Time pertains to the capacity of delivery services to offer consumers the option to choose from a range of predetermined time windows. By selecting one of these periods, customers may ensure that their item will be delivered on the following day within the specified timeframe (Manerba, Mansini and Zanotti, 2018).

In Vietnam, there are some delivery companies that provide users with the option to arrange receiving times. Based on statistical data provided by Ahamove (2018), it can be observed that scheduled delivery is a highly utilized feature and second only to the cash-on-delivery (COD) service. This preference may be attributed to the inherent advantages of scheduled delivery, which offer enhanced flexibility and convenience for both the LMD staffs and the customers. In summary, the option to set up time to receive parcels must be considered by LMD companies in Vietnam to become an important feature in the system. From there, the LMD will become more efficient and cost-effective in order to satisfy consumers and protect the environment.

[S03] Convenience of Delivery Location

The problem of customers not being at home to receive deliveries and the requirement that deliveries be made more than once have created difficulties for customers as well as LSPs, which has led to an increase in the delivery costs (Das and Fianu, 2018). Therefore, the ability of the LMD company to provide alternative delivery locations enables customers to have an active role in selecting the delivery location of their goods. This, in turn, improves the delivery process's efficiency, ultimately resulting in higher success rates and lower overall costs.

The convenience of delivery location implies a delivery service's capacity to offer a range of delivery locations so that consumers can select where their orders are delivered. In addition to a person's home or place of business, the delivery location could also be a receiving box (RB) or a pre-designated collect-and-delivery point (Lim, Jin and Srai, 2018).

Besides at-home delivery, LMD companies in Vietnam have also initially deployed other delivery locations. Vietnam Post is presently implementing the deployment of 70 Post Smarts, strategically positioned in central post offices, flats, commercial areas, and office complexes. This initiative aims to enhance customer convenience during the goods-receiving process. Hanoi and Ho Chi Minh City have the highest concentrations of Post Smarts (VNPost, 2022). Therefore, offering diversified delivery locations would be taken into consideration by Vietnam LMD companies to enhance their performance.

[S04] Convenience of Returning Goods

The rise of E-commerce within urban areas has correspondingly resulted in an increase in the amount of returned goods due to certain differences between the goods advertised on the e-commerce platform and the actual goods received by customers (Xu and Yue, 2009). With a rough estimate of 30% of orders being returned, it can be a huge cost to businesses if not handled properly (Boxme, 2020). It is worth noting that companies with user-friendly and adaptable return policies can enhance customer satisfaction, enhance service quality, mitigate avoidable financial losses, and bolster customer loyalty.

Convenience of returning goods means that logistics businesses have customer-friendly return policies and procedures, which ensure ease, flexibility, and the option to select from a variety of return options (Wodnicka and Skurpel, 2021) .

Understanding the importance of return and warranty services (reverse logistics), Vietnam LSPs have been providing solutions for online sellers and E-commerce businesses to handle returns in the easiest way possible (Boxme, 2020).

[S05] Timeliness of Customer Service Response

The demand for delivery services is experiencing a steady growth, however, it is important to note that not all orders are executed with seamless efficiency and utmost safety. Hence, customers have a right to make requests or register complaints regarding their orders. Quick and prompt customer service helps to ensure client happiness, which helps to keep customers and encourage them to make more purchases in the future.

The timeliness of customer service response refers to the promptness of replying to customers' inquiries, as well as the processing time for deliveries, returns, and replacements (Dung et al., 2023). E-commerce platform and LSPs are required to respond to these issues rapidly and resolve them (Jayachandran, Hewett and Kaufman, 2004).

In Vietnam, customers have various methods to express their issues or seek clarification, including contacting directly with the hotline, filing complaints using the application, accessing the website's complaint section to initiate a request, and visiting the post office for guidance and resolution (Nhat Tin Express, 2022).

[S06] Timeliness of Goods Delivery

Timeliness of goods delivery refers to the degree of adherence to predetermined schedules or customer expectations in the transportation and receipt of ordered products (Li et al., 2006). This aspect is crucial across industries for its profound impact on customer satisfaction, operational efficacy, and broader supply chain performance. Factors including transportation modes, route optimization, and technological tracking solutions monitor the timeliness of deliveries (Li et al., 2006). Moreover, a report by the World Bank (2019) highlights the importance of efficient logistics, including timely delivery for enhancing trade competitiveness. Delays in goods delivery can hinder trade flow and increase costs, adversely affecting the nation's export potential.

In Vietnam, where economic growth and cross-border trade are accelerating, ensuring timely goods delivery is paramount. Nguyen et al. (2021) underscore that efficient delivery timelines contribute to reduced lead times, inventory holding costs, and operational

disruptions. Meeting delivery deadlines is particularly essential given Vietnam's role in global value chains.

In conclusion, the timeliness of goods delivery is a pivotal factor in Vietnam's logistics ecosystem. Efficient delivery schedules contribute to supply chain resilience, trade competitiveness, and customer loyalty. As Vietnam navigates its economic expansion and global integration, prioritizing timely goods delivery remains integral to optimizing its logistics performance.

[S07] Integrity of Goods

Integrity of goods pertains to the unaltered condition, authenticity, and consistency of products as they traverse the supply chain, safeguarding against damage, tampering, or unauthorized alterations (Chen and Qi, 2016). Good arrivals are undamaged or accepted for undesirable issues by establishing replacement processes in professionals (Restuputri, Fridawati and Masudin, 2022). It involves maintaining the inherent attributes, specifications, and quality of goods during storage, handling, and transportation processes. This aspect is crucial for assuring customer satisfaction, regulatory compliance, and maintaining brand reputation.

In Vietnam, where trade volumes are escalating and consumer expectations are rising, maintaining the integrity of goods is crucial. Lan et al. (2021) emphasize that preserving product quality during transportation and storage is essential for customer retention and market competitiveness. Moreover, as delineated within a publication featured in the official periodical of the Ministry of Industry and Trade of Vietnam, the assurance of goods integrity stands out as a pivotal determinant within the trajectory of enhancing service quality within the logistics sector, consequently engendering elevated levels of merchandise excellence and heightened user contentment (Binh et al., 2021).

In conclusion, the integrity of goods is a critical consideration in Vietnam's logistics industry. Preserving product quality throughout the LMD is essential for customer satisfaction, trust building, and operational efficiency. As Vietnam positions itself as a competitive player in global markets, safeguarding the integrity of goods remains pivotal for sustainable growth and reputation enhancement.

[S08] Accuracy of Goods Arrival

Accuracy of goods arrival denotes the precision with which ordered products align with expected quantities, specifications, and delivery schedules upon reaching their destination, a pivotal factor in evaluating supply chain performance (Chen et al., 2023).

Sunil Chopra and P Meindl (2013) emphasize the pivotal role of accurate goods arrival in achieving a responsive and agile supply chain. Timely and precise deliveries reduce inventory holding costs, enhance customer service, and mitigate disruptions across the supply network. A study by Dinh (2022) in Vietnam context explores the challenges and opportunities in achieving accurate goods arrival in E-commerce logistics. The study highlights the role of effective communication, collaboration among stakeholders, and proper inventory management in enhancing accuracy, especially in the context of Vietnam's logistics landscape, ensuring accurate goods arrival gains prominence due to its potential to streamline supply chain operations and meet evolving customer expectations. These findings underline the need for a holistic approach to address accuracy challenges specific to Vietnam's logistics ecosystem.

[S09] Accuracy of Logistics Information

Accuracy of logistics information refers to the degree of precision and correctness exhibited by data associated with various facets of supply chain operations, including inventory levels, transportation statuses, and order specifications (Iveta et al., 2014). This pivotal aspect significantly influences decision-making processes within supply chain management (Marinagi, Trivellas and Reklitis, 2015). Ensuring the accuracy of logistics information is imperative as erroneous data can lead to sub-optimal decisions, operational disruptions, and increased costs. Consequently, maintaining high levels of information accuracy contributes to enhancing supply chain efficiency, reducing uncertainties, and fostering improved coordination among stakeholders.

In Vietnam, where the logistics sector is experiencing rapid growth, ensuring accurate logistics information is paramount. A study by Ha Anh et al. (2022) underscores the critical role of accurate information in optimizing supply chain processes and mitigating disruptions. These emphasize the need for real-time tracking and data-sharing mechanisms to enhance accuracy.

In conclusion, the accuracy of logistics information is a cornerstone of effective supply chain management, particularly in Vietnam's burgeoning logistics industry. It directly influences

supply chain efficiency, customer satisfaction, and trade competitiveness. As Vietnam continues to integrate into the global economy, ensuring accurate logistics information remains imperative for sustainable growth and enhanced economic performance.

[S10] Costs

Logistic costs are the comprehensive sum of expenses incurred throughout the end-to-end supply chain processes, including procurement, transportation, storage, handling, and distribution of goods (Guihang, Yanqin and Chuyao, 2021). These costs play a pivotal role in determining the overall operational efficiency and financial performance of supply chain networks. Logistic costs are also critical consideration for organizations aiming to optimize resource allocation and enhance competitiveness in dynamic market environments (Govindan et al., 2020).

With the burgeoning trade activities and rapidly developing logistics sector in Vietnam, managing logistic costs is essential. As articulated by Nguyen Nga (2023) in the article titled "How high is the logistics cost in Vietnam?", the prevailing scenario in Vietnam underscores a considerable prominence of domestic logistics expenses within the framework of product pricing. The cost of transportation constitutes approximately 50% to 60% of the total logistics expenditure, a proportion that exceeds that of many other countries (VIRAC's Report, 2023). LMD costs make up approximately 28% of the overall shipping expenses, reaching up to 53% for on-demand delivery situations (Viet Dung, 2023). This substantial expense not only raises the end price for consumers but also reflects inefficiencies in the organization of the distribution system. Nguyen et al. (2021) emphasize that optimizing logistic costs can lead to improved operational efficiency and better resource allocation. Given Vietnam's strategic position in global value chains, effective logistic cost management contributes to enhancing the nation's overall competitiveness. Furthermore, a report by the Ministry of Industry and Trade of Vietnam (2017) acknowledges the role of logistic cost reduction in fostering economic growth.

In conclusion, as Vietnam continues its trajectory toward economic integration and global connectivity, effective logistic cost management remains a strategic imperative for sustained growth and success.

[S11] Technology Capability

Technology capability refers to an organization's inherent capacity and proficiency in leveraging technological resources to enhance operational processes, innovate business models, and gain a competitive edge (Gheitarani et al., 2022). It includes the integration, utilization, and management of digital tools, systems, and solutions across various functional areas. The degree of an organization's technology capability significantly influences its adaptability to technological advancements and its potential for achieving strategic goals (Reichert and Zawislak, 2014).

Vietnam's logistics sector is witnessing rapid transformation, and the adoption of technology capability is crucial for sustainable growth. A report by the United Nations Industrial Development Organization (2020) underscores the role of technology capability in overcoming traditional inefficiencies. During the Digital Transformation conference dedicated to the cultivation of a contemporary and sustainable logistics industry in 2023, the Ministry of Industry and Trade underscored the Vietnamese government's substantial commitment to expediting the digital transformation endeavor within the logistics domain. This endeavor aims to not only address the recent challenges stemming from the epidemic but also harness the prevailing opportunities afforded by the digital revolution and the advancements stemming from the 4.0 Industrial Revolution (Ngoc Han, 2023). Inefficient logistics practices have been a bottleneck for Vietnam's trade growth. By leveraging technology capability, LSPs can address challenges related to route optimization, inventory management, and delivery tracking.

[S12] Urban Distribution System

Urban distribution system is a potential factor studied by researchers in urban logistics based on the factors of strong urbanization in recent times. In the research papers of Mansouri, Sahu and Ülkü (2023), similar concepts are used to talk about urban distribution systems such as urban distribution center, urban consolidation centers, urban freight transport, etc. Additionally, urban distribution systems are characterized as measures implemented by the public sector to regulate freight transport based on factors such as the volume of freight entering a city, the facilities employed for consolidation and sorting, and the associated cost burdens, externalities, and impacts of these activities (Alexandra et al., 2016).

In Vietnam, Hanoi and Ho Chi Minh City stand out with the highest concentration of warehouses, "mega-warehouses," and fulfillment centers in the country. This strategic placement aims to efficiently cater to a substantial number of online consumers, leveraging

a multimodal transport system for optimal logistics operations (Boxme, 2022). Moreover, according to the approved project, Ho Chi Minh City will build 8 logistics centers with a total area of more than 750 hectares and projects with the function of "similar to a logistics center" showing the government's interest in the construction of urban distribution centers (Dinh Tran, 2023).

[S13] Green Vehicle

The popularity of E-commerce along with the urbanization process has led to a strong growth in the demand for urban transportation of goods. The implementation of green vehicles in urban logistics plays a significant role in mitigating issues such as environmental pollution, global warming, and reducing dependence on traditional oil-based transportation (Patella et al., 2021). Policymakers in large cities introduce and rapidly disseminate low-emission means to reduce greenhouse gas emissions (Mazur et al., 2015). In the research paper by Klimecka-Tatar et al. (2021), it is emphasized that using green vehicles to build a modern fleet is an important factor suitable for building a sustainable logistics system. When compared to conventional vehicles, green vehicles that are environmentally friendly, such as electric, hybrid, and hydrogen vehicles offer the benefit of lower CO2 emissions (Islam and Gajpal, 2021). In Vietnam, consistent with a report published at the Workshop on Experimental Results and Policy Consultation on Green Transport Services, jointly organized by the United Nations Development Program (UNDP) and the Development Research Institute of Thua Thien Hue Province in 2023, drivers using electric vehicles have an average delivery efficiency 50% higher than the group using petrol vehicles while energy costs are 50% lower (Anh Hoang, 2023). In addition to reducing costs, switching to electric vehicles is also an important step for LMD providers to prepare market expansion plans toward the goal of greening (VTV Digital, 2023).

[S14] Green Packaging

With the strong development of E-commerce and trend of environmental protection in recent years, green packaging has become a significantly important solution to reduce waste and environmental pollution, thereby promoting sustainable development (Wandosell et al., 2021). In research papers on urban LMD and E-commerce logistics, green packaging is considered an indispensable factor when it comes to solutions to develop a sustainable delivery system, mentioned by names such as green packaging (Shrinivas Brahme and Shafighi, 2022), sustainable packaging (James and Kurian, 2021), reusable packaging

(Baskoro, 2020), eco-packaging or eco-friendly packaging (Wandosell et al., 2021), etc. In the context of this study, green packaging is defined by its commitment to ensuring products are both effective and safe for human health and the environment involved the utilization of environmentally friendly materials for packaging purposes (Pauer et al., 2019).

In the context of Vietnam, businesses are encouraged to adopt packaging made from recyclable or biodegradable materials, emphasizing a commitment to environmental sustainability in the natural surroundings (Tapchitaichinh, 2023). The trend of using eco-friendly packaging in the way of packaging goods in E-commerce is now very developed, for example, Lazada has used an automatic packaging size determination system to reduce waste. and use FSC-certified packaging or reuse cartons as backing materials (Ngan Thuong, 2023).

[S15] Green Warehouse

The warehousing system stands out as a pivotal element in the operations of an E-commerce delivery company, and it serves as a significant contributor to the overall emissions in the supply chain (Bartolini, Bottani and Grosse, 2019). In the context of global warming, emission reduction proposals are researched and applied by LMD companies, in which the green warehouse system is considered a major impact factor in mitigating environmental problems and ensuring social safety (Fernando and Ibrahim, 2023). In the near future, effective management of the green warehouse system in a sustainable way will maintain economic efficiency, minimize environmental impact and create a suitable working environment (Akandere, 2017). A green warehouse is characterized as a facility that optimizes energy usage and space/layout for inventory and storage, simultaneously minimizing unnecessary movement included the implementation of energy-efficient lighting systems, the utilization of solar power plants for warehouses, and the incorporation of daylight, along with strategic warehouse layouts and inventory management strategies.. (Karia et al. 2016).

Vietnam is currently making great efforts to develop its economy in the direction of green growth and sustainable development. Thus, green warehouse is one of the top concerns of the government as well as businesses to develop their logistics operations toward sustainability (Phuong Lien, 2022). Green warehousing will help reduce carbon emissions when it is properly restructured and invested in distribution centers. Specifically, enterprises make investments in equipment using new technologies or renewable energy in warehouses

and distribution centers. Some companies in Vietnam have been investing and developing in the field of green warehouses, for example, Lazada and its central warehouse in Binh Duong, prioritizing the use of solar power instead of grid electricity promoting sustainability in operations (V.C., 2023).

[S16] Green Management System

Due to the increasing focus on environmental pollution through transportation activities, LSPs and governments have taken various measures to reduce the environmental impact of activities related to transport and logistics (Zhou et al., 2023). Integrating green development into logistics management is a necessary strategy to establish a sustainable logistics system including the innovation of green logistics management, the training of operation personnel, and accelerating research and development (Li, 2019). A Green Management System is conceptualized as an approach that involves the development of strategic planning, control, and assessment for green logistics practices aimed at enhancing environmental, economic, and social sustainable development. This encompasses elements such as top management support and commitment, total participation, as well as education and training. (Karia, Abu and Asaari, 2016).

According to the report "E-commerce in 2023", it is indispensable to focus on all three aspects of environment, society and governance (ESG) when building a sustainable business of E-commerce in Vietnam. In addition, to meet the urgency in human resource training, the building of a sustainable human resource development and management model ensures three factors: diversity, equity and inclusion (Di Di, 2023).

[S17] Health and Safety

The ever-increasing trade volumes of E-commerce in Vietnam, which showed a 25% growth rate in 2022 (Do Phong, 2023), have resulted in massive package quantities that must be delivered every day, particularly in urban areas. The last-mile from the warehouse to the consumer requires an increasing number of delivery trucks. This development has resulted in congestion and a detrimental impact on health and safety (Savelsbergh and Van Woensel, 2016).

The increased usage of (electric) bicycles/tricycles and light cars improves the quality of life by reducing CO2 emissions and other air pollutants that cause health concerns (Bosona, 2020). With the growing LMD activity in urban areas, social health must be prioritized.

Along with that, health and safety refers to individuals' well-being and safety within a society for the right to not only be safe but to take every precaution of adaptation and security to avoid future casualties and physical harm (Eizenberg and Jabareen, 2017). For example, the cooperation of Ahamove and Vinfast or Lazada and Selex Motors (Ngoc Diep, 2023) in deploying electric vehicles into the delivery field promises to bring many benefits in terms of safety and health to the community.

[S18] Government Regulations

The employment of appropriate rules and regulations is critical to reducing externalities, particularly congestion, noise, and air pollution, caused by urban delivery operations (Ranieri et al., 2018). The government regulations are defined as guidelines and standards for energy use, waste disposal, and emissions; along with offering incentives to LSPs towards sustainability (Marchet, Melacini and Perotti, 2014). Governments and LSPs should work together to develop a sustainable plan for urban LMD in order to deal with the complexity of urban logistics settings (Siegfried, 2021).

Proper policies and regulations are needed to implement innovations such as ICT, ITS, and Industry 4.0 within cities (Ranieri et al., 2018). It also provides certain subsidies for implementing green practices in smart supply chains (Sharma, Prakash and Singh, 2022). The government should highlight and make widely available policies which is supporting green enterprises (Shrinivas Brahme and Shafighi, 2022).

In the context of Vietnam, the government needs to increase investment in upgrading infrastructure for the transportation process to facilitate the development of the industry (Baochinhphu, 2018; Tram and Giang, 2023).

[S19] Customer Satisfaction

ISO 9000 (2015) defines customer satisfaction as the perception of how well their expectations have been fulfilled. LMD is the last step of the entire supply chain, which is directly linked to customer satisfaction (Siegfried, 2021). Factors affecting customer satisfaction include the many benefits they receive when using LMD services, such as lower prices, a wide range of delivery options, more convenience in purchasing, and time savings (Siegfried, 2021). E-commerce customers are also requiring faster delivery and higher-quality services (Siegfried, 2013). Cho et al. (2021) has demonstrated that customer satisfaction has a large beneficial influence on customer loyalty. Measuring customer

satisfaction is crucial for understanding purchasing behavior and improving long-term performance of a company (Minh Ngo, 2015). LMD companies should improve their sustainable management abilities to meet the expectations of customers (Siegfried, 2021). If the experience with LMD service is good, customers will be satisfied and establish long relationship with ecommerce platform and vice versa *(*Ngoc Phat et al., 2022).

[S20] Employee Satisfaction

Employee satisfaction refers to the level of contentment and fulfillment employees experience in their workplace (Alam et al., 2012). The driver is an important stakeholder in LMD service, so creating their satisfaction will promote the sustainable development of LSPs. Without the involvement of delivery personnel, delivery companies may lose competitiveness because delivery drivers are typically the only people who need to contact the customer directly during the entire goods delivery process (Siegfried, 2021). Freight LMD services with light vehicles and bikes increase jobs (driving jobs) and create more relaxed working conditions for drivers of tricycles (i.e., fewer parking restrictions) (Bosona, 2020).

Pursuing the goal of building a balanced human resource, a Vietnam E-commerce platform - Tiki is on a journey to create a happy human resource with three key factors: Wellness, Flexibility, and Family-orientation (Anh Duong, 2021). Lazada Vietnam is also one of the E-commerce companies that is considered to have an outstanding working environment with a comprehensive care policy and equal opportunities for employees (P.V, 2022).

[S21] Cooperation Among Stakeholders to Adapt Change in Customer Behavior

LSPs need to have a clear understanding of their customers, based on which an effective strategy can be designed and implemented by matching the right innovative services to the right consumers (Wang et al., 2020). To address customer concerns, LMD companies along with their stakeholders such as local authorities, LMD staffs and retailers must adopt a sustainable approach to city logistics in LMD, taking into account the perspectives of customers so that appropriate solutions can be devised quickly (Kiba-Janiak et al., 2021).

Ignat and Chankov (2020) have shown that presenting the environmental and social implications of last-mile deliveries motivates consumers and causes them to switch from their first delivery choice to a more sustainable one. Customer requirements are becoming increasingly diverse in terms of delivery location and time, payment methods, or time

requirements. Providing these new services effectively also creates many challenges and complexities for LMD companies as they have to continuously innovate and improve systems as well as strengthen cooperation between relevant parties (Marta and Eduard, 2020). Therefore, adapting to customer changes in behavior is essential in developing LMD service.

Vietnamese LMD companies have made positive changes to meet the demand for convenience in delivery locations and times, such as the application of SmartLooker or Collection and delivery points (Bambooship, 2022).

2.4 Methodology

2.4.1 MCDM model

Multiple criteria decision-making, often referred to as MCDM or MADM, is a methodology used to assess and choose one or more options from a group of available alternatives. MCDM offers a structured approach for comparing alternatives by considering and evaluating a multitude of conflicting criteria (Shyur and Shih, 2006). MCDM models are frequently crafted to aid decision-makers in resolving intricate decision-making challenges across various industries and sectors, encompassing areas. Since the early 1970s, these problems necessitating multi-criteria decision-making solutions have found support through MCDM models. Numerous multi-criteria decision-making techniques have been identified, including the Analytical Hierarchical Process (AHP), Analytic Network Process (ANP), Fuzzy Analytic Network Process (FANP), Artificial Neural Network (ANN), Data Envelopment Analysis (DEA), and more, which can be employed to tackle decision-making predicaments.

MCDM methods offer a means to assess these conflicting factors and determine the most suitable alternative based on various criteria, as articulated by Siksnelyte-Butkiene et al. in 2020. Given the intricate nature of multifaceted decision-making challenges, entrepreneurial intent can be viewed as a complex multi-criteria decision-making (MCDM) problem. This complexity arises from the inclusion of both quantitative and qualitative elements, along with the consideration of multiple criteria in the decision-making process (Shyur and Shih, 2006).

2.4.2 AHP model

The Analytical Hierarchical Process (AHP) method, an invaluable research technique based on the multi-criteria decision-making (MCDM) model, was first introduced by (Saaty, 1988). The AHP serves as a decision-making tool based on hierarchical analysis, offering a straightforward computational approach underpinned by robust theoretical foundations. Its primary purpose is to aid individuals or groups of experts in the assessment, analysis, and resolution of complex decision-making dilemmas, particularly those involving the selection of the most suitable option from a multitude of alternatives or addressing multi-attribute decision-making challenges. This method proves instrumental in addressing pivotal questions such as "Which option should I choose?" or "Which option is the best fit?" by facilitating the selection of the alternative that aligns most closely with the predefined criteria of the decision maker.

The AHP model boasts the capacity to ascertain the weight of each criterion, rendering it a potent tool for analysing strategic and well-informed choices within various domains (Jato-Espino et al., 2014) The versatility of AHP becomes evident as it has been adopted in numerous contexts to enhance decision-making processes. For instance, Serrano-Hernandez et al. leveraged the AHP to prioritize transportation modes and routes, thereby optimizing logistical operations (Serrano-Hernandez, Ballano and Faulin, 2021). Similarly, Filiz Mizrak applied the AHP technique to construct a systematic framework for prioritizing risk and crisis management strategies in the logistics sector based on their relevance and potential impact (Mızrak, 2023). Moreover, Urza-Morales et al. harnessed the technique of relative weights through the AHP methodology in their research, particularly in the context of selecting transport systems (Urzúa-Morales et al., 2020). As indicated by the outcomes yielded through the AHP method, Gurcan et al. effectively determined a suitable third-party logistics provider by evaluating both tangible and intangible criteria (Gürcan et al., 2016). Furthermore, Kauf and Tłuczak have affirmed that the AHP method represents the most suitable approach for identifying optimal locations for logistics centers, thereby streamlining supply chain operations (Kauf and Tłuczak, 2018).

In summary, our selection of the AHP method for this article is underpinned by two compelling reasons that underscore its suitability and efficacy within the logistics and LMD field.

First and foremost, the prevalence of AHP in previous research within the logistics field is a testament to its proven applicability in addressing complex logistical challenges. Numerous researchers have successfully employed the AHP method in their studies. This well-established track record demonstrates that AHP can provide valuable insights and solutions in our specific area of interest, and also lending credibility to its use in our research concerning LMD.

Secondly, the core objective of our research is to rank and prioritize multiple criteria, thereby elucidating the relative importance of these factors for companies operating in the logistics sector in urban erea in Vietnam. AHP's inherent capability to comprehensively and transparently rank various criteria aligns seamlessly with our research goals. By leveraging AHP, we can offer clear and data-driven responses to critical questions, providing companies with the guidance they need to make informed decisions and optimize their logistical processes.

2.5 Research gap

Since urbanization and E-commerce have rapidly expanded, the urban logistics and LMD sector faces increasing pressure to enhance efficiency and competitiveness while fostering sustainable development (Lan Huong et al., 2023). Despite its significance, LMD, the final stage of order fulfillment, is considered the most expensive and least efficient aspect of logistics, accounting for approximately 28% of the total delivery cost and impacting E-commerce operations (Song et al., 2016; Ranieri et al., 2018; Van Duin Hogeschool Rotterdam and Wiegmans, 2019). In Vietnam, these inefficiencies lead to resource wastage, environmental pollution, subpar customer experiences, and harm to business reputations (Hoang Ha, 2022).

Therefore, to adapt to the burn growth situation of Vietnam's urban E-commerce, logistics companies must address the challenges posed by LMD services. Thus, evaluating factors affecting LMD implementation is crucial for promoting the sustainable development of E-commerce logistics. LSPs need to consider determinants like service quality, technology, cost implications, and customer satisfaction levels.

Recognizing the imperative of investigating strategies and remedies pertaining to the global LMD predicament, several researchers have authored comprehensive, thorough, and intricately detailed articles. A notable research is Xiaohong Jiang et al.'s work titled

"Utilizing the FAHP, ISM, and MICMAC Approaches to Analyze the Sustainability Influencing Factors of LMD in Rural E-Commerce Logistics." (Jiang et al., 2019b). The study emphasizes the need to improve LMD efficiency in rural areas by providing a well-structured set of criteria for assessing service performance. However, it only focuses on customer service, overlooking key aspects like environmental considerations, technological elements, and alignment with sustainable economic development goals. To establish a robust LMD system, researchers should consider a multidimensional perspective that includes service quality, economic feasibility, and environmental sustainability. Given its exclusive focus on rural areas, it's important to note that the established criteria may not universally apply to urban settings. Conversely, the article titled "Sustainable Urban Delivery: The Learning Process of Path Costs Enhanced by Information and Communication Technologies," authored by Russo and Comi (2021) addresses the significant environmental challenges engendered by delivery services in urban settings. The article highlights environmental issues in global urban areas and proposes technological solutions for sustainable LMD systems. However, sustainability in LMD goes beyond environmental concerns, encompassing aspects like service quality, cost-effectiveness, government policies, and technological integration. These research gap emphasizes the urgent need for comprehensive research to understand the intricate relationships among various facets of sustainable development in urban LMD, offering companies a robust framework to navigate the complexities of modern urban delivery sustainability. Nevertheless, these researchs can be a valuable reference for future urban investigations, offering a foundational understanding for constructing new framework.

In recent years, researchers in Vietnam, particularly from Hanoi University of Industry (Ha Anh et al, 2022a), have begun recognizing the significance of LMD in the country's economic development (add research name). Notably, this study focused on the relationship between LMD services and customer satisfaction revealed a connection between service quality and overall satisfaction, providing specific recommendations for businesses. However, this research primarily addresses customer-oriented aspects and represents only one facet of establishing a sustainable LMD system. Future research should encompass a broader spectrum, including operational, environmental, and regulatory factors such as supply chain logistics, technological innovations, cost-effectiveness, environmental impact, and compliance. Simultaneously, students from RMIT University offered an overarching perspective on integrating sustainability into LMD in Vietnam Vietnam (Hoang Ha, 2022),

contributing a valuable tool for stakeholders. Despite limitations like a preliminary literature overview, their research provides a foundational understanding of LMD complexities in Vietnam. Further investigation is essential to quantitatively assess the relative importance of each criterion, facilitating the formulation of a well-defined developmental trajectory for LMD companies, empowering them to take specific, well-informed actions aligned with industry needs.

After considering the research gap, the authors find the importance of a thorough review of existing literature underscores the dearth of research employing the AHP methodology to comprehensively evaluate all the critical factors that must be considered in the development of a sustainable LMD system. Given the paramount importance of establishing such a system for corporate growth and the sustainable advancement of both individual enterprises and the national economy, a notable gap persists in the available literature. Hence, this study seeks to address this gap by leveraging the AHP method to explore the factors influencing the sustainability of LMD services in Vietnam. In doing so, it aims to formulate a comprehensive set of criteria that can serve as a roadmap for businesses, offering fresh insights and methodologies for companies to research and develop their own sustainable LMD systems.

2.6 Conclusion

This study aims to use the AHP method to not only contribute to the academic discourse but also serve as a valuable resource for LSPs and other stakeholders, providing them with the tools and insights required to optimize their LMD processes. Ultimately, the pursuit of sustainability in LMD systems is not only vital for the growth of individual companies but also integral to the sustainable development of the nation's economy, making this research both timely and essential in the current economic landscape of Vietnam.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter provides a clearer comprehension of the methodology and the rationale why it was chosen for the study.

3.1.1 Research philosophy

The evolution of knowledge and the nature of that knowledge are essential to research philosophy. The idea is that when you conduct research, you are gaining knowledge in a certain topic. Given that we are researchers in the field of business and management, we must be careful of the philosophical commitments we make through the research method, since this has a significant impact not just on what we do, but also on our understanding of what we are investigating (Johnson and Clark, 2006). There are four management research philosophies: positivism, realism, interpretivism, and pragmatism (Saunders et al., 2009).

In this study, the authors adopt pragmatism as the the research philosophy because pragmatism can seek an appropriate balance by emphasizing the application of research results rather than an all-or-nothing, mutually exclusive philosophical perspective (Saunders et al., 2009). In order to answer the research question which is what critical factors impact the sustainability of LMD of urban E-commerce logistics in Vietnam, the authors applied multiple points of view to better address the study topic. The authors simultaneously investigate literature of related researches and consultation from different experts to present a set of criteria as well as conduct face-to-face questionnaire with ten experts specializing logistics and supply chain field to analyze both quantitative and qualitative data. The concept of pragmatism entails research strategies that integrate operational judgments based on 'what will work best' in answering the topics under evaluation. This allows the authors to do research in novel and dynamic methods to solve research problems.

3.1.2. Research approaches

Three main research approaches including deduction, induction, and abduction.

Inductive data collection is data collection and theory development based on data analysis. Inductive approach generates unproven hypotheses whose generalizability ranges from

specialized to broad. The goal of gathering data is to explore a phenomenon, identify themes and patterns, and construct a conceptual framework (Saunders et al., 2009). This research is conducted by the inductive method because the reasearch objectives is to develop a conceptual framework including a set of criteria impacting the sustainability of urban E-commerce LMD. After the research process and data analysis which are conducting a literature review and collecting expert consultation, the authors develop the priority ranking of 6 main criteria and 21 sub-criteria that have impact on LMD in Vietnam urban area.

3.1.3 Research methods

Two main types of research methods including quantitative and qualitative. The emphasis on quantitative (numbers) versus non-numeric (words) data is one technique to differentiate the two.

Quantitative is a term that is often used to refer to any data-gathering tool or data analysis technique that generates or uses numerical data (Saunders et al., 2009).

Qualitative is a term that is often used to refer to any data-gathering tool or data analysis technique that generates or uses non-numerical data. Therefore, qualitative data may incorporate videos and images (Saunders et al., 2009).

This study used quantitative and qualitative data to enhance the advantages of one type of data while balancing its limitations. Clearly, the first phase is when the authors collect qualitative data through literature review of related paper and experts' consultation to develop conceptual framework including a set of criteria that impact the sustainability of urban E-commerce LMD. The second phase is when the authors employ questionnaire to collect quantitative data through Saaty's point scale.

This research method indentification is also explained in a paper named "Models, Methods, Concepts & Applications of the Analytic Hierarchy Process" by Saaty and Vargas in 2012 where they clearly stated that AHP entails addressing intricate issues through logical and systematic rationality, integrating both qualitative and quantitative elements of human thought into the decision-making process.

3.2 Data collection methods

In this research, the authors use non-probability sampling techniques which is purposive sampling. This type of sampling method allows researchers to use their judgment in selecting samples that will best allow them to answer the research questions and meet the study objectives (Saunders et al., 2009). Purposive sampling is frequently utilized when working with small samples. (Saunders et al., 2009).

Documentary secondary data in this study is collected from written documents such as government publications, research papers, books, journal, and newspapers in both Vietnam and international.

Primary data in this study is gathered by questionnaire. The questionnaire is interviewer-administered using closed questions, which refers to questionnaires in which interviewers directly meet with respondents and present questions in person (Saunders et al., 2009).

Ten experts were surveyed for this study to assess the priorities of criteria for the sustainability of LMD in Vietnam's urban areas. Face-to-face questionnaire enable the authors to guarantee that all experts understand how the AHP technique works and are well-versed in the set of criteria to properly evaluate the priority ranking of the criteria. All ten selected experts are specialized in the fields of logistics and supply chain who meet the established criteria such as: high professional qualifications; with degrees recognized by competent authorities; and having more than 5 years of working experience and professional capacity in logistics and supply chain field, preferably in the field of LMD. Below is the profile of ten experts surveyed in this research:

Table 3.1 Detailed profile of ten experts *(Authors)*

Expert	**Working Experience**	**Education**	**Skilled Field**
Expert 1	5-10 years	Bachelor Degree	Freight Forwarding
Expert 2	5-10 years	Bachelor Degree	Logistics and Supply Chain Management
Expert 3	5-10 years	Bachelor Degree	Logistics and Supply Chain Management

Expert 4	5-10 years	Bachelor Degree	Logistics and Supply Chain Management
Expert 5	5-10 years	Doctor of Philosophy	Logistics and Supply Chain Management
Expert 6	5-10 years	Doctor of Philosophy	Logistics and Supply Chain Management
Expert 7	More than 10 years	Master Degree	Logistics and Supply Chain Management
Expert 8	More than 10 years	Master Degree	Logistics and Supply Chain Management
Expert 9	More than 10 years	Master Degree	Logistics and Supply Chain Management
Expert 10	More than 10 years	Master Degree	E-commerce Business Owner

3.3 Data analysis methods

The AHP method was invented in 1980 by Saaty, a decision-making method based on hierarchical analysis, a simple calculation method with a solid theoretical basis to support individuals or groups of experts in evaluating, analyzing, and making decisions to choose the best option among many variants or handling multi-attribute decision-making problems (Saaty, 1988). It helps answer questions like "Which option should I choose" or "Which option is best" by selecting the option that best meets the decision maker's provided criteria.

The concept of AHP is to break down a complex problem into multiple elements (performed in steps 1 and 2 below). The researchers then create a numeric system to compare the impact of each element versus others (step 3). These values are then calculated to weigh the contribution of each element's importance on the overall main topic (steps 4 to 8), which later helps decision-makers understand the impact of each element and analyze the best solutions to the problem.

AHP is best used in cases where human evaluation is involved, for example, planning, ranking, and prioritization. In this study, AHP is used to transform experts' evaluations into quantifying the impact of different aspects of LMD logistics.

Step 1: Define the problem and decision objectives

This phase of the research entails the establishment of the uppermost level within the hierarchical structure. At this step, the top level assumes the responsibility of encompassing the discrete issues that necessitate resolution within the purview of the research. This includes a comprehensive consideration of the problem statement, research objectives, and the overarching research purpose. In the context of this specific research article, the identification and articulation of the problem statement and research purpose have been meticulously derived from the Introduction section of the manuscript.

Step 2: Develop the AHP model's hierarchical structure

In this phase, the researcher, guided by the research article's established purpose, systematically identifies and outlines the key criteria with a direct impact on the article's objectives. This process involves analyzing these major criteria and further disassembling them into smaller, more specific factors, and the bottom of the hierarchy typically contains decision alternatives thus creating a hierarchical framework. This hierarchy provides a structured and methodical approach to assess and evaluate the various factors that collectively define the research's scope, facilitating a systematic exploration of the research priorities.

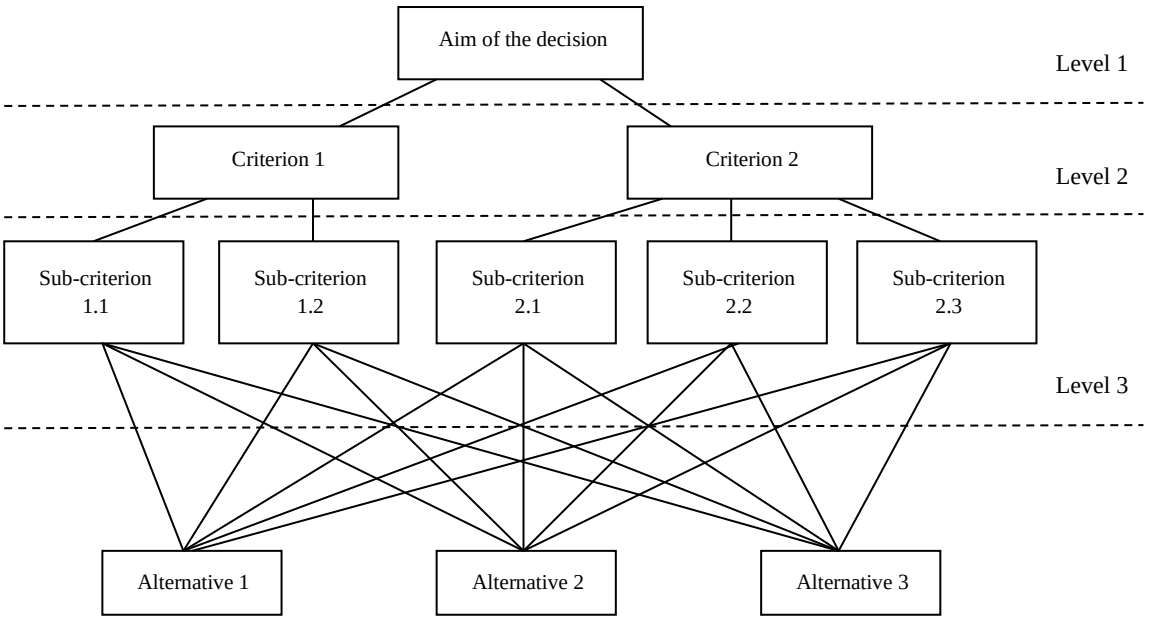

Figure 3.1: Hierarchical structure in the AHP method *(Watróbski et al., 2016)*

Step 3: Collect experts' evaluation.

Satty's point scale is required in this step. It scales from 1 to 9, depending on the impact and priority of an element on others. If an element score is more than 1, that means it's more important than its pear and vice versa. The semantics of each scoring can be found in Table 3.1 below.

To ensure the integrity of the score, only experts are eligible for the evaluation. We select experts based on main criteria including people with high professional qualifications; with degrees recognized by competent authorities; having more than 5 years of working experience and professional capacity in the field of logistics and supply chain. There evaluations are used by the AHP system to process the analysis.

Table 3.2 Satty's point scale *(Saaty, 1988)*

Semantics	Grade	Reciprocal
Equal important	1	1
Moderately more important	3	1/3
Strongly more important	5	1/5
Very strongly more important	7	1/7
Extremely more important	9	1/9
Compromise/between	2, 4, 6, 8	1/2, 1/4, 1/6, 1/8

Step 4: Develop pairwise comparison matrix.

Experts assign scores to determine the importance of criteria and sub-criteria in a pairwise comparison matrix. This matrix is of size n by n, with n rows and n columns representing elements. The element Aij signifies the level of importance of the element in row i compared to the element in column j.

$$A= [A_{ij}]_{nn} = \begin{bmatrix} A_{11} & A_{12} & \dots & A_{1n} \\ A_{21} & A_{22} & \dots & A_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ A_{n1} & A_{n2} & \dots & A_{nn} \end{bmatrix} \quad (1)$$

Step 5: Develop a normalized matrix.

The pairwise comparison matrix, A = $[A_{ij}]_{nn}$ is normalized according to formula (2), where each element in the matrix is divided by the sum of each column to produce a normalized pairwise matrix.

$$C_{ij} = \frac{A_{ij}}{\sum_{i=1}^{n} A_{ij}} \begin{bmatrix} C_{11} & C_{12} & \dots & C_{1n} \\ C_{21} & C_{22} & \dots & C_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ C_{n1} & C_{n2} & \dots & C_{nn} \end{bmatrix} (2)$$

Step 6: Calculate the weight of criteria

Weights are determined using equation (3), where the weight of criterion is obtained by dividing the sum of each normalized row in the matrix by the number of criteria utilized (n).

$$W_{ij} = \frac{\sum_{i=1}^{n} C_{ij}}{n} \begin{bmatrix} W_{11} \\ W_{21} \\ \vdots \\ W_{n1} \end{bmatrix} (3)$$

Step 7: Check the consistency ratio (CR).

The Consistency Ratio (CR) assesses the level of consistency and agreement among experts' viewpoints during the discussion. This ratio measures how consistent the data is in comparison to its inherent randomness. It is calculated using formula (4):

$$CR = \frac{CI}{RI} (4)$$

Where: CI is the consistency index; RI is a random index and shown in Table 2.

The consistency index (CI) and λ_{max} are respectively calculated by formula (5) and (6):

$$CI = \frac{\lambda_{max} - n}{n-1} \ (5)$$

Where: λ_{max} is the largest eigenvector; n is the number of criteria.

This is the approximate method, the principal eigenvector value is approximately evaluated as following (Ishizaka and Lusti (2006)):

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{A_{ij} * w_j}{w_i} \ (6)$$

Where: λ_{max} is the eigenvalue of eigenvector; n is the number of criteria; w_i are criteria weight, the average each row in the normalized matrix; the summations of matrix $A_{ij} * w_j$ is shown weighted sum value.

If the CR value is 0.1 or less, it is considered acceptable. Conversely, if the CR value exceeds 0.1, we should ask the experts to review and potentially revise their judgments.

Table 3.3 Random Index (RI) *(Saaty, 1988)*

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.58

Step 8: Consolidate the evaluation of multiple decision-makers

To achieve an aggregated assessment of the pairwise comparisons made by all decision-makers participating in the decision-making process, we calculate the average of each individual evaluation using equation (7).

$$\prod_{i=1}^{n} a_i = \sqrt[n]{a_1 a_2 \dots a_n} \quad (7)$$

Where: a= Pairwise comparison scale given by an expert

n = Number of experts

The reason the geometric mean is employed, as opposed to the arithmetic mean, is because it maintains the matrix's reciprocal property. This is crucial when consolidating evaluations from multiple individuals to arrive at a single evaluation for the entire group. Following the collection of data from ten experts, Excel software will be used to compute the geometric mean values. Thus, to finalize the contributive results, these values was put in the matrix and went back to check the CR (using similar formula in steps 4 to 7).

3.4 Ethical considerations

In preparation for the survey phase, the researchers uphold a commitment to ethical research practices. Before conducting the survey, the respondents are asked for permission and are well-informed on the research. All respondents are well guided on the methodology's scoring system and on how to fill in the questionnaire. These guidelines are documented and conducted for both online and face-to-face surveys. The researchers make sure the

respondents’ names and information are confidential. These ethical measures collectively underscore the research's dedication to rigorous and responsible data collection.

3.5 Conclusion

This chapter summarizes clearly the methodology used and the reasoning for choosing the methodology. Both quantitative and qualitative data are used to take advantage of the surveys and experts’ consultation. Moreover, these data minimize the impact of studies’ limitation on the same topic.

The AHP is used to calculate the importance of different factors of the main topic. Ten different experts in the LMD industry did answer a sample of questions. Evaluations are reviewed to make sure all scoring amounts are sensible. At the end of the analytics process, a clear ranking of different aspects is produced.

CHAPTER 4: FINDINGS AND ANALYSES

4.1 Case study

The AHP method was invented by Saaty (1980) as a structured technique used to handle complex decision-making problems, which is utilized (Figure 4.2). AHP enables decision-makers to systematically analyze and evaluate different factors based on their relative importance and make informed decisions. Besides, by using expert perspectives, the AHP method can help prioritize critical factors and can also address the complex interactions and trade-offs between the factors involved in the decision-making process. Therefore, the AHP model is deployed to analyze critical factors towards sustainable LMD businesses in Vietnam's urban E-commerce context, in which 6 main criteria (Service Convenience, Service Responsiveness, Service Reliability, Economic Aspect, Environmental Aspect, and Social Aspect) and 21 sub-criteria are proposed. Figure 4.1 illustrates this hierarchy which consists of all criteria and sub-criteria related to them.

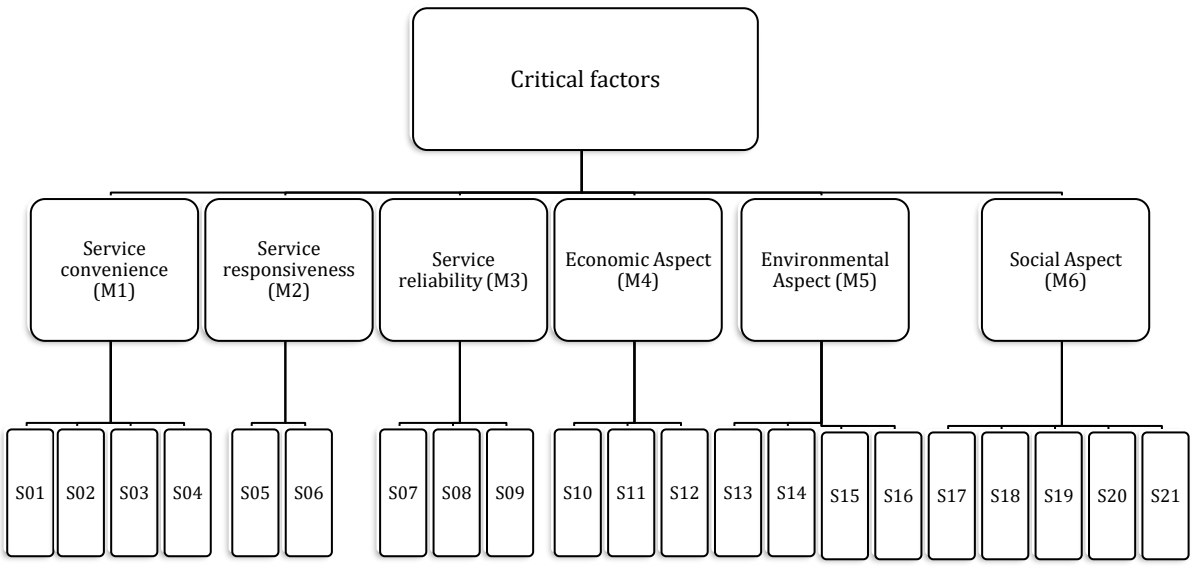

Figure 4. 1 The hierarchical structure of the criteria set *(Authors)*

In this research, ten experts experienced in the LMD industry were surveyed to evaluate the importance of criteria for the sustainability of LMD in Vietnam urban areas. We selected experts based on main criteria including people with high professional qualifications; with degrees recognized by competent authorities; and having more than 5 years of working

experience and professional capacity in the field of logistics and supply chain, preferably in the field of LMD. Therefore, we searched, contacted, and interviewed ten experts as lecturers, masters, and doctors philosophy and experts with expertise and experience working in the field of economics and trade, and knowledge of the fields of logistics and supply chain. This research employed face-to-face questionaire to collect data in order to ensure all experts clearly understand how the AHP method works and know thoroughly about the set of criteria. Figure 4.2 presents a step-by-step process in which this research is conducted and previously explained in more detail in Chapter 3.

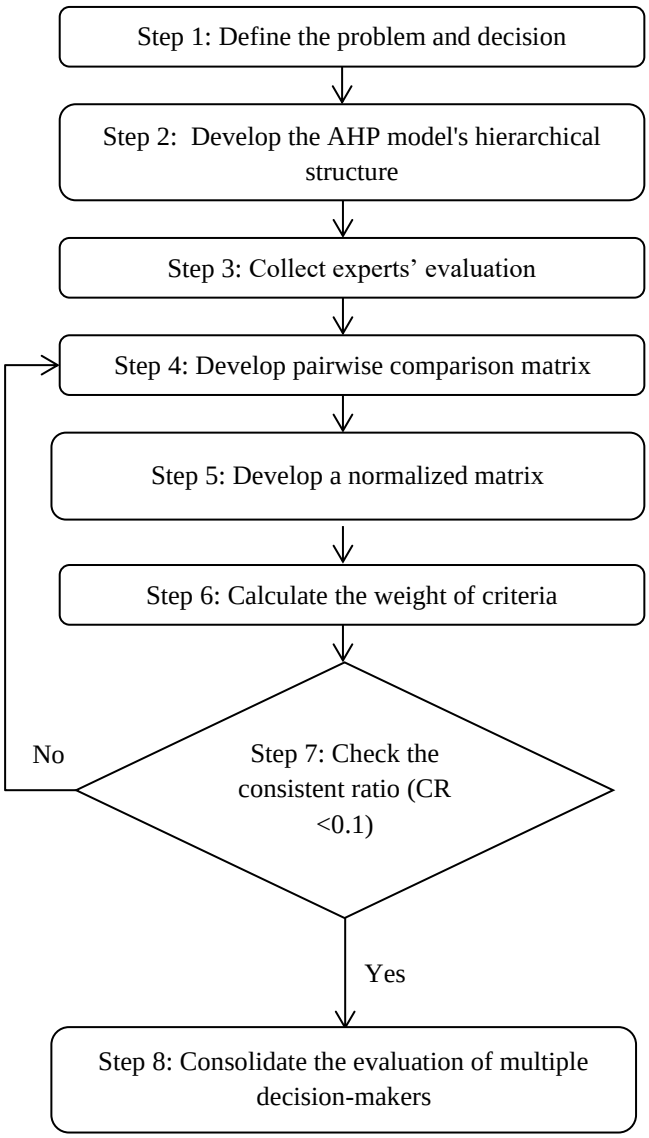

Figure 4.2 Flowchart of proposed AHP method

4.2 Results

4.2.1 Main criteria

As a first step, the questionnaire are shared to ten experts with extensive expertise. The study's objective, the significance of the criteria, and the questionnaire structure are all thoroughly discussed. The pairwise comparison matrix' consistency ratios are also calculated using the relevant numerical values in the standard AHP approach of Satty's point scale shown in Table 3.1. Then, pairwise comparison, geomatric means of main criteria and the step of normalized comparison to calculate consistency ratio (CR) have been presented in Table 4.1, 4.2, 4.3, and 4.4 respectively.

Table 4.1 Initial comparison matrix for main criteria

	Left criteria is greater									**Right criteria is greater**									**Number of Experts**
	1/9	**1/8**	**1/7**	**1/6**	**1/5**	**1/4**	**1/3**	**1/2**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**		
M1					2	1		2	1	1	2	1						**M2**	10
M1										4	4	2						**M3**	10
M1								1			1	3	3	2				**M4**	10
M1							1			3	2	3	1					**M5**	10
M1								2	1		1	2	2	2				**M6**	10
M2									4	1		2		3				**M3**	10
M2								1	1	3				1	1	3		**M4**	10
M2							2	1		2		2		1	2			**M5**	10
M2		1					1		2	2	1		1		1	1		**M6**	10
M3							1			8	1							**M4**	10
M3						1	1	3	3	1	1							**M5**	10
M3		1						2	2	4	1							**M6**	10
M4				1			2	3	2	1	1							**M5**	10
M4	1	1			1			1	4	1			1					**M6**	10
M5						1		1	1	3	3			1				**M6**	10

Table 4.2 Geomatric mean for main criteria's pairwise comparison

Main Criteria	M1	M2	M3	M4	M5	M6
M1	1.000	1.187	0.370	0.262	0.443	0.395
M2	0.842	1.000	0.413	0.321	0.499	0.476
M3	2.702	2.421	1.000	0.598	1.320	0.960
M4	3.812	3.115	1.672	1.000	1.534	1.534
M5	2.256	2.004	0.758	0.652	1.000	0.601
M6	2.531	2.102	1.041	0.652	1.663	1.000

Table 4.3 Normalized comparison matrix for main criteria

Main Criteria	M1	M2	M3	M4	M5	M6
M1	0.077	0.100	0.070	0.078	0.069	0.080
M2	0.065	0.085	0.079	0.092	0.077	0.096
M3	0.208	0.205	0.190	0.171	0.204	0.193
M4	0.282	0.263	0.318	0.286	0.237	0.309
M5	0.174	0.169	0.144	0.186	0.155	0.121
M6	0.195	0.178	0.198	0.186	0.258	0.201
Sum	1	1	1	1	1	1

Table 4.4 Pairwise comparisons for main criteria

Main Criteria	Calculation to obtain criteria weight	Criteria Weight	Rank
M1	3.669	0.079	6
M2	3.551	0.082	5
M3	9.001	0.195	3
M4	12.515	0.283	1
M5	7.271	0.158	4
M6	8.989	0.203	2
Consistent ratio = 0.006			

Table 4.4 displays the weighted sum scores for each of the main criteria. M1=0.079, M2=0.082, M3=0.195, M4=0.283, M5=0.158, M6=0.203. The order of significance is M4>M6>M3>M5>M2>M1. The most important main criteria is the Economic Aspect.

Based on the previous charter's description, after experts' evaluation – step 3 and consolidated all 10 experts' evaluations – step 8, the authors continue to demonstrate AHP's calculation in step-by-step to check the CR for the the main criteria pairwise comparison matrix (A1) as follows:

Step 4: Develop pairwise comparison matrix

- Use the equation (7) of geomatrix mean to calculate Aij weight in each matrix

$$\prod_{i=1}^{n} a_i = \sqrt[n]{a_1 a_2 \dots a_n} \Rightarrow A_{21} = \sqrt[10]{\frac{1}{5} * \frac{1}{5} * \frac{1}{4} * \frac{1}{2} * \frac{1}{2} * 1 * 2 * 3 * 3 * 4} = 0.842$$

Similar application to compute the remain Aij in each matrix, the results for the A1 are shown:

$$A = \begin{bmatrix} A_{11} & A_{12} & \dots & A_{1n} \\ A_{21} & A_{22} & \dots & A_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ A_{n1} & A_{n2} & \dots & A_{nn} \end{bmatrix} \Rightarrow A1 = \begin{bmatrix} 1 & 1.187 & 0.370 & 0.262 & 0.443 & 0.395 \\ 0.842 & 1 & 0.413 & 0.321 & 0.499 & 0.476 \\ 2.702 & 2.421 & 1 & 0.598 & 1.320 & 0.960 \\ 3.812 & 3.115 & 1.672 & 1 & 1.534 & 1.534 \\ 2.256 & 2.004 & 0.758 & 0.652 & 1 & 0.601 \\ 2.531 & 2.102 & 1.041 & 0.652 & 1.663 & 1 \end{bmatrix}$$

Step 5: Develop a normalized matrix

- Sum of columns (Sn): Compute the sum of each columns of each matrix

$$S1 = 1 + 0.842 + 2.702 + 3.812 + 2.256 + 2.531 = 12.992$$

Similar formular with the remain columns of A1 matrix, the results are shown respectively:

$$S2 = 11.829,\ S3 = 5.254,\ S4 = 3.496,\ S5 = 6.459,\ S6 = 4.966$$

- Develop a normalized matrix

$$C_{ij} = \frac{A_{ij}}{\sum_{i=1}^{n} A_{ij}} \begin{bmatrix} C_{11} & C_{12} & \dots & C_{1n} \\ C_{21} & C_{22} & \dots & C_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ C_{n1} & C_{n2} & \dots & C_{nn} \end{bmatrix} \Rightarrow C_{21} = \frac{A_{21}}{S1} = \frac{0.842}{1+0.842+2.702+3.812+2.256+2.531} = 0.065$$

Similar application to compute the remain Cij in each matrix, the results for the A1 are shown:

$$\begin{bmatrix} 0.077 & 0.100 & 0.070 & 0.078 & 0.069 & 0.080 \\ 0.065 & 0.085 & 0.079 & 0.092 & 0.077 & 0.096 \\ 0.208 & 0.205 & 0.190 & 0.171 & 0.204 & 0.193 \\ 0.282 & 0.263 & 0.318 & 0.286 & 0.237 & 0.309 \\ 0.174 & 0.169 & 0.144 & 0.186 & 0.155 & 0.121 \\ 0.195 & 0.178 & 0.198 & 0.186 & 0.258 & 0.201 \end{bmatrix}$$

Step 6: Calculate the weight of criteria

- Use the equation (3) of criteria weight from each rows of the above normalized matrix to calculate Wij in each matrix

$$W_{ij} = \frac{\sum_{i=1}^{n} C_{ij}}{n} \begin{bmatrix} W_{11} \\ W_{21} \\ \vdots \\ W_{n1} \end{bmatrix} \Rightarrow W_{11} = \frac{0.077+0.100+0.070+0.078+0.069+0.080}{6} = 0.079$$

Similar application to compute the remain Aij in each matrix, the results for the A1 are both presented in table 4.4 and the matrix below:

$$\begin{bmatrix} 0.079 \\ 0.082 \\ 0.195 \\ 0.283 \\ 0.158 \\ 0.203 \end{bmatrix}$$

Step 7: Check the consistency ratio (CR) for the A1

- Compute λ_{max}

Multiply the initial matrix for main criteria (A1) with its criteria weight matrix to calculate the weighted sum value*:*

$$\begin{bmatrix} 1 & 1.187 & 0.370 & 0.262 & 0.443 & 0.395 \\ 0.842 & 1 & 0.413 & 0.321 & 0.499 & 0.476 \\ 2.702 & 2.421 & 1 & 0.598 & 1.320 & 0.960 \\ 3.812 & 3.115 & 1.672 & 1 & 1.534 & 1.534 \\ 2.256 & 2.004 & 0.758 & 0.652 & 1 & 0.601 \\ 2.531 & 2.102 & 1.041 & 0.652 & 1.663 & 1 \end{bmatrix} \text{x} \begin{bmatrix} 0.079 \\ 0.082 \\ 0.195 \\ 0.283 \\ 0.158 \\ 0.203 \end{bmatrix} = \begin{bmatrix} 0.476 \\ 0.496 \\ 1.180 \\ 1.708 \\ 0.955 \\ 1.226 \end{bmatrix}$$

Divide the weighted sum value matrix to the criteria weight matrix to find out the matrix's eigenvectors:

$$\begin{bmatrix}0.476\\0.496\\1.180\\1.708\\0.955\\1.226\end{bmatrix} / \begin{bmatrix}0.079\\0.082\\0.195\\0.283\\0.158\\0.203\end{bmatrix} = \begin{bmatrix}6.027\\6.032\\6.043\\6.043\\6.035\\6.050\end{bmatrix}$$

As the number of criteria is 6, we take n = 6, λ_{max} or eigenvalue is calculated as follows:

$$\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{A_{ij} * w_j}{w_i} = \frac{6.027+6.032+6.043+6.043+6.035+6.050}{6} = 6.039$$

- Compute the consistency index (CI)

$$\text{CI} = \frac{\lambda\text{max}-\text{n}}{n-1} = \frac{6.039-6}{6-1} = 0.006$$

- Compute the consistency ratio (CR)

With n = 6 we have an RI = 1.24, CR = CI/RI = 0.047/1.24 = 0.006 < 0.1. Therefore, it is acceptable inconsistency.

4.2.2 Sub-criteria

Similar steps are used to evaluate sub-criteria.

- **Service Convenience's sub-criteria:**

Table 4.5 Initial comparison matrix for Service Convenience's sub-criteria

	Left criteria is greater									**Right criteria is greater**									**Number of Experts**
	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1/2**	**1/3**	**1/4**	**1/5**	**1/6**	**1/7**	**1/8**	**1/9**		
S01					1		1			1		2	2	1	1	1		**S02**	10
S01							1		1	1	1	3	2	1				**S03**	10
S01							1	5			2		1	1				**S04**	10
S02						1	1	2	3	2			1					**S03**	10
S02				1	2	1	1	3		1	1							**S04**	10
S03					2	1	2	2		2	1							**S04**	10

Table 4.6 Geomatrix mean of pairwise comparison for Service Convenience's sub-criteria

Service Convenience (M1)	S01	S02	S03	S04

S01	1.000	0.376	0.373	0.902
S02	2.663	1.000	1.091	2.178
S03	2.681	0.916	1.000	1.769
S04	1.109	0.459	0.565	1.000

Table 4.7 Normalized comparison matrix for Service Convenience's sub-criteria

Service Convenience (M1)	S01	S02	S03	S04
S01	0.134	0.137	0.123	0.154
S02	0.357	0.364	0.36	0.372
S03	0.36	0.333	0.33	0.302
S04	0.149	0.167	0.187	0.171
Sum	1	1	1	1

Table 4.8 Pairwise comparisons for Service Convenience's sub-criteria

Service Convenience (M1)	Calculation to obtain criteria weight	Criteria Weight	Rank
S01	2.651	0.137	4
S02	6.932	0.363	1
S03	6.366	0.331	2
S04	3.133	0.168	3
Consistent ratio = 0.003			

According to Table 4.8, the weighted sum scores of the sub-criteria in Service Convenience (M1) are as follows. S01=0.137, S02=0.363, S03=0.331, S04=0.168. The ranking is S02 > S03 > S04 > S01.

- **Service Responsiveness's sub-criteria:**

Table 4.9 Initial comparison matrix for Service Responsiveness's sub-criteria

	Left criteria is greater																	**Right criteria is greater**		**Number of Experts**
	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1/2**	**1/3**	**1/4**	**1/5**	**1/6**	**1/7**	**1/8**	**1/9**			
S05					1				3	2		3		1				**S06**	10	

Table 4.10 Geomatrix mean of pairwise comparison for Service Responsiveness's sub-criteria

Service Responsiveness (M2)	S05	S06
S05	1	0.564
S06	1.773	1

Table 4.11 Normalized comparison matrix for Service Responsiveness's sub-criteria

Service Responsiveness (M2)	S05	S06
S05	0.361	0.361
S06	0.639	0.639
Sum	1	1

Table 4.12 Pairwise comparisons for Service Responsiveness's sub-criteria

Service Responsiveness (M2)	Calculation to obtain criteria weight	Criteria Weight	Rank
S05	1.564	0.361	2
S06	2.773	0.639	1
Consistent ratio = 0			

Table 4.12 presents the weights assigned to the sub-criteria in Service Responsiveness (M2). S05=0.361, S06=0.639. S06 is prioritized over S05 in the ranking.

- **Service Reliability's sub-criteria:**

Table 4.13 Initial comparison matrix for Service Reliability's sub-criteria

	Left criteria is greater									**Right criteria is greater**									**Number of Experts**
	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1/2**	**1/3**	**1/4**	**1/5**	**1/6**	**1/7**	**1/8**	**1/9**		
S07					1	2	1	1	5									**S08**	10
S07					1	2	3	3			1							**S09**	10
S08					1		1	2	1	3	2							**S09**	10

Table 4.14 Geomatrix mean of pairwise comparison for Service Reliability's sub-criteria

Service Reliability (M3)	S07	S08	S09
S07	1	1.854	2.377
S08	0.539	1	0.982
S09	0.421	1.018	1

Table 4.15 Normalized comparison matrix for Service Reliability's sub-criteria

Service Reliability (M3)	S07	S08	S09
S07	0.51	0.479	0.545
S08	0.275	0.258	0.225
S09	0.215	0.263	0.229
Sum	1	1	1

Table 4.16 Pairwise comparisons for Service Reliability's sub-criteria

Service Reliability (M3)	Calculation to obtain criteria weight	Criteria Weight	Rank
S07	5.231	0.511	1
S08	2.521	0.253	2
S09	2.439	0.236	3
Consistent ratio = 0.007			

The following are the weighted sum scores for Service Reliability sub-criteria (M3), as shown in Table 4.16. S07 = 0.511, S08 = 0.253, S09 = 0.236. The order of rating is S07, S08, S09.

- **Economic Aspect's sub-criteria:**

Table 4.17 Initial comparison matrix for Economic Aspect's sub-criteria

	Left criteria is greater									**Right criteria is greater**									**Number of Experts**
	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1/2**	**1/3**	**1/4**	**1/5**	**1/6**	**1/7**	**1/8**	**1/9**		
S10				1	5	2	1				1							**S11**	10
S10					2	2		3		1	2							**S12**	10
S11								1	2	2	3			1		1		**S12**	10

Table 4.18 Geomatrix mean of pairwise comparison for Economic Aspect's sub-criteria

Economic Aspect (M4)	S10	S11	S12
S10	1	3.584	1.679
S11	0.279	1	0.456
S12	0.596	2.195	1

Table 4.19 Normalized comparison matrix for Economic Aspect's sub-criteria

Economic Aspect (M4)	S10	S11	S12
S10	0.533	0.529	0.536
S11	0.149	0.148	0.145
S12	0.318	0.324	0.319
Sum	1	1	1

Table 4.20 Pairwise comparisons for Economic Aspect's sub-criteria

Economic Aspect (M4)	Calculation to obtain criteria weight	Critera Weight	Rank
S10	6.263	0.533	1
S11	1.735	0.147	3
S12	3.791	0.32	2
Consistent ratio = 0			

Based on the data shown in Table 4.20, the weighted sum scores of Economic Aspect sub-criteria (M4) can be observed. The values of S10, S11, and S12 are 0.533, 0.147, and 0.32, respectively. According to the ranking, the order of preference is S10 followed by S12, and then S11.

- **Environmental Aspect's sub-criteria:**

Table 4.21 Initial comparison matrix for Environmental Aspect's sub-criteria

	Left criteria is greater									**Right criteria is greater**									**Number of Experts**
	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1/2**	**1/3**	**1/4**	**1/5**	**1/6**	**1/7**	**1/8**	**1/9**		
S13									1	2	2	3	2					**S14**	10
S13							2	3	2	1			2					**S15**	10
S13					1		3	2			2	1		1				**S16**	10
S14				1	3		3			2	1							**S15**	10

S14		2			2	1	1			2	2						**S16**	10
S15					2		1	2	1	2			1	1			**S16**	10

Table 4.22 Geomatrix mean of pairwise comparison for Environmental Aspect's sub-criteria

Environmental Aspect (M5)	S13	S14	S15	S16
S13	1	0.334	1.037	1.096
S14	2.993	1	2.102	1.874
S15	0.964	0.476	1	1.096
S16	0.912	0.534	0.912	1

Table 4.23 Normalized comparison matrix for Environmental Aspect's sub-criteria

Environmental Aspect (M5)	S13	S14	S15	S16
S13	0.17	0.143	0.205	0.216
S14	0.51	0.427	0.416	0.37
S15	0.164	0.203	0.198	0.216
S16	0.155	0.228	0.181	0.197
Sum	1	1	1	1

Table 4.24 Pairwise comparisons for Environmental Aspect's sub-criteria

Environmental Aspect (M5)	Calculation to obtain criteria weight	Criteria Weight	Rank
S13	3.467	0.184	4
S14	7.969	0.431	1
S15	3.536	0.195	2
S16	3.358	0.19	3
Consistent ratio = 0.012			

The weighted sum scores for Environmental Aspect sub-criteria (M5) are as shown in Table 4.24. S13=0.184, S14=0.431, S15=0.195, S16=0.19. Ranking in order of importance is S14 > S15 > S16 > S13.

- **Social Aspect's sub-criteria:**

Table 4.25 Initial comparison matrix for Social Aspect's sub-criteria

	Left criteria is greater									Right criteria is greater									Number of Experts
	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**1/2**	**1/3**	**1/4**	**1/5**	**1/6**	**1/7**	**1/8**	**1/9**		
S17	1						1			5	1	1	1					**S18**	10
S17					2			1		2	1	2	1	1				**S19**	10
S17					1	3	1	3		2								**S20**	10
S17	1				1		1	2		2	1	1	1					**S21**	10
S18				1			1	2	1	4					1			**S19**	10
S18				1	2	2	1	2	1		1							**S20**	10
S18	1				1	1	1	2	1		2					1		**S21**	10
S19				1	3	3		1	1	1								**S20**	10
S19				1		1		4	2			1			1			**S21**	10
S20								2	1	1	1	3	1	1				**S21**	10

Table 4.26 Geomatrix mean of pairwise comparison for Social Aspect's sub-criteria

Social Aspect (M6)	S17	S18	S19	S20	S21
S17	1	0.653	0.622	2.13	1.084
S18	1.532	1	0.972	2.502	1.405
S19	1.607	1.029	1	2.938	1.299
S20	0.47	0.4	0.34	1	0.451
S21	0.922	0.712	0.77	2.218	1

Table 4.27 Normalized comparison matrix for Social Aspect's sub-criteria

Social Aspect (M6)	S17	S18	S19	S20	S21
S17	0.181	0.172	0.168	0.197	0.207
S18	0.277	0.264	0.262	0.232	0.268
S19	0.291	0.271	0.27	0.272	0.248
S20	0.085	0.105	0.092	0.093	0.086
S21	0.167	0.188	0.208	0.206	0.191
Sum	1	1	1	1	1

Table 4.28 Pairwise comparisons for Social Aspect's sub-criteria

Social Aspect (M6)	Calculation to obtain criteria weight	Criteria Weight	Rank
S17	5.489	0.185	4
S18	7.411	0.261	2
S19	7.873	0.270	1
S20	2.661	0.092	5
S21	5.622	0.192	3
Consistent ratio = 0.003			

The weighted sum scores of Social Aspect sub-criteria (M6) are shown in Table 4.28. S17=0.185, S18=0.261, S19=0.27, S20=0.092, S21=0.192. S19>S18>S21>S17>S20 is the order of importance.

4.2.3 Final results

Table 4.29 Priorities and synthesized priorities of criteria and sub-criteria

Main Criteria	**Sub-Criteria**	**Priorities**	**Local Rank**	**Synthesized Priorities**	**Global Rank**
M1. Service Convenience	S01. Convenience of Payment	0.137	4	0.011	21
	S02. Convenience of Setting The Parcel Receiving Time	0.363	1	0.029	17
	S03. Convenience of Delivery Location	0.331	2	0.026	18
	S04. Convenience of Returning Goods	0.168	3	0.013	20
M2. Service Responsiveness	S05. Timeliness of Customer Service Response	0.361	2	0.030	15
	S06. Timeliness of Goods Delivery	0.639	1	0.053	7
M3. Service Reliability	S07. Integrity of Goods	0.511	1	0.100	2
	S08. Accuracy of Goods Arrival	0.253	2	0.049	8
	S09. Accuracy of Logistics Information	0.236	3	0.046	9
M4. Economic	S10. Costs	0.533	1	0.151	1

Aspect	S11. Technology Capability	0.147	3	0.042	10
	S12. Urban Distribution System	0.320	2	0.090	3
M5. Environmental Aspect	S13. Green Vehicle	0.184	4	0.029	16
	S14. Green Packaging	0.431	1	0.068	4
	S15. Green Warehouse	0.195	2	0.031	13
	S16. Green Management Systems	0.190	3	0.030	14
M6. Social Aspect	S17. Health and Safety	0.185	4	0.038	12
	S18. Government Regulations	0.261	2	0.053	6
	S19. Customer Satisfaction	0.270	1	0.055	5
	S20. Employee Satisfaction	0.092	5	0.019	19
	S21. Cooperation Among Stakeholders to Adapt Change in Customer Behavior	0.192	3	0.039	11

The weight coefficients of the sub-criteria are determined through the implementation of step 6, which allows for the calculation of the relative weight coefficients. The ultimate weight coefficient serves as a measure of the importance of certain criteria in relation to other criteria. Table 4.29 displays the final relative weight coefficients of the criteria. S10 "Costs" takes the highest weight. Following that, criterion S07 “Integrity of Goods” takes the second weight. Next, criterion S12 “Urban Distribution System” takes the third weight. Next, criterion S14 “Green Packaging” takes the fourth weight. Finally, criterion S19 “Customer Satisfaction” takes the fifth weight and is also the last criterion evaluated among the top 5 weighted sub-criteria.

4.3. Discussion

In the sphere of urban LMD in Vietnam, the research mentions many criteria that tend to impact the sustainability of urban E-commerce LMD system. Trend assessment is often complex, and experts' weighted criteria may have both subjective and objective elements, so

AHP's correlation pair comparison method provides reliable results. Following the analysis, the authors have a list of comprehensive six primary criteria, which are further subdivided into 21 sub-criteria with prioritized ranking both inside their local ranking and the global ranking. The ranking will serve as a reference for corporations and policymakers when making decisions. LMD companies can select and modify criteria based on their business situation and market conditions for implementation. Within this section, we will discuss the most important main criteria and the five highest-ranking criteria as determined by experts. Economic Aspect is regarded as the most crucial main criterion; 5 most influential sub-criteria are Costs, Integrity of Goods, Urban Distribution System, Green Packaging, respectively.

In this research, the evaluation of urban E-commerce last-mile sustainability focuses on main dimensions: service quality aspects including service convenience, service responsiveness, service reliability, environmental aspect, economic aspect, and social aspect (Qorri et al., 2018). According to the National Institution for Finance, logistics industry in Vietnam is confronting several challenges such as limitations in infrastructure, capital scale, and lack of efficiency in management level and strategy, which lead to high logistics costs, waste of time and resources, unfavorable customer experience, etc (Viet Hung, 2019). Especially, LMD in urban areas is both time and cost-inefficient because of many problems, including limitations in traffic and road infrastructure, traffic congestion, lack of warehousing, distribution systems and technology adoption, etc (Vtv.vn, 2023). Because of the changing nature of the urban environment and economic activities, boosting the sustainability of LMD in urban settings is challenging. Currently, Vietnamese logistics companies have been applying solutions to achieve economic benefits in order to gain competitive advantages such as cost optimization, investment in technology and automation, cooperation in logistics activities, etc (Hong Thao, 2022b). Therefore, the current situation of the logistics industry and LMD in particular requires the concentration on the Economic aspect in the initial step of developing sustainable LMD according to the data results.

According to the results, costs (S10) is the most selected sub-criteria that experts consider vital for the sustainable growth of urban E-commerce LMD. Logisics plays a particularly important role in creating a competitive advantage for each country. As a result, it is necessary to discover ways to minimize logistics costs in Vietnam, enhance the value of goods, and increase competitiveness advantages (Hoa et al., 2020). Vietnam's logistics costs are high for many reasons such as infrastructure, labor productivity, inter-industry and inter-

business connectivity, low technology application, ineffective investment, etc (VnEconomy, 2022). Markedly, LMD constitutes the most expensive and harmful component of the whole supply chain (Visser et al., 2014; Kin et al., 2018). A research by Giang et al. (2020) stated that LMD costs account for 53% of total e-commerce expenses. According to Phuong (2019), high logistics costs are a concern that must be addressed in Vietnam's business and finding solutions to reduce logistics cost in order to gain the competitive advantage is an urgent issue. Therefore, it is reasonably considered that reducing logistics costs is an important task that must be resolved to develop sustainable supply chain in Vietnam (Vtv.vn, 2023).

Integrity of goods (S07) is placed second in top 5 sub-criteria that expert selected as most important factors in LMD. With the constant development of E-commerce activities in Vietnam, consumers not only prefer shopping products online with better pricing but also care about how safety their orders are finally received (Kenresearch, 2018). As a result, maintaining the integrity of goods during this period can improve a company's reputation and customer satisfaction, leading it to obtain a competitive advantage (Phuong, 2020). For various reasons, the integrity of goods in LMD in Vietnam is critical from the perspective of management. The integrity or safety of goods appears to ensure that they are delivered in their entire and compliant undamaged condition, which might directly impact the E-commerce or logistics company's reputation. In some ways, protecting the integrity of goods can eliminate the need for costly and time-consuming returns and exchanges, highlighting the business's operational efficiency (Ha, Akbari and Au, 2023). Furthermore, with an increasing demand for online purchases in Vietnam, but under the current system, distributors lack information about the temperature and condition of goods delivered, as this is not tracked and thus cannot guarantee the quality of their products and higher-end perishable goods, which remains a key aspect for improvement (Hoang, 2019). Therefore, during times of cost-cutting, logistic and distribution systems need to stay at high standards to maintain goods quality. Businesses need to have a service quality management staff in all distribution stages to ensure customer satisfaction. Building a strong customer base is a foundation for sustainable business growth.

Urban Distribution System (S12) is a potential system that can be applied in cities in Vietnam. Considering that cities such as Ha Noi, Ho Chi Minh City have large and high-density populations, an urban distribution system is necessary for LMD activities to increase service efficiency, save costs, and reduce emissions. The Urban Distribution System not only

brings great benefits to businesses but is also a durable system that helps connect users and businesses better. In Vietnam, ideas such as smart-locker or convenience store pick-up points have not been applied much in practice, which leads to a shortage of collect and pick-up points. A tight urban distribution system can satisfy this for customers, increasing successful delivery efficiency for businesses. Experts in the industry appreciate this based on the fact that urban areas in Vietnam, with their geographical and population characteristics, have a large number of residents in a distinct area, leading to an urgent demand in the urban distribution system. Unlike rural areas or cities where population density is sparse, cities in Vietnam require LMD companies to have an effective and sustainable distribution system. In Vietnam, Hanoi and Ho Chi Minh City have the highest density of warehouses, "mega-warehouses," and fulfillment centers nationwide. This strategic distribution aims to cater to a substantial volume of online consumers. According to a report released by the Vietnam E-commerce Association (VECOM), the predominant share of e-commerce activities occurs in the two largest cities in the country, Hanoi and Ho Chi Minh City, collectively representing over 75% of e-commerce transactions nationwide (Hong Van, 2023). Therefore, the location of the order fulfillment center (or E-commerce warehouse) greatly determines the operational efficiency. Ho Chi Minh City and Hanoi emerge as the primary e-commerce hubs in Vietnam, boasting strategic locations, comprehensive infrastructure, and a growing trend of Logistics Service Providers (LSPs) investing in warehouses and large-scale logistics centers in these areas (Trungtamwto.vn, 2023). Urban distribution system can lead to transformative improvements in the LMD process. First and foremost, by developing dedicated urban distribution centers strategically located within metropolitan areas, logistics companies can significantly reduce the burden of navigating congested city streets, optimizing the use of vehicles, and minimizing delivery times. Additionally, government involvement can expedite the implementation of environmentally friendly transportation solutions, such as electric and low-emission vehicles (Schneider et al., 2014), further contributing to sustainability objectives. Moreover, by providing logistical support in terms of infrastructure and regulatory frameworks, the government can enable logistics companies to better meet the evolving needs of urban consumers (Mansouri et al., 2023). In essence, the creation of an urban distribution system is a win-win proposition, fostering economic growth, reducing environmental impact, and ultimately enhancing the overall efficiency and effectiveness of logistics operations within densely populated areas.

The swift growth of e-commerce has propelled the development of LMD services, leading to a heightened consumption of packaging materials and an escalating concern for environmental pollution (Wang et al., 2022). LMD service in Vietnam is a new market that has exploded in recent years. Environmental optimization faces many considerations in terms of investment costs, potential levels, and infrastructure. Meanwhile, Green Packaging (S14) is seen as a potential solution, easy to implement with low investment costs but high efficiency. While other "green" factors such as green vehicles, green warehouses, or green management systems require a large and long-term investment, as well as a suitable infrastructure system, green packaging is easy to apply and does not require much cost like other solution (Cong Tri, 2019). Green packaging criteria is highly appreciated by industry experts for its potential in the LMD market in urban areas in Viet Nam, based on the actual level of development of the industry. At the current level, applying an easy-application, low-cost method like green packaging is reasonable and suitable for businesses. In the research literature on urban LMD and e-commerce logistics, green packaging is considered an indispensable element when referring to solutions for developing sustainable delivery systems. In the Vietnam context, one of the most obvious factors is that online retail uses more and more environmentally unfriendly packaging, especially packaging made from slow-degrading plastic. Furthermore, the collection and recycling rate of packaging used in e-commerce is still low (Vietnam E-Commerce Association, 2023a). The Advisory Council of the Vietnam E-Commerce Association (VECOM), as per their proposal in 2023, has advocated for a Sustainable E-Commerce Development Program. This initiative places a strong emphasis on environmental protection activities, the implementation of circular economy principles, and the reduction, collection, and recycling of packaging and plastic materials within the online business sector. To implement green packaging, companies need to implement the use of green materials, reduce the use of one-time packaging material, and do clean and proper packaging (Zhang and Zhao, 2012) The government can adopt legislation to enable green packaging, such as lower tax for recycled materials, or promoting the use of new packaging systems. Companies need to push the support from the government to enable low-cost transformative green packaging. Consumers are also more likely to support companies following the government trend.

When completing online transactions, consumers can enjoy ease, simplicity, and time efficiency thanks to LMD (Chen and Dubinsky, 2003). As a result, although being a minor component of the overall supply chain, LMD can be viewed as the final interaction of an E-

commerce transaction. Both large corporations and small E-commerce vendors have a deep interest in understanding and use LMD as a channel to increase customer satisfaction (S19). Leading regional companies immediately joined the E-commerce market in Vietnam, which has a lot of expansion potential including the primary E-commerce retailers including Shopee.vn, Tiki.vn, Lazada.vn and other smaller businesses like Sendo.vn, Adayroi.com, etc. Despite having multiple investments, many small businesses have failed due to not being able to compete for customer satisfaction against other big platforms (Adayroi fell into bankruptcy; Sendo merged with Tiki). Following a time of market dominance, Lazada.vn has likewise lost ground to Shopee.vn and is now lagging behind (Vietnam.vn, 2023). In addition, ensuring customer satisfaction is crucial due to its significant impact on repeat sales, word of mouth recommendations, consumer loyalty, and overall company performance (Xenophon et al., 2014). Therefore, E-commerce enterprises would struggle to survive in the market if they fail to maintain increasing consumer satisfaction and thus cultivate client loyalty, especially in the increasing demand for social aspects in sustainable LMD (Vietnam Business Forum, 2022).

CHAPTER 5: CONCLUSIONS AND IMPLICATIONS

5.1. Conclusions

In this study, several strategic goals related to sustainability within the LMD of the logistics sector are presented. Different approaches to improve LMD service quality are also prioritized based on their effectiveness. Each of the main criteria presented in the study - Service Convenience, Service Responsiveness, Service Reliability, Economic Aspect, Environmental Aspect, and Social Aspect - plays a distinct role in minimizing and managing inefficiencies in the delivery process to customers. In the context of Vietnam's outstanding E-commerce development, LMD optimization is inevitable. LSPs improving related issues in LMD is a key task to ensure E-commerce sustainable development. In this study, the AHP method was applied to a case study where LMD was evaluated as a sustainable implementation in a developing country. According to the process of literature review and synthesis of experts' consultation, the authors have proposed a set of criteria including 6 main criteria and 21 sub-criteria that are considered actually potential in implementing towards sustainable development of LMD services in urban Vietnam. This set of criteria was evaluated during the case study. Although the criteria and sub-criteria are all considered appropriate to the context of the LMD market in urban Vietnam, the authors applied the AHP method and selected 1 main criterion and 5 most important sub-criteria. The lower ranking of criteria and sub-criteria does not negate their potential. This set of criteria will help companies providing LMD services in Vietnam have a comprehensive and objective view, thereby improving services, increasing competitiveness and moving towards sustainable development. The 5 most important sub-criteria provide a suitable approach for LMD companies to devise measures and strategies to improve their urban LMD systems.

5.2. Limitation and future research

The research, while offering valuable insights, does present several limitations that open the potential for further exploration in the field. Primarily, this study exclusively focuses on urban areas within Vietnam and inherently disregards the considerable distinctions that exist in rural regions. These disparities encompass factors like environmental conditions, infrastructure, educational resources, and topographical considerations, among others. To comprehensively understand the dynamics of a sustainable LMD system across the nation,

it is essential for future research to shift its lens toward rural areas, unraveling the unique factors that shape the LMD landscape in these settings.

Furthermore, it is worth emphasizing that this study's domain of investigation is primarily centered around "last-mile delivery of E-commerce". This selective focus means that the findings may not be universally applicable to other logistic chain, such as procurement, which exhibit their distinctive characteristics. Expanding the scope of inquiry in future research endeavors to encompass a broader spectrum of LMD logistics, beyond E-commerce, can provide a more comprehensive understanding of Vietnam's LMD services from a holistic perspective.

The current findings emphasize the considerable impact of variables such as costs, goods integrity, the urban distribution system, green packaging, and customer satisfaction on the implementation of sustainable LMD in the context of urban E-commerce logistics in Vietnam. Future research endeavors hold the potential to delve deeper into the nuances of the identified variations, aiming to comprehend the intricate complexity and relationships among these factors. A focused study that examines the impact of the top criteria on other factors and the overall LMD process can significantly support and augment the existing findings. Another avenue for future research involves an exploration of emerging technologies and innovative logistic systems, acknowledging their transformative potential in reshaping the efficiency and sustainability of LMD. Notably, the increasing prominence of sustainability as a key business concern in the logistics industry opens up yet another dimension for research exploration. Future studies could concentrate on unraveling the dynamics of sustainability in urban settings, offering specific actionable insights for businesses committed to fostering E-commerce sustainable development over the long term. In short, this study serves as a foundational platform that can be extended through future research endeavors, contingent upon the specific questions and angles researchers choose to address.

5.3. Implication

Firstly, the report presents AHP as an assessment tool for decision-making and prioritization for advanced topics. The report clearly represent how to breakdown LMD topic to multiple-level of criteria, also how to collect and analyze data, then how to use the analysed data to ranked the priorities criteria based on recent findings. Businesses can use this report as a

guideline on how to replicate similar analysis using the AHP model to answer further complex business questions that related to impact assessment, prioritization, fund allocation, etc.

Secondly, the report offers a list of comprehensive 6 main criteria which in turn comprise 21 sub-criteria with prioritization ranking both within their local category and also the overall topic. This helps companies to have a more comprehensive picture of the topic and all related factors. Depending on the specific needs or business question, the reader can focus on a specific group of criteria.

Thirdly, the report also provides an analysis and in-depth investigation through discussing the top 5 criteria to offer useful managerial insights that could have an impact on the sustainable approach of logistics companies. There are available research and documents on improving and maximizing LMD quality and efficiency. For cost-cutting, a research found multiple cost-control methods as the center of logistic management to ensure high profitability in e-commerce (Qi and Huimin, 2021). For intergrity of goods, Dorofeev et al. (2020) highlighted virtual tool as a solution. For urban distribution system, Xuefei and Gengbao (2018) also raised terminal distribution system to maximize efficiency of transportation and logistic in urban area. For green packaging, the research of Guirong and Zongjian (2012) listed down the important areas to improve green packaging management. Lastly, for customer satisfaction, some logistic management methodologies that take customer statisfaction as the highest priority (Paulo and Josefa, 2021).

In summary, this research lays the foundation for advancing sustainable practices in E-commerce logistics. The criteria developed through rigorous analysis and expert insights offer actionable guidance to enhance sustainability, reduce costs, and improve customer satisfaction. Furthermore, the recommendation for government support in creating urban distribution systems holds immense potential for transforming the logistics landscape. As the E-commerce sector continues to evolve, the implementation of these insights promises a more sustainable and efficient future for the industry.

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APPENDIX

Appendix 1. Selected Studies

Authors	Purpose of the Study	Findings/Contributions of the Study
Silva et al. (2023)	The authors aimed to characterize the sustainable urban LMD research field through a systematic literature review (N = 102).	The key findings are that there are no ideal last-mile solutions, and their limits should be investigated further by taking the so-called "triple bottom line of sustainability" into account.
Kiba-Janiak et al. (2021)	The authors' goal was to identify trends in sustainable LMD in the E-commerce sector in cities from the standpoint of numerous stakeholders.	The added value of te paper is a comprehensive approach to sustainable city logistics of last-mile delivery that incorporates the viewpoints of all stakeholders and the identification of trends in this area.
Awwad et al. (2018)	The authors intended to provide a framework for further reducing GHG emissions, with a concentration on CO2 emissions, for sustainable logistics.	The findings showed that, if applied, those innovative solutions may significantly decrease CO2 emissions in LMD.
Bosona (2020)	The authors' main objective was to identify significant difficulties of urban freight LMD and the potential for improvement.	The findings showed that the LMD challenges were classified as technological, infrastructural, LMD system and management, and logistic cost associated challenges, and were generally discussed.
Marte et al. (2020)	The authors' purpose was to investigate the types of impacts that E-commerce-Related LMD has and will have on cities.	The findings indicated that, to varying degrees, the four impact aspects examined (economic, social, environmental, and technical) have only received preliminary coverage in the available literature.
Wang, Nguyen, et al. (2021)	The authors' objective was to provide decision-makers with a comprehensive and consistent strategy for assessing and selecting the most efficient 3PLs.	According to the findings, the most influential aspects in the logistics outsourcing challenge are dependability and delivery time, customer voice, logistics cost, network management, and quality of service.
Ranieri et al. (2018)	The authors presented a review of current scientific literature contributions on new last-mile logistics solutions, with an emphasis on externality cost reduction.	The contributions are divided into five categories: novel vehicles, proximity stations or points, collaborative and cooperative urban logistics, transportation management and routing optimization, and innovations in public policy and infrastructure.
Siegfried and Zhang (2021)	The authors developed a sustainable approach for urban LMD based on data collected from long-term empirical research and a survey of E-commerce customers in Germany and China.	The findings showed that a sustainable urban LMD model should take into account the demands of E-commerce clients, the economic performance of logistics businesses, and the public's interest in sustainability.
Ignat and Chankov (2020)	The authors wanted to investigate if E-commerce customers modify their LMD preference after receiving information on the	The results indicated that showing environmental and social implications of LMD increases E-commerce the customer's likelihood of choosing a sustainable option.

	environmental and social sustainability of various solutions.	
Chia-Nan Wang et al. (2021)	The authors attempted to assess the sustainability performance of certain prominent LMD enterprises in Vietnam.	The findings achieved conventional ranks, with Grab Express being the best performing firm in the LMD environment.
Ali et al. (2021)	The authors aimed to develop a new sustainable logistics service quality (SLSQ) scale after studying the literature on sustainable service quality (SSQ) and logistics service quality (LSQ).	The findings included a scale for evaluating the overall service quality of Egypt's LSPs.

Appendix 2. Initial set of criteria

Main criteria	Sub-criteria
Service convenience (M1)	Convenience of Payment (S01)
	Convenience of Setting The Pick-Up Time (S02)
	Convenience of Pick-Up Point (S03)
	Convenience of Returning Goods (S04)
Service responsiveness (M2)	Timeliness of Customer Service Response (S05)
	Timeliness of Goods Return Processing (S06)
	Timeliness of Goods Delivery (S07)
	Timeliness of Goods Arrival (S08)
Service reliability (M3)	Integrity of Goods (S09)
	Accuracy of Goods Arrival (S10)
	Accuracy of Logistics Information (S11)
Service empathy (M4)	Employee Service Attitude (S12)
	Employees Actively Remind Customers to Open The Inspection (S13)
	Advance Reservation of Goods Pickup (S14)
	Rationality of The Value-Added Services (S15)
Technology (M5)	Routing Optimization (S16)
	Blockchain (S17)
	Warehouse Digitalization (S18)
Environment (M6)	Green Vehicle (S19)
	Green Packaging (S20)
	Green Warehouse (S21)
	Green Management System (S22)
	Collect & Delivery Points (S23)
Economic (M7)	Delivery Costs (S24)
	Crowd Logistics (S25)
	Urban Distribution Systems (S26)
Society (M8)	Health And Safety (S27)
	Government Regulations (S28)
	Customer Satisfaction (S29)

	Employee Satisfaction (S30)
	Change In Consumer Behavior (S31)

Appendix 3. Questionnaire and evaluation tables in data collection

Q1: How important is Service Convenience compared with Service Responsiveness?

Q2: How important is Service Convenience compared with Service Reliability?

Q3: How important is Service Convenience compared with Economic Aspect?

Q4: How important is Service Convenience compared with Environmental Aspect?

Q5: How important is Service Convenience compared with Social Aspect?

Q6: How important is Service Responsiveness compared with Service Reliability?

Q7: How important is Service Responsiveness compared with Economic Aspect?

Q8: How important is Service Responsiveness compared with Environmental Aspect?

Q9: How important is Service Responsiveness compared with Social Aspect?

Q10: How important is Service Reliability compared with Economic Aspect?

Q11: How important is Service Reliability compared with Environmental Aspect?

Q12: How important is Service Reliability compared with Social Aspect?

Q13: How important is Economic Aspect compared with Environmental Aspect?

Q14: How important is Economic Aspect compared with Social Aspect?

Q15: How important is Environmental Aspect compared with Social Aspect?

Q16: How important is Convenience of Payment compared with Convenience of Setting The Parcel Receiving Time ?

Q17: How important is Convenience of Payment compared with Convenience of Delivery Location?

Q18: How important is Convenience of Payment compared with Convenience of Returning Goods?

Q19: How important is Convenience of Setting The Parcel Receiving Time compared with Convenience of Delivery Location?

Q20: How important is Convenience of Setting The Parcel Receiving Time compared with Convenience of Returning Goods?

Q21: How important is Convenience of Delivery Location compared with Convenience of Returning Goods?

Q22: How important is Timeliness of Customer Service Response compared with Timeliness of Goods Delivery?

Q23: How important is Integrity of Goods compared with Accuracy Of Goods Arrival?

Q24: How important is Integrity of Goods compared with Accuracy Of Logistics Information?

Q25: How important is Accuracy Of Goods Arrival compared with Accuracy Of Logistics Information?

Q26: How important is Costs compared with Technology Capability?

Q27: How important is Costs compared with Urban Distribution System?

Q28: How important is Technology Capability compared with Urban Distribution System?

Q29: How important is Green Vehicle compared with Green Packaging?

Q30: How important is Green Vehicle compared with Green Warehouse?

Q31: How important is Green Vehicle compared with Green Management Systems?

Q32: How important is Green Packaging compared with Green Warehouse?

Q33: How important is Green Packaging compared with Green Management Systems?

Q34: How important is Green Warehouse compared with Green Management Systems?

Q35: How important is Health And Safety compared with Government Regulations?

Q36: How important is Health And Safety compared with Customer Satisfaction?

Q37: How important is Health And Safety compared with Employee Satisfaction?

Q38: How important is Health And Safety compared with Cooperation Among Stakeholders To Adapt Change In Customer Behavior?

Q39: How important is Government Regulations compared with Customer Satisfaction?

Q40: How important is Government Regulations compared with Employee Satisfaction?

Q41: How important is Government Regulations compared with Cooperation Among Stakeholders To Adapt Change In Customer Behavior?

Q42: How important is Customer Satisfaction compared with Employee Satisfaction?

Q43: How important is Customer Satisfaction compared with Cooperation Among Stakeholders To Adapt Change In Customer Behavior?

Q44: How important is Employee Satisfaction compared with Cooperation Among Stakeholders To Adapt Change In Customer Behavior?

Table. Quantitative 9-point scale. (Harlem et al., 2017)

Scale	Description
1	Equal relative importance
2	Equally to moderately more important
3	Moderately more important
4	Moderately to strongly important
5	Strongly important
6	Strong to very strongly more important
7	Very strongly more important
8	Very strongly to extremly more important
9	Extreamly important (High priority)

Main criteria																		
	Left Criteria is greater									Right Criteria is Greater								
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Service Convenience																		Service Responsiveness
Service Convenience																		Service Reliability
Service Convenience																		Economic Aspect
Service Convenience																		Environmental Aspect
Service Convenience																		Social Aspect
Service Responsiveness																		Service Reliability
Service Responsiveness																		Economic Aspect
Service Responsiveness																		Environmental Aspect
Service Responsiveness																		Social Aspect
Service Reliability																		Economic Aspect
Service Reliability																		Environmental Aspect
Service Reliability																		Social Aspect
Economic Aspect																		Environmental Aspect
Economic Aspect																		Social Aspect
Environmental Aspect																		Social Aspect

Service Convenience																		
	Left Criteria is greater										Right Criteria is greater							
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Convenience of Payment																		Convenience of Setting The Parcel Receiving Time
Convenience of Payment																		Convenience of Delivery Location
Convenience of Payment																		Convenience of Returning Goods
Convenience of Setting The Parcel Receiving Time																		Convenience of Delivery Location
Convenience of Setting The Parcel Receiving Time																		Convenience of Returning Goods
Convenience of Delivery Location																		Convenience of Returning Goods

Service Responsiveness																		
	Left Criteria is greater										Right Criteria is greater							
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Timeliness of Customer Service Response																		Timeliness of Goods Delivery

Service Reliability																		
	Left Criteria is greater										Right Criteria is greater							
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Integrity of Goods																		Accuracy of Goods Arrival
Integrity of Goods																		Accuracy of Logistics Information
Accuracy Of Goods Arrival																		Accuracy of Logistics Information

	Economic Aspect																	
	Left Criteria is greater									Right Criteria is greater								
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Costs																		Technology Capability
Costs																		Urban Distribution System
Technology Capability																		Urban Distribution System

Environmental Aspect																		
	Left Criteria is greater									Right Criteria is greater								
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Green Vehicle																		Green Packaging
Green Vehicle																		Green Warehouse
Green Vehicle																		Green Management Systems
Green Packaging																		Green Warehouse
Green Packaging																		Green Management Systems
Green Warehouse																		Green Management Systems

Social Aspect																		
	Left Criteria is greater									Right Criteria is greater								
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Health And Safety																		Government Regulations
Health And Safety																		Customer Satisfaction
Health And Safety																		Employee Satisfaction
Health And Safety																		Cooperation Among Stakeholders to Adapt Change in Customer Behavior
Government Regulations																		Customer Satisfaction

Government Regulations																	Employee Satisfaction
Government Regulations																	Cooperation Among Stakeholders to Adapt Change in Customer Behavior
Customer Satisfaction																	Employee Satisfaction
Customer Satisfaction																	Cooperation Among Stakeholders to Adapt Change In Customer Behavior
Employee Satisfaction																	Cooperation Among Stakeholders to Adapt Change In Customer Behavior