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# Criteria For Site Selection of Semi-Automatic, Small and Medium- Sized Car Parking System from Sustainability Perspective

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## Abstract

The semi-automatic car parking system has been used in many cities across the world due to its many benefits, including its tiny model, compaction, need for less space, and speedy construction. The car parking system solution may hold the key to addressing the parking needs of urban areas since it has specifications that are appropriate to the needs and characteristics of HoChiMinh City. However, in terms of sustainable and aesthetically pleasing urban development, choosing the best location to place the parking model is difficult. Therefore, this research aims to determine the selection of criteria affecting the location of semi-automatic car parking criteria based on a Multicriteria Decision Making Model (MCDM). The contribution of this study is a set of guidelines with four primary criteria and eighteen sub-criteria to assist private businesses and local management organizations choose the best location for semi-automatic parking to maximize efficiency and toward urban sustainability.

***Keywords:*** small and medium car parking system; traffic planning; urban sustainability; MCDM

## Introduction

District 2 area is one of the areas with high urbanization rates in Ho Chi Minh City (HCMC) in general and Thu Duc City in particular. The population of District 2 at the time of its establishment was 86,027 people in 1997 and reached the milestone of 171,311 in 2019, the average population growth of the district is more than 3,800 people per year [1-2]. In the context of rapid and massive urbanization, a series of changes have significantly affected the socio-economic life of the region, especially the significant increase in the number of motorized traffic in the area and a series of problems arise such as lack of parking space, illegal parking, traffic jams, and environmental pollution.

In the study area, Thao Dien ward and part of An Phu ward, the most obvious urbanization are witnessed within District 2. With the rapid development of infrastructure and real estate in the area, the area's population increased rapidly. The population of Thao Dien ward increased from 8,559 people in 1997 to 18,455 people in 2012, and the population of An Phu ward increased from 7,548 people to 23,289 people in 2012 [1, 3]. Through the satellite map analysis method (Figures 1a, b), it is observed that construction density, concretized area, and population density have changed markedly. Corresponding to the increase in population is the massive increase in the number of motorized vehicles to meet the mobility needs of the people, thereby leading to an increase in the demand for parking in the area.

As observed by the research team, a series of parking facilities of all types and sizes have been built in the area, most of which are private services, located in the premises of apartment buildings, and residential areas. However, most of the above services are spontaneous and have not been studied in scientific planning, thereby wasting land funds, and somewhat limiting the investment efficiency of private services when participating in urban parking services. Due to its advantages such as a small and compact model, quick construction time, and occupy little land funds, the semi-automatic car parking systems (SAPSs) have been applied in many cities around the world. The model of SAPS with a small and medium scale, has been applied in some areas in HCMC [4]. With the application of this solution, the empty spaces and undeveloped areas will be fully utilized, as well as increase the exploitation capacity of the existing parking lots. The initial phase of SAPS construction, SAPS siting, has a substantial impact on the service quality and operational effectiveness of SAPSs over their whole life cycle. However, choosing the optimal location is a tough decision in terms of sustainable and harmonious urban development. Decision makers must consider many factors when selecting a suitable site to meet economic and environmental requirements. Thus, it is crucial to develop an appropriate framework to identify the best locations for SAPSs.

The rest of the paper is organized as follows. Section 2 reviews the relative past studies. Section 3 proposes the framework for the selection of criteria affecting the location of semi-automatic car parking based on MCDM. Section 4 presents the results and discussion. Section 5 concludes this study.

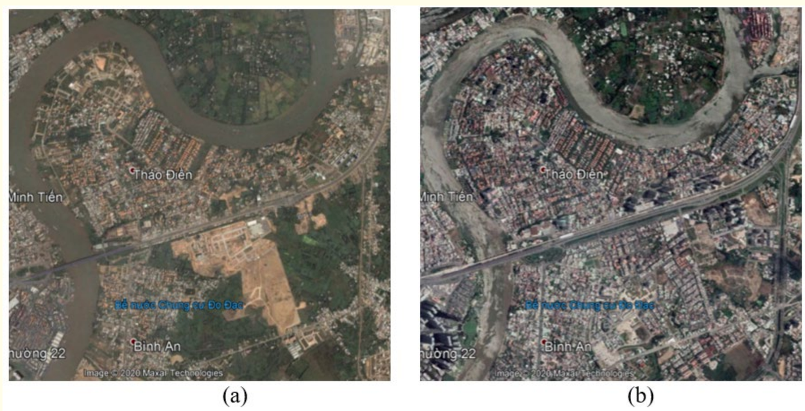


***Figure 1:*** The area of Thao Dien Ward and part of An Phu Ward, District 2, Thu Duc City, Ho Chi Minh City changed over time. (a) 2005; (b) 2020. (Source: Google Earth Pro).

## Literature Review

### *Overview of parking technologies and solutions in Vietnam and International*

Currently, parking solutions in the world can be divided into 3 main groups as follow: on-street parking (roadway and sidewalk); off-street parking (parking lot); and parking facilities, of which parking facilities include 2 main types: parking using the existing structure of the building (basement or high floor); and multi-storey independent parking structure model [5]. In Vietnam, most parking solutions are on-street parking and off-street parking [6]. To meet the increasing parking demand of people in the center city, a pilot project of a car parking system on the road surface of 23 streets in three districts (Districts 1, 5, and 10) has been implemented by the Department of Transport, HCMC in August 2018 [7]. In addition, medium and large-scale underground and high-rise parking projects are planned by the HCMC government and encouraging private investors to participate, based on the Prime Minister's approval since 2013 [8-10]. Recently, multi-storey independent parking structure models have also been applied by the private sector. For example, the project of a 2-storey, semi-automatic small-sized car parking (Puzzle Parking) at Electricity Construction Consulting Joint Stock Company in District 3; or a semi-automatic medium-sized car parking project in the basement of Golden King's house, District 7, HCMC. Thereby, it can be seen that the technologies used for car parking types in HCMC are mainly semi-automatic, small and medium-sized.

Around the world, all three groups of parking are used. In particular, the solution of multi-storey independent parking structure model is widely applied in urban areas [5]. The most used models in the world include: (i) tower type; (ii) Multi-Layer Circulation; (iii) Rotary Type; (iv) Puzzle Parking. The above models are automatic or semi-automatic, small and medium-sized, and very suitable for agencies with a small number of employees cars range from 06-20.

### *Relevant studies*

Ibrahim (2017) studied planning trends and smart technology solutions, to reduce traffic jams in the city of Santa Monica, USA [5]. Automated car parking systems are also planned and managed by city government agencies. However, this study used large-scale automatic car parking models. Yang (2017) analyzed the existing problems in parking management in Hangzhou, China from various aspects, such as parking shortages, lack of management agencies, inefficient use of parking lots in some areas, and the lack of a permanent mechanism to engage social forces in the construction of parking lots, thereby proposing solutions to solve these problems from different perspectives, such as promoting the role of urban parking planning and management, establishing and perfecting parking management mechanisms, and encouraging the private sector to participate in the construction and management of parking lots [11]. However, due to the high and fixed price of the service fee for using the smart parking system, few people use it [12]. To solve this cost problem, Maternini (2017) studied and proposed a variable-priced parking program for multi-story car parking in the city of Brescia, Italy. The authors concluded that the variable parking fee is one of the tools that can regenerate the downtown areas by reducing the parking area on the street, optimizing the use of multi-story car parking, and improving the quality of public transport. However, the study has not referred to small and medium-sized automatic parking systems [13]. In Japan [14], coin-parking facilities are widely used in densely populated urban areas. However, this system has limitations such as small car capacity (2-6 cars), no high floor, and large area occupancy.

Vo Trong Cang and Vo Minh Phuc (2020) proposed a list of criteria for recommending automated parking sites selection in HCMC as follows: private land (unbuilt for housing, construction...), projects that have not yet been able to deploy, gaps/backspaces (area of 50-500m2) or existing parking lots in public areas/works, adjacent to roads with a minimum width of the existing roadbed of 6m, ensuring conditions of safety, and fire prevention [4]. However, these criteria are suggested based on the subjectivity of the author, not on extensive and comprehensive scientific research. In another study conducted by Zhao and Li (2016), they introduced four main criteria (economy, technology, society, and environment) and thirteen sub-criteria, which aid in the selection of charging stations for electric vehicles in Tianjin, China [15]. Wu et al. (2016) presented six main criteria (economy, technology, society, environment, service availability, and geography) and eighteen sub-criteria to select the locations of electric vehicle charging stations in Beijing, China [16]. Kaya et. al (2020) offered six main criteria (economic, environmental, energy, transportation, taxi, and geographical) and twenty-five sub-criteria affecting the site selection of electric taxi charging stations in the city of Istanbul, Turkey [17]. Guo and Zhao (2015) summarized three main criteria (economic, social, and environmental) and eleven sub-criteria, affecting the process of choosing a charging station location for vehicles in Beijing, China [18]. Erbaş et al. (2018) conducted research and identified three main criteria (economy, urban, and environment) and fifteen sub-criteria, for optimal site selection of an electric vehicle charging station in Ankara city, Turkey [19]. Table 1 summarizes the criteria for site selection of related research subjects in previous studies. It can be seen that there are very few studies on the selection criteria for the locations of SAPS in Vietnam and the world. Therefore, this research has practical significance and is completely new, contributing towards sustainable urban development for HCMC.

| ***Main criteria*** | ***Sub-criteria*** | *[4]* | *[15]* | *[16]* | *[17]* | *[18]* | *[19]* |
|---|---|---|---|---|---|---|---|
| Economy | Land cost | | x | | | x | x |
| | Internal rate of return (IRR%) | | x | | | | |
| | Annual operation and maintenance cost | | x | x | | x | |
| | Total construction cost | | | x | x | x | |
| | Payback period | | | x | | x | |
| | Income rate | | | | x | | |
| | Number of vehicles in service area | | | | x | | x |
| Environment | Vegetation influence | | x | x | x | x | x |
| | Water influence | | | x | x | x | x |
| | Proximity to earthquake | | | x | x | | x |
| | Proximity to landslide risk | | | x | x | | x |
| | Possibility of expansion in future | x | | x | | | x |
| | Slope of land | | | | x | | x |
| | Greenhouse gas emissions reduction | | x | | | x | |
| | Fine emission reduction | | x | x | | x | |
| | Availability of space for disposal of waste | | | x | | | |
| | Air quality | | | | x | | |
| Technology | Substation capacity | | x | | | | |
| | Stability of foundation | | | x | | | |
| | Impact on power system | x | x | x | | | |
| | Power network security | x | x | | | | |
| | Proximity to substation | | | x | | | |
| | Availability of infrastructure for fast construction | x | | x | | | |
| Society | Impact on people life | | x | x | | x | |
| | Service area population | x | x | x | | x | x |
| | Proximity to main road | x | x | x | x | x | x |
| | Proximity to intersection | x | x | x | x | x | x |
| | Suitability with urban development planning | x | x | | | | |
| | Local gorverment support policy | | | x | | | |
| | Service area | x | | x | x | | x |
| | Distance to gas station | | | | x | | x |
| Taxi | Taxi stands | | | | x | | |
| | Number of taxis in service area | | | | x | | |

*Source*: [4] Vo Trong Cang and Vo Minh Phuc (2020), [15] Zhao and Li (2016), [16] Wu et. al (2016), [17] Kaya et. al (2020), [18] Guo and Zhao (2015), [19] Erbaş et. al (2018).

***Table 1:*** Summary of criteria in previous related studies.

## Methodology

The evaluation process of selecting the optimal location is a multi-criteria-based evaluation procedure, which is a complex process with incomplete and vague information. One of the objectives of this topic is to propose a set of criteria including technical characteristics, management requirements, product evaluation, environmental impact, and other objects in socio-economic activities to assist business investors and management agencies in deciding on the optimal location for semi-automated car parking. Thus, data collection is one of the most important stages for this topic, which determines the results of the computational model, analysis, and selection of criteria. The data collection process requires an appropriate method and clearly defined objectives. Furthermore, data collection can be difficult and complex. If the data collection process is not well prepared, it will greatly affect the research process. In addition, all previous work such as defining questionnaires, and designing case studies will become useless. Therefore, the MCDM is proposed to analyze the selection of criteria affecting the site selection of semi-automatic car parking (Figure 2).

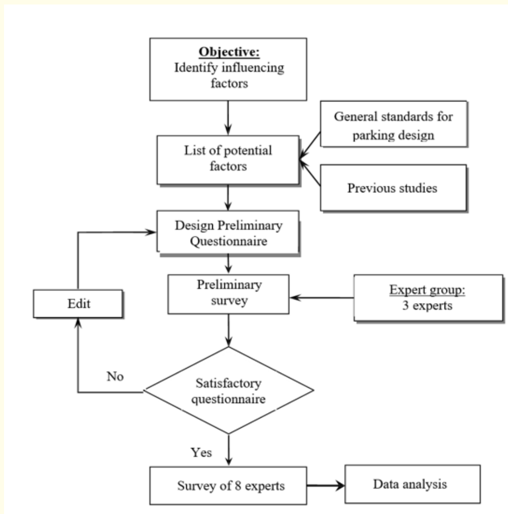


***Figure 2:*** Research model.

Both qualitative and quantitative methods are used in this paper. In the first stage, qualitative methods are used to select the potential criteria affecting the site selection of semi-automatic car parking. During this stage, the authors have read and studied documents (books, related studies, general standards on parking design) related to the semi-automatic car parking model, thereby identifying potential factors affecting the selection of semi-automatic, small and medium-sized car parking locations for urban areas. In terms of sustainable urban development, the selected criteria should cover all factors: economy, technology, environment, and society. Therefore, a list of criteria including the above 4 factors is selected. Next, a preliminary questionnaire is designed based on the above-mentioned criteria. This questionnaire has not been disseminated to the public, but is only a pilot survey, by sending it to experts. After getting feedback from experts, the structure, language, and detail of the questionnaire are improved. The implementation of the pilot survey was conducted by a group of 3 experts through direct interviews. This group of experts has many years of experience in the field of deploying smart and automated parking systems. They are working in manufacturers, and traders, have more than 15 years of experience and are holding important roles in private and public enterprises. Finally, a complete questionnaire consisting of 4 main criteria and 32 sub-criteria, used for data collection, was created (Appendix 1). Subsequently, an official survey was conducted with 8 experts in the field. The authors directly contacted each expert to present the problem and explain clearly how to do it. Experts must be experienced and knowledgeable in the field of urban planning, transport infrastructure, and semi-automatic car parking models and willing to spend time answering questionnaires or interviewing. However, a small number of experts who are unable to meet face-to-face due to different conditions are contacted by phone and email to explain clearly how to implement the questionnaire.

In the second stage, quatitative methods are used to reduce complex factors. The Cronbach's alpha coefficient and the value of Relative Importance Index (RII) of each criteria are calculated. The Cronbach's alpha coefficient is a statistical test of how closely the items in the scale correlate with each other. The formula for calculating Cronbach's alpha coefficient is as follows:

$$\alpha = \frac{N\rho}{1+\rho(N-1)}$$

where:

- $\rho$ is the mean correlation coefficient between the items.
- $N$ is the number of items in the study.

By convention, a set of items used to measure is good if a coefficient $\alpha$ greater than or equal to 0.6 but preferably greater than 0.7 [20].

Besides, the method of Relative Importance Index is used to determine the relative importance of related criteria [21]. The score of a 5-point Likert scale used is equal to the value of W, which is the weight given by the respondent for each item. The RII is calculated using the following formula:

$$RII = \frac{\Sigma w}{A \times N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5 \times N}$$

where:

- $w$ is the score assigned to each item, as answered by each expert on the Likert scale;
- $A$ is the highest score;
- $N$ is the total number of experts who responded.

The RII value can vary from 0 to 1. The higher RII value of that criterion, the more stable and important the criterion is, and vice versa. According to Chan et al. (1997), the relative importance of related criteria obtained from RII is as follows:

| ***Relative Importance*** | ***RII*** |
|---|---|
| Very high (VH) | 0.85 < RII < 1.0 |
| High (H) | 0.7 < RII < 0.85 |
| High- Medium (H-M) | 0.65 < RII < 0.7 |
| Medium (M) | 0.5 < RII < 0.65 |
| Medium - Low (M-L) | 0.35 < RII < 0.5 |
| Low (L) | 0.2 < RII < 0.35 |
| Very low (VL) | 0 < RII < 0.2 |

***Table 2:*** Correlation between the relative importance of the criteria and the RII value [22].

The analytical tools used in this study include software SPSS v16.0, M.S. Excel® 2017.

## Results and Discussions

After collecting data from the expert group, statistical analysis is carried out. Figures 3 and 4 show the number of surveyed experts with questions "Have you participated in the actual project implementation?" and "classification by working position".

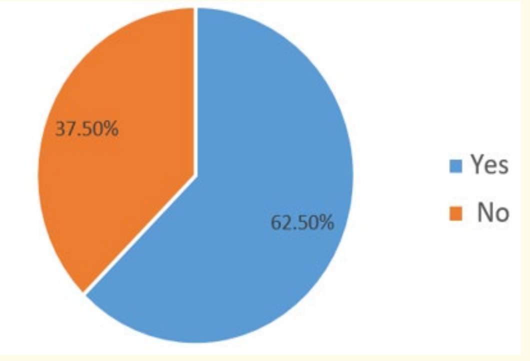


***Figure 3:*** Classification of respondents according to "Have you participated in the actual project implementation?".

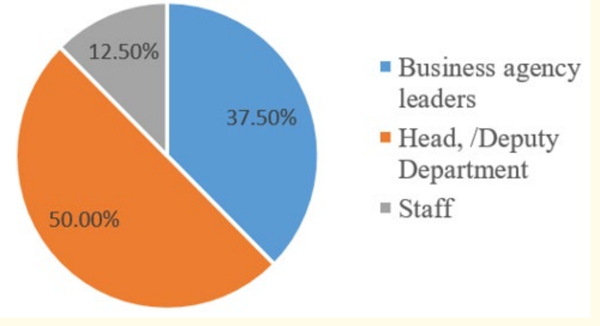


***Figure 4:*** Classification of respondents by "work position".

The analysis process begins by checking Cronbach's alpha coefficient, which is used to check the consistency and reliability of the scale used in the questionnaire. The results of Cronbach's alpha coefficient for four main criteria in terms of economic, technical, social, and environmental aspects are 0.725, 0.860, 0.713, and 0.813, respectively. The result completely satisfies the requirements of the scale's reliability as required by [20]. Table 3 shows the results of testing the reliability of the scale for four main criteria.

| ***Scale*** | ***Number of observed variables*** | ***Cronbach anpha*** |
|---|---|---|
| Economy | 7 | 0.725 |
| Technology | 6 | 0.860 |
| Society | 12 | 0.713 |
| Environment | 7 | 0.813 |

***Table 3:*** Results of testing the reliability of the scale.

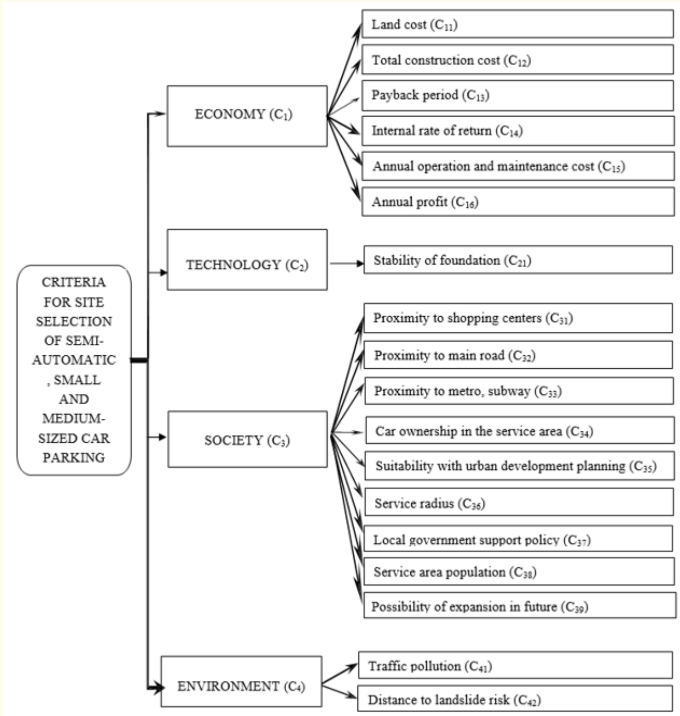


***Figure 5:*** Summary of 18 sub-criteria for the site selection of semi-automatic, small and medium-sized car parking for urban areas.

Table 4 shows the RII of the criteria along with their respective ratings and importance. From the results of RII data analysis, there are 18 criteria with levels of "important" to "very important", respectively, with RII values in the range of 0.7- 0.925 points. Thus, these 18 criteria are selected (Figure 5). Among the 18 selected criteria, in which six economic criteria, one technical criterion, nine social criteria, and two environmental criteria have been assessed by experts as criteria of "Very High" and "High" relative importance. The criterion "Proximity to shopping centers" ranks the highest priority among all the criteria listed in Table 4, with an RII value of 0.925. This is considered one of the most important criteria for choosing to invest in the location of semi-automatic car parking. The following four criteria "Total construction costs"; "Land cost"; "Payback period" and "Internal rate of return (IRR%)" have the same RII value of 0.9 and are considered as the second most important criterion when considered in the sustainable criteria. Total construction cost is the cost that business investors must expense to invest in the parking system at the beginning stage. It mainly includes the cost of the initial capital investment, interest, insurance, taxes, license fees, and other costs. It can be seen that these four above-mentioned criteria all belong to the group of economic aspects. Therefore, the economic factor is also utterly important in deciding the location of the parking model. However, it is still not the most important determining factor, but the criterion "Proximity to shopping centers" is. This can be explained that experts all consented that the parking lot model investment project should be selected to be located near shopping centers, to bring the highest operating efficiency when the model goes into business. In addition, criteria belonging to social groups such as: "Proximity to main road"; "Proximity to metro, subway"; "Suitability with urban development planning" all have the same RII index of 0.9.

| *Encode* | *Selection criteria* | *RII* | *Ranking by group* | *Overall ranking* | *Relative Importance* |
|---|---|---|---|---|---|
| **I** | ***ECONOMY*** | | | | |
| EC1 | Land cost | 0.900 | 1 | 2 | VH |
| EC2 | Total construction cost | 0.900 | 1 | 2 | VH |
| EC3 | Payback period | 0.900 | 1 | 2 | VH |
| EC4 | Internal rate of return (IRR%) | 0.900 | 1 | 2 | VH |
| EC5 | Annual operation and maintenance cost | 0.850 | 6 | 10 | VH |
| EC6 | Annual profit | 0.875 | 5 | 9 | VH |
| EC7 | Removal cost | 0.625 | 7 | 23 | M |
| **II** | ***TECHNOLOGY*** | | | | |
| TE1 | Proximity to substation | 0.625 | 3 | 23 | M |
| TE2 | Impact on power system | 0.450 | 6 | 32 | M-L |
| TE3 | Substation capacity | 0.525 | 5 | 31 | M |
| TE4 | Stability of foundation | 0.725 | 1 | 17 | H |
| TE5 | Power network security | 0.625 | 3 | 23 | M |
| TE6 | Availability of infrastructure | 0.675 | 2 | 19 | H-M |
| **III** | ***SOCIETY*** | | | | |
| SO1 | Service area population | 0.775 | 8 | 15 | H |
| SO2 | Proximity to main road | 0.900 | 2 | 2 | VH |
| SO3 | Proximity to intersection | 0.625 | 12 | 23 | M |
| SO4 | Proximity to metro, subway | 0.900 | 2 | 2 | VH |
| SO5 | Proximity to shopping centers | 0.925 | 1 | 1 | VH |
| SO6 | Service radius | 0.800 | 6 | 12 | H |
| SO7 | Impact on people life | 0.675 | 10 | 19 | H-M |
| SO8 | Possibility of expansion in future | 0.750 | 9 | 16 | H |
| SO9 | Local government support policy | 0.800 | 6 | 12 | H |
| SO10 | Car ownership in the service area | 0.825 | 5 | 11 | H |
| SO11 | Citizen habit in service area | 0.650 | 11 | 21 | M |
| SO12 | Suitability with urban development planning | 0.900 | 2 | 2 | VH |
| **IV** | ***ENVIRONMENT*** | | | | |
| EN1 | Air pollution | 0.650 | 3 | 21 | M |
| EN2 | Traffic pollution | 0.800 | 1 | 12 | H |
| EN3 | Adverse impacts on water resource | 0.550 | 6 | 29 | M |
| EN4 | Adverse impacts on soil and vegetation | 0.550 | 6 | 29 | M |
| EN5 | Noise pollution to people's lives | 0.625 | 4 | 23 | M |
| EN6 | Distance to landslide risk | 0.700 | 2 | 18 | H |
| EN7 | Distance to earthquake | 0.600 | 5 | 28 | M |

***Table 4:*** Criteria for site selection of semi-automatic, small and medium-sized car parking for urban areas.

## Conclusions and Recommendations

### *Conclusions*

The conclusions drawn from the study are as follows:

i. The study has comprehensively considered all the factors affecting the selection of the optimal location for placing semi-automatic, small and medium-sized car parking in urban areas. Those factors include economy, technology, society, and environment. The goal of the application of the car parking model is to solve the parking needs of people in the study area. However, the economic and technical aspects are not merely considered, but the factors affecting the society and the environment are also analyzed and evaluated, aiming to move towards an environmentally friendly technology model and sustainable green development.
ii. From the results of 18 selected criteria, it can be seen that almost social criteria are dominant criteria. In addition, criteria relating to economic aspects also account for a large proportion. It proves that selecting the optimal location for semi-automatic car parking, is not only based on economic factors, but also favorable traffic factors. It should be considered all factors affecting the surrounding society and must be in convenient locations for users. The criteria that should be prioritized when selecting the location of semi-automatic car parking are to be near shopping centers, main roads, metro lines, subways, and in public service. This is completely suitable, to meet the needs for convenient transportation for customers, because they have a need to park their car near service points, shopping malls, and restaurant areas, or they have a demand for parking services to change modes of transportation (transit). Besides economic or social factors, factors affecting the surrounding environment have also been considered in this study, aiming at sustainability and environmental friendliness for this new technology in urban areas in Vietnam.

### *Recommendation for future research*

In the future, the authors suggest using algorithm models in multi-criteria selection problems such as the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Technique for Order Performance by Similarity to Ideal Solution (TOPSIS), Fuzzy AHP... to calculate the weight of each criterion affecting the site selection of semi-automatic car parking. After that, determining how much the influence of each criterion is, assists investors and government planners have a more general view of the influence of the criteria on their decisions. In addition, a Geographic Information System (GIS) combined with multi-criteria decision-making models can be applied to automatically propose the optimal location of semi-automatic car parking. And the comparison between the location of the proposed parking lot and the existing parking lot, to determine whether the existing parking lots are optimally located.

## Acknowledgement

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***Appendix 1***. Questionnaire Survey on sustainable criteria for site selection of semi-automatic, small and medium-sized car parking system for urban area.

This questionnaire aims to determine the necessity of criteria affecting the selection of locations for a semi-automatic, medium, and small-sized car parking for urban areas. Therefore, the valuable information you contribute to the survey questionnaire is essential data for the study's success and the application of its results in practice. We hope you will take a moment to share your experiences. Any information you provide will be kept confidential and used for research purposes only.

We look forward to receiving your attention and help.

***Section A***. Assessment of the importance of criteria affecting the site selection for a semi-automatic, medium, and small-sized car parking for urban areas.

Please rate your opinion on a 5-point Likert scale on the following criteria in terms of their importance.

1. Not at all important.
2. Low important.
3. Neutral.
4. Very important.
5. Extremely important.

Not at all important 1→ 2 → 3 → 4 → 5 Extremely important.

| *Order* | *Encode* | *Selection criteria* | *Important level* | | | | |
|---|---|---|---|---|---|---|---|
| **I** | | ***ECONOMY*** | | | | | |
| 1 | EC1 | Land cost | 1 | 2 | 3 | 4 | 5 |
| 2 | EC2 | Total construction cost | 1 | 2 | 3 | 4 | 5 |
| 3 | EC3 | Payback period | 1 | 2 | 3 | 4 | 5 |
| 4 | EC4 | Internal rate of return (IRR%) | 1 | 2 | 3 | 4 | 5 |
| 5 | EC5 | Annual operation and maintenance cost | 1 | 2 | 3 | 4 | 5 |
| 6 | EC6 | Annual profit | 1 | 2 | 3 | 4 | 5 |
| 7 | EC7 | Removal cost | 1 | 2 | 3 | 4 | 5 |
| **II** | | ***TECHNOLOGY*** | | | | | |
| 8 | TE1 | Proximity to substation | 1 | 2 | 3 | 4 | 5 |
| 9 | TE2 | Impact on power system | 1 | 2 | 3 | 4 | 5 |
| 10 | TE3 | Substation capacity | 1 | 2 | 3 | 4 | 5 |
| 11 | TE4 | Stability of foundation | 1 | 2 | 3 | 4 | 5 |
| 12 | TE5 | Power network security | 1 | 2 | 3 | 4 | 5 |
| 13 | TE6 | Availability of infrastructure | 1 | 2 | 3 | 4 | 5 |
| **III** | | ***SOCIETY*** | | | | | |
| 14 | SO1 | Service area population | 1 | 2 | 3 | 4 | 5 |
| 15 | SO2 | Proximity to main road | 1 | 2 | 3 | 4 | 5 |
| 16 | SO3 | Proximity to intersection | 1 | 2 | 3 | 4 | 5 |
| 17 | SO4 | Proximity to metro, subway | 1 | 2 | 3 | 4 | 5 |
| 18 | SO5 | Proximity to shopping centers | 1 | 2 | 3 | 4 | 5 |
| 19 | SO6 | Service radius | 1 | 2 | 3 | 4 | 5 |
| 20 | SO7 | Impact on people life | 1 | 2 | 3 | 4 | 5 |
| 21 | SO8 | Possibility of expansion in future | 1 | 2 | 3 | 4 | 5 |
| 22 | SO9 | Local government support policy | 1 | 2 | 3 | 4 | 5 |
| 23 | SO10 | Car ownership in the service area | 1 | 2 | 3 | 4 | 5 |
| 24 | SO11 | Citizen habit in service area | 1 | 2 | 3 | 4 | 5 |
| 25 | SO12 | Suitability with urban development planning | 1 | 2 | 3 | 4 | 5 |
| **IV** | | ***ENVIRONMENT*** | | | | | |
| 26 | EN1 | Air pollution | 1 | 2 | 3 | 4 | 5 |
| 27 | EN2 | Traffic pollution | 1 | 2 | 3 | 4 | 5 |
| 28 | EN3 | Adverse impacts on water resource | 1 | 2 | 3 | 4 | 5 |
| 29 | EN4 | Adverse impacts on soil and vegetation | 1 | 2 | 3 | 4 | 5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 30 | EN5 | Noise pollution to people's lives | 1 | 2 | 3 | 4 | 5 |
| 31 | EN6 | Distance to landslide risk | 1 | 2 | 3 | 4 | 5 |
| 32 | EN7 | Distance to earthquake | 1 | 2 | 3 | 4 | 5 |

* Besides the above criteria, do you recommend any other necessary criteria?

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***Section B***. General information:

Please answer appropriately by ticking a cross (x) in the corresponding box (◻).

1. Have you ever participated in the investment and development of a semi-automatic, small and medium car parking project?

◻ Yes ◻ No

2. What is your current position in the enterprise?

◻ Leader ◻ Head/ Deputy department

◻ Staff ◻ Other (please specify):…………

3. What is the capital source of the project that you usually participate in?

◻ Government ◻ Private (domestic)

◻ Other (please specify):………………………………

For any further information or requests, please contact:

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Thank you very much for your participation and time.

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