USING THE AHP METHOD TO EVALUATE LAUNDROMAT STORE LOCATION SELECTION: A CASE STUDY IN BANGKOK METROPOLITAN REGION

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Abstract

Consumer behaviors are changing fast as everyday life is becoming more and more competitive. For this reason, the lifestyle of living has changed to a more urban society, especially in the Bangkok Metropolitan Region. People who live or work in an urban society, tend to be often in a hurry. This is the reason why many people have become increasingly interested in using laundry services. The key to success in business will always depend on many key factors. One of these is the location selection factor. This study investigates the selection of a suitable location for opening a laundry shop in the Bangkok Metropolitan Region via a multi-criteria decision process (Multi-Criteria Decision Making: MCDM) analyzed using the Analytic Hierarchy Process (AHP). It was found that the top nine important criteria were 1) population density, 2) average housing prices in the area, 3) number of parking spaces, 4) rental fees, 5) number of competitors, 6) ease of access, 7) surrounding environment, 8) distance from the main road, and 9) distance from schools and universities. Four locations were selected for the study, namely Chatuchak District, Soi Phahonyothin 24; Bang Khen District, Phahon Yothin Road; Bangkapi District, Soi Ramkhamhaeng 24; and Lat Krabang District, Soi Lat

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Krabang 46. From the study, it was found that Soi Lat Krabang 46 was the best alternative for setting up a laundromat store.

Keywords: Strategic Location Selection, laundromat store, Analytical Hierarchy Process

1. INTRODUCTION

Current socio-economic conditions have resulted in changing consumer behavior and a change to a more specific "Niche Market" due to the fast-paced lifestyle and increased tiredness from work (Kasikorn Research Center, 2018). In 2016, the Department of Provincial Administration (Registration Statistical System, Department of Provincial Administration, 2016) predicted that the number of employees of Generation Y (Gen Y) in various organizations is as high as 80 percent of the total workforce, making Gen Y unique. Gen Y especially like convenience and speed, using technology as a factor that is important in life. Another distinctive characteristic of people in Gen Y is that they want to live a balanced life (Lertphiphatthanon, 2018). According to the Lazy User theory, these people will choose the solution that requires the least effort, making their decision according to the lowest effort level. Effort refers to the combination of money spent, time spent, and energy spent. According to this theory, people will determine the physical or mental tasks needed to meet user needs by deploying technology (Tetard & Collan, 2009). Therefore, service industry entrepreneurs are required to provide many types of service to meet the needs of consumers and offer convenience. This is an opportunity for entrepreneurs to offer a variety of products to meet the changing needs of their customers, but it requires the application of technology and innovation to create added value for their products (Kasikorn Research Center, 2018). Businesses that are likely to meet the needs of the main target customers (Gen Y) are the service businesses. "Convenience Laundromats" are self-service shops that allow customers to bring their clothes for washing and drying using machines and other equipment that reduces the time taken for these chores; they are usually open for 24 hours. Entrepreneurs are more interested in investing in this type of business. One factor that affects the likelihood of a service business being successful in the long run is choosing the correct location. This is one of the things that entrepreneurs must focus on in their strategic planning (Hernandez, 2007; Kuo et al., 2002; Turhan et al., 2013). Specifically, assessing the market potential of the area in which the store is located is an important strategic tool that helps retailers to attract customers to the store (Grewal et al., 2009).

Based on the literature review and related research, no studies have examined the decision of location

when opening a service business. Therefore, this research presents an idea for entrepreneurs who want to find a location to open a convenience store business in Bangkok via a case study for the benefit of laundry service entrepreneurs or those involved in selecting the appropriate location for this service business. A decision support tool was built based on the Multiple Criteria Decision-Making (MDCM) method, evaluating scores based on the importance of criteria and then considering each one individually to rank them until the best choice can be determined. The results will be reliable because it is a step-by-step and efficient decision-making model.

1.1 Objectives of the Research

1. To study the criteria affecting the establishment of a convenience laundromat in the Bangkok Metropolitan Region.
2. To find the optimal location for the establishment of a convenience laundromat in the Bangkok Metropolitan Region.

2. LITERATURE REVIEW

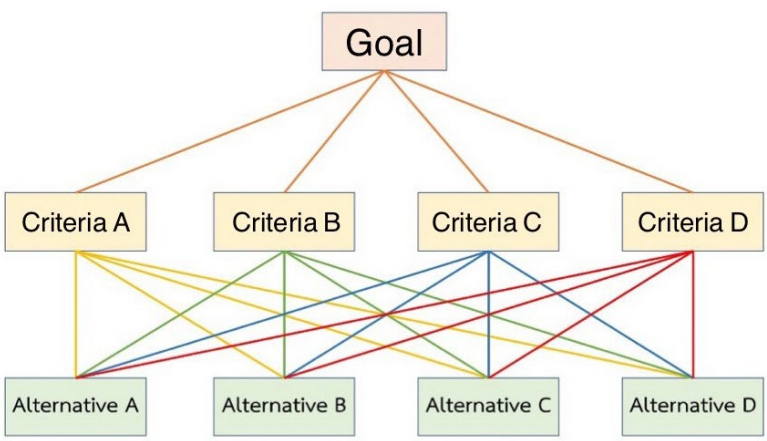
2.1 Location Theory

Making a decision regarding the location for a business depends largely on issues such as the beginning of new business operations, the expansion of a business or branch, or the inadequacy of a current location—in other words, issues that involve change. The location will be the base for operations, and is therefore a long-term commitment. Any factors lacking in a location are difficult to fix. Therefore, business owners must consider the many needs which require fulfillment, in combination with the many location options available. Each choice cannot usually meet all of the specific needs; the business owner should aim to choose the location that best meets as many of the needs as possible. Many scholars have presented the factors involved in selecting an optimum location. For example, Zentes et al. (2007) presented the retail location decision process, which has three steps: (1) Marketing considerations influence the selection of potential areas for new retailers. (2) Area analysis influences the selection of the most suitable area for a store after viewing a number of areas. (3) Site evaluation influences the selection of the best site after a review of all features that could be related to the potential performance of a store. Following these steps, a final decision can be made regarding which specific site is most suitable. The factors involved in choosing a location are (1) customer characteristics, including the number of customers and future customer trends, (2) accessibility of the business, (3) competitive conditions in the area, and (4) the costs that will arise.

2.2 Analytic Hierarchy Process Theory

The Analytic Hierarchy Process (AHP) is a decision-making process

theory. This approach is used to synthesize data and evaluate decision criteria. It involves classification of complicated problems into various levels of decision-making criteria that can be conveniently determined. It can also use both actual data and qualitative assessment of factors for evaluation in a single model. The pairwise comparisons between elements are the inputs of the AHP model. A ratio score is the consequent outcome of the AHP process, which allows comparisons between choices, while also providing insights into their related merits (Saaty and Kearns, 1985). This method is properly used for conditions in which the problems in decision making can be separated into criteria, sub-criteria, and alternatives. It is a technique for analyzing and organizing complex decisions using mathematics and psychology. Furthermore, pairwise comparisons are created at all levels of the hierarchy in the AHP method, thereby it is difficult to execute the AHP method when the number of alternatives and criteria increases (Singh, 2013). The AHP approach also helps decision-makers to determine the most valuable alternative and understand their problems. Besides this, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method is an appropriate technique when there are many criteria and alternatives (Ozcan et al., 2011). Saaty (1980) developed the analytic hierarchy process (AHP) theory. It is a multicriteria decision-making method. Using multiple criteria to make a decision is an efficient and convenient process of prioritizing. It can be used for complex decisions with the pair comparison method. This theory is widely used today to make decisions. There are four steps in AHP, as discussed in the following paragraphs.



Step 1: Identifying the Problems and Developing the Hierarchy Process

AHP starts with breaking down the complex problems into the elements of the hierarchical process. The highest level is the overall objective. The next level includes the criteria and the elements that affect decision-making. The third level contains the sub-criteria. Finally, the lowest level of the hierarchical process contains the decision alternatives. The elements in each row of the hierarchy process are assumed to be independent from each other, meaning that the significance level of all criteria does not depend on the lower elements of that criteria (Saaty, 1990).

Step 2 Setting Comparative Judgment to Determine the Priority. This step consists of three sub-steps: pairwise comparisons, weight calculation, and consistency check.

In the pairwise comparison, the comparative significance of the different elements at each level is determined. The strength of influence of the elements is compared to the components at the higher level. The scale used in the comparison is the AHP 1-9 fundamental scale. The pairwise comparisons start from the lowest level (alternative level) and end at the second level (first level of criteria). After all elements have been paired with the AHP 1-9 scale, the next step is to create an equilibrium matrix, which is also known as a pairwise comparison matrix.

The weight calculation is next. After the pairwise comparison matrix has been created, the next step is to use mathematical processes to compute the eigenvector and the largest eigenvalue for each matrix. The eigenvector provides the priority level (weighted value), and the eigenvalues can be used as a measurement for checking the consistency. The calculation methods for eigenvectors and eigenvalues can be studied from research work (Saaty, 1980).

Finally, for the consistency check, the AHP method can measure the degree of consistency for each set by calculating a consistency ratio (C.R.) for each matrix. If the C.R. is

Table 1 AHP 1-9 Fundamental Scale.

(Rating level)	(Verbal Judgment or Preference)
9	Extremely important
8	Very to extremely important
7	Very strongly important
6	Strongly to very strongly important
5	Strongly important
4	Moderately to strongly important
3	Moderately important
2	Equally to Moderately important
1	Equally important

equal to zero, then it is fully consistent. If the C.R. is equal to one, then it is inconsistent. If the C.R. is large (typically, the critical value is 0.1), the judgment is unreliable. The acceptable range of C.R. also depends on the size of the matrix. For example, if the matrix is a 3x3 matrix, then the C.R. should not exceed 0.05, but if the matrix size is 4x4, the C.R. should not exceed 0.08. For matrix sizes larger than 5x5, the C.R. should not exceed 0.1. If the C.R. value exceeds a specified level, then the assessor's discretion must be reviewed (Saaty, 1994).

Step 3: Synthesis to Achieve the Overall Priorities.

The synthesis method in the AHP model is quite similar to determining expectations using a decision tree approach. The prioritization structure at each level is derived from the calculation of global priorities. The level of importance obtained from each set is referred to as the local priorities. These local priorities can refer to the above components. The global priorities are obtained by multiplying the local priorities with the global priorities of the above components.

Step 4: Sensitivity Analysis:

Synthesis analysis is a test for the stability of the results by changing the priorities of various criteria.

2.3 Related Research

Turhan et al. (2013) compiled a series of studies looking at site selection criteria from 1972 to 2012. The results showed that the criteria related to the location of a store were as follows:

- **Population structure**. The study found that there were multiple factors in terms of demographic characteristics (income, age, gender, etc.), and in terms of customer spending characteristics, as well as other factors such as number of households, population size, population density, and population growth rate.
- **Economic factors**. The study found that there were factors in terms of household income, income distribution, residents' willingness to spend their money at the store, rentals, etc.
- **Competition**. The study found that there were factors in terms of the size and number of competitor stores, shopping alternatives, etc.
- **Saturation level**. Retailers use the index of retail saturation (IRS), an indicator of the condition of consumption of consumer goods per retail area.
- **Store characteristics**. The study found the factors of ease in accessibility, store-image attributes, and costs. Ease in accessibility refers to the availability of roads, streets, and parking facilities which make it easier for customers to access to the shopping area.
- **Magnet**. This means that the location has magnet stores available which attract customers to the retailer's own store as well.

There are also many researchers who studied store location selection using the MDCM approach. Erbiyik et al. (2012) studied decisions on retail store location using the analytical hierarchy process (AHP) method, in which several experts were used to determine the weight of each factor. There were five main factors which could be divided into 15 secondary factors. Cost (M) consisted of the value of the rent (M1), the cost of furnishing the retail store (M2), and the terms and length of the contract (M3). Competition (R) consisted of competitive power (R1), number of competitors (R2), and the competitor distance sub-criterion (R3). Traffic density (T) consisted of vehicle traffic (T1) and passenger traffic (T2). Finally, physical qualifications (F) consisted of store size (F1), parking space (F2), and retail store visibility (F3). Location (Y) included location on the main road (Y1), located within a shopping center (Y2), location near a business center area (Y3), and location near a settlement or residential area (Y4). Roig-Tierno et al. (2013) conducted an application study of the retail location selection process using geographic information systems (GIS), and the AHP factors that influence the success of a retail store. There are many factors such as several people passing through the store, storefront visibility, the distance between a retail store or supermarket and a competitor's store, the potential market within the commercial area of a retail store, accessibility by car, and ease of access by foot. In addition, Yıldız and Tüysüz's study (2019) on strategic retail location investment in Turkish food retailing set criteria for the location (city) selection as: number of competitors in the city, rent levels, per capita GDP, food retailing consumption amount, number of enterprises, age distribution of the population, urbanization level of the population, population density, average saving account amount per person, and the unemployment rate of the city. However, supply chain and logistics factors need to be taken into consideration as well. In addition, Hikmet et al. (2012) also analyzed the optimal location area for a retail store in Turkey. The results revealed that the selection criteria were traffic density, competition conditions, location of the store, costs, and physical features. Tinessa et al. (2020) stated that retailers are willing to pay more for locating their activities closer to pedestrian zones than to subway stations.

For research on the location selection of laundromat businesses, there are two studies. Pagadala and Gupta (2018) studied laundry start-ups in India. Washing clothes is a busy job for everyone; therefore, providing laundry services through an online system makes it easy to access; these must be reasonable with no fines, and clothing delivery. This system offers 100% quality assurance, including service pick-up and drop-off. There are a variety of formats for the convenience of the customers, and customers can contact the company through a variety of ways. The clothing is RFID-enabled for different cleaning processes and to prevent

Table 2 Retail Site Location Selection Criteria

Researcher and Year of Research	Test Site	Criteria
Erbiyik et al. (2012)	Retail store location areas in Turkey	• Cost • Competition • Traffic density • Physical qualifications • Location
Hikmet et al. (2012)	Retail store location areas in Bosna Hersek, Türmak Kavşağı and Toki Konutlari (Turkey)	• Traffic density • Competition conditions • Location of store • Costs • Physical features
Tierno et al. (2013)	The retail site location decision process was applied to the opening of a new supermarket in the Spanish city of Murcia.	• Several people passing through the store • Storefront visibility • The distance between the retail store or supermarket and a competitor's store • The potential market within the commercial area of the retail store • Accessibility by car • Ease of access by foot
Bhate and Shivdas (2017)	Laundromats spread across different states within India	• Population density • Location of the store
Pagadala and Gupta (2018)	The laundry start-ups in India	• Population density • Per capita GDP of the city
Yıldız and Tüysüz (2018)	Turkish food retailing (Turkey)	• Number of competitors in the city • Rent levels in the city • Per capita GDP of the city • Food retailing consumption amount in the city • Number of enterprises in the city • Age distribution of the population in the city • Urbanization level of the population in the city • Population density of the city • Average savings account amount per person • Unemployment rate of the city
Tinessa et al. (2020)	Retailing from the case study of Naples (Italy)	• Closer to pedestrian zones

mistakes that could occur in the clothing delivery. The target customers of this business are those living in densely populated areas. A laundry business grows well in environments which include highly educated and high-income groups. These groups are regarded as the upper middle class and see that time is more important and more valuable than money. Due to hard work, the remaining time left after work can be used to relax and socialize. A laundry company also needs B2B customers, such as hotels, resorts, spas, and universities. Bhate and Shivdas (2017) also emphasized that the success of laundromats includes factors such as reducing wait times and having a delivery service. The location should be in a crowded place (high population density) and not far from the residence of customers because the laundromats must consider the cost of transportation as well. Table 2 summarizes the research related to the factors of location selection, including the location of retail stores.

3. METHODOLOGY OF THE RESEARCH

3.1 Tools Used in the Research

For this study, data were collected from past theoretical studies and related research, as well as via the collection of relevant factors and their application in the selection of a suitable location for a laundromat. A geographic information system (GIS) was used in the selection of the location, along with information collected via site surveys. Information regarding the factors affecting location selection was then used to create a questionnaire.

3.2 Data Analysis

A questionnaire was used to construct a framework for the factors affecting location selection and for calculating the weights of the factors. The respondents were three experts with different types of expertise. A total of three experts was deemed sufficient for determining the choice of criteria for laundromat store location selection. The criteria for selecting the experts included having at least 10 years of experience in selecting locations or having expertise in retail or service businesses. The first expert specialized in project management, which is useful in considering an economic comparison of the cost-effectiveness of various investment options such as when doing a feasibility study. The second expert specialized in logistics and supply chain management, which helps to efficiently manage operation and transportation factors. The third expert specialized in retail and service marketing, which helps to classify the retail perspective and primary potential customers of the laundromat stores. The factors were analyzed by the AHP, following the decision hierarchy shown in Figure 2.

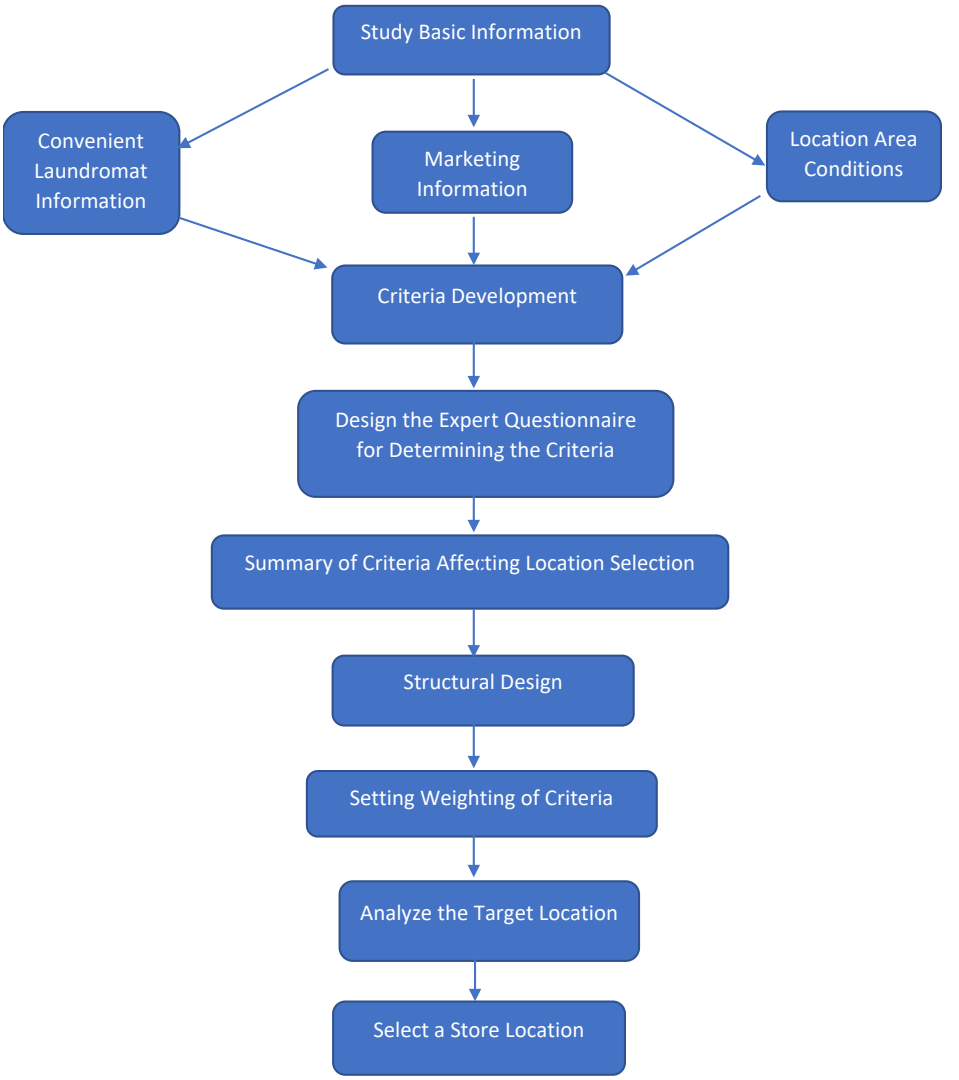


Figure 2 Research Process

4. RESEARCH RESULTS

4.1 Determining Criteria for Making Decisions on Location

During the literature review, information was collected from theories, concepts, and related research, regarding how to choose a suitable location for a laundromat. The GIS and a site survey were also used. The criteria chosen are shown in Table 3. The criteria factors that were considered in the AHP were as follows: population density, average housing prices in the area, number of parking spaces, rental fees, number of competitors, ease of access, the surrounding environment, distance from the main road, distance from schools and universities, laws and tax requirements, utilities, and traffic.

These criteria were used to determine the location of the convenience laundromat. The four location options were Chatuchak District, Soi Phahonyothin 24 (A1); Bang Khen District, Phahon Yothin Road (A2); Bangkapi District, Soi Ramkhamhaeng 24 (A3); and Lat Krabang District, Soi Lat Krabang 46 (A4). The experts in each field considered the criteria factors, indicating that the top nine most important criteria were population density (X1), average housing prices in the area (X2), number of parking spaces (X3), rental fees (X4), number of competitors (X5), ease of access (X6), the surrounding environment (X7), distance from the main road (X8), and distance from schools and universities (X9); this information was used to generate a decision chart (see Figure 3).

Table 3 Criteria Used for Making a Decision on the Location of a Laundromat

Criterion Number	Criterion	Explanation	Source of Information
X1	Population density	The area should have no fewer than 140,000 resident	The Bureau of Registration Administration/ Department of Provincial Administration (2019), Land Survey and Map Division & Department of City Planning and Urban Development/ Bangkok Metropolitan Administration (2019)
X2	Average house price in the area	The average house price should be higher than 100,000 baht per square wah	Department of Lands (2021), The Treasury Department (2019)
X3	Number of parking spaces available	Sufficient space for parking should be nearby	Site surveys
X4	Rental fee for laundromat	The rental price should not exceed 50,000 baht per month	District office/ Site surveys
X5	Number of competitors	The number of competitors in the neighborhood should be as few as possible	District office/ Site surveys
X6	Ease of access to the laundromat	Customers should be able to reach the shop easily by car or public transportation, and the shop should be clearly visible	Site surveys

Table 3 Criteria Used for Making a Decision on the Location of a Laundromat (Continued)

Criterion Number	Criterion	Explanation	Source of Information
		.	
X7	Surrounding environment	The surrounding environment should have sufficient utilities for the laundromat store and also nearby communities, residential areas, apartments, university dormitories, temples or churches, and others.	District office/ Site surveys
X8	Distance of laundromat from the main road	The location should not be more than 500 meters from the main road.	Site surveys
X9	Distance of laundromat from schools and universities	The distance from schools and universities should not be more than 3 kilometers	District office/ Site surveys

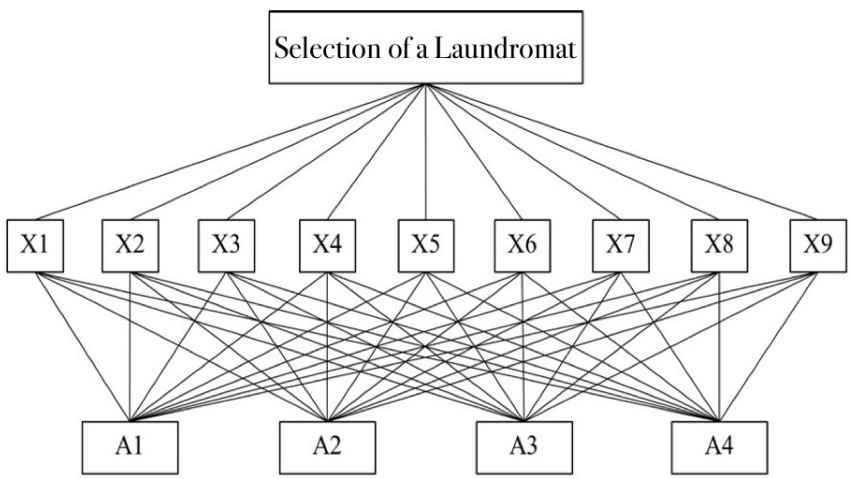


Figure 3 Hierarchical Structure or Model of Location Decision-Making

4.2 Determination of the Level of Importance for Each Criteria Factor Used in Making a Decision Regarding the Location of a New Convenience Laundromat

The study of the importance of all nine factors, and their influence in the selection of the location for the convenience laundromat indicated that the most important criteria factor was population density, followed by number of competitors, average housing price in the area, surrounding environment, distance from schools and universities, distance from the main road, rental fees, number of parking spaces, and ease of access respectively.

4.3 Consistency Ratio (CR) Examination

When the weight of each criteria factor was known, the coherence of the factors was checked with a pairwise comparison to calculate its reasonability. These results could then be used as a weighting value. If the CR value was less than or equal to 0.10, the factor was consistent, while if the CR was greater than 0.10, the factor was considered inconsistent. The scores in the pairwise comparison must then be re-adjusted by calculating the coherence ratio of the reasonable CR with the following equation:

$$CR = \frac{CI}{RI}$$

by CR = Consistency Ratio; Generally, for acceptable consistency, the consistency ratio CR = CI/RI must be less than 10%
CI = Consistency Index; is a measure of deviation from perfect consistency
RI = Random Consistency Index; CI of a randomly generated matrix

The Consistency Index (CI) can be found from

$$CI = \frac{\lambda - n}{n - 1}$$

Where N = the size of the square matrix and λ or λmax is the maximum Eigen Value of the specific coefficient and the Random Consistency Index (RI) as shown in Table 4 (Saaty, 1980).

The values of CI and CR can be calculated as follows: Calculation of λ begins with the introduction of the matrix. The pairwise comparison is multiplied by the weighting matrix for each criteria factor, as shown in Tables 5, 6, and 7.

Table 4: Random Consistency Index - RI - (for number of items compared in a matrix)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Table 5 Matrix of Pairwise Comparisons of First Expert Analysis Criteria

	X1	X2	X3	X4	X5	X6	X7	X8	X9	Weight	
X1	1	3	7	7	3	9	5	5	9	0.3150	3.2020
X2	1/3	1	7	6	1/3	8	5	5	9	0.1875	1.9500
X3	1/7	1/7	1	1/2	1/8	3	1/4	1/6	3	0.0294	0.2930
X4	1/7	1/6	2	1	1/5	3	1/3	1/2	5	0.0454	0.4340
X5	1/3	3	8	5	1	8	3	7	7	0.2271	2.3580
X6	1/9	1/8	1/3	1/3	1/8	1	1/6	1/8	1/2	0.0160	0.1610
X7	1/5	1/5	4	3	1/3	6	1	3	7	0.0959	0.9510
X8	1/5	1/5	6	2	1/7	8	1/3	1	3	0.0643	0.6830
X9	1/9	1/9	1/3	1/5	1/7	2	1/7	1/3	1	0.0194	0.1940

In Table 5, the result is then divided by the weight of the significance. The average of the results was found as follows:

λ = [3.202/0.315 1.95/0.1875
0.293/0.0294 0.434/0.0454
2.358/0.2271 0.161/0.016
0.951/0.0959 0.683/0.0643
0.194/0.0194]
= [10.165 10.4 9.9659 9.5594
10.383 10.0625 9.9165 10.622 10]
= [10.165+10.4+9.9659+9.5594
+10.383+10.0625+9.9165+10.622
+10]/9
= 91.0743/9 = 10.1194

$$CI = \frac{\lambda - n}{n-1} = (10.1194\text{-}9)/\ (9\text{-}1)$$
$$= 1.1194/8 = 0.1399$$

Therefore, the consensus ratio of the CR rationale is made by comparing the RI values equal to 1.45; when the number of factors that were compared equals 9, the factors are as follows:

$$CR = \frac{CI}{RI} = 0.1399/1.45$$
$$= 0.0965 \text{ (1st expert CR value).}$$

Table 6 Matrix of Pairwise Comparisons of 2nd Expert Analysis Criteria

	X1	X2	X3	X4	X5	X6	X7	X8	X9	Weight	
X1	1	5	5	4	7	9	3	3	2	0.2757	2.6690
X2	1/5	1	1/3	1/4	3	3	1/5	1/5	1/5	0.0358	0.3660
X3	1/5	3	1	1/2	3	7	1/5	1/5	1/5	0.0543	0.5550
X4	1/4	4	2	1	3	7	1/4	1/5	1/5	0.0687	0.7000
X5	1/7	1/3	1/3	1/3	1	3	1/3	1/5	1/5	0.0295	0.2930
X6	1/9	1/3	1/7	1/7	1/3	1	1/5	1/7	1/9	0.0159	0.1610
X7	1/3	5	5	4	3	5	1	2	1/3	0.1442	1.4800
X8	1/3	5	5	5	5	7	1/2	1	1/4	0.1349	1.4120
X9	½	5	5	5	5	9	3	4	1	0.2409	2.4350

In Table 6, the result was then divided by the weight of significance. The average of the results was found as follows:

λ = [2.669/0.2757 0.366/0.0358
0.555/0.0543 0.7/0.0687
0.293/0.0295 0.161/0.0159
1.48/0.1442 1.412/0.1349
2.435/0.2409]
= [9.68 10.223 10.221 10.189
9.932 10.1257 10.263 10.467
10.108]
= [9.68+10.223+10.221+10.189
+9.932+10.1257+10.263+10.467
+10.108]/9
= 91.2087/9 = 10.1343

$$CI = \frac{\lambda - n}{n-1} = (10.1343\text{-}9)/\ (9\text{-}1)$$
= 1.1343/8 = 0.1417

Therefore, the consensus ratio of the CR rationale was made by comparing the RI values equal to 1.45; when the number of factors that were compared equals 9, the factors are as follows:

$$CR = \frac{CI}{RI} = 0.1417/1.45$$
= 0.0977 (2nd expert CR value).

In Table 7, the result was then divided by the weight of significance. The average of the results was found as follows:

λ = [2.534/0.2635 1.535/0.1551
1.074/0.1007 1.055/0.0981
2.38/0.2368 0.407/0.0408
0.595/0.0561 0.236/0.0245
0.236/0.0245]
= [9.6166 9.896 10.665 10.754
10.05 9.975 10.606 9.632 9.632]
= [9.6166+9.896+10.665+10.754
+10.05+9.975+10.606+9.632
+9.632]/9
= 90.826/9 = 10.0918

$$CI = \frac{\lambda - n}{n-1} = (10.0918 - 9)/\ (9\text{-}1)$$
= 1.0918/8 = 0.1365

Table 7: Matrix of Pairwise Comparisons of 3rd Expert Analysis Criteria

	X1	X2	X3	X4	X5	X6	X7	X8	X9	Weight	
X1	1	3	5	3	1	5	4	7	7	0.2635	2.5340
X2	1/3	1	3	3	1/3	5	3	5	5	0.1551	1.5350
X3	1/5	1/3	1	3	1/5	4	3	4	4	0.1007	1.0740
X4	1/3	1/3	1/3	1	1/3	2	5	7	7	0.0981	1.0550
X5	1	3	5	3	1	5	3	5	5	0.2368	2.3800
X6	1/5	1/5	1/4	1/2	1/5	1	1/4	3	3	0.0408	0.4070
X7	1/4	1/5	1/3	1/5	1/3	4	1	3	3	0.0561	0.5950
X8	1/7	1/5	1/4	1/7	1/5	1/3	1/3	1	1	0.0245	0.2360
X9	1/7	1/5	1/4	1/7	1/5	1/3	1/3	1	1	0.0245	0.2360

Therefore, the consensus ratio of the CR rationale was made by comparing the RI values equal to 1.45; when the number of factors that were compared equals 9, the factors are as follows:

$$CR = \frac{CI}{RI} = 0.1365/1.45$$
=0.0941 (3rd expert CR value).

The CR values of the three experts were calculated to be 0.0965, 0.0977, and 0.0941. Therefore, it can be concluded that the pairwise comparison is consistent with the reasons within the acceptable criteria. In other words, the weight of each criteria factor in influencing the selection of the location is consistent and acceptable. The results are shown in Table 8.

4.4 Comparison of Criteria Factors in Each Choice for Deciding on the Location of the New Convenience Laundromat

The weight of the importance of the factors used in the choice of location were averaged and compared, as shown in Table 9.

Because ease of access (X6) and surrounding environment (X7) were decision-making criteria, the data could not be easily quantified. Factor weighting therefore required a decision-making technique capable of qualitatively analysing the data. Pairwise comparisons X6 and X7 were required for each alternative, as shown in Table 10.

Table 8 Summary of the CI and CR Values of the Three Experts

Experts	CI	RI	CR=CI/RI
1	0.1399	1.45	0.0965
2	0.1417	1.45	0.0977
3	0.1365	1.45	0.0941

Table 9 Average Weight and Priority Values from a Matrix of Pairwise Comparisons of the Three Expert Analysis Criteria

	Weight#1	Weight#2	Weight#3	Weight Average	Rank
X1	0.3150	0.2757	0.2635	0.2847	1
X2	0.1875	0.0358	0.1551	0.1262	3
X3	0.0294	0.0543	0.1007	0.0615	8
X4	0.0454	0.0687	0.0981	0.0707	7
X5	0.2271	0.0295	0.2368	0.1645	2
X6	0.0160	0.0159	0.0408	0.0242	9
X7	0.0959	0.1442	0.0561	0.0988	4
X8	0.0643	0.1349	0.0245	0.0745	6
X9	0.0194	0.2409	0.0245	0.0949	5

After the pairwise comparisons (Table 10), the weights of Alternatives X6 and X7 were obtained. Quantitative data of the other alternatives were collected and adjusted with vector normalization, as shown in Table 11, and the data were adjusted to bring the sum to one, as shown in Table 11. In addition, Table 12 and table 13 show the calculation of the significant weight of each choice, found by taking the average weight score of the experts multiplied by the weight values of the alternative, adjusted to a total of 1.

The matrix of pairwise comparisons of the analysis criteria of the three experts was used to find the factors or important criteria affecting the location selection. In order of the most to the least important, the analysis indicated these were population density (X1), number of competitors (X5), average housing prices in the area (X2), surrounding environment (X7), distance from

Table 10: Matrix of Pairwise Comparisons of Criteria X6 and X7 for Each Alternative

For X6	A1	A2	A3	A4	Weight
A1	1	1/3	1/7	1/5	0.0593
A2	3	1	1/3	1	0.1899
A3	7	3	1	3	0.5350
A4	5	1	1/3	1	0.2158
consistency = 0.0211					

For X7	A1	A2	A3	A4	Weight
A1	1	1/5	1/7	1/5	0.0508
A2	5	1	1/3	1/5	0.1404
A3	7	3	1	1	0.3956
A4	5	5	1	1	0.4132
consistency = 0.8410					

Table 11: Alternative Weights After Vector Normalization

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**
A1	0.0143	0.0402	0.0074	0.9860	0.3103	0.0593	0.0508	3.3818	0.1710
A2	0.0254	0.0495	0.0074	0.6574	0.6207	0.1899	0.1404	1.4795	0.4024
A3	0.0160	0.0310	0.0296	1.1269	0.2069	0.5350	0.3956	2.5669	0.6219
A4	0.0408	0.0341	0.0222	1.1269	0.3103	0.2158	0.4132	1.0444	0.3258
Sum	0.0964	0.1548	0.0667	3.8971	1.4483	1	1	8.4726	1.5212

Table 12: Calculation of the Significance Weight of Each Alternative

	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**
A1	0.2847* 0.1482	0.1262* 0.2600	0.0615* 0.1111	0.0707* 0.2530	0.1645* 0.2143	0.0242* 0.0593	0.0988* 0.0508	0.0745* 0.3991	0.0949* 0.1124
A2	0.2847* 0.2629	0.1262* 0.3200	0.0615* 0.1111	0.0707* 0.1687	0.1645* 0.4286	0.0242* 0.1899	0.0988* 0.1404	0.0745* 0.1746	0.0949* 0.2646
A3	0.2847* 0.1659	0.1262* 0.2000	0.0615* 0.4444	0.0707* 0.2892	0.1645* 0.1429	0.0242* 0.5350	0.0988* 0.3956	0.0745* 0.3030	0.0949* 0.4089
A4	0.2847* 0.4229	0.1262* 0.2200	0.0615* 0.3333	0.0707* 0.2892	0.1645* 0.2143	0.0242* 0.2158	0.0988* 0.4132	0.0745* 0.1233	0.0949* 0.2142

Table 13: The Overall Significance Weight of Each Choice

	X1	X2	X3	X4	X5	X6	X7	X8	X9	Total
A1	0.0422	0.0328	0.0068	0.0179	0.0353	0.0014	0.0050	0.0297	0.0107	0.1818
A2	0.0748	0.0404	0.0068	0.0119	0.0705	0.0046	0.0139	0.0130	0.0251	0.2611
A3	0.0472	0.0252	0.0273	0.0204	0.0235	0.0129	0.0391	0.0226	0.0388	0.2572
A4	0.1204	0.0278	0.0205	0.0204	0.0353	0.0052	0.0408	0.0092	0.0203	0.2999

Table 14: Results from the AHP Calculation Method

Alternatives	Scores	Ranks
A1	0.1818	4
A2	0.2611	2
A3	0.2572	3
A4	0.2999	1

schools and universities (X9), distance from the main road (X8), rental fees (X4), number of parking spaces (X3), and ease of access (X6) respectively. In addition, alternative A4 had the highest weight score of 0.2999, making it the location with the best ratings in accordance with the purpose of setting up a laundromat compared to all other alternatives. This decision was made using the AHP method to rank the attractiveness of the location options for the location of a convenience laundromat in Bangkok according to the nine criteria (Table 14).

In the AHP method, the sum of the final score for every alternative is equal to 1 or is equivalent to 100%. These scores are used for comparison to make a final decision on the most suitable and desirable alternative.

5. CONCLUSIONS

Nowadays, trends of customer lifestyle have already changed. Customers want a more convenient lifestyle. This is an opportunity for entrepreneurs in the service industry to promote new innovations and technological services to meet customer needs. Accordingly, laundromat stores are self-service laundry shops where coin-operated washing machines and clothes dryers are available for use 24 hours a day. The machines can reduce washing and drying time. However, in order to create a successful self-service laundromat business, the most important factor affecting the growth of business in the long run is selecting the correct location for the laundromat store. Location selection is a significant strategy in business.

Laundromat stores have begun to focus on attracting potential customers to further expand their revenue. A decision-maker should consider (a) population density, (b) number of competitors, (c) average housing prices in the area (d) surrounding environment, (e) distance from schools and universities, (f) distance from the main road, (g) rental

fees, (h) number of parking spaces, and (i) ease of access respectively, as choosing the best location for the laundromat store is very important. To help entrepreneurs to assess a business's location suitability, this paper proposed using the AHP model to assist entrepreneurs' decision-making and discovery of a satisfying location candidate. To select the best location, taking into consideration both qualitative and quantitative criteria is necessary.

This study considered the location selection problem for a laundromat store in Bangkok. Four locations were selected for the study, namely Chatuchak District, Soi Phahonyothin 24; Bang Khen District, Phahon Yothin Road; Bangkapi District, Soi Ramkhamhaeng 24; and Lat Krabang District, Soi Lat Krabang 46. The results showed that the most desirable location for the laundromat store is Soi Lat Krabang 46 as this location has a higher population density and a more desirable surrounding environment than the other potential locations.

5.1. Suggestions for Future Research

Researchers should consider studying other multicriteria decision-making methods, such as the Fuzzy Analytic Hierarchy Process method, TOPSIS, and the heterogeneity of the decision-making, as this could help to better understand and approximate real-life scenarios. Collecting data using questionnaires or interviews with a sample of consumers who wish to use laundry services could also be used to identify new additional parameters that could be used as new criteria to accommodate the uncertainty of location problems. The results of each method could be used to make more accurate decisions on location selection.

5.2. Expected Benefits of this Research

Laundromat entrepreneurs and retailers can use the finding of this research regarding the top five factors: 1) population density, 2) number of competitors, 3) average house price in area, 4) surrounding environment, and 5) distance of laundromat from schools and universities respectively, to determine the next retail location that will have maximum efficiency.

REFERENCES

Bhate, H. J., & Shivdas, A. (2017). Analysis of Critical Success Factors of Laundromats in Emerging Economies Like India: An Application of Gap Analysis. *International Journal of Applied Business and Economic Research*, 15(4).

Economic Analysis. (2018). *Kasikorn Research Center*.

Erbiyik, H., Ozcan, S., & Karaboga, K. (2012). Retail store location selection problem with multiple analytical hierarchy process of decision making an application in Turkey. 8th International Strategic Management

Conference, *Procedia-Social and Behavioral Sciences*, 58, 1405-1414.

Evaluate Asset. (2019). *The Treasury Department*. Retrieved from https://www.treasury.go.th/th/

Grewal, D., Levy, M., & Kumar, V. (2009). Customer experience management in retailing: An organizing framework. *Journal of Retailing*, 85(1), 1-14.

Hernandez, T. (2007). Enhancing retail location decision support: The development and application of geovisualization. *Journal of Retailing and Consumer Services*, 14, 249-258.

Kuo, R. J., Chi, S. C., & Kao, S. S. (2002). A decision support system for selecting convenience store location through integration of fuzzy AHP and artificial neural network. *Computers in Industry*, 47(2), 199-214.

LandsMaps. (2021). *Department of Lands*. Retrieved from https://www.dol.go.th/

Lertphiphatthanon, W. (2018). Thai Gen Y People' Travelling Behavior and Motivation Patterns. *Dusit Thani College Journal*, 12, 134-149.

Official statistics registration system. (2019). *The Bureau of Registration Administration (BORA), Department of Provincial Administration*. Retrieved from https://www.bora.dopa.go.th/index.php/th/

Ozcan, T., € Celebi, N., & Esnaf, S. (2011). Comparative analysis of multi-criteria decision making methodologies and implementation of a warehouse location selection problem. *Expert Systems with Applications*, 38, 9773–9779.

Pagadala, A., & Gupta, R. (2018). PKC Laundries: a start-up business at the crossroads. *Emerging Markets Case Studies Collection,* 8(3), 1-27.

Population by age. (2016). Registration Statistical System, *Department of Provincial Administration.*

Population Statistics. (2019). *Land Survey and Map Division, Bangkok Metropolitan Administration*. Retrieved from http://office.bangkok.go.th/lsmd/

Saaty, T. L. (1980). The Analytic Hierarchy Process. *McGraw-Hill*, New York.

Saaty, T.L. (1990). Multicriteria decision making: The analytic hierarchy process, *RWS Publications*, Pittsburgh.

Saaty, T.L. (1994). How to make a decision: The analytic hierarchy process, *Interfaces*, 24(6), 18-43.

Saaty, T.L., & Kearns, K.P. (1985). Analytical Planning: The Organization of Systems, *Pergamon Press Inc*., Elmsford, NY.

Singh, R.K. (2013). Prioritizing the factors for coordinated supply chain using analytic hierarchy process (AHP). *Measuring Business Excellence*, 17 (1), 80–98.

Tetard, F., & Collan, M. (2009). Lazy User Theory: A Dynamic Model to Understand User Selection of

Products and Services. In: 2nd Hawaii International Conference on System Sciences. *Institute of Electrical and Electronics Engineers (IEEE)*, Waikolao, 1-9.

Tierno, N. R., Puig, A. B., Vera, J. B., & Verdu, F. M. (2013). The Retail Site Location Decision Process Using GIS and the Analytical Hierarchy Process. *Applied Geography*, 40, 191-198.

Tinessa, F., Pagliara, F., Biggiero, L., & Veneri, G. D. (2020). Walkability, accessibility to metro stations and retail location choice: Some evidence from the case study of Naples. *Research in Transportation Business & Management*.

Turhan, G., Akalin, M., & Zehir, C. (2013). Literature Review on Selection Criteria of Store Location Based on Performance Measures. *Procedia-Social and Behavioral Sciences*, 99, 391-402.

Yıldız, N., & Tüysüz, F. (2018). A hybrid multi-criteria decision making approach for strategic retail location investment: application to Turkish food retailing. *Socio-Economic Planning Sciences, 68.*

Zentes, J., Morschett, D., & Schramm-Klein, H. (2007). Strategic Retail Management. *Springer Gabler*.