

CARBON NEUTRAL DELIVERY IN VIETNAM'S E-COMMERCE CONTEXT

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ABSTRACT

This study aims to analyze the potential and challenges of adopting carbon-neutral delivery solutions in Vietnam's rapidly growing e-commerce sector. Objectives include examining current practices, identifying barriers to implementation, and exploring consumer attitudes toward eco-friendly delivery options. The primary research method employed is a comprehensive literature review of academic articles, reports, and case studies. Data were gathered from reputable databases such as Google Scholar and Scopus, focusing on themes like green logistics, consumer behavior, and regulatory frameworks. The results indicate that Vietnam has made significant progress in establishing a regulatory framework for carbon neutrality, including the National Climate Change Strategy and the development of a domestic carbon market. However, logistics operations remain a major contributor to greenhouse gas emissions. Challenges also include high initial costs for electric vehicles (EVs), underdeveloped charging infrastructure, and low consumer demand for sustainable delivery services. Additionally, consumer demand for eco-friendly delivery services is limited due to low awareness of their environmental benefits. Despite these barriers, the research highlights opportunities in government-led sustainability initiatives, increasing environmental awareness among consumers, and advancements in logistics technology. Thus, achieving carbon-neutral delivery in Vietnam requires coordinated efforts from businesses, policymakers, and consumers. Businesses should invest in green technologies and engage consumers through awareness campaigns and incentives. Policymakers need to implement supportive regulations, develop EV infrastructure, and offer financial incentives for green logistics. Together, these strategies can align Vietnam's logistics practices with global sustainability goals and position the country as a leader in sustainable e-commerce.

Keywords: Carbon Neutral Delivery, Sustainable Logistics, E-commerce in Vietnam, Consumer awareness, Electric Vehicles.

INTRODUCTION

As the number of people shopping online continues to grow, logistics operations have experienced steady expansion in recent years. Carbon emissions have emerged as one of the most closely examined global environmental challenges.

The International Energy Agency (IEA) reported that in 2018, road transportation accounted for 29.4% of the world's total carbon emissions, making it a significant contributor to overall carbon dioxide output (Ritchie, 2020).

Vietnam's e-commerce sector has experienced exponential growth in recent years, with annual growth rates of 25-30% between 2015 and 2020. This surge has significantly increased the demand for delivery services, leading to a rapid expansion of logistics networks and a higher number of delivery vehicles. According to the Vietnam E-commerce Association (VECOM), the volume of online orders has doubled over the past five years, placing immense pressure on transportation infrastructure and contributing to environmental concerns.

Although the logistics sector experienced a brief slowdown during the COVID-19 pandemic, it has since recovered, contributing 4.92 percent to Vietnam's GDP in 2023, amounting to over VND 502.56 trillion, according to Statista. Forecasts indicate that by 2025, the logistics industry will grow at a faster pace than the national GDP, with a focus on developing multi-modal transportation systems and enhancing last-mile delivery services. A VnEconomy report highlights that Vietnam is currently home to over 34,000 logistics service providers (Melissa Cyrill, 2024)

Delivery operations in e-commerce contribute substantially to greenhouse gas emissions, primarily due to the reliance on fossil-fueled vehicles. Research by Nguyen et al. (2020) estimates that delivery vehicles in Vietnam emit approximately 5 million tons of CO₂ annually, accounting for around 10% of the total emissions from the transportation sector. This poses a significant challenge to Vietnam's commitment to reducing emissions under the Paris Agreement.

Globally, companies are adopting carbon neutral delivery solutions, such as electric vehicles (EVs), route optimization technologies, and participation in carbon offset programs. In Vietnam, some enterprises have begun piloting EVs for delivery, but adoption remains limited due to high initial costs and underdeveloped infrastructure. Tran et al. (2021) reported that only about 5% of logistics companies in Vietnam use environmentally friendly vehicles, highlighting the gap between global trends and local practices.

While carbon-neutral delivery has gained traction globally, particularly in developed markets, limited research explores its application in emerging economies like Vietnam. Existing studies primarily focus on the environmental impacts of logistics in developed nations, overlooking the unique economic, infrastructural, and cultural challenges faced by developing countries. Additionally, the majority of research emphasizes technological advancements, with insufficient attention given to the role of collaboration between stakeholders, such as businesses, policymakers, and consumers, in overcoming these barriers.

The objectives of this study are multifaceted and aim to provide a comprehensive understanding of carbon neutral delivery in Vietnam's e-commerce context. First, the study seeks to analyze the current state of carbon neutral delivery, focusing on emerging practices and innovations within the country. Second, it aims to identify the key barriers that hinder the implementation of carbon neutral logistics in Vietnam's e-commerce sector. Third, the research explores the attitudes and behaviors of Vietnamese consumers toward eco-friendly delivery methods. Lastly, the study provides actionable recommendations for stakeholders, including e-commerce companies, consumers, and policymakers, to support the adoption of sustainable logistics practices and overcome existing challenges.

Literature Review

Delivery process

In the e-commerce model, the carbon footprint is largely generated by complex transportation chains. The green design addresses this issue by integrating sellers' systems with an online marketplace platform to efficiently collect order details. Sellers then partner with third-party logistics providers to handle product deliveries. This approach eliminates the need for the online marketplace platform's distribution center by allowing third-party logistics providers to collect parcels directly from sellers. The logistics provider's distribution center takes over the tasks of sorting and routing orders, which are then sent to local depots and delivered directly to consumers. Reducing transportation steps streamlined process significantly lowers the carbon footprint associated with deliveries. A comparison of carbon footprint values between the traditional e-commerce model and this green model highlights the substantial environmental benefits achievable through optimized logistics practices.

The following diagram clearly demonstrates that activities such as browsing and trips completed by car result in the highest levels of carbon emissions during the initial delivery stage.



Figure 1. Conventional shopping trip: g/CO₂ per consumer trip. *Source: Li (2024).*

Figure 1 highlights how various transportation methods used during the initial delivery phase result in different levels of carbon emissions. A key scenario is trip chaining, which optimizes personal trips and reduces emissions. In contrast, browsing trips negatively impact the environment, potentially doubling or tripling emissions during online shopping. On average, a combined trip generates around 1,069 grams of CO₂ emissions. Data analysis reveals that car travel remains the least eco-friendly option for first deliveries.

The lifecycle of a product often extends beyond its first delivery, especially in the e-commerce industry, where return rates average around 30%. This significant volume of returns requires extra resources for packaging and transportation, increasing the environmental impact of the logistics process.

Carbon neutral delivery

Carbon-neutral delivery refers to the process of transporting goods in a manner that results in net-zero carbon dioxide (CO₂) emissions. This is achieved by first minimizing emissions through strategies such as utilizing electric vehicles, optimizing delivery routes, and employing sustainable packaging. Any remaining emissions are then offset by investing in environmental projects that either prevent an equivalent amount of CO₂ from being emitted or remove it from the atmosphere. According to Shan et al. (2021) carbon neutrality involves balancing the total greenhouse gas emissions produced - either directly or indirectly - by a country, business, product, activity, or individual within a specific timeframe. According to Wei et al. (2022), "carbon neutrality" is achieved when CO₂ emissions reach a peak and subsequently start decreasing. It refers to the point where the total anthropogenic CO₂ emissions of a specific entity are balanced by the corresponding anthropogenic removals within a defined timeframe.

Furthermore, carbon neutral delivery is similar to green shipping which offers energy-efficient solutions for transporting large volumes of cargo while supporting the global shift toward a low-carbon green economy. Consequently, green shipping is recognized for its effectiveness in reducing pollution emissions and promoting a more sustainable environment. This growing significance has made green shipping a global priority, spurring a surge in research over the past three decades (Wan et al., 2016).

Moreover, the Intergovernmental Panel on Climate Change (Matthews et al., 2022) notes that while the terms "carbon neutrality" and "net zero emissions" are largely similar, they differ in certain aspects, including scope, goals, and approaches (Zhao et al., 2022). Although these phrases are frequently used interchangeably, understanding their distinctions is crucial for shaping effective supply chain strategies.

In general, carbon neutrality is poised to become one of the most impactful scenarios in the global digital transformation journey, with digital intelligence technology expected to play a pivotal role as the foundational framework driving the entire carbon neutrality process.

Vietnam's E-commerce Landscape

Vietnam's e-commerce sector is rapidly becoming a key player in the Southeast Asian market, experiencing substantial growth in recent years. By 2022, e-commerce revenue had surged to around 16.4 billion USD, representing approximately 7.5% of the nation's total retail sales of goods and services. From a strategic standpoint, e-commerce provides a supportive environment for the adoption of innovative business models and the sustained advancement of the national innovation system (Van et al., 2021).

According to eMarketer, Vietnam ranks among the top five countries with the fastest-growing cross-border e-commerce market, achieving an annual growth rate of 20%. Social commerce, a subset of e-commerce that

integrates digital platforms and social media to enable both social interaction and online transactions, accounted for 65% of Vietnam’s online retail sector in 2021, reaching a total value of \$22 billion (Giulia Interesse, 2023). In the previous year, the nation’s four leading platforms—Shopee, Lazada, Tiki, and Sendo—collectively generated 135 trillion VND (approximately 5.73 billion USD) in revenue. Shopee and Lazada remain the top two e-commerce platforms, while Tiktok Shop, despite launching in mid-2022, quickly emerged as the third-largest retail e-commerce platform in Vietnam (Vietnam Plus, 2023).

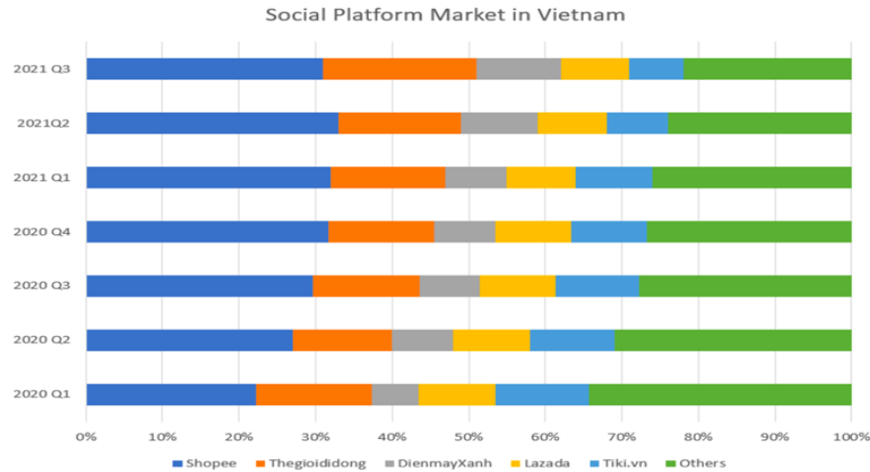


Figure 2. Social platform market in Vietnam (Q&Me, 2022).

As noted in the *Country Commercial Guide for Vietnam* (2023), Vietnam had approximately 69 million smartphone users in 2022, reflecting an impressive internet penetration rate of 71%. Projections suggest this number will rise to over 82 million by 2025. Such widespread internet access and smartphone adoption are expected to provide strong and enduring support for the continued growth and stability of Vietnam's online retail sector. The rise of online shopping has significantly influenced consumer behavior, bringing about profound shifts in the retail landscape. The convenience, variety, and customer-centric experiences offered by e-commerce platforms have reshaped traditional shopping patterns, leading to notable changes in purchasing habits.

However, the rapid growth of online retail in Vietnam has raised significant environmental concerns, particularly in terms of packaging waste, energy consumption, and carbon emissions from extensive logistics operations. The demand for faster deliveries and increasing transportation activities has contributed to a growing carbon footprint.

Carbon Neutral Logistics Trends in the world

While research on environmentally friendly practices in shipping has a long-standing history, there has been a significant rise in both the number of published papers and journals over the past five years. This trend likely reflects growing concerns about the environmental impacts of shipping, advancements in alternative energy technologies, engines, and materials designed to reduce pollution, as well as the complexities policymakers face in implementing environmental regulations. Furthermore, the broader availability of diverse data sources and enhanced computational capabilities now enable researchers to conduct more comprehensive studies, contributing to notable progress in this field. Table 1 presents the number of published papers and journals grouped in five-year intervals over the years.

Table 1. Journals on green shipping research from 1988 to 2017.

No.	Journals	1988-1992	1993-1997	1998-2002	2003-2007	2008-2012	2013-2017	1988-2017
1	Transportation Research Part D	0	0	0	3	15	54	72
2	Maritime Policy & Management	2	1	1	0	11	24	39
3	Transportation Research Part E	0	0	2	0	2	21	25
4	International Journal of Shipping Transport Logistics	0	0	0	0	1	11	12
5	International Journal of Sustainable	0	0	0	0	4	7	11

6	Transport Policy	0	1	0	2	3	5	11
7	European Journal of Transport and Infrastructure Research	0	0	0	7	0	0	7
8	Maritime Economics & Logistics	0	0	1	0	1	6	8
9	Transportation Research Part A	0	1	0	0	1	4	6
10	Transport Reviews	1	0	1	1	1	3	6
11	Journal of Transport Geography	0	1	0	0	1	3	5
12	International Journal of Transport Economics	0	0	0	0	0	2	2
13	Journal of Transport Economics and Policy	1	0	0	0	1	0	2
14	Transportation Letters	0	0	0	0	0	2	2
15	European Transport Research Review	0	0	0	0	1	0	1
16	Research in Transportation Economics	0	0	0	0	1	0	1
17	Transportation Journal	0	0	0	0	0	2	2
18	Transportation Research Part B	0	0	0	0	1	0	1
	Total	4	4	5	13	42	145	213

Source: Shi et al. (2018).

The total number of studies increased steadily across the different periods, starting from only 4 papers between 1988 and 1992 to 145 papers during 2013–2017. This reflects a growing interest in the topics of green shipping and carbon-neutral delivery, especially in the past two decades, with a sharp rise after 2008. This reflects the urgent demand for sustainable solutions in the logistics sectors to address global environmental challenges. Given the ongoing advancements in green technologies and stricter environmental regulations, this research area is likely to continue expanding in the coming years.

Los Angeles – Shanghai Corridor

The United States, one of 19 countries that signed the Clydebank Declaration, recently released an initial strategic plan for the creation of a Green Corridor. The US emphasized its commitment to active collaboration with international partners to achieve zero-carbon emissions in the shipping industry by 2050. Notably, in late January 2022, the US formed a partnership network involving cities, ports, and shipping companies to develop the Los Angeles – Shanghai route, one of the world's largest container shipping lanes, as a Green Corridor (Offshore Energy, 2022). These efforts are anticipated to significantly accelerate the decarbonization of maritime transportation between the two major ports in the US and China.

Port of Antwerp – Port of Montreal Green Corridor

During Climate Change Conference 26th, the Port of Antwerp and the Port of Montreal formalized a cooperation agreement to develop the first Green Corridor in the North Atlantic. Building on a strong partnership that began in 2013, the two ports committed to sharing knowledge and expertise while working together to create economic value and contribute to international efforts to combat climate change.

This agreement aims to advance the adoption of low-carbon fuels and establish clean infrastructure for ocean transport between Europe and North America. A key focus is promoting both direct and indirect electric propulsion in international shipping by driving progress in the production, supply, and utilization of green hydrogen.

United Kingdom (UK)

In April 2018, the UK played a key role as a leading IMO Member State in proposing an initial strategic resolution aimed at reducing greenhouse gas (GHG) emissions, with a firm commitment to cutting emissions in the shipping industry by at least 50% by 2050. In line with this objective, the UK government released the Maritime 2050 Report in January 2019, outlining a long-term strategic vision for promoting sustainability and eco-friendly practices in the maritime sector (UK Department for Transport, 2019).

In addition, there are many cases around the world for instance, Sainsbury's supermarkets in the UK have transitioned their delivery fleet to electric vans, while China has adopted electric bicycles for short-distance deliveries (Robinson et al., 2014). Likewise, home deliveries in urban areas can utilize alternative transportation methods that produce no carbon emissions, such as public transport systems like trams (Visser et al., 2014). These approaches offer potential environmental and societal benefits (van Loon, 2015). By transforming negative impacts into positive outcomes, these measures contribute to more sustainable e-commerce and ecological practices.

Unlike the United Kingdom, developing countries such as Pakistan face significantly lower regulatory pressures regarding carbon neutrality. For example, a company in Pakistan noted that while the government has enhanced regulations and introduced incentives for businesses aiming to achieve carbon neutrality, these measures primarily focus on the export sector.

METHODOLOGY

The primary research method employed in this study is the literature review, which involves systematically collecting, analyzing, and synthesizing information from existing academic articles, reports, and credible sources. This method was chosen to gain a comprehensive understanding of the key concepts related to carbon-neutral delivery, consumer awareness, and sustainable logistics. By reviewing a wide range of scholarly articles, both theoretical and empirical, the study identifies current trends, best practices, and research gaps in the field.

The literature review process was carried out by searching reputable databases such as Google Scholar, Scopus, and Web of Science, using relevant keywords like "carbon-neutral delivery," "Vietnamese e-commerce logistics," and "consumer attitudes toward sustainability." The selected articles were analyzed and categorized based on themes, including regulatory frameworks, consumer preferences, and green logistics initiatives.

This method helps establish a strong theoretical foundation for the study and ensures that the findings are aligned with existing knowledge. Additionally, it allows the study to compare Vietnam's context with global practices in sustainable logistics. This approach contributes to proposing future research directions and actionable strategies for promoting carbon-neutral delivery in Vietnam.

Key Discussion Points

Regulatory framework on carbon neutral delivery

Developing a regulatory framework for carbon-neutral delivery is essential to mitigate the environmental impact of logistics and transportation. Clearly, the Internet is a transformative technology for advancing environmental policies. However, policymakers in the environmental sector have faced significant challenges as they navigate this rapidly evolving domain of interdisciplinary interactions and ever-changing technological landscapes. In the years ahead, governments around the world are expected to introduce targeted laws and regulations for businesses and supply chains to uphold their commitments to achieving carbon neutrality.

The International Maritime Organization (IMO) has set ambitious targets to decarbonize shipping, aiming for a 50% reduction in greenhouse gas emissions by 2050 compared to 2008 levels. This goal encourages the adoption of carbon-neutral practices in maritime logistics. Countries are implementing policies to promote carbon-neutral delivery. For instance, the European Union's 'European Green Deal' targets climate neutrality by 2050, influencing logistics and delivery services to adopt sustainable practices. (Standardclub, 2021).

Vietnam has demonstrated a strong commitment to achieving carbon neutrality by 2050, implementing a comprehensive regulatory framework to guide this transition. This framework encompasses national strategies, legal instruments, and sector-specific action plans aimed at reducing greenhouse gas (GHG) emissions across various industries, including transportation and delivery services.

In July 2022, the Vietnamese government approved the National Climate Change Strategy, which outlines the country's roadmap to achieve net-zero emissions by 2050. This strategy sets specific targets for GHG emission reductions and emphasizes the development of sustainable infrastructure and the adoption of clean energy technologies (Climate Action Tracker, 2023).

Effective January 2022, Vietnam's revised Law on Environmental Protection provides the legal basis for establishing a carbon market. This law mandates the use of best available technologies to control pollution and limit environmental impacts, thereby promoting carbon-neutral practices across various sectors, including logistics and delivery services (World Bank Group, 2021).

Vietnam is expediting the development of its domestic carbon market, with plans to assign emission quotas to industries such as power, iron and steel, and cement by 2025. This initiative aims to create economic incentives for businesses to reduce their carbon footprints, aligning with global carbon pricing mechanisms and facilitating compliance with international trade regulations. (S & P Global, 2024).

The transportation sector, a significant contributor to GHG emissions, is a focal point in Vietnam's carbon neutrality efforts. The government has approved an action plan to reduce carbon emissions in transportation, aiming for all transport to run on electricity or green energy by 2050. This plan includes the gradual reduction of fossil-fueled vehicles and substantial investments in sustainable transport infrastructure (Vietnam Briefing, 2022).

In conclusion, Vietnam's regulatory framework for carbon-neutral delivery is characterized by comprehensive national strategies, robust legal instruments, and proactive sector-specific action plans. These measures, supported by international partnerships, position Vietnam on a progressive path toward achieving its carbon neutrality objectives by 2050.

Vietnamese consumer awareness and attitudes toward carbon neutral delivery

A key factor highlighting the significance of the last mile in express transportation is consumer delivery preferences. Over the past five years, about one-third of individuals have reported a decrease in their free time due to longer commutes, family obligations, and school-related tasks (National Retail Federation, 2020). As a result, the demand for convenience in various aspects of life has risen, including the expectation for online retailers to provide more convenient delivery services.

In major cities like Ho Chi Minh City and Hanoi, traffic congestion and long commuting times are common, leading to a reduction in free time for many individuals. This encourages consumers to prefer online shopping, where fast and convenient last-mile delivery is highly valued. With more dual-income households and young professionals in Vietnam's growing urban areas, convenience has become a key purchasing criterion. Consumers expect retailers to offer services such as same-day delivery, next-day delivery, and even time-slot deliveries.

For instance, Shopee has launched Shopee Xpress, a dedicated logistics service offering same-day and next-day delivery in major cities such as Ho Chi Minh City and Hanoi; Tiki's premium service, TikiNOW, offers 2-hour delivery for selected products in key urban areas.

However, Vietnamese consumers are increasingly aware of environmental issues, which influences their purchasing behaviors, including attitudes toward carbon-neutral delivery services. Studies indicate a growing environmental consciousness among Vietnamese consumers, leading to a preference for eco-friendly products and services.

A study by Hoang Van Hai and Nguyen Phuong Mai (2013) found that consumers with higher education levels in Hanoi, Ho Chi Minh City, and Da Nang are more concerned about environmental issues and possess sufficient knowledge of eco-products and green purchasing. These environmentally conscious consumers exhibit positive attitudes toward green purchasing and express a strong willingness to engage in such behaviors in the future.

Further research by Pham Thi Be Nam and Phan Thi Tuyet Van in 2021 revealed that Vietnamese consumers have significant environmental awareness and are inclined to purchase eco-friendly products. Key factors positively affecting their attitudes toward eco-friendly purchase intentions include environmental concern, personal norms, satisfaction, word of mouth, and willingness to pay. Among these, environmental concern is the primary factor influencing purchasing intentions.

While these studies highlight a general trend toward eco-friendly consumption, specific empirical research on Vietnamese consumer attitudes toward carbon-neutral delivery services is limited. However, the increasing environmental awareness and positive attitudes toward green products suggest a potential openness to carbon-neutral delivery options. Businesses aiming to implement such services in Vietnam should consider these consumer attitudes and the importance of environmental concerns in purchasing decisions.

In conclusion, Vietnamese consumers are becoming more environmentally conscious, positively influencing their attitudes toward eco-friendly products and services. Although direct studies on carbon-neutral delivery are scarce, the general trend suggests a favorable reception to such initiatives.

Opportunities of advancing carbon neutral delivery in Vietnam

On December 9th, 2024, Prime Minister Pham Minh Chinh issued a directive to accelerate the execution of the national green growth strategy for the 2021–2030 period, with a long-term vision extending to 2050. This initiative marks a significant move toward achieving the goal of carbon neutrality (Vietnamplus, 2024).

Significantly, Vietnam and the International Partnership Group (IPG) reached an agreement on the Just Energy Transition Partnership (JETP) last year, securing a commitment of \$15.5 billion to support the country's shift towards clean energy. This is also one of the most important opportunities for Vietnam (Binh Truong, 2023).

Moreover, according to Vu Trung Kien, Director of Climate Change Resilience Centre (2024), the global shift towards sustainability is attracting significant investments in green technologies. Vietnam's commitment to carbon-neutral transportation is expected to draw both domestic and international investors, fostering economic growth and job creation. The government's plan to develop a carbon market further enhances investment prospects in sustainable projects.

The growing emphasis on sustainable consumption has profoundly influenced Vietnam's business environment, driving companies to adjust their strategies and operations in response to changing consumer preferences. This trend is further supported by KPMG Vietnam's 2022 Customer Experience Excellence (CEE) report (Nguyen Tuan Hong Phuc, 2022), which reveals that 93% of consumers are more likely to pay a premium for products from businesses committed to Environmental, Social, and Governance (ESG) principles. These findings underscore the critical role of sustainability in shaping business practices, including the adoption of green logistics solutions, such as those provided by DHL Express Vietnam.

Similarly, in 2023, Lazada Logistics aims to introduce the first 100 electric motorbikes for deliveries in Vietnam as part of its Green Delivery program, contributing to emission reduction efforts. The adoption of electric vehicles aligns with regional and global trends, reinforcing Lazada's commitment to a sustainable and eco-friendly future. Earlier, in 2022, Lazada partnered with brands on LazMall to launch the LazEarth campaign in celebration of Earth Day, promoting greater consumer access to eco-friendly products. In terms of order packaging, Lazada has implemented various waste reduction initiatives, including recycling packaging materials, using technology to automate the selection of appropriately sized packaging, and employing sustainable, FSC-certified packaging materials. Additionally, nylon linings have been replaced with recycled paper materials. Lazada has also invested in advanced sorting technology to improve efficiency, accuracy, traceability, and cost-effectiveness while minimizing environmental impact (VECOM, 2023).

Challenges of advancing carbon neutral delivery in Vietnam

While the pursuit of carbon-neutral delivery in Vietnam is essential for sustainable development, it is impeded by significant economic, logistical, cultural challenges, and regulatory that require coordinated efforts from the government, private sector, and society to overcome.

Firstly, the transition to carbon-neutral delivery systems necessitates substantial initial investments in electric vehicles (EVs) and renewable energy infrastructure. High upfront costs for EVs and the development of supporting infrastructure can be prohibitive for many logistics providers. A report by McKinsey (2022) highlights that Vietnam's shift towards sustainability will require considerable investment, posing economic challenges for businesses and the government.

Secondly, the current inadequacy of electric vehicle (EV) charging infrastructure poses significant logistical hurdles. The scarcity of charging stations, especially in rural areas, leads to 'range anxiety' among potential EV users, hindering the adoption of electric delivery vehicles. Currently, there are nearly 150,000 electric vehicle charging points across the country, according to the Vietnam Electricity Group in Hanoitimes (Ngoc Mai, 2024). However, these stations are primarily located in apartment buildings, shopping centers, parking lots, and gas stations.

Thirdly, delivering goods to rural regions in Vietnam is complicated by underdeveloped infrastructure and a dispersed population, making the implementation of carbon-neutral delivery solutions more complex. Inadequate road and port facilities, high logistics costs, and a shortage of skilled labor are key obstacles that need to be addressed. The government has prioritized infrastructure development and public-private partnerships to overcome these issues, with ongoing investments in road, rail, and port projects.

Fourthly, while there is a growing interest in sustainable practices among Vietnamese consumers, a significant portion remains unaware of or indifferent to eco-friendly delivery options. The limited consumer demand for eco-friendly delivery services poses a challenge for businesses considering investments in green logistics. Without clear consumer preference for sustainable delivery options, companies may find it economically unviable to invest in the necessary infrastructure and technologies required for carbon-neutral logistics. This situation creates a feedback loop where the lack of consumer demand leads to limited business investment, which in turn results in fewer eco-friendly delivery options being available in the market.

Recommendations. To overcome these challenges and capitalize on emerging opportunities, collaboration among businesses, consumers, and policymakers is critical.

Recommendations for businesses. Vietnam's e-commerce market is expanding rapidly, driven by increasing internet penetration and a growing middle class. Major players such as Shopee, Lazada, and Tiki are competing aggressively by improving delivery speed and convenience. However, this growth in delivery services is accompanied by higher carbon emissions. Despite rising global interest in sustainable logistics, high costs of adopting green technologies, such as electric vehicles (EVs) and renewable energy solutions, remain a significant barrier for businesses in Vietnam. Moreover, the fragmented logistics network in rural areas further complicates the deployment of eco-friendly delivery options. In order to overcome these barriers and contribute to carbon neutrality while maintaining their competitiveness in the e-commerce sector, companies should invest in green logistics technologies such as EV fleets and renewable energy-powered warehouses. Another example is Amazon with "Shipment Zero" program which aims to make 50% of its shipments carbon-neutral by 2030. This includes the adoption of electric vehicles and renewable energy for warehousing and transportation (Amazon, 2020).

Moreover, e-commerce companies could also develop partnerships with logistics providers focusing on sustainability, businesses can scale up eco-friendly delivery solutions. Examples from global leaders, such as DHL Express, show that green logistics can be a viable long-term strategy. GHTK (Giao Hang Tiet Kiem) is testing the use of electric bicycles for urban deliveries, reducing emissions from traditional motorbikes; Viettel Post has piloted electric motorbikes and trucks for delivery services in major cities; VNPost collaborates with international

organizations to implement eco-friendly delivery solutions, including electric bicycles and renewable energy-powered transportation; Lalamove has started using electric motorbikes for inner-city deliveries in cities like Ho Chi Minh City and Hanoi.

The e-commerce businesses can implement carbon offsetting programs such as offering customers the option to offset the carbon footprint of their deliveries by contributing to green initiatives such as tree planting or renewable energy projects or integrating a "green delivery fee" where customers can voluntarily pay a small additional amount for carbon offsetting.

In the age of AI, investing in advanced technologies like AI and data analytics to optimize delivery routes, reducing unnecessary fuel consumption and emissions is also a good idea.

E-commerce platforms like Shopee and Lazada could set up small fulfillment hubs in provincial areas like the Mekong Delta to serve nearby rural communities efficiently. Promoting warehouse localization strategies is a practical and impactful step toward advancing carbon-neutral delivery while addressing rural logistics challenges in Vietnam.

In order to increase customer experience, the e-commerce businesses can reward customers who choose eco-friendly delivery options with loyalty points, discounts, or other perks; host interactive events or gamified challenges encouraging customers to reduce their carbon footprint; promote slower, more sustainable delivery methods (e.g., consolidated shipments or delivery scheduling) to reduce the carbon impact. For example: Companies like Amazon provide discounts for opting into slower delivery services.

Recommendations for consumers

Vietnamese consumers are becoming more aware of sustainable consumption, with surveys indicating that many are willing to pay a premium for eco-friendly products. Despite this, awareness and demand for eco-friendly delivery options remain low. Many consumers prioritize low-cost, fast shipping over sustainable alternatives. Without significant consumer demand, businesses are reluctant to invest in green logistics. Therefore, every consumer should understand the benefits of green logistics, such as carbon-neutral shipping or the use of electric vehicles (EVs).

Opt for carbon-neutral or eco-friendly delivery when provided, even if it means waiting longer or paying a small premium. Prioritize slower shipping options, as express delivery often involves higher emissions due to less efficient routes or modes of transport. Purchase from e-commerce platforms or brands that provide eco-friendly delivery options. Provide feedback or reviews encouraging more sustainable practices, highlighting your preference for green logistics. Share information about eco-friendly delivery on your social media or with your friends and family to inspire them to make similar choices. Recommend platforms and companies that offer sustainable delivery options to your network. Consolidate your orders instead of placing multiple small orders to reduce delivery trips. Avoid unnecessary returns by making informed purchasing decisions, thus reducing the environmental impact of reverse logistics. Join or support campaigns that promote green delivery solutions. For example, sign petitions or support policies that encourage businesses to invest in green logistics. Volunteer or donate to organizations advocating for sustainable e-commerce practices. Contact businesses or customer service teams and ask them to provide eco-friendly delivery options if they don't already. Leave feedback suggesting they improve sustainability in their delivery processes. Take advantage of discounts, loyalty points, or rewards offered for choosing sustainable delivery options. Encourage businesses to implement such incentives if they don't already exist.

Recommendations for policymakers. The Vietnamese government has shown commitment to sustainability through initiatives such as the national green growth strategy and the Just Energy Transition Partnership (JETP) agreement. However, regulatory support specific to green logistics remains limited. Challenges such as the high cost of EVs, lack of EV charging infrastructure, and fragmented rural logistics networks hinder the adoption of carbon-neutral delivery solutions. What policy measures can be implemented to support businesses in transitioning to green logistics? Firstly, policymakers should offer subsidies or tax incentives for businesses adopting EVs and renewable energy solutions in their logistics operations. Secondly, government can collaborate with private investors to build EV charging stations in urban and rural areas to support electric delivery fleets. Especially, government need to establish national guidelines for carbon-neutral logistics and requiring e-commerce platforms to meet sustainability criteria would accelerate the transition toward greener practices. Moreover, Vietnamese government need to align Vietnam's green logistics goals with international frameworks like the Paris Agreement and the Just Energy Transition Partnership (JETP) to attract foreign funding and expertise as well as to collaborate with ASEAN countries to develop regional guidelines and standards for sustainable logistics. Finally, creating benchmarks to monitor the effectiveness of carbon-neutral delivery policies and adjust strategies is really necessary.

CONCLUSION

- This study provides a comprehensive analysis of the current state of carbon-neutral delivery in Vietnam's e-commerce sector, highlighting emerging practices and innovations. While global trends demonstrate a growing adoption of green logistics solutions such as electric vehicles (EVs), route optimization, and carbon offset programs, Vietnam remains in the early stages of this transition. Some logistics providers have started piloting EVs and integrating eco-friendly packaging, yet widespread implementation is hindered by high costs and infrastructural limitations. Nonetheless, there is a clear opportunity for businesses to capitalize on sustainable delivery initiatives as consumer and regulatory pressures continue to evolve.
- Despite the potential benefits, the study identifies several barriers to adopting carbon-neutral logistics in Vietnam. High initial investment costs, limited charging infrastructure for EVs, and inefficient supply chain management pose significant challenges. Additionally, the dominance of small and medium-sized logistics enterprises (SMEs) makes large-scale sustainability efforts difficult, as these companies often lack the financial capacity to invest in green technology. Government incentives, improved infrastructure, and collaborative industry efforts will be essential in addressing these obstacles and fostering the growth of sustainable delivery solutions.
- The research also examines Vietnamese consumers' awareness and attitudes toward eco-friendly delivery options. While there is increasing interest in sustainability, many consumers continue to prioritize low-cost and fast shipping over green alternatives. Limited awareness of the environmental impact of traditional logistics further dampens demand for sustainable delivery solutions. Raising public awareness through targeted education campaigns, transparent eco-labeling, and corporate initiatives could shift consumer behavior and encourage greater acceptance of carbon-neutral logistics.
- To facilitate the adoption of sustainable delivery solutions, this study provides key recommendations for businesses, consumers, and policymakers. E-commerce companies should integrate green logistics into their operations by offering incentives for eco-friendly shipping choices, investing in energy-efficient transportation, and adopting warehouse localization strategies. Consumers play a crucial role in driving demand for sustainable logistics by making informed purchasing decisions and supporting businesses that prioritize environmental responsibility. Finally, policymakers must introduce regulatory frameworks, financial incentives, and infrastructure investments to accelerate the transition toward a more sustainable e-commerce ecosystem. Fostering collaboration among stakeholders can help Vietnam make significant progress in achieving its carbon reduction targets while ensuring sustainable growth in its e-commerce sector.

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