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Location Selection Models for Apartment Project Development by the Modified Analytic Hierarchy Process

Vuttapong Larpcharoen[1], Kongkoon Tochaiwat[1]*, Thanaphob Muntom[1], Varalee Thumvisuttivarakorn[2]

[1] Faculty of Architecture and Planning, Thammasat University, Bangkok, Thailand

[2] Narai Property Co., Ltd

Abstract: Apartments are rental housing that grows in line with the demand for habitats, both from the increase in the population and the relocation of residence for work and study. The right location selection for the development of a rental residential project is an important factor that a project developer must decide before actualizing a project since it is a factor that is tied to the location of the land and the surrounding environments. This research aimed to develop the models for the location selection for apartment development, by using the Modified Analytic Hierarchy Process. This was done by collecting the data from 150 samples of apartment rental business entrepreneurs from five different areas, 30 from each. The data were then analyzed using the Modified Analytic Hierarchy Process to compare the importance of the main and sub-criteria using the pairwise comparison. The results showed that the transportation criterion was the most important criterion for developing apartment projects in almost all areas of Bangkok, except for the Thonburi area, in which the entrepreneurs are most concerned about the daily-life facilities, as well as the Eastern Bangkok area that weighs the utmost importance to the source of workplaces. Apartment developers or those who are interested in investing in such rental projects can use this model to assess the potential of different areas for analyze and compare for the precise select of the potential location to be developed as an apartment project.

Keywords: modified analytic hierarchy process, apartment development, location, selection model, real estate development.

修正层次分析法的公寓项目开发选址模型

摘要: 公寓是随着人口的增加和工作和学习的居住地搬迁而随着对栖息地的需求而增长的出租房屋。开发出租住宅项目的正确选址是项目开发商在实施项目之前必须决定的一个重要因素，因为它与土地的位置和周围环境有关。本研究旨在通过使用改进的层次分析法开发公寓开发选址模型。这是通过收集来自五个不同地区的 150 个公寓租赁企业企业家样本的数据来完成的，每个地区有 30 个。然后使用改进的层次分析法对数据进行分析，以使用成对比较来比较主要标准和子标准的重要性。结果表明，交通标准是曼谷几乎所有地区开发公寓项目的最重要标准，除了企业家最关心日常生活设施的吞武里地区和曼谷东部地区。这对工作场所的来源至关重要。公寓开发商或有兴趣投资此类租赁项目的人可以使用此模型来评估不同区域的潜力，以进行分析和比较，从而精确选择要开发为公寓项目的潜在位置。

关键词: 修正层次分析法、公寓开发、选址、选择模型、房地产开发.

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About the authors: Vuttapong Larpcharoen, Kongkoon Tochaiwat, Thanaphob Muntom, Faculty of Architecture and Planning, Thammasat University, Bangkok, Thailand; Varalee Thumvisuttivarakorn, Narai Property Co.,Ltd

Corresponding author Kongkoon Tochaiwat, kongkoon@tu.ac.th

1. Introduction

Rental residential projects are an important part of the real estate business in Thailand. Over the past several decades, rental housing has played an important role in responding to the needs of people from other regions moving into the city for a career or education, especially in Bangkok. An apartment is a type of rental housing that has been growing in parallel with the housing demands both from the increase in the area population itself and the desire to relocate to the industrial areas and to study in various educational institutions [1]. However, although the need for housing is necessary to sustain life, for some, there are limitations in the provision of residence for themselves and their families due to the rising cost of properties [2]-[3]. Their solution is to rent a residence that is not far from the workplaces or schools to avoid traffic problems, reduce wasted time and travel expenses. This information is consistent with [4] stating that the admissions of students or the relocation of the people from both the upcountry and the nearby areas result in more investors interested in starting a rental residential business, whether it be dormitories, rental houses, mansions and apartments, especially in the communities and neighborhoods near the educational institutions, to meet the needs of the growing number of tenants.

From the study of the past studies, it was found that most of the studies focused on the perspective of tenants or customers, for example, [5], which studied the factors affecting the tenants' behavior in renting apartments by analyzing the social media advertising. The tenants' behaviors that affect the importance of the marketing strategies of the housings in Pluakdaeng district, Rayong province, was scrutinized in [6]. Lastly, [7] covered the factors affecting the decisions to rent private dormitories among university students. This study reflects that the operators of rental residential businesses place importance on the development of service quality since it affects the satisfaction and decisions of the customers and stimulates the willingness to return to the service, as well as the customer loyalty [8]. Entrepreneurs bring this notion to be part of the business operations to create competitive advantages, improve the product and service qualities and continually develop in accordance with the everchanging business environment [9]. Moreover, it was found that there were several studies focusing on the factors affecting the decisions to rent housing, such as [10], which revealed that family size, income, head of the family's education, availability of water source, security, convenience to access workplace, conditions of roads and other factors all have a considerable impact on monthly rent. Access to public transportation, such as bus and rail terminals, also increases the value of a residential property [11]. Moreover, the location of the residence is very crucial in influencing its price [12].

However, the literature reviews on the past studies revealed a gap in publications focusing on the success factors of the rental housing project developers, especially on choosing the right location for developing rental housing projects. This is an important factor that developers of rental residential projects must decide before actually realizing a project since the location is a factor that is related to the area and the surrounding environments of the land where the project is being developed [13]. If the developer of a rental residential project fails to choose an appropriate location or picks the area that lacks the potential to develop a project, the problem to access such project will raise and affect the success of the project development. This notion agrees with [14] that suggested that the important matter in developing a housing real estate is to assess that the land to be developed for a project is located in an area that is desirable to the target market and has potential for future growth.

For this reason, the researchers were interested in studying the importance of location factors in the development of rental residential projects using the Modified Analytic Hierarchy Process, which uses the principle of multi-criteria-decision-making (MCDM) to prioritize several criteria [15]. This research benefits those who are interested in developing apartments by choosing a potential location that effectively meets the needs of the target market.

2. Literature Review

2.1. Criteria for the Location Selection

The literature review recealed that there were several studies which studied the criteria in choosing the location for real estate development projects, which can be summarized as shown in Table 1.

Table 1 Criteria and sub-criteria acquired from the literature review

	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]	[24]	[25]
1. Daily Life Facility										
1.1 Being Near Community				✶			✶	✶		
1.2 Being Near a Convenience/Community Store				✶	✶	✶	✶			✶
1.3 is Near the Market				✶	✶	✶	✶			
1.4 Being Near Shopping Mall	✶			✶	✶	✶	✶			
2. Transportation										
2.1 is Near the Main Road				✶	✶		✶	✶		
2.2 Being Near Secondary Road				✶	✶	✶	✶			
2.3 Being Near Sky/Underground Train Stations	✶			✶	✶	✶	✶	✶		
2.4 Being Near Bus/Van/Motorcycle Station	✶	✶	✶	✶	✶	✶	✶	✶		✶

Continuation of Table 1									
3. Public Utility and Public Assistance									
3.1 Being Near Hospital			✶	✶	✶	✶	✶		
3.2 Being Near a Religious Site		✶			✶		✶		
4. Source of Workplace									
4.1 Being Near Office Buildings	✶	✶	✶	✶	✶	✶	✶		
4.2 Being Near Educational Institution	✶	✶		✶	✶	✶	✶		✶
4.3 Being Near Government Service Centers				✶	✶	✶	✶		
4.4 Being Near Airport				✶	✶		✶	✶	

Based on Table 1, there are fourteen sub-criteria in choosing the location for real estate development projects acquired from the literature which can be categorized into four aspects: daily life facility, transportation, public utility and public assistance and source of workplace. These sub-criteria will be the determinants of the location selection model and their coefficients will be calculated using the Modified Analytic Hierarchy Process, as explained in the following sections.

2.2. Criteria for Decision-Making

The Analytic Hierarchy Process (AHP) is a method used to analyze data for the best alternatives, focusing on the principle of dividing the problem structures into hierarchies. The first step is to define the goal, followed by the criteria, the sub-criteria and the alternatives, respectively [15]. It is an analytical decision to find the best alternative by analyzing and comparing the criteria set in pairs (pairwise) until all criteria are compared to prioritize the importance weight of each criterion and achieve the best alternative [15]. If the results or scores turn out to be consistent, the criteria can be prioritized to finding the best option.

In the past, there have been quite many studies where the application of the Analytic Hierarchy Process was modified, such as [26], which studied the qualifications of a contractor for public utilities in a housing project by using the Likert Scale instead of the pairwise comparison. However, in this research, the Modified Analytic Hierarchy Process was used to actualize the abstract factors into concrete numerical scores. The analysis was stopped when the importance weights of the main and sub-criteria were obtained. However, these factors were not used in the decision-making process.

3. Methodology

This research used the mixed methodology by interviewing five experts who have the past experience of selecting the locations for apartment developments, to screen and pick the criteria that affect the decisions to choose the locations for apartment development obtained from the related literature. These criteria were then used in the questionnaires as a tool for the data collection from the sample groups of 150 entrepreneurs who invested in the apartments and have developed not less than two projects. The sample groups are investors from five different zones of Bangkok, the researcher picked 30 from each. The data were then analyzed using the descriptive statistics such as the mean and the Modified Analytic Hierarchy Process (Modified AHP). The importance weight of each pair of main and sub-criteria was compared in a pair-wise manner. The questionnaire must prove its consistency for the content validity by acquiring the Item-Objective Congruence or IOC of the research, which must bear not less than 0.5 in value for each [27]. However, the researchers set the criteria to compare the importance weight of each main and sub-criteria in pairs, as shown in Table 2.

Table 2 The criteria for comparing each main and sub-criteria in pairs (Adapted from [15])

Importance Level	Meaning	Description
1	Equally Important	The factors being compared are equally important.
3	Less Important	The first factor being compared is slightly less or more important than another factor.
5	Moderately More Important	The first factor being compared is moderately less or more important than another factor.
7	Highly More Important	The first factor being compared is highly less or more important than another factor.
9	Ultimately More Important	The first factor being compared is ultimately less or more important than another factor.

The researchers analyzed the data by using the Modified Analytic Hierarchy Process with the following steps [15]:

1. Structure the hierarchy. The first stage is the highest stage of the goal of the location selection of an apartment. The second stage includes the main criteria, consisting of the daily-life facilities, the transportation, the public utility and public assistance and the source of workplaces, while the third stage belongs to the sub-criteria of each main criterion.

2. Calculate relative priority. The researchers performed a calculation to find the mean of the importance weight of each criterion obtained from the pairwise comparison of each pair of the main and sub criteria. These criteria were weighed and surveyed among the sample group of entrepreneurs who invested in the rental residential apartment projects. If criterion A has more importance weight compared to criterion B

being considered, the mean will be calculated using the reciprocal value as shown in Table 2, for example, criterion A has more importance weight than criterion B at a high level, the score value is seven, simultaneously, if criterion A has less im-portance weight than criterion B at a high level, the score value is determined to be 1/7, and so on.

3. Calculate the weight or the relative priority of the main and sub-criteria, until the total importance weight of all alternatives was scored according to the specified criteria.

4. Calculate the Consistency Index (C.I.) using the formula C.I. = $(\lambda_{max} - n) / (n - 1)$, where λ_{max} is the calculated sum of the data in each vector (Maximum Eigen Values). The sum is obtained by multiplying the importance weight score of each vertical criterion by the importance weight score of each criterion and n is the size of the matrix.

5. Calculate the Consistency Ratio (C.R.) by dividing the Consistency Index by the Random Consistency Index (R.I.), of which the consistency value must not exceed 0.10 [15].

Furthermore, to apply this model to select the right location to develop an apartment project, the analyst must assess the potential of the area according to each sub-criterion, to achieve a clear and concise assessment. The researchers therefore analyzed the values of each sub-criterion as a guideline for the analysts to use and specify the value in the location selection for the apartment project development with the model obtained. The researchers interviewed five experts about the maximum and minimum travel time it should take to travel from the apartment to the location specified in each sub-criterion to determine the rating for each criterion to construct a land potential assessment model for the apartment project development by estimating the data range. These data ranges were divided into three equal intervals for the scores of 2-4, respectively. Locations with travel time less than the lowest and greater than the highest were scored five and one accordingly

4. Results and Discussion

4.1. The Results of the Expert Interviews

The researchers interviewed five experts who have experience in land selection and project location analysis to determine the factors affecting the location selection of the apartment development projects at the highest level. This factor was used to categorize the data into groups, which a model was developed from each group of data. The importance scores obtained from the expert are summarized in Table 3.

From Table 3, the results from the experts revealed that the factor affecting the location selection of the apartments in the highest level is the zone of Bangkok concerning the apartment located.

Table 3 Factors affecting the location selection of apartments

Factors	Importance Scores Obtained From the Experts					Mean
	A	B	C	D	E	
Zone of Bangkok	5.0	5.0	5.0	5.0	5.0	5.0
Land Area	4.0	4.0	4.0	4.0	5.0	4.2
Land Price	3.0	4.0	4.0	4.0	5.0	4.0
Rental Price of Apartment	3.0	4.0	4.0	3.0	5.0	3.8
Number of Apartment Rooms	3.0	4.0	4.0	3.0	5.0	3.8

Additionally, the researchers picked the criteria, which influence the decisions to choose the location for the real estate development derived from the related studies, selecting only those bearing the importance weight in the high to highest levels (with the mean of 3.41 – 5.00 from 5-Scale of Likert), according to [28], which can be summarized into sub-criteria of each main criterion as follows:

1) The daily-life facility aspect: Four sub-criteria were opted, including being near a community, being near convenience/community store, being near a market and being near a shopping mall (with the means of 5.00, 4.40, 4.20, and 4.20, respectively).

2) The transportation aspect: Four sub-criteria were opted, including being near the main road, being near the secondary road, being near sky/underground train station and being near bus/van/motorcycle station (with the means of 4.80, 4.60, 4.60, and 4.20, respectively).

3) The public utility and public assistance aspect: Two sub-criteria were opted, including being near a hospital and being near a religious site (with the means of 4.80 and 3.60, respectively).

4) The workplace aspect: Four sub-criteria were opted, including being near the office building zone, near educational institution, near government service centers, and near airport (with the means of 4.60, 4.20, 3.80, and 3.60, respectively).

4.2. Importance of the Location Criteria for the Apartment Development

The researchers assigned the stages of the Modified Analytic Hierarchical process as follows:

The first stage was done by classifying the data according to the zone of Bangkok, which can be categorized into five groups as: (1) the Upper District of Bangkok, (2) the Inner District of Bangkok, (3) the Eastern District of Bangkok, (4) Thonburi District and (5) the Central Business District.

The second stage consisted of four main criteria of the location selection, namely, the daily life facility, the transportation, the public utility and assistance and the source of workplace criteria.

The second stage consisted of four main criteria of the location selection, namely, the daily life facility, the transportation, the public utility and assistance and the source of workplace criteria.

The researchers analyzed the data, using the

Modified Analytic Hierarchy Process by figuring the means of the importance score of each criterion obtained from the pairwise comparison of each main and sub-criteria in pairs. The calculation was performed to find the importance weight of the main and sub-criteria tiers until the total importance scores of the alternatives were obtained according to the specified criteria. The consistency index and the consistency ratio were then calculated and the result of the criteria for considering the consistency must not exceed 0.1. The researchers calculated the weight of the sub-criteria by multiplying the weight of the main criterion by the percentage of the weight of each sub-criterion compared to all of the sub-criteria of the main criterion. For example, if we consider the apartment development project in the Upper Bangkok districts, the sub-criterion of being near the communities (a1,1) bears an importance weight of 0.04. The weight value can be calculated compared to all sub-criteria of the daily-life facility criterion (a1) by multiplying the weight of the main criterion with the percentage of the weight value of the sub-criterion, which is 32.25 x 0.04 equals 1.29, etc. However, the results of the location selection criteria and sub-criteria for the apartment developments can be displayed according to Table 4.

4.2.1. The Upper District of Bangkok

The main criterion with the highest importance weight values for developing the apartments in the upper Bangkok district is the transportation criterion (with the importance weight value of 39.85%), followed by the daily-life facility criterion (32.25%), the source of workplace criterion (23.60%) and the public utility and assistance criterion (4.30%), respectively. While the first three sub-criteria with combined importance weight values greater than 50 percent were being near a shopping mall (20.96%), being near bus/van/motorcycle station (19.93%) and near the office building (12.27%), respectively.

4.2.2. The Eastern District of Bangkok

The main criterion with the highest importance weight values for developing the apartments in the eastern Bangkok districts is the source of workplace criterion (with the importance weight value of 41.00%, followed by the transportation criterion (28.00%), the daily-life facility criterion (25.00%) and the public utility and assistance criterion (6.00%), respectively. While the first five sub-criteria with combined importance weight values greater than 50 percent were Being near the office building (22.14%), near the sky/underground train station (14.56%), being near the educational institution (11.48%), being near the convenience /community store (8.75%), and being near shopping mall (8.75%), respectively.

Table 4 The weight values of the criteria/sub-criteria

Criteria/Sub-Criteria		**Zone of Bangkok**				
		Upper Bangkok District	**Inner Bangkok District**	**Eastern Bangkok District**	**Thonburi District**	**Central Business District**
Main Criteria	Daily Life Facility (a_1)	32.25	36.75	25.00	45.00	40.00
	Transportation (a_2)	39.85	36.75	28.00	41.00	47.00
	Public Utility and Public Assistance (a_3)	4.30	17.00	6.00	7.00	4.00
	Source of Workplace (a_4)	23.60	9.50	41.00	7.00	9.00
Daily Life Facility Sub-Criteria	Being Near Community ($a_{1.1}$)	1.29	2.57	3.75	3.15	3.60
	Being Near Convenience /Community Store ($a_{1.2}$)	4.20	20.58	8.75	22.30	19.20
	Being Near Market ($a_{1.3}$)	5.80	2.94	3.75	12.30	6.40
	Being Near Shopping Mall ($a_{1.4}$)	20.96	10.66	8.75	6.55	10.80
Transportation Sub-Criteria	Being Near Main Road ($a_{2.1}$)	9.96	10.66	3.92	6.36	6.58
	Being Near Secondary Road ($a_{2.2}$)	2.39	1.10	1.12	1.23	1.88
	Being Near Sky/Underground Train Station ($a_{2.3}$)	7.57	18.38	14.56	20.61	24.44
	Being Near Bus/Van/Motorcycle Station ($a_{2.4}$)	19.93	6.61	8.40	12.20	14.10
Public Utility and Public Assistance Sub-Criteria	Being Near Hospital ($a_{3.1}$)	3.74	14.79	4.98	6.44	3.32
	Being Near a religious site ($a_{3.2}$)	0.56	2.21	1.02	1.26	0.68
Source of Workplace Sub-Criteria	Being Near Office Building ($a_{4.1}$)	12.27	5.13	22.14	2.20	4.68
	Being Near Educational Institution ($a_{4.2}$)	4.72	2.85	11.48	2.20	2.07
	Being Near a Government Service Center ($a_{4.3}$)	4.72	1.04	3.69	2.00	1.53
	Being Near Airport ($a_{4.4}$)	1.89	0.48	3.69	1.20	0.72

4.2.3. The Thonburi District of Bangkok

The main criterion with the highest importance weight values for developing the apartment projects in the Thonburi district of Bangkok is the daily-life facility criterion (with the importance weight value of 45.00%), followed by the transportation criterion (41.00%), while the public utility and assistance and the source of workplace criteria have the same importance weight values of 7.00%. The first three sub-criteria with combined importance weight values greater than 50 percent were being near the convenience/community store (22.30%), being near the sky/underground train station (20.61%) and being near the market (12.30%).

4.2.4. The Central Business District of Bangkok

The main criterion with the highest importance weight values for developing the apartment projects in the central business district of Bangkok is the transportation criterion (with the importance weight value of 47.00%), followed by the daily-life facility criterion (40.00%), the source of workplace criterion (9.00%) and the public utility and assistance criterion (4.00%), respectively. The first three sub-criteria with combined im-portance weight values greater than 50 percent were Being near the sky/underground station (24.44%), being near the convenience/community store (19.20%), and being near the bus/van/motorcycle station (14.10%).

4.3. Suggested Values for the Sub-Criteria in the Model

Based on the interview results, the authors can suggest the values for substituting the sub-criteria variables in the location selection models as shown in Table 5.

Table 5 demostrates that the appropriate travel time range for each sub-criterion is different. For example, the appropriate travel time to the convenience/community store ranges between 5-20 min. The appropriate travel time to the airport is between 40–80 min. In this regard, the researchers agreed that the matter depends on various factors such as the frequency of the travel patterns, the mode of transportation, the number of service providers the travelers can choose from and the travel time of the day, etc.

Table 5 The values of the sub-criteria in the models

Sub-criteria	**Travel Time from Expert Opinions (Minutes)**		**Travel Time Range (minutes)**				
	Maximum	**Minimum**	**5 Scores**	**4 Scores**	**3 Scores**	**2 Scores**	**1 Score**
Being Near Community ($a_{1.1}$)	25.00	10.00	< 10.00	10.00-14.99	15.00-19.99	20.00-24.99	≥ 25.00
Being Near Convenience/Community Store ($a_{1.2}$)	20.00	5.00	< 5.00	5.00-10.99	11.00-15.99	16.00-19.99	≥ 20.00
Being Near Market ($a_{1.3}$)	34.00	15.00	< 15.00	15.00-21.99	22.00-27.99	28.00-33.99	≥ 34.00
Being Near Shopping Mall ($a_{1.4}$)	50.00	25.00	< 25.00	25.00-33.99	34.00-41.99	42.00-49.99	≥ 50.00
Being Near Main Road ($a_{2.1}$)	25.00	10.00	< 10.00	10.00-14.99	15.00-19.99	20.00-24.99	≥ 25.00
Being Near Secondary Road ($a_{2.2}$)	30.00	11.00	< 11.00	11.00-17.99	18.00-23.99	24.00-29.99	≥ 30.00
Being Near a Sky/Underground Train Station ($a_{2.3}$)	30.00	11.00	< 11.00	12.00-17.99	18.00-23.99	24.00-29.99	≥ 30.00
Being Near a Bus/Van/ Motorcycle Station ($a_{2.4}$)	21.00	5.00	< 5.00	5.00-10.99	11.00-15.99	16.00-20.99	≥ 21.00
Being Near Hospital ($a_{3.1}$)	30.00	11.00	< 11.00	11.00-17.99	18.00-23.99	24.00-29.99	≥ 30.00
Being Near a Religious Site ($a_{3.2}$)	40.00	15.00	< 15.00	15.00-23.99	24.00-31.99	32.00-39.99	≥ 40.00
Being Near an Office Building ($a_{4.1}$)	56.00	25.00	< 25.00	25.00-35.99	36.00-45.99	46.00-55.99	≥ 56.00
Being Near an Educational Institution ($a_{4.2}$)	40.00	17.00	< 17.00	17.00-24.99	25.00-31.99	32.00-39.99	≥ 40.00
Being Near a Government Service Center ($a_{4.3}$)	40.00	17.00	< 17.00	17.00-24.99	25.00-31.99	32.00-39.99	≥ 40.00
Being Near an Airport ($a_{4.4}$)	80.00	40.00	< 40.00	40.00-53.99	54.00-66.99	67.00-79.99	≥ 80.00

To exemplify the model applications, assuming that a land located in the upper Bangkok district equally requires the travel time from the location to various places, which are 20 min, the location potential score of this land for apartment project development can be calculated as so, [1.29(2) + 4.20(1) + 5.80(4) + 20.96(5) + 9.96(2) + 2.39(3) + 7.57(3) + 19.93(2) + 3.74(3) + 0.56(4) + 12.27(5) + 4.72(4) + 4.72(4) + 1.89(5)] / 100 = 3.46, which is considered as a good interval (3.41 - 4.20 score range), according to [28].

From the research results, the researchers found that transportation is always among the top one or two most important criteria to decide for a location of the apartment development projects in all districts. The results showed that the group of residents who chose to live in an accommodation, such as an apartment, desired convenience in traveling and the convenience in their daily life, which was consistent with [11]. The research revealed that accessibility to transit points like rail stations, significantly appreciates residential property. While the daily-life facility is among the top two criteria along with transportation in most areas, except for the Eastern district of Bangkok, on which the specialists commented that the source of work-place, is of the priority, followed by transportation, making the daily-life facility comes in the third when concerned of the importance criteria. This is due to the unique characteristic of Bangkok's Eastern districts,

which connect multiple workplaces in Samutprakarn Province, such as the Bang Pli Industrial Estate, Bang Pu Industrial Estate and Suvarnabhumi Airport, etc.

5. Conclusions and Recommendations

From the data analysis using the Modified Analytic Hierarchy Process, the researchers could develop the models in the form of Multiple Regression Equation as described in formulas (1) – (5):

Location Score = (Daily Life Facility) + (Transportation) + (Public Utility) + (Workplace) (1)

$$\textit{Daily Life Facility} = a_{1.1}\,\textit{(Community)} + a_{1.2}\,\textit{(Store)} + a_{1.3}\,\textit{(Market)} + a_{1.4}\,\textit{(Shopping Mall)} \quad (2)$$

$$\textit{Transportation} = a_{2.1}\,\textit{(Main Road)} + a_{2.2}\,\textit{(Secondary Road)} + a_{2.3}\,\textit{(Train)} + a_{2.4}\,\textit{(Other Public Transportation)} \quad (3)$$

$$\textit{Public Utility} = a_{3.1}\,\textit{(Hospital)} + a_{3.2}\,\textit{(Religious Site)} \quad (4)$$

$$\textit{Workplace} = a_{4.1}\,\textit{(Office Building)} + a_{4.2}\,\textit{(Educational Institution)} + a_{4.3}\,\textit{(Government Service Center)} + a_{4.4}\,\textit{(Airport)} \quad (5)$$

where:

1) The weight value of each sub-criterion is shown in Table 4

2) The value of each sub-criterion (between one to five) when considering the travel time from the location to different places specified in the sub-criteria is shown in Table 5.

When considering the groups of the sub-criteria for the decision to select a location for developing the apartment projects with the highest importance weight and a combined importance weight of more than 50 percent, the researchers found that for the daily-life facility criteria, the sub-criterion of being near convenience/community stores was in the highest priority group sub-criteria for all studying zones, except for the upper parts of Bangkok, which significantly places more importance on the sub-criteria of being near the shopping mall. This reflects the lifestyle of the Upper Bangkokians, since the sky/underground train systems in the areas are still under construction. People thus rely mainly via private vehicles or public transport. Consequently, household consumer products are purchased in department stores in bulk for gradual household use, which is more cost-effective than buying in convenience or community stores.

For the transportation criteria, the researchers found that the proximity to sky/underground train station sub-criterion was in the highest priority group of sub-criteria, with the combined weight values greater than 50% in all areas of Bangkok, except for the Upper districts, as for the case of the daily life facility aspect. For this specific area of Bangkok, the criterion with the highest level of importance weight is the sub-criterion of being near the bus/van/motorcycle stations. The researchers believed that because of the sky/underground train system being under construction, the apartment residents must rely mainly on the public transport in the modes of buses, vans, and motorcycle taxis than people in other areas being compared. Moreover, the re-searchers also discovered an interesting point for the case of the public utility, public assistance and the source of workplace sub-criteria, that is, the proximity to hospital sub-criteria is of high importance for the apartment projects in the inner districts of Bangkok, while the sub-criteria of being near the office buildings and the educational institutions are of a high importance level for the apartment projects in Eastern Bangkok area.

In this regard, apartment business operators or those interested in developing the rental residential projects can use the models to assess the potential of land in Bangkok, to accurately analyze and compare the potential and decide on the location that is suitable for developing an apartment project. This is because the model summarizes the decision-making criteria obtained from the experienced experts with a systematic and academically-based analysis process. On the part of researchers or academics, the main criteria and sub-criteria, as well as the process of applying the hierarchical analysis and the specification of the main and sub-criteria in the numerical orders as proposed in the research, can be used for further study and create other decision-making models. However, the researchers suggested that one must take into the account the caution in developing a model from the Modified AHP process that the number of the sub-criteria of each main criterion should be equal or close in the amount, so that the importance level of the sub-criterion from the different main criteria can be compared in values.

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