



**Working Paper 2026
- Vol. 2, No. 2**

**ỨNG DỤNG PHƯƠNG PHÁP PHÂN TÍCH THỨ BẬC (AHP) VÀ KỸ THUẬT XẾP
HẠNG THEO ĐỘ TƯƠNG ĐỒNG VỚI GIẢI PHÁP LÝ TƯỞNG (TOPSIS) TRONG
ĐÁNH GIÁ MỨC ĐỘ PHÙ HỢP ĐỊA ĐIỂM ĐẶT TỦ NHẬN HÀNG TỰ ĐỘNG:
NGHIÊN CỨU VỀ SHOPEE TẠI THÀNH PHỐ HỒ CHÍ MINH**

Author: Lê Nguyễn Quỳnh Trâm¹

2312535022 – Institute of Business and International Trade,
k62.2312535022@ftu.edu.vn

Phan Trần Bách Hợp

2313535008 – Institute of Business and International Trade,
k62. 2313535008@ftu.edu.vn

Đào Ngọc Thế Dương

2312535005 – Institute of Business and International Trade,
k62. 2312535005@ftu.edu.vn

Võ Hoàng Phương

2313535019 – Institute of Business and International Trade,
k62. 2313535019@ftu.edu.vn

Nguyễn Ngọc Phương Quyên

2314535004 – Institute of Business and International Trade,
k62. 2314535004@ftu.edu.vn

Lê Đức Phương An

2213535028 – Institute of Business and International Trade,
k61. 2213535028@ftu.edu.vn

Foreign Trade University - Ho Chi Minh City Campus

¹ Corresponding author

Tóm tắt

Ngành thương mại điện tử tại Việt Nam tăng trưởng nhanh đã làm gia tăng áp lực lên logistics chặng cuối, đặc biệt tại các đô thị nhiều xe máy như TP. Hồ Chí Minh. Tủ gửi hàng tự động nổi lên như giải pháp giảm giao hàng thất bại, nhưng hiệu quả phụ thuộc lớn vào mức độ phù hợp của vị trí đặt tủ. Nghiên cứu này áp dụng mô hình tích hợp AHP–TOPSIS để đánh giá 110 vị trí tủ gửi hàng của Shopee dựa trên sáu yếu tố không gian chính từ góc nhìn người dùng. Kết quả cho thấy “Gần khu dân cư”, “Gần nơi làm việc” và “Loại hình nhà ở” là những yếu tố ảnh hưởng mạnh nhất, trong khi mật độ dân số và khả năng tiếp cận giao thông đóng vai trò phân biệt quan trọng giữa các vị trí hiệu quả cao và thấp. Mô hình mang lại công cụ định lượng hỗ trợ doanh nghiệp và nhà quy hoạch trong tối ưu hóa triển khai tủ gửi hàng tại Việt Nam.

Từ khoá: giao hàng chặng cuối, tủ gửi hàng tự động, AHP, TOPSIS, thương mại điện tử

ANALYTIC HIERARCHY PROCESS AND TECHNIQUE OF ORDER OF PREFERENCE BY SIMILARITY TO IDEAL SOLUTION IN ASSESSING PARCEL LOCKER SITE SUITABILITY: A SHOPEE CASE STUDY IN HO CHI MINH CITY

Abstract

The e-commerce industry in Vietnam has witnessed an unprecedented growth, along with customer demands in terms of speed, reliability, and convenience in delivery changing at an alarming pace. This transformation has compounded the operation of the last-mile logistics in highly motorbike-oriented cities such as Ho Chi Minh City. Parcel lockers have emerged as a promising replacement of the traditional home delivery to prevent failed delivery attempts and maximize both efficiency as well as routing. Remarkably, site suitability is a vital factor that determines the implementation of parcel lockers, especially in Vietnamese context. This paper develops a framework to evaluate the suitability of the parcel locker location through customers' perspective by using two models namely Analytic Hierarchy Process (AHP) and Technique of Order of Preference by Similarity to Ideal Solution (TOPSIS). Based on existing literature and professional assessments, six major spatial determinants were synthesized. This provides a logical, evidence-based strategy of assessing existing locations, hence prioritizing consumer convenience and operational viability. Besides, it also enhances the practice of methodological rigor in the last-mile planning context and presents a context-specific decision-support tool available to logistics operators, urban planners, and policymakers who are concerned with the sustainability of e-commerce in the fast-paced urbanizing environment in Vietnam.

Keywords: last-mile delivery, parcel locker, AHP, TOPSIS, e-commerce

1. Introduction

The e-commerce industry in Vietnam has expanded at a high rate over the past few years and has established itself as the third-largest market in Southeast Asia. The industry has reached

25 billion USD in 2024, which is 9% of national retail revenue, and is expected to increase to 62.5 billion USD in 2030 (Dung, 2025). With the growth of online shopping, the pressure on last-mile delivery systems is increasing to achieve speed, reliability, and cost-efficiency demands.

Despite its dominance in last-mile delivery, attended home delivery in Vietnam still suffers from high first-attempt failure rates (T. Hoang, 2019). The need for synchronization between consumers and couriers leads to resource inefficiencies and costly redeliveries (Agatz et al., 2008). Urban trends like smaller households and a growing working population (GSO, 2019; 2022) also make it increasingly unlikely that recipients are home during delivery windows. Parcel lockers offer an effective alternative by consolidating deliveries and achieving high first-attempt success (Lin et al., 2021). However, their performance depends heavily on appropriate site selection. Existing international models often prioritize cost and overlook behavioral or spatial factors critical to customer adoption, and they cannot be directly applied to Vietnam due to its unique density, mobility patterns, and infrastructure constraints.

Shopee's wide launch of smart pickup points on May 15, 2025 shows why a solid framework for evaluating parcel locker locations is essential. Combining findings from previous empirical research, with the emphasis on Asian regions like Bangkok (Thongkam, 2020), Singapore (Ma et al., 2024), and Guangzhou (Zheng et al., 2021), six factors stand out to be more influential for parcel locker adoption of customers, which are: Residential Proximity, Workplace Proximity, Household and Dwelling Type, Population Density, Transport Accessibility, and Leisure–Commercial Site. The study is organized as follows: Part 1: Introduction; Part 2: Literature Review & Conceptual Framework; Part 3: Methodology & Results; Part 4: Discussion of Findings; and Part 5: Conclusions & Recommendations.

2. Literature Review and Conceptual Framework

Parcel lockers are now a key tool used in last-mile delivery in rapid expansion of e-commerce. They allow customers to retrieve parcels conveniently through digital codes or apps that help reduce failed deliveries, costs and emissions (Kahr, 2022). However, the success of parcel lockers depends heavily on customer adoption and on the site locations. Poorly located lockers result in low utilization rates and undermine the operational or environmental benefits intended by their deployment (Schaefer, 2021; Lin et al., 2022).

Research shows that customer adoption of parcel lockers is driven mainly by convenience, safety, and time efficiency. Theories like the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) emphasize performance expectancy and effort expectancy are determinants of adoption, while spatial convenience, how close, accessible, and integrated a locker is into users' daily routines, acts as a physical manifestation of these constructs (Fara, 2023; Venkatesh et al., 2003). Lockers placed along people's daily routes (e.g., near workplaces, bus stops, or housing areas) reduce effort and time cost, strengthening perceived usefulness and trust (An et al., 2022). Conversely, lockers situated in isolated or unsafe areas raise perceived risks and discourage use (Schaefer, 2021). The Push–Pull–Mooring (PPM) framework further explains well-located lockers attract customers, while

inconveniently located ones push them back to traditional delivery (Nguyen et al., 2024). Thus, location is not merely an operational concern but a decisive factor influencing behavioral acceptance and long-term sustainability.

Table 1: List of Empirical Studies

Source: Synthesized by the Authors (2025)

Empirical Studies	Authors
Factors influencing adoption and usage probability of automated parcel lockers (Thailand)	Thongkam (2020)
Location analysis of parcel locker Network: Effects of spatial characteristics on operational performance (Singapore)	Ma et al. (2024)
A GIS-Based Bivariate Logistic Regression Model for the Site-Suitability Analysis of Parcel-Pickup Lockers: A Case Study of Guangzhou, China	Zheng et al. (2021)
Customer switching intention from home delivery to smart locker delivery: Evidence from Vietnam	N. Nguyen et al. (2024)
A Robust Optimization Method for Location Selection of Parcel Lockers under Uncertain Demands	Wang et al. (2022)
Determining locations and layouts for parcel lockers to support supply chain viability at the last mile	Kahr (2022)
Planning location of parcel lockers using group Analytic Hierarchy Process in Spherical Fuzzy environment	Moslem and Pilla (2024)
Spatio-temporal analysis of Australia Post parcel locker use during the initial system growth phase in Queensland (2013–2017)	Leung et al. (2023)
Optimizing parcel locker locations in a city crowd logistics network	Zhang et al. (2023)

Table 2: Common Themes Identified Across Prior Studies

Source: Synthesized by the Authors (2025)

Common Themes	Evidence From Prior Empirical Studies
Demand primarily emerges from residential areas	Kahr (2022): lockers located in high-density inner-city residential zones; Thongkam (2020): “near home” is strongest preference; Nguyen et al. (2024): convenience defined partly by proximity to residential areas; Zheng et al. (2021): distance to nearest residential quarter is the most important factor.

Workplaces form a secondary demand cluster	Leung et al. (2023): central-city sites characterized by high employment density; Thongkam (2020): notable share of users prefer lockers near offices; Zheng et al. (2021): proximity to commercial office buildings is a key determinant.
Housing structure influences usage patterns	Ma et al. (2024): dwelling unit size and age significantly associated with usage and pickup time; Thongkam (2020): higher adoption among condominium and apartment residents; Zheng et al. (2021): some dwelling types (e.g., dormitories) show weak relevance.
Areas with higher population or activity concentration show stronger suitability	Kahr (2022): selected zones have high resident concentration; Ma et al. (2024): population and building density linked to demand; Moslem and Pilla (2024): high-density areas rated as strong candidate sites; Zheng et al. (2021): commercial building density positively associated with suitability.
Ease of access and transport connectivity is critical	Kahr (2022): lockers frequently placed at transit nodes (subway, tram, bus stops); Ma et al. (2024): street intersections and bus-stop proximity increase usage; Moslem and Pilla (2024): accessibility is key evaluation criterion; Thongkam (2020): longer travel distance reduces adoption; Zheng et al. (2021): distance to bus stops highly influential.
Mixed-use or commercial environments enhance suitability	Kahr (2022): supermarkets, markets, hospitals included as POIs; Moslem and Pilla (2024): post offices and commercial areas ranked highly; Ma et al. (2024): living amenities nearby increase demand; Zheng et al. (2021): commercial-building density boosts suitability.

Synthesizing evidence from 10 empirical studies spanning over a broad area, and with the emphasis on Asian areas like Bangkok, Singapore, and Guangzhou, six determinants emerge as the most influential for customers' adoption of parcel locker: Residential Proximity, Workplace Proximity, Household and Dwelling Type, Population Density, Transport Accessibility, and Leisure–Commercial Site. These factors represent the interaction between where people live and work, how they move, and what activities coincide with parcel collection. From this synthesis, a conceptual framework for Site Suitability of Parcel Lockers is proposed as follows:

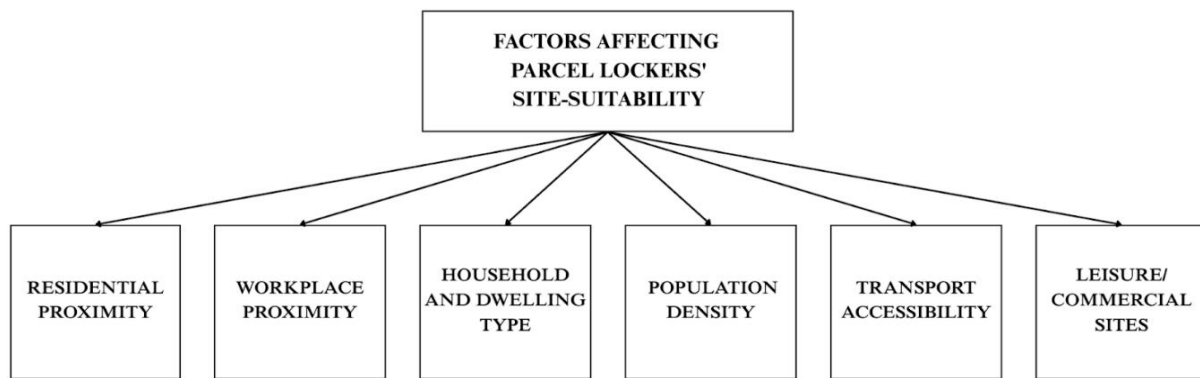


Figure 1: Conceptual framework for evaluation of site suitability

Source: Authors' own creation (2025)

3. Methodology and Results

This research used a quantitative method which combines two multi-criteria decision-making techniques: Analytical Hierarchy Process (AHP) and Technique of Order of Preference by Similarity to Ideal Solution (TOPSIS) (Saaty, 1980; Hwang and Yoon, 1981; Triantaphyllou, 2000; Belton và Stewart, 2002). This helps to meet two fundamental research objectives: (1) to measure the relative significance of location-related variables from the conceptual framework above from customer's perspective; and (2) to assess and rank the existing parcel locker sites based on the weighted factors. The process includes collecting expert judgement and synthesizing to determine the final weights for the factors. Then secondary quantitative data was collected as inputs for the ranking matrix in TOPSIS.

For AHP's analysis, experts from various backgrounds were surveyed (coded E1 - E4). Expert 1 and 2 are high-level directors in logistics firms (ITL and Everich), each with nearly 20 years of industry experience. Expert 3 and 4 are FTU2 professors in Logistics and Supply Chain management, and Economics majors with around 10 years of academic experience. This diversity of expertise was important because it helped us ensure the reliability and practicality of the final criteria weights.

In the survey, every expert was requested to rank pairs of factors in terms of their relative significance. The comparison was made on a continuous scale from 1 to 9 where the expert chose a point on the line to show the extent to which the factor was more significant and by how much. The further the selection made from the focal point (5), the higher the perceived importance of that factor. Once the data has been collected, these continuous responses are converted into the discrete AHP scale of 1-3-5-7-9 and its inverse fractions (1/3, 1/5, 1/7, 1/9).

Table 3: Synthesis of the priority levels of the level-1 factors

Source: Authors' own creation (2025)

Criterion A	Responses of Experts				Criterion B
	E1	E2	E3	E4	
Residential Proximity	9	1	5	1/7	Workplace Proximity
	5	1/3	1	7	Household & Dwelling Type
	9	0,2	5	3	Population Density
	3	1	5	3	Transport Accessibility
	9	3	5	1	Leisure/Commercial Sites
Workplace Proximity	3	1/3	1/5	7	Household and Dwelling Type
	9	1/3	1/3	3	Population Density
	9	1	1	5	Transport Accessibility
	9	3	5	5	Leisure/Commercial Sites
Household and Dwelling Type	9	1/3	3	1/5	Population Density
	7	1	3	1/7	Transport Accessibility
	7	1	3	1/7	Leisure/Commercial Sites
Population Density					Transport Accessibility
	3	3	1/5	1	
	3	1/3	1/3	3	Leisure/Commercial Sites
Transport Accessibility	3	1/3	1/3	7	Leisure/Commercial Sites

Table 4: Consistency ratio of each expert and the expert panel

Source: Authors' own creation (2025)

Set	Importance	$\lambda_{\max}$	CI	RI	CR	Status
Expert E1	3	7,6779	0,3356	1,2400	0,2706	FAIL
Expert E2	2	7,9272	0,3854	1,2400	0,3108	FAIL
Expert E3	3	7,8401	0,3680	1,2400	0,2968	FAIL
Expert E4	1	7,3033	0,2607	1,2400	0,2102	FAIL
EXPERTS PANEL		6,2415	0,0483	1,2400	0,0390	PASS

The individual expert judgments had Consistency Ratios (CRs) exceeding 0.10. Nevertheless, the group matrix obtained the CR of 0.039 after aggregation based on the Weighted Geometric Mean Method, which is below the allowable limit. It has been demonstrated in the previous literature of Grošelj & Stirn (2012) that the result of group-level aggregation may diminish inconsistencies even in case of high levels of individual CRs. Thus, analysis was done in terms of group CR, sensitivity test subsequently done (see Table 6) to confirm the strength of the result. Based on the views expressed by experts above, we did the weightings of each factor as follows:

Table 5: Weight allocation of factors using AHP model

Source: Authors' own creation (2025)

Ranking	Factors	Weight
1	Residential Proximity	0.3391
2	Workplace Proximity	0.1995
3	Household & Dwelling Type	0.1938
4	Population Density	0.1027
5	Transport Accessibility	0.0877
6	Leisure & Commercial Sites	0.0772
Total Weight		1

The robustness test was done in the perspective of testing the stability of the results of the AHP Model related to slight changes in weights and variations in expert consistency. The sensitivity analysis is grounded on the “rank flip threshold” whereby the sensitivity of the weight variation that might change the ranking of alternatives is identified. The sensitivity analysis proves the strength of the AHP results. Residential Proximity remains its leading position and this factor needs to be reduced by 41 percent in order to lose its rank. The Workplace Proximity and Household & Dwelling Type factors have a slight sensitivity with

boundaries ($\pm 2.9\%$), which shows the same importance. Transport Accessibility and Public/Utility Sites can alternate the ranking with a variation of 12-14% whereas Population Density would require a 88.6% growth to alter its place. Overall, the rankings are very consistent, which supports the validity of the consensus weights:

Table 6: Sensitivity test of the AHP model's conclusion

Source: Authors' own creation (2025)

Criterion	Baseline Weight	% to overtake Neighbor Above	% to be overtaken by Neighbor Below
Residential Proximity	0.3391		-41,17
Workplace Proximity	0.1995	69,97	-2,86
Household & Dwelling Type	0.1938	2,94	-47,01
Population Density	0.1027	88,7	-14,61
Transport Accessibility	0.0877	17,1	-11,97
Leisure & Commercial Sites	0.0772	13,6	

The substitute that the author team employed in the case is the “List of Shopee’s Smart Lockers’ Location in HCMC, and it provides more detailed information about the location of the lockers, including the name, the ward and the district. The raw dataset has 224 parcel lockers units in HCMC. However, most of these units are located in a complex. For instance, two or more lockers are located in different blocks of the same apartment. In order to eliminate the issue of redundancy, the authors group proximate units into a single functional unit site to present findings that can capture significant differences as opposed to repeated observations (Anes & Abreu, 2025). After condensing, 110 alternatives will be analyzed:

Table 7: Overview of Shopee lockers and sites in HCMC

Source: Authors' own creation (2025)

District	Population (people)	Area (km ²)	No. of Lockers	No. of Sites
Binh Chanh Town	680,000	253	9	4
Nha Be Town	175,360	100	6	3
District 1	205,180	7.73	2	2
District 10	372,450	5.72	4	1
District 11	332,536	5.14	4	4
District 12	520,175	52.78	34	18

District 3	196,433	4.92	1	1
District 4	203,060	4.18	4	3
District 5	187,510	4.27	5	2
District 6	258,945	7.19	4	3
District 7	324,620	35.69	15	12
District 8	451,290	19.18	22	8
Binh Tan District	702,650	51.89	13	5
Binh Thanh District	490,618	20.76	15	7
Go Vap District	663,313	19.74	6	3
Phu Nhuan District	182,477	4.88	2	2
Tan Binh District	470,350	22.38	4	3
Tan Phu District	464,493	16.06	9	8
Thu Duc City	1.013.795	211,56	64	21

In order to utilize the TOPSIS model, the decision matrix was created based on the locker sites of Shopee as alternatives and six factors that were derived through AHP usage. All criteria were characterized as the variable of “benefit” or “cost”, which implies that the higher the value is, the better the site is ranked in terms of user adoption potential. The six variables have the following direction and measurement:

Table 8: Direction and measurements of 6 factors

Source: Authors' own creation (2025)

Criterion	Direction	Measurement/Scoring
Residential Proximity	Cost	Manual 1 (best) - 5 (worst) scoring based on distance to nearest residential cluster
Workplace Proximity	Benefit	Manual 1 (worst) - 5 (best) scoring based on the overall proximity to employment areas in HCMC
Household & Dwelling Type	Benefit	Manual 1 (worst) - 5 (best) scoring based on the location type
Population Density	Benefit	Population Density in the Ward (people/km ²)
Transport Accessibility	Cost	Distance to the nearest Main Road (m)
Leisure/Commercial Sites	Benefit	No. of Mall/Convenience Stores in the Ward

Table 9: Sources of Data for 6 factors

Source: Authors' own creation (2025)

Criterion	Direction	Source of Data
Residential Proximity	Cost	
Workplace Proximity	Benefit	Google Maps' open data
Household & Dwelling Type	Benefit	
Population Density	Benefit	General Statistics Office of Vietnam (2021)
Transport Accessibility	Cost	Google Maps' open data
Leisure/Commercial Sites	Benefit	HCMC Department of Industry and Trade (2021)

The ideal best and ideal worst values are, respectively, the highest and lowest value of each criterion calculated from the input data. The closer one's criterion is to the Ideal Best value, the higher one's ranking is.

Table 10: The ideal best & worst for 6 factors

Source: Authors' own creation (2025)

Criterion	Direction	Ideal_Best	Ideal_Worst
Residential Proximity	Cost	0	0,1569794775
Workplace Proximity	Benefit	0,02342500389	0,01377941405
Household & Dwelling Type	Benefit	0,01905032517	0,004762581292
Population Density	Benefit	0,02971769353	0,0005651111192
Transport Accessibility	Cost	0	0,04225099899
Public/Utility Sites	Benefit	0,01382739169	0,000395068334

Moreover, the Closeness Coefficient (CC) is also utilized to indicate the relative closeness of each site to the ideal solution, which represents the overall performance of each site. From the calculated CC, we have the list of the 10 best and worst Locker Sites as follows:

Table 11: Top 10 highest ranking sites

Source: Authors' own creation (2025)

Alternative	Site Name	Ward	District	Rank	CC
A10	Cao ốc Ngô Gia Tự	2	10	1	0,9189
A14	Tân Phước Plaza	7	11	2	0,9183
A13	Chung cư Khải Hoàn Apartment	5	11	3	0,9101
A68	Tòa nhà Phước Thành	2	Bình Thanh	4	0,9098

A67	Chung cư Mỹ Phước	2	Bình Thanh	5	0,9092
A83	Chung cư An Bình	Phu Tho Hoa	Tan Phu	6	0,9066
A85	Trung Đông Plaza	Phu Trung	Tan Phu	7	0,9054
A84	Chung cư Đại Thành	Phu Trung	Tan Phu	8	0,9052
A79	Chung cư Carillon Apartment	12	Tan Binh	9	0,9048
A87	Chung cư Âu Cơ Tower	Tan Thanh	Tan Phu	10	0,9042

Table 12: Top 10 lowest ranking sites

Source: Authors' own creation (2025)

Alternative	Site Name	Ward	District	Rank	CC
A52	Khu lưu trú công nhân KCN	Tan Thuan Dong	7	101	0,6646
A104	Khu TTTM Lucky Dragon	Phuoc long	Thu Duc City	102	0,6646
A9	Tòa nhà văn phòng 146 Nguyễn Công Trứ	Nguyen Thai Binh	1	103	0,655
A108	Tòa nhà 55 Đặng Như Mai	Thanh My Loi	Thu Duc City	104	0,6486
A39	Central Mall Q6	3	6	105	0,6486
A33	Tòa nhà Giày Việt Plaza	9	3	106	0,6486
A99	ĐH KHXH & NV CS2	Linh Trung	Thu Duc City	107	0,6486
A53	Trường Trung cấp Sài Gòn	Tan Thuan Dong	7	108	0,6486
A32	Trung tâm khai thác 3	Trung My Tay	12	109	0,6486
A51	FPT Tân Thuận 3	Tan Thuan Dong	7	110	0,6451

4. Discussion of Findings

4.1. For AHP results

Residential Proximity ranked highest because most Vietnamese online shoppers live in cities where urban consumers make up 86% of the e-commerce market, and Gen Z accounts for 43% of this group (Vietnam Briefing, 2024; Start.io, 2024). For these users, who prefer convenience, lockers in apartment lobbies or residential complexes are easier to pick up parcels because they get rid of traffic or waiting time for delivery issues. This aligns with findings from Singapore and Guangzhou, where smart lockers near large apartment areas are used frequently (Ma et al., 2024; Zheng et al., 2021). Therefore, placing lockers near apartment complexes, gated communities, and large residential projects would increase regular use in Vietnam.

Workplace Proximity ranks second and is impacted by Vietnam's commuting pattern. Because motorcycles account for nearly 80% of all daily trips and public transport just below 5%, commuters enjoy flexible stops and can pause along their routes (Transformative Urban Mobility Initiative [TUMI], 2023). This makes lockers near offices, industrial parks, and mixed-use corridors more attractive while supporting trip chaining - combining errands like parcel pickup with daily commutes for convenience purposes. Evidence from Bangkok and Guangzhou further reinforce this, showing that lockers near workplaces allow efficient retrieval during or after work, consistent with Vietnam's "multi-stop" mobility behavior (Thongkam, 2020; Zheng et al., 2021).

Household & Dwelling Type ranks third and is affected by rapid change in urban housing in Vietnam. In fact, in both Hanoi and HCMC, around 70% of new housing supply is now apartments (The Investor, 2024). This new lifestyle has made parcel lockers part of shared facilities. However, urban areas dominated by landed houses use lockers mainly when they are near workplaces or shopping areas. Therefore, dwelling type is a context-sensitive factor: strong in city centers but weaker in low-density, suburban areas.

Population Density and Transport Accessibility are in fourth and fifth place, respectively. Regarding population density, a dense area may attract many potential users and help people get used to seeing parcel lockers around their neighborhood. This makes parcel lockers appear familiar, especially among young consumers. However, its effect is indirect. High density alone cannot overcome the issue of congestion or difficulty in local access. Accessibility is also affected by traffic regulations (Decree 168/2021/NĐ-CP). Although motorcycle users can stop briefly almost anywhere, this can not be a big, strong benefit due to parking restrictions and congestion. Therefore, accessibility is regarded to be most critical at only the local level, those places that are safe, legal, and easy to reach rather than across an entire city.

Lastly, **Commercial/Leisure Sites** ranks lowest but still a strategic factor in placing smart lockers. Vietnamese consumers are now changing their shopping habits to visiting convenience stores, around four to five times a month, instead of going to big supermarkets or markets (Tuoi Tre News, 2023). When placing lockers near these small stores, people can collect parcels while running small errands, which can save both time and effort. In contrast, lockers in shopping malls or large retail centers are less effective because those trips have to be planned and less frequent. Therefore, co-location has the strongest influence in busy neighborhood areas where it is convenient for short walks so that locker use can easily become part of daily routines.

4.2. For TOPSIS results

The TOPSIS results show that whether a smart locker site succeeds or not does not fully depend on just one factor, but on how several factors work together. The best-performing areas analysed from the findings are Districts 10, 11, Binh Thanh, and Tan Phu. The reason is that they have a good mix of advantages of being near homes and workplaces, along with the benefit of high population densities.

Even though population density resulted in lower weight in the AHP model result, it still matters. Once the main factors are considered, density gives these areas extra benefits, turning

“good” locations into “great” ones. In other words, when density advantages come along with strong proximity and easy access, it strengthens the impact of those advantages even more.

On the other hand, low-performing sites are often found in industrial zones, university areas, or outer districts. Contrary to the above findings, those locations' low performance happens when this balance does not work. These places may have a lot of people in one spot of location, like workers or students, but poor access still makes it inappropriate. In fact, lockers placed deep inside factories or campuses force people to go far out of their way, which breaks their daily route. In these cases, accessibility becomes a problem that reduces the benefits of density or workplace proximity significantly, making people less likely to use the lockers.

This contrast shows an important core principle about Vietnam's urban environment: success often depends on how major and minor factors interact, not on the dominant factor. When districts have already met basic standards in residential and workplace conditions, it is the smaller factors that make the crucial difference. Indeed, population density increases potential demand, while accessibility decides whether that potential demand successfully turns into real use.

4.3. Reality check: Shopee's deployment

Our research team also checked the reality from Shopee's current locker network in HCMC. The results also support these findings. In the company's highest concentration including Thu Duc, District 12, District 8, and Binh Tan, there is a combination of large and well-known residential areas, workplaces like Vinhomes Grand Park, Linh Trung Export Processing Zone, or Quang Trung Software Park. These real choices from Shopee are consistent to the priorities factor analysed and resulted in high weight: those focus on locations close to where people live and work. However, there are still noticeable gaps that are worth considering. Central districts such as 1, 3, 5, and 10, which also have both high population density and active office zones, are still underserved. This shows that Shopee's current strategy is effective but still not fully complete when assessing all other factors.

For operators, the insight concluded from the analysis is that in order to achieve optimization, it requires both strategy for macro and micro areas. On a large scale, they should choose areas where residential and workplace zones overlap to place lockers. On a smaller scale, each site must be checked for real data of accessibility and convenience representing daily use. Population density should only serve as a criteria for scaling, not as a decisive factor when considering true convenience. Accessibility criteria should be checked in both legal and physical aspects before installation. By that way, the model can transform beyond abstract analysis into a practical roadmap for future expansion.

4.4. Summary

Overall, the results show that in dense cities like HCMC, proximity to homes and workplaces is the key driver of initial locker adoption, while density and accessibility shape how frequently customers use them. Factors such as housing type and nearby commercial areas further enhance convenience and familiarity. Together, these elements form a solid set of

criteria for evaluating locker performance. In a motorbike-dominant urban environment, understanding this balance is crucial for achieving both efficiency and user acceptance in last-mile delivery.

5. Conclusion

5.1. Key findings

The study identified and weighted six key location-related factors influencing locker adoption in the Vietnamese context. Through the AHP model, Residential Proximity and Workplace Proximity are the most critical determinants of user adoption and convenience. Applying the AHP model to data from 110 Shopee locker locations in HCMC confirmed its practical validity. Also, the TOPSIS ranking clearly showed that the best performing sites aligned with the highest-weighted criteria. The analysis also confirmed that in dense urban environments like HCMC, lower-weighted factors can still have considerable impact to decide final performance because High Population Density may help provide more potential users but poor Transport Accessibility pushes good sites down the ranking. This shows that effective site selection depends not only on core criteria but also on how these secondary factors combine together.

In practical perspective, the proposed model offers a valuable tool for businesses to optimize their parcel locker network. This mechanism would enable companies such as Shopee, Lazada, and logistics service providers to make evidence-based decisions where to expand or relocate locker sites that efficiently allocate resources, avoid costly misplacements and eventually enhance locker utilization rates and customer satisfaction.

5.2. Contribution of the research

Although parcel locker adoption has been widely examined in international literature, prior studies remain highly fragmented in terms of theoretical grounding and variable selection. Existing research tends to focus on country-specific contexts and relies on diverse, unaligned frameworks, ranging from facility-location optimization (Kahr, 2022), expert-driven MCDM models (Moslem & Pilla, 2024), technology-acceptance perspectives (Thongkam, 2020), switching-behavior theories (Nguyen et al., 2024), to walkability-based urban analyses (Ma et al., 2024). As a result, the field lacks a unified and transferable framework that synthesizes these dispersed insights into a coherent set of spatial determinants applicable across different urban environments.

This study addresses that gap by developing an integrated theoretical framework that consolidates common themes identified across prior empirical studies. By synthesizing recurring spatial demand patterns, accessibility considerations, population-activity concentrations, and housing-related characteristics, the proposed framework provides a theoretically grounded structure for evaluating parcel-locker site suitability.

Furthermore, this study operationalizes the framework through an AHP model informed by expert judgments collected in Vietnam. This context-specific yet theoretically generalizable approach enhances the methodological relevance of parcel-locker research in dense and

heterogeneous urban environments such as HCMC. The findings thus offer both a unified analytical foundation for future global research and a practical decision-support tool tailored to emerging markets like HCMC, Vietnam.

5.3. Strategic Recommendations

5.3.1. For existing locker sites

High-performing sites located in Districts 10, 11, Binh Thanh, and Tan Phu demonstrate strong user demand. Shopee needs to increase capacity in these hubs by deploying a more tiered approach, including bigger or modular lockers, and to improve the user experience, it should introduce more features, like faster parcel retrieval and better signage. On the other hand, sites that fail to perform well in industrial areas, university campuses, or limited-access sites ought to be rationalized. Shopee can also take a twofold approach, initially, transfer or reuse lockers to more convenient locations, including parking lots or entrance areas. Second, the firm will be able to carry out specific promotional campaigns to check whether the demand can be aroused before final relocation decisions are taken.

5.3.2. For future deployment

Future expansion should prioritize dense residential areas, especially apartment complexes and multi-family housing clusters, where parcel lockers can become part of the "shared amenity" ecosystem. Sites should also be well integrated into commuting flows, with legal and convenient stopping points for motorbikes, reflecting Vietnam's dominant travel mode. It is advised that Shopee should institutionalize a data-driven site selection framework. The combination of the AHP–TOPSIS model, supported by demand forecasting and GIS-based analytics, will minimize the risk of underutilized sites and allow the planning of the network on a large scale and in the long term. Moreover, there should be an opportunity to exploit partnerships with local authorities, real estate developers, and convenience store chains to acquire prime locations both in public and semi-public spaces, which will guarantee accessibility and visibility.

5.3. Limitations

This study has several limitations. First, the analytical framework relies on previous empirical studies, so it may not be fully comprehensive and is constrained by the weaknesses of those sources. Second, the AHP results depend on qualitative judgments from a limited group of experts, which may introduce bias. Third, the TOPSIS analysis uses mixed secondary data from GSO, Google Maps Open Data, and the research team's own scoring where no reliable database existed, reducing the robustness of the results. In addition, the dataset was compiled in 2021, before the 2025 provincial administrative merger. Fourth, the study focuses only on spatial and locational factors shaped by customer behavior, excluding broader elements such as service quality and operational costs. This helps sharpen the analysis but narrows its explanatory scope. Finally, the reliance on expert opinions in AHP may affect the objectivity of the weightings. Therefore, the framework and findings should be viewed as an initial foundation for future research using richer data and wider dimensions of parcel locker adoption.

REFERENCES

1. Agatz, N., Campbell, A. M., Fleischmann, M., & Savels, M. (2008). Challenges and opportunities in attended home delivery. In *Operations research, computer science. Interface series* (pp. 379–396).
2. An, H. S., Park, A., Song, J. M., & Chung, C. (2022). Consumers' adoption of parcel locker service: protection and technology perspectives. *Cogent Business & Management*, 9(1).
3. Anes, V., & Abreu, A. (2025). Adaptive Cluster-Based normalization for robust TOPSIS in multicriteria Decision-Making. *Applied Sciences*, 15(7), 4044.
4. Belton, V., & Stewart, T. J. (2002). *Multiple Criteria Decision analysis: an Integrated approach*. [https://www.research.manchester.ac.uk/portal/en/publications/multiple-criteria-decision-analysis\(bec5eeb3-0434-464a-bb51-2c06d7e1c2b5\).html](https://www.research.manchester.ac.uk/portal/en/publications/multiple-criteria-decision-analysis(bec5eeb3-0434-464a-bb51-2c06d7e1c2b5).html)
5. Dung, T. (2025, January 7). Viet Nam's e-commerce market up 20% in 2024. en.baochinhphu.vn. <https://en.baochinhphu.vn/viet-nams-e-commerce-market-up-20-in-2024-111250107155234946.htm>
6. Fara. (2023). The Future of Deliveries: Parcel Locker Intentions. *The European Proceedings of Social and Behavioural Sciences*.
7. General Statistics Office of Vietnam. (2022). *Statistical yearbook of Vietnam 2022*. Statistical Publishing House.
8. Grönroos, C. (2008). Service logic revisited: who creates value? And who co-creates? *European Business Review*, 20(4), 298–314.
9. Grošelj, P., & Stirn, L. Z. (2012). Acceptable consistency of aggregated comparison matrices in analytic hierarchy process. *European Journal of Operational Research*, 223(2), 417–420.
10. Hoang, T. (2019). Last-mile delivery for e-Commerce in Vietnam: Current situation and future challenges.
11. Hwang, C.-L., & Yoon, K. (1981). Methods for Multiple Attribute Decision Making. *Multiple Attribute Decision Making*, 58–191.
12. Iannaccone, G., Marcucci, E., & Gatta, V. (2021). What Young E-Consumers Want? Forecasting Parcel Lockers Choice in Rome. *Logistics*, 5(3), 57.
13. Kahr, M. (2022). Determining locations and layouts for parcel lockers to support supply chain viability at the last mile. *Omega*, 113, 102721.

14. Lin, Y., Wang, Y., Lee, L. H., & Chew, E. P. (2022). Profit-maximizing parcel locker location problem under threshold Luce model. *Transportation Research Part E: Logistics and Transportation Review*, 157, 102541.
15. Ma, B., Teo, C., & Wong, Y. D. (2024). Location analysis of parcel locker Network: Effects of spatial characteristics on operational performance. *Transportation Research Part E Logistics and Transportation Review*, 192, 103776.
16. Nguyen, N., Minh Trang Nguyen, Thuy, T., & Manh Hung Nguyen. (2024). Customer switching intention from home delivery to smart locker delivery: Evidence from Vietnam. *Innovative Marketing*, 20(2), 140–151.
17. Saaty. (1980). Analytic hierarchy process (AHP). <https://www.iied.org/sites/default/files/pdfs/2022-02/20781G.pdf>
18. Schaefer, J. S., & Figliozzi, M. A. (2021). Spatial accessibility and equity analysis of Amazon parcel lockers facilities. *Journal of Transport Geography*, 97, 103212.
19. Start.io. (2024). E-commerce consumers in Vietnam. Start.io Audience Data. <https://www.start.io/audience/e-commerce-consumers-in-vietnam>
20. The Investor. (2024). Vietnam's housing supply doubles in 2024, dominated by high-end apartments. The Investor. <https://theinvestor.vn/vietnams-housing-supply-doubles-in-2024-dominated-by-high-end-apartments-report-d13963.html>
21. Thongkam, O. (2020). Factors influencing adoption and usage probability of automated parcel lockers.
22. Transformative Urban Mobility Initiative. (2023). *Deep dive city: Ho Chi Minh City, Vietnam*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. <https://transformative-mobility.org/wp-content/uploads/2023/12/Ho-Chi-Minh-Deep-Dive.pdf>
23. Triantaphyllou, E. (2000). Multi-criteria decision making Methods: A comparative study. In *Applied optimization*.
24. Tuoi Tre News. (2023, September 12). Vietnamese visit convenience stores more often than supermarkets, traditional markets. Tuoi Tre News. <https://tuoitrenews.vn/news/business/20230912/vietnamese-visit-convenience-stores-more-often-than-supermarkets-traditional-markets/75152.html>
25. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information technology: toward a Unified View. *MIS Quarterly*, 27(3), 425–478.

26. Vietnam Briefing. (2024). Vietnam's e-commerce sector outlook in 2024. Vietnam Briefing<https://www.vietnam-briefing.com/news/vietnams-e-commerce-sector-outlook-in-2024.html>
27. Viu-Roig, M., & Alvarez-Palau, E. J. (2020). The Impact of E-Commerce-Related Last-Mile Logistics on Cities: A Systematic Literature review. *Sustainability*, 12(16), 6492.
28. Zheng, Z., Morimoto, T., & Murayama, Y. (2021). A GIS-Based bivariate logistic Regression model for the Site-Suitability analysis of Parcel-Pickup lockers: a case study of Guangzhou, China. *ISPRS International Journal of Geo-Information*, 10(10), 648. <https://doi.org/10.3390/ijgi10100648>
29. Hoang, P. (2021) *Dân số, Diện tích các quận tại TP HCM Cập nhật 2021*. <https://rentapartment.vn/dan-so-dien-tich-quan-tphcm/>.
30. Danh sách Cửa hàng tiện lợi hoạt động trên địa bàn TP.HCM (2021) https://moit.gov.vn/upload/2005517/fck/files/DANH_S_CH_C_C_C_A_H_NG_TI_N_L_I_ANG_HO_T_NG_190721_e7fcf.pdf.
31. Moslem, S., & Pilla, F. (2024). Planning location of parcel lockers using group Analytic Hierarchy Process in Spherical Fuzzy environment. *Transportation Research Interdisciplinary Perspectives*, 24, 101024.
32. Leung, A., Lachapelle, U., & Burke, M. (2023). Spatio-temporal analysis of Australia Post parcel locker use during the initial system growth phase in Queensland (2013–2017). *Journal of Transport Geography*, 110, 103634.
33. Zhang, S., Le, T. V., & Roorda, M. (2023). Optimizing Parcel Locker Locations in a City Crowd Logistics Network. *Transportation Research Record Journal of the Transportation Research Board*, 2677(12), 267–283.