

SUSTAINABLE LAST-MILE DELIVERY AND CONSUMER TRADE-OFFS IN VIETNAM: A PLS-SEM ANALYSIS OF ONLINE SHOPPERS

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ABSTRACT:

Amid the rapid expansion of e-commerce in Vietnam and the resulting pressure on urban logistics systems, the transition to sustainable last-mile delivery (LMD) has become increasingly imperative. This study analyzes the key determinants of online consumers' intentions to adopt green delivery options, with particular emphasis on the mediating role of consumer attitudes. Using Partial Least Squares Structural Equation Modeling (PLS-SEM) on survey data from 524 consumers, the findings indicate that perceived convenience and subjective norms are the primary drivers of sustainable adoption behavior. The results provide empirical insights into the behavioral mechanisms underlying green delivery choices, contributing to a deeper understanding of how sustainable practices can be integrated into urban logistics systems within the context of a rapidly evolving digital economy.

Keywords: sustainable last-mile delivery, Trade-offs, intention to use, PLS – SEM.

1. Introduction

Vietnam's e-commerce growth drives economic development but strains urban logistics. The last-mile delivery (LMD) segment reveals sharp contradictions between operational efficiency and sustainability goals. (Bosona, 2020) notes that fragmented trips and high stop frequencies in LMD waste fuel and significantly increase greenhouse gas (GHG) emissions and noise pollution in cities.

In response, "green logistics" solutions, such as electric vehicles (EVs) (Caggiani, Colovic, Prencipe, Ottomanelli, 2021), route optimization (El Karkouri, Hassine, Ledmaoui, Chaibi, Saadane, Enneya, El

Aroussi, 2025), and smart parcel lockers (Niemeijer & Buijs, 2023), have emerged. However, their effectiveness depends heavily on consumer adoption. While developed markets show willingness to pay for green delivery, the "trade-off" between personal convenience and environmental responsibility in Vietnam remains poorly understood.

Recent studies in Vietnam have often focused only on isolated aspects, such as innovativeness in using delivery stations (Tsai, Ngo, Che, Lin, 2024) or cost prioritization for fast-moving consumer goods. However, the lack of an integrated theoretical framework to fully explain psychological factors and

goal-directed motivations has created a significant "gap" in predicting user behavior.

Therefore, this study is conducted to deeply analyze the factors governing the intention to adopt sustainable last-mile delivery by combining the Theory of Planned Behavior (TPB) and the Theory of Reasoned Goal Pursuit (TRGP). By examining the impacts of environmental awareness, perceived cost, convenience, and social pressure under the mediating role of attitudes, the paper provides a multi-dimensional perspective on how Vietnamese consumers balance economic benefits and sustainable values.

Based on the Partial Least Squares Structural Equation Modeling (PLS-SEM) method with a survey sample of 524 users, the research results not only contribute to the theoretical foundation but also propose practical solutions such as establishing "green-by-default" options and optimizing centralized pickup points. This serves as an important basis for transport enterprises and policymakers to build a sustainable urban logistics ecosystem, aligning with current digital economy trends.

2. The research overview

2.1. Theoretical framework

This study integrates the Theory of Planned Behavior (TPB) and the Theory of Regulatory Goal Pursuit (TRGP) (Ajzen & Kruglanski, 2019) to explain consumer psychology in sustainable LMD. According to TPB, behavioral intention is driven by attitude, subjective norms, and perceived behavioral control. TRGP deepens this by explaining the trade-offs consumers face: balancing "promotion" goals (long-term environmental benefits) against "prevention" goals (avoiding extra time/costs). The analytical framework focuses on five independent variables: perceived convenience, perceived cost, environmental awareness, subjective norms, and online shopping habits, all influencing intention through the mediating role of attitude.

2.2. Research model

Based on the results of previous studies and the theoretical framework, the study proposes six

factors, consisting of Perceived Cost (PC); Perceived Convenience (PCon); Subjective Norms (SN); Environmental Awareness (EA); Attitude toward sustainable delivery (ASD); Environmental Concern (EC); Consumer Intention to Use sustainable delivery (IU).

Research hypotheses:

H1a: Perceived cost negatively affects consumer intention to adopt sustainable delivery

H1b: Perceived convenience positively affects consumer intention to adopt sustainable delivery.

H1c: Subjective norms positively affect consumer intention to use sustainable delivery.

H1d: Environmental awareness positively affects consumer intention to adopt sustainable delivery.

H2a: Perceived cost negatively affects attitude toward sustainable delivery.

H2b: Perceived convenience positively affects attitude toward sustainable delivery.

H2c: Subjective norms positively affect attitude toward sustainable delivery.

H2d: Environmental awareness positively affects attitude toward sustainable delivery.

H3a: Environmental concern positively moderates the relationship between subjective norms and consumer intention to adopt sustainable delivery.

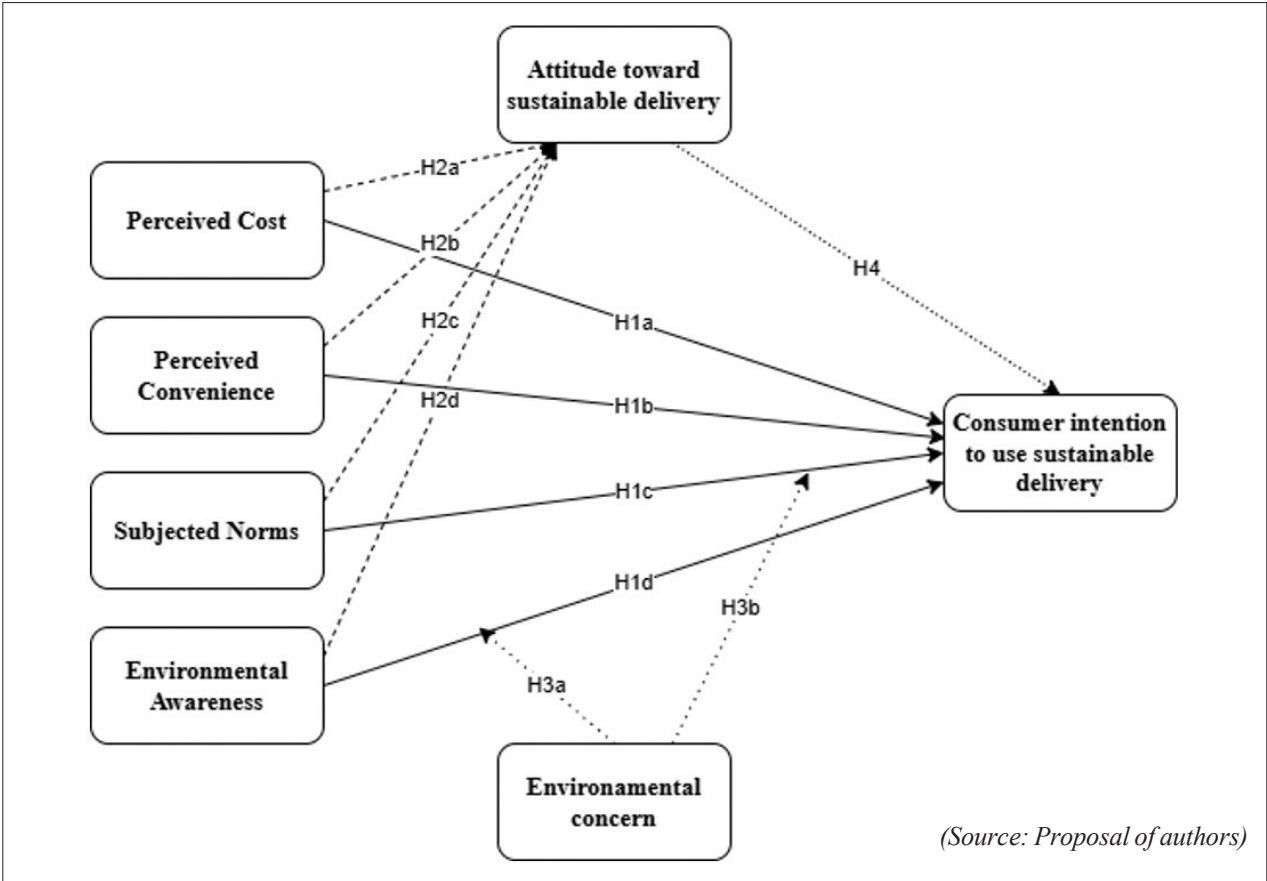
H3b: Environmental concern positively moderates the relationship between environmental awareness and consumer intention to adopt sustainable delivery.

H4: Attitude toward sustainable delivery positively affects consumer intention to adopt sustainable delivery.

3. The current state of last-mile delivery services and consumer trade-offs in Vietnam

Vietnam's e-commerce boom exerts immense pressure on last-mile delivery (LMD), a stage decisive for service quality but fraught with shortcomings. Characterized by frequent, small-scale trips and low consolidation (Bosona, 2020), LMD has become the most complex and costly supply chain phase. It can account for up to 53% of e-commerce expenses, with 39% of consumers willing

Figure 1. Proposed research model



to switch suppliers over unsatisfactory delivery experiences (Liêm Trần Thanh and Tiến Nguyễn Duy, 2020).

Beyond financial burdens, traditional LMD poses severe ecological challenges. Road transport handles over 70% of Vietnam's domestic freight, generating the highest greenhouse gas (GHG) emission intensity per ton-kilometer (Tạp chí Kinh tế và Dự báo, 2025). In dense urban areas, the proliferation of delivery vehicles heavily exacerbates traffic congestion, air, and noise pollution.

Furthermore, online shopping habits prioritizing speed inadvertently expand the carbon footprint. Express delivery can increase emissions by 10% to 12% compared to standard options. This impact worsens as consumers frequently place fragmented, uncoordinated orders, severely undermining carriers' ability to optimize routes (VnExpress, 2025).

Restructuring LMD is imperative, aligning with Vietnam's commitment to achieving Net Zero emissions by 2050. While economic policies like carbon credit markets encourage green investments, the transition is heavily dictated by urban planning. In hubs like Hanoi and Ho Chi Minh City, high population density and narrow alleys render large freight transport inefficient, favoring two-wheeled vehicles. Consequently, the LMD ecosystem currently operates three parallel delivery modes.

First, door-to-door home delivery remains the most preferred option (Buldeo Rai, Verlinde, Macharis, 2019). Primarily utilizing internal combustion engine motorcycles, this mode maximizes consumer convenience and speed. However, its near-absolute adoption rate directly correlates with high emissions and congestion, making it the least sustainable LMD model.

Second, electric vehicle (EV) delivery is currently in the testing phase. Recognizing emission pressures, logistics companies are transitioning their fleets. Nevertheless, adoption remains modest due to barriers such as initial investment costs, limited charging infrastructure, and EV payload limitations.

Third, out-of-home delivery, typified by collection points and smart parcel lockers, allows order consolidation, eliminating failed deliveries and reducing empty trips. Despite its high sustainability, consumer utilization remains very low, functioning primarily to educate the market.

The core bottleneck in adopting sustainable LMD is not technological limitation, but consumer reluctance when confronting trade-offs. Asking customers to abandon door-to-door habits or accept longer delivery times requires sacrificing personal utility regarding speed and convenience. This conflict between environmental consciousness and personal benefit maximization creates a significant psychological behavioral gap.

This study explores the factors influencing the adoption of sustainable LMD services. It provides a foundation to assist logistics enterprises and policymakers in formulating greening strategies that are both environmentally friendly and commercially feasible.

To empirically quantify these trade-offs, a survey of 524 online shoppers in Vietnam was conducted. Respondents are primarily Gen Z and Millennials, the core e-commerce demographic with high shopping frequencies and extensive delivery carrier experience. Data was collected predominantly in Hanoi and Ho Chi Minh City, key locations where sustainable solutions like EVs and smart lockers are actively piloted.

4. Evaluation and analysis of PLS-SEM results

The analytical results obtained from the Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 4 software have provided profound insights into the consumer trade-off process regarding the selection of sustainable last-

mile delivery services. First and foremost, perceived convenience was identified as the pivotal factor, exerting the strongest positive impact on both consumer attitudes and behavioral intentions. This reflects the reality that consumers tend to prioritize sustainable delivery methods when the process ensures flexibility and does not disrupt their personal schedules, typically exemplified by the use of smart parcel locker systems at convenient locations along their daily commute.

In tandem with convenience, subjective norms also play a significant role, proving that Vietnamese consumers' psychology is substantially influenced by community trends and the opinions of significant others. As "green living" increasingly becomes a positive social norm and trend, the intention to utilize eco-friendly logistics services rises accordingly to align with the expectations of those around them. Another notable finding is the "cost paradox," as the research results indicate that perceived cost does not have a significant negative impact on the intention to use within this specific survey sample. This suggests a crucial shift in modern consumer mindsets, where customers are willing to accept comparable or slightly higher fees if they clearly perceive the genuine environmental value provided by the service.

Finally, while environmental awareness has a direct impact on attitudes, environmental concern acting as a moderating variable does not significantly alter the causal relationships within the model. This demonstrates that the decision to choose sustainable delivery is currently a result of the intersection between pragmatic benefits (convenience) and individual moral responsibility, rather than merely depending on the specific level of environmental sensitivity of each individual.

5. Solutions and policy implications for promoting sustainable delivery

Based on the empirical findings, this paper proposes specific sets of solutions targeting relevant stakeholders to foster a sustainable delivery ecosystem in Vietnam. First, for e-commerce

platforms and logistics providers (such as Shopee, Lazada, or Viettel Post), the focus should be placed on realizing infrastructure solutions by accelerating the installation of smart parcel locker networks in public spaces. Since convenience has been proven to be the key driver, reducing dependence on direct delivery times and individual shippers will facilitate a more proactive transition to sustainable methods for consumers. Furthermore, businesses should actively transition to electric vehicle (EV) delivery fleets, combined with media campaigns that emphasize the value of community contribution to activate subjective norms, helping users perceive the social significance of choosing green services.

From a macro-management perspective, the Government and relevant authorities must act as catalysts by perfecting the legal framework, particularly by issuing stricter emission standard regulations for transport vehicles in inner-city areas. Applying tax incentives or subsidies for pioneering logistics enterprises that utilize clean energy will serve as a vital economic lever to drive this transition. Moreover, regarding urban planning, policymakers need to integrate goods collection points and EV charging station systems into the city's general infrastructure. Instead of solely

focusing on the traditional door-to-door delivery model, which exerts significant pressure on traffic and the environment, building centralized collection points will create a solid foundation to support the long-term development of sustainable logistics models.

6. Conclusion

Integrating Theory of Planned Behavior (TPB) and Theory of Reasoned Goal Pursuit (TRGP), this study demonstrates that attitude critically mediates Vietnamese consumers' intention to adopt sustainable last-mile delivery. Specifically, environmental awareness, perceived convenience, and subjective norms significantly drive adoption decisions. Interestingly, perceived cost and general environmental concern show no significant impact, indicating that convenience heavily outweighs financial barriers. Consequently, practical strategies should prioritize enhancing service convenience over financial subsidies. E-commerce and logistics firms must expand smart locker networks, leverage social proof, and maintain price parity. Furthermore, policymakers should invest in green urban infrastructure and targeted environmental education to effectively align consumer behaviors with sustainability goals ■

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**GIAO HÀNG CHẶNG CUỐI BỀN VỮNG
VÀ NHỮNG ĐÁNH ĐỔI CỦA NGƯỜI TIÊU DÙNG
TẠI VIỆT NAM:
NGHIÊN CỨU PLS-SEM ĐỐI VỚI
NGƯỜI MUA SẴM TRỰC TUYẾN**

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TÓM TẮT:

Sự bùng nổ thương mại điện tử tại Việt Nam đang gây áp lực lớn lên hệ thống logistics đô thị, khiến việc chuyển đổi sang giao hàng chặng cuối bền vững trở nên cấp thiết. Nghiên cứu này khám phá các nhân tố chi phối ý định lựa chọn giao hàng xanh của người tiêu dùng, đồng thời nhấn mạnh vai trò trung gian của thái độ tiêu dùng. Sử dụng mô hình PLS-SEM với dữ liệu từ 524 khách hàng, kết quả chỉ ra sự tiện lợi cảm nhận và chuẩn mực chủ quan là động lực chính thúc đẩy hành vi bền vững. Qua đó, nghiên cứu đề xuất giải pháp hoàn thiện hệ sinh thái logistics đô thị, góp phần kiến tạo nền kinh tế số bền vững và cung cấp cơ sở thực tiễn cho các doanh nghiệp vận tải.

Từ khóa: giao hàng chặng cuối bền vững, sự đánh đổi, ý định sử dụng, PLS-SEM.