

**A decision-making approach for selecting bank branch location: A Case
Study in Bangladesh**

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This Report Presented in Partial Fulfillment of the Requirements for the
Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL [capital letter, Bold, Font-14, Alignment-middle]

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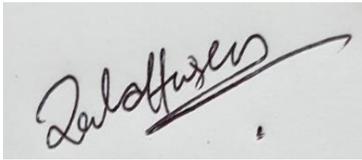
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We hereby declare that, this project has been done by us under the supervision of **Md. Zahid Hasan, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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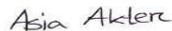


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ABSTRACT

The best location for bank branch is crucial to the success of banking business. And the selection of proper location is the first and foremost importance decision making process in terms of multi criteria problems. The main importance for deciding where to site the bank branch are: the rate of population growth and deposits and loans, business competition, having easy access. This research paper's objective is to provide a framework which helps in decision support system in order to select the most appropriate site for a bank branch considering a case study in Bangladesh. This paper provides an ultimate framework to select the most optimal site for bank branch among five alternatives. Total population, urbanization rate, construction cost, security, entrepreneurship rate and utilities are the main criteria to select the best alternatives. An AHP (Analytical Hierarchy Process) provides the best possible model to solve this type of multi criteria decision making problems. AHP model was proposed by an American methodology to get an optimal solution to several attribute problems. To denote the practicality of the proposed model in decision support system, AHP has been applied to initiate real world location selection

TABLE OF CONTENTS

CONTENTS	PAGE
Board of examiners	i
Declaration	ii
Acknowledgements	iii
Abstract	iv
CHAPTER	
CHAPTER 1: INTRODUCTION	1-4
1.1 Introduction	1
1.2 Motivation	3
1.3 Expected Outcome	4
1.4 Report Layout	4
CHAPTER 2: BACKGROUND	5-8
2.1 Introduction	5
2.2 Related Works	5
2.3 Scope of the Problem	7
2.4 Challenges	8

CHAPTER 3: RESEARCH METHODOLOGY	9-20
3.1 Introduction	9
3.2 Research Model	10
3.3 Data Collection Procedure	11
3.4 AHP Methodology	16
CHAPTER 4: NUMERICAL EXPERIMENT AND RESULT ANALYSIS	21-29
4.1 Introduction	21
4.2 Numerical Experiment	22
4.3 Result Analysis	28
CHAPTER 5: CONCLUSION AND FUTURE WORKS	30-31
5.1 Conclusion	30
5.2 Future Works	31
REFERENCES	32

LIST OF FIGURES

FIGURES	PAGE NO
Figure 3.1: Basic proposed model for bank branch location selection	10
Figure 3.2: Architectural theory diagram	16
Figure 4.1: Graphical overview for site selection scores	28

LIST OF TABLES

TABLES	PAGE NO
TABLE 3.1: MULTIPLE ATTRIBUTES & THEIR TYPES	15
TABLE 3.2: AHP 1-9 SCALE	17
TABLE 3.3: RANDOM INDEX TABLE	20
TABLE 4.1: PAIRWISE COMPARISON MATRIX TABLE	22
TABLE 4.2: PAIRWISE COMPARISON MATRIX TABLE DIVIDED BY COLUMN	23
TABLE 4.3: CRITERIA WEIGHT MATRIX TABLE	24
TABLE 4.4: CRITERIA WEIGHT MATRIX TABLE MULTIPLIED WITH ELEMENT	24
TABLE 4.5: FUZZY VALUE	26
TABLE 4.6: MULTIPLE ALTERNATIVE TABLE	26
TABLE 4.7: MINIMUM VALUE TABLE	26
TABLE 4.8: DIFFERENCE FROM MINIMUM VALUE	27
TABLE 4.9: MULTIPLIED BY WEIGHT FROM WEIGHT MATRIX	27
TABLE 4.10: SUMMARISE OF SITE SELECTION USING AHP	29

CHAPTER 1

INTRODUCTION

1.1 Introduction

Selection of convenient location plays a magnificent role in banking system. As banking system has become the daily necessity of lives to satisfy the service there has to have the availability of bank branch. But as it is concerned with cost so a proper location should be selected to ensure the best service and profitability and use. Poor selection of choice can cause into excessive disaster such as unavailability of utilities, more costly, less security etc. [1].

Along with the service the thing profitability also have the strategic significance in banking system. The proper selection can help in bank's profitability in some ways. Such as, a new bank branch will be created, people will have the availability of service, and customer will be diverted to the new one from the existing one. And as a result, it will create less pressure on economic operation [2].

In order to select the most convenient sites for new bank branch, this is necessary to construct a set of criteria to make easy the decision-making process. [4] Total population of an area can be valuable criteria on locating site for bank branch. Without population it is of no use to construct a new bank branch. So, the criteria population is a must. The more urban the population then they feel the more significance of firms like bank, hospital, companies. So, the urbanization share of total population is also necessary. In any business organization like banking cost concern is one of the most important things. Every organization makes some feasibility analysis before starting any further progress. And the cost concern has the strategic importance in this regard. Security purpose is another important issue. Entrepreneurship rate is also necessary. Entrepreneurship and Urbanization rate both can be related to each other. The rate of entrepreneurship will be increased if the area is more urban. And finally comes the utility concern and these criteria is concerned with three categories and they are availability of

roads, electricity and gas.

Location selection is a multi-attribute decision because it can't be decided on the basis of only one attribute, multiple criteria will be needed to make the right decision. And there are couple of approaches to solve the multi criteria problem. Among them Analytical Hierarchy Process (AHP) is a methodology to do such problems [1].

AHP is a method that was proposed by an American telecommunicator named Prof. Thomas L. Satty. It provides hierarchical structure which has different level. It can do pairwise comparison. And It has the advantage that it allows little inconsistency in judgment because it is quite difficult to be consistent all the time for human being. So, it can provide a ratio scale which shows the weight of any attribute.

The scale is weighed from 1 to 9 to show the judgmental value. It indicates the importance of an attribute. For instance, if construction cost (an attribute) is weighed as 5 respected to total population then total population is significantly more important than construction cost. And construction cost acts reciprocal to the total population

1.2 Motivation

To come out from the darkness scientific and numerical research is the root for the benightment of choosing of bank branch location. The scientific investigation of any problem can lead towards an optimal and a perfect solution. Now-a-days a lot of problems are raising that are related to decision support system such as site selection for any business. And to find out the best bank branch location some tasks should be performed first. Such as background analysis, identification of problems etc. And to solve the ultimate problem this research paper proposes an optimal framework. This research paper can be a hope of admiration for those who has the immense desire to contribute themselves on the scientific field. As it is a multi-criteria decision-making problem so two types of people are going to be inspired by this research paper because along with numeric it has scientific aspects too. These two types are investors and mass people. This paper has the complete framework for site selection problems and also has the elaborate concepts on multi criteria decision making problem. And this particular paper focuses on the decision science field. Many investors are in dilemma as a suitable location is the prior necessity in terms of opening a business. And without proper location that investor may face a huge loss. With the help of an Analytical Hierarchy Process the problem of this bank branch location can be solved. By following the research paper investors may have the opportunity to get themselves involved with the scientific research. This research paper can be motivational for those who are eager to start a new business. And could help them find out the best site for their start up. Elaborate numerical and scientific experiment have been performed in order to solve the location selection problems.

1.3 Expected Outcome

- 1) To determine the weight of attributes.
- 2) To rank the attributes according to their priority.
- 3) To evaluate the consistency ratio.
- 4) To select the possible best location for bank branch.

1.4 Report Layout

This paper is containing a total of five chapters named as Introduction, Background, Research Methodology, Numerical Experiment and Result Analysis and Conclusion and Future Works.

Chapter 1: Introduction; This chapter describes about Introduction, Motivation, Expected Output, Report Layout.

Chapter 2: Background; This chapter includes Introduction, Related Works, Scope of the Problem, Challenges.

Chapter 3: Research Methodology; It is containing Introduction, Research Model, Data Collection Procedure, AHP Methodology

Chapter 4: Numerical Experiment and Result Analysis; this chapter helps to evaluate Problem Statement, Numerical Experiment, Result Analysis.

Chapter 5: Conclusion and Future Works; finally, the total Conclusion, Future Works is evaluated and shown in this chapter.

CHAPTER 2

BACKGROUND

2.1 Introduction

Introduction In daily life people take many different decisions. Decision making is a serious problem to the people who don't have any knowledge in decision making science. To take a right decision is not easy at all since different attributes are playing crucial role for the selection of the options. However, it is a complex and time-consuming task to take the right decision. Any kind of success depends on the proper and logical decision making. A wrong decision can lead into destruction. So, this paper is based on the decision making. This paper describes about the Analytic Hierarchy Process (AHP) to take the right decision and to select the best alternatives. AHP is a prodigious decision-making approach which lets the decision maker to take right decision. AHP is widely used to make a rank of all the alternatives according to their priorities. So, to know details on decision making, different multi-criteria decision making model are used all over the world. AHP describes about the factors and attributes related to any decision. It provides the exact overview on any decision related problem to the decision maker.

2.2 Related Works

For the increasing demographics several decisions and problems are emerging. It is more necessary to have knowledge on the decision fields. It is a stubborn and troublesome errand to choose the best other options among thousands of alternatives. So, to choose the right decision and to choose best alternative, different decision-making approaches are widely used. Some multi criteria decision making approaches are-Analytic Hierarchy Process (AHP), Fuzzy AHP, Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) and so on. All these approaches sort all the alternatives according to their score. So, the decision maker can easily find the best solution according to the score level. This paper describes deeply about the Analytic Hierarchy Process (AHP). This research

describes the step wise procedure to sort out the best cold storage warehouse location according to the highest scores. Several researches have been performed worldwide based on this topic. Several methodologies have been applied on for site selection. So, now for multi criteria decision making, there are several methodologies for the warehouse location selection. This work is carried out with AHP method. Analytical Hierarchy Process (AHP) is developed by Thomas L. Saaty in 1980 [38]. It is one of the best methodologies for solving multi criteria decision making problems since it offers various aspects like Attributes, sub-attributes, pairwise comparison matrix and different alternatives [28,29]. Au et.al [30] used FAHP for country site selection. He made a decision model to find the best solution. AHP is used for the software selection by the pairwise comparison of the attributes and alternatives by Lai et al [31]. Garcia et al. [1] used the Analytic Hierarchy Process for the warehouse site selection. A compact relationship for selection the warehouse is emerged using AHP by Korpela and Tuominen [12]. A unified framework is proposed using AHP by Shang and Sueyoshi [32] for the selection of a tremendous manufacturing system. Tummala et al. [33] used AHP for evaluating concurrent engineering in the industry. Armacost et al. [34] applied AHP. They used AHP for the housing selection based on customer requirements. A manufacturing system is proposed by Abdi and Labib [35]. AHP approach is implemented in different decision-making sectors. But the main drawback of the AHP approach is uncertainty. It does not talk about the existing uncertainty moreover Beynon [36] describes to his proposed model about the uncertainty level with the help of both Dempster-Shafer theory as well as AHP model. so, DS/AHP basically used in his paper calculates the possible uncertainty created by AHP model. A combined fuzzy multi criteria decision making approach is used by Onut et al.

[7] to select the best location for shopping mall. Chen [10] used the desired AHP approach for convention site selection. Nuclear power plant location is set using AHP with GIS environment by Abudeif et al. [9]. Geographic Information System is used for the industrial site selection by Rikalovic and Lazarevic [11]. Vlachopoulou et al. [13] also used GIS for warehouse site selection. An organic farming site is selected using AHP and GIS by Mishra et al. [15]. Chen and management [17] proposed the field depot location selection model based on AHP. Solar plan thermal plant which is an investment project developed by

Aragones-Beltran et al. [18]. They made the model which is implemented under multi criteria decision making approach. Neissi et al. [19] used AHP in a semi-arid region for site selection. Sure service terminal location is modeled by AHP framework and derived by Hegde and Tadjkamalla[22].The decision scientist find an efficient feature using AHP method. Any decision can be taken using AHP approach. It provides rational results. It uses Thomas L. Saaty (1-9) scale point for making the pairwise correlation framework which is the main framework for the initialization of the process. Another technical way to solve MCDM issues is TOPSIS manifested by Hwang and Yoon in 1981[37]. It helps to rank the set of alternatives as like as AHP method. Saaty [28, 29] designed his own proposed model AHP for solving critical decision related issues and relative measurement. For the decision- making purposes, scientific researches on decision science helps by providing continuous knowledge which enlighten us for being successful while taking any critical decision.

2.3 Scope of the Problem

Scope of the Problem Previously delineates briefly about various aspects why this work is obligate, this research is about making and handling several multi-criteria decision related problems. This research describes the stepwise process to select the best optimal alternative among many alternatives. It describes about multiple attributes, sub- attributes. It shows the final ranking according to scores as well as the criterion result. All these works are done using Analytic Hierarchy Process (AHP) which will be executing over next three chapters. Besides these some obstacles and problems arises while working with this project. It is compulsory to handle and reduce the mistakes that happens during the bank branch location selection process. Actually, a new location is selected by analyzing the different approach as well as applying previous knowledge's and researches. So, the chance to do any kind of mistakes stays generally. Some common mistakes that AHP approach should reduce are given as follows:

- 1) Taking decision without analyzing huge data of research.
- 2) Short term aspects, factors, criteria should be eliminated while selecting a new location.
- 3) Site selection on a very remote and uncertain area is another obstacle.

2.4 Challenges

Challenges One of the major challenges while writing this research paper is to select the appropriate attributes. Another challenge is to select the alternatives. Because before selecting alternatives, attributes a huge knowledge must be collected since any error while making decision may cause massive destruction. Another most heavy challenge is to calculate the criteria and sub-criteria weights. Analyzing many research papers and with the help of AHP model the weights are assigned. So, it also one of the key challenges for the researchers. Alternatives choosing is also very difficult since numerous factors must be inspected. After finding criteria weights the next challenge is to check the consistency ration. Consistency Ration must be less than 0.10. So, if the consistency ratio is less than 0.10 then only the calculated criteria weight is accurate work for the research otherwise not. So, these are the challenges while writing a research paper.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Before starting any business any instructors should do some background analysis. Then to do so problems should be identified. Then the task is to make a plan. If the plan doesn't work properly then the plan should be fixed. After that one can proceed to further more steps and which is researching and selecting attributes for the plan. The fifth task is using the AHP model. If the consistency ratio is less than 0.10 then the investors can get the desired output. And thus, the investor will get the whole knowledge on the particular business criteria he. This as paper been planning describes for about. A framework the Analytical Hierarchy Process(AHP) over all to take success the in right any decision business and. To select the best alternatives. AHP is a prodigious decision-making approach which lets the decision maker to take right decision. Location selection is a multi-attribute decision because it can't be decided on the basis of only one attribute, multiple criteria will be needed to make the right decision. And there are couple of approaches to solve the multi criteria problem. Every organization makes some feasibility analysis before starting any further progress. And the cost concern has the strategic importance in this regard. Security purpose is another important issue. Entrepreneurship rate is also necessary. Entrepreneurship and Urbanization rate both can be related to each other. The rate of entrepreneurship will be increased.

3.2 Research Model

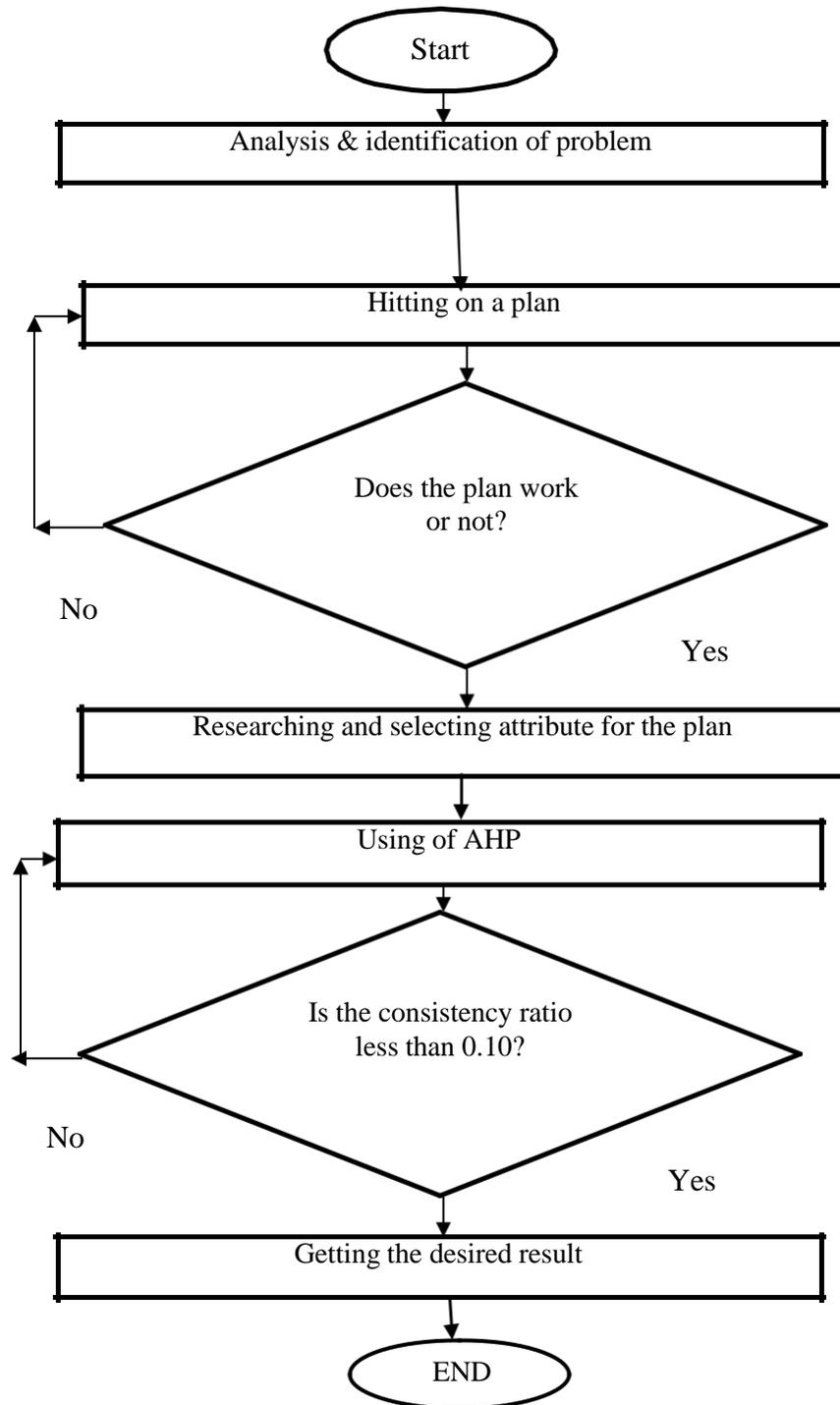


Figure 3.1: Basic proposed model for bank branch location selection

3.3 Data Collection Procedure

In the above figure 3.1, the model represents the process of data collection to achieve the proper site for branch location. It can be said that all the information and data are gathered together based on the proposed research model stated above. All the attributes, criteria and alternatives are selected which can satisfy the research experiment. A lot of factors are gathered together for research purpose. The data for site selection has been compiled. Based on the research model a chain of data collection procedure has been stated bellow.

3.3.1 Analysis and Identification of Problems

Researching on the topic on that the investors have been trying to start up a business is the first and foremost job. The investors should do some background analysis and search for the issues that can be an obstacle in the business. The paper on which this work is being done states the selection of bank branch location. And it is not an easy job to find out the best location. If the location is not proper then the investor must face a huge loss in business, which can be a great loss in the field of entrepreneurship in Bangladesh.

3.3.2 Hitting on a Plan

Where there is a problem there is also a solution. To meet the necessity of the bank branch the proper location must be selected to construct the bank. And to do so a proper plan should be ready. So that the business might not fall in future. And it can meet both the investors and the mass people demand.

3.3.3 Researching and Selecting Attributes on The Plan

Selection of attributes for the plan is the major task in this field. Because based the attributes all the calculations will proceed further. So, the attributes over there are:

1. Total population
2. Urbanization rate
3. Construction cost
4. Security
5. Entrepreneurship rate
6. Utilities

Using this attributes that is stated above and putting them in the AHP model. If the consistency ratio is less than 0.10 then the attributes selection and their weight is correct. And thus, the work will proceed.

3.3.4.1 Total Population

Total population is considered the most important criteria or attributes. The more the population the more the use of the bank branch. Population is considered to be the asset of a country. If people go to bank for their transition then the branch will profit in many. So, people play the vital role in this business.

The more people the more transition.

The more transition the more profit.

3.3.4.2 Urbanization Rate

Urbanization rate describes or shows that turning or creating more cities in any areas. An

urban area has the more necessity of bank than the rural areas. Because it has more commercial spaces, institutes that does a lot of banking transition or activities.

More commercial activities.

3.3.4.3 Construction Cost

Cost of construction on can be an obstacle in any business. If the cost is too high then it should consider that whether the branch can have enough profit or not. The cost should not

Exceed the limit.

the affordability of construction cost.

Construction cost is one of the important criteria. A proper measurement should be taken before constructing a new branch. The best location can reduce the transportation cost also. Depreciation cost should be in mind also. Office equipment and machineries lose its value day by day. And labor cost is also considerable.

3.3.4.4 Security

In decision support system for location selection, security is also important criteria. If the crime rate is high then it's very risky to start up a new business. An anonymous accident like robbery can happen. Then the business might fall, so, the investor must do some research of the recent crime on that area the investor has been trying to open a branch. The security system must have had.

Security system.

Recent local crimes.

3.3.4.5 Entrepreneurship Rate

Entrepreneurship rate is also a major attribute for location selection. If the location the investor has been planning to open the business is surrounded by another business or companies or market then this area will become more commercial and it will be helpful in profit of the business.

Commercial activities.

3.3.4.6 Utilities

Utilities refers to the availability and advantages of necessities. It includes electricity. Without electricity banking activities are kind of impossible task. The availability of road is also important.

Availability of road.

Electricity, Gas etc.

Table 3.1: List of Multiple Attributes And their types

	Attributes	Attributes Type	Description
Bank Branch Site Selection	T.P.	Numerical	T.P. = Current population status in a certain area
	U.R.	”	U.R. = Previous percentage of urban areas or cities living people of total population
	C.C.	”	C.C. = Includes land, rent, construction etc. which are related to cost
	S	Categorical	S = Security concern
	E.R.	Numerical	E.R. = Rate of running new business
	U	Boolean	U = Includes electricity, availability of road, water, gas etc.

3.4 AHP Methodology

Thomas L. Saaty developed the Analytical Hierarchy Process in 1980 which is an effective method for complex decision making. This method is highly used to set priorities of the alternatives, criteria, sub-criteria. AHP decides the inclinations among the arrangement of choices by utilizing pair-wise correlations of the chain of command components at all levels [41]. The following steps of the AHP methodology is explained as follows.

3.4.1 Identification of Problems, Criteria, Alternatives and Objectives

Identification of problems, objectives, main criteria, alternatives are the part of hierarchy structures. An analytical hierarchy process describes all the issues related to our problem. Here, Fig-3.2 shows the analytical hierarchy structure of bank branch location selection in decision making system.

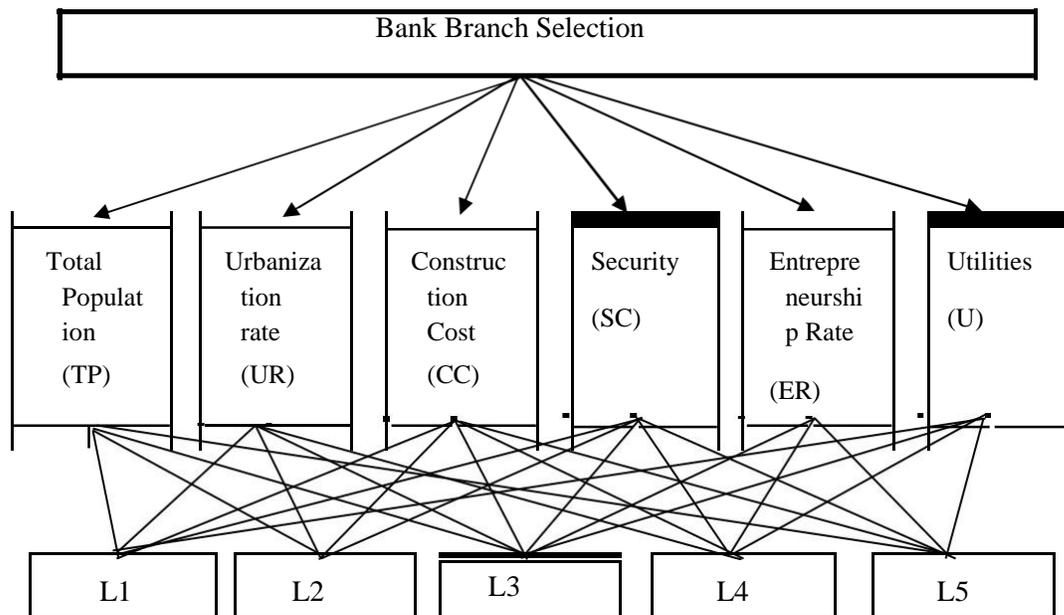


Fig- 3.2 Architectural theory diagram

Fig- 2 shows the various types of criteria. It is very significant for the investor to design a hierarchy structure. It will highlight the essential objectives that should be initiated by the

Investor. Information about any business plan can be described by hierarchy model. To find the best attractive analytical hierarchy model is very important. To find the best location for bank branch identification of problems, selecting main criteria, alternatives are the major task. And to solve all the problem mentioned above designing analytical hierarchy model is very important task.

3.4.1 Pairwise Comparison Matrix of Criteria

The AHP method creates a comparison matrix $M(d \times d)$ to calculate various criteria weights by using (1-9) weight scales in AHP method. Here is the matrix :

21	22	23	...	2
...
1	2	3	...	

TABLE 3.2: AHP 1-9 SCALE

Value	Refers to
1	Specifies equal important
2	Provides middle value of the adjacent scale
3	The foregoing is nominally more important than the subsequent
4	Provides middle value of the adjacent scale
5	The foregoing is obviously more important than the subsequent
6	Provides middle value of the adjacent scale
7	The foregoing is significantly more important than the subsequent
8	Provides middle value of the adjacent scale
9	This scale has the highest importance

importance 3,

The matrix can be expressed as Mij matrix. I denotes row number and j denotes column number.

then the M_{ij} will be $1/i^2$. So, if the importance is given to any element of the matrix, then the inverse values will be placed in M_{ji} position. As an example, if M_{13} is given significantly more then the inverse value will be M_{31} . If M_{14} position is set with a value 1, then the corresponding transposed position of M_{41} will be set to 5 (obviously more

importance) and it defines the inverse value. When both attributes contribute equally, then they set value of 1. All the equal importance are set along to the diagonal direction.

After setting up the matrix M, the weight of each attribute(w_i) will be calculated by applying the following rules :

1. The summation of each column.

$$i = 1, 2, 3, \dots, n \text{ \& } j=1, 2, 3, \dots, n$$

$$n = \text{no. of attributes}$$

Where, $w_i = \frac{1}{\sum_{j=1}^n M_{ji}}$ (3)

2. The summation of each row.

3. Then

$$j = 1, 2, 3, \dots, n \text{ \& } i = 1, 2, 3, \dots, n$$

$$n = \text{no. of criteria}$$

$$w_j = \frac{1}{\sum_{i=1}^n M_{ij}}$$

dividing w_j by n, we get w_j/n .

Where,

$$i = 1, 2, 3, \dots, n$$

$$n = \text{no. of criteria}$$

And thus, criteria weight can be obtained.

Consistency Check:

The best acceptable consistency ratio must be less than 0.10. If the weights of each criteria is not assigned properly, then the consistency ratio may exceed the limit. The following rules are required to calculate the consistency ratio (CR).

To calculate

1. Calculating :

element of

each element should be multiplied by their corresponding criteria weights. If, each element is (denoted as V).

$$V = E * W \dots \dots \dots (5)$$

After calculating each elements weighted value, the summation of each row should be calculated again.

$$\sum_{i=1}^n \dots \dots \dots (6)$$

Here,

$$i = 1, 2, 3, \dots, n$$

Now, $n = 6 = \dots \dots \dots (7)$

$$\sum_{i=1}^n$$

2. Calculation of consistency index (C.I) :

$$C.I = \frac{\lambda_{max} - n}{n(n-1)} \dots \dots \dots (8)$$

Where,

C.I = Consistency Index

3. Checking the Consistency Ratio (C.R) :

C.R =

Where,

R.I = Random Index

C.R must be less than 0.10

If C.R < 0.10 then we can go for next step.

If C.R < 0.10, the data is consistent.

If C.R ≥ 0.10, the data is inconsistent.

R.I for different values of n is defined in Table 3.2

TABLE 3.3: RANDOM INDEX Table

Criteria Number	Random Index
1	00
2	00
3	0.52
4	0.89
5	1.11
6	1.26
7	1.35
8	1.40
9	1.45
10	1.49
11	1.52
12	1.54
13	1.56

CHAPTER 4

NUMERICAL EXPERIMENT AND RESULT ANALYSIS

4.1 Introduction

To find the best bank branch location selection that is the most valuable problem in this decision support system this research might be an optional solution. This research paper put an emphasize on the decision support system. It focuses on the making of decision in choosing location. Location selection has the significant importance in any business organization or criteria [2]. The first and foremost problem selecting bank branch location selection problem is finding obstacles, identification of problems. Through some background analysis and making of a team to do so can help solving this problem. That decision making team will look into whether there is enough security or necessity of bank branch. And thus, the research or business investor will move forward. The second important issue is that the business competition. It can be described as such though the selected location has enough population, security, utilities etc., it can be an issue of high risk if there is already such a business institution. Then, competitive market can be an issue of second thought. Because the investor can face a great loss [3]. This research paper identifies, analyzes and creates optional solution. So, that the investor can reach huge profit. In this paper there are five locations selected that is denoted as L1, L2, L3, L4 and L5. Using AHP model the optional or best alternatives selected among those locations for the bank branch location selection. So, this research paper describes the tentative methodology implementation for the site selection problems based on multi-criteria decision support system. The analytical hierarchy process that has been used in this paper is a structured technique that was developed by Thomas L. Saaty in the 1970's. So, the main purpose of this research paper is to select the optional site selection for bank branch.

4.2 Numerical Experiment

Pairwise comparison matrix (M) for main criteria is created to calculate the weight for each main criterion by using AHP method. Since there are six main criteria observed, first the decision maker takes into account the weight. The investors analyzed that they should offer the highest priority to criteria accessibility. According to their cognizance on market basis investigation, they sorted the criteria weight as follows –

Total Population (TP) > Urbanization Rate (UR) > Construction Cost (CC) > Security (SC) > Entrepreneurship Rate (ER) > Utilities (U)

Total population and Urbanization rate are more important than Construction cost. Beside that Entrepreneurship and Security both are important. The main criteria weights are sorted in order to the background detail analysis. Five optimal alternatives are selected by the decision makers. Table 4.1: describes Pairwise comparison by using equation (1) for finding the criteria weight that describe the priority.

TABLE 4.1: PAIRWISE COMPARISON MATRIX (M) Table

Attributes	TP	UR	CC	SC	ER	U
TP	1	3	5	7	6	8
UR	1/3	1	2	4	3	5
CC	1/5	1/2	1	3	2	4
SC	1/7	1/4	1/3	1	3	2
ER	1/6	1/3	1/2	1/3	1	3
U	1/8	1/5	1/4	1/2	1/3	1

Now, the sum of each column is calculated by using equation - (2) and also represented in Table 4.1.

For instance, Total Population / .

The summation of total population column, 1

$$\begin{aligned}
 &= \frac{7}{1000} + \frac{53}{1000} \\
 \text{TP} &= \frac{60}{1000} \\
 &= 0.06
 \end{aligned}$$

Similarly, for UR = 5.25, CC = 9.05, S = 15.8, ER = 15.3 & U = 23

TABLE 4.2: PAIRWISE COMPARISON MATRIX (M) TABLE DIVIDED BY COLUMN

Attributes	TP	UR	CC	SC	ER	U
TP	0.517	0.571	0.552	0.443	0.392	0.347
UR	0.115	0.190	0.220	0.253	0.196	0.217
CC	0.103	0.095	0.110	0.189	0.130	0.173
SC	0.073	0.047	0.033	0.063	0.196	0.086
ER	0.085	0.057	0.055	0.018	0.065	0.130
U	0.064	0.038	0.027	0.031	0.019	0.043

Table – 4.2 is created by dividing each and every element of the column by their respective criteria in the Mij matrix.

Now, the summation of each row is calculated by using equation - (3).

$$\begin{aligned}
 \text{TP} &= \frac{1000}{1933} + \frac{47}{100} + \frac{100}{181} + \frac{35}{79} + \frac{20}{51} + \frac{23}{8} \\
 &= 2.822
 \end{aligned}$$

Similarly, UR = 1.231, CC = 0.8, S = 0.498, ER = 0.41, U = 0.222

TABLE 4.3: CRITERIA WEIGHT MATRIX TABLE

Criteria	Geometric mean
T.P	0.470
U.R	0.205
C.C	0.133
S	0.083
E.R	0.068
U	0.037

Table - 4.3 is structured by using equation - (4). This is the criteria weighted table. For instance, $TP = 2.8226$

$$= 0.470$$

Similarly, $UR = 0.205$, $CC = 0.133$, $S = 0.083$, $ER = 0.068$ & $U = 0.037$

Now, multiplying criteria weight (W) with each element of the matrix E, using equation - (5) table 4.4 is formed.

Table – 4.4 CRITERIA WEIGHT MATRIX TABLE MULTIPLIED WITH EACH ELEMENT

	TP	UR	CC	SC	ER	U
TP	1X0.470	3X0.205	5X0.133	7x0.083	6x0.068	8x0.037
UR	$\frac{1}{3}$ X0.470	1X0.205	2x0.133	4x0.083	3x0.068	5x0.037
CC	$\frac{1}{5}$ X0.470	$\frac{1}{2}$ X0.205	1x0.133	3x0.083	2x0.068	4x0.037
SC	$\frac{1}{7}$ X0.470	$\frac{1}{4}$ X0.205	$\frac{1}{2}$ x0.133	1x0.083	3x0.068	2x0.037
ER	$\frac{1}{6}$ X0.470	$\frac{1}{3}$ X0.205	$\frac{1}{3}$ x0.133	$\frac{1}{3}$ x0.083	1x0.068	3x0.037
U	$\frac{1}{8}$ X0.470	$\frac{1}{5}$ X0.205	$\frac{1}{5}$ x0.133	$\frac{1}{8}$ x0.083	$\frac{1}{6}$ x0.068	1x0.037

Using equation - (6), the summation of each row is calculated, $1 = 0.035470 + 0.615 + 0.665 + 0.581 + 0.408 + 0.296$

$$= 0.470$$

$$= 6.45744$$

Similarly, $\lambda_1 = 6.69995$, $\lambda_2 = 6.23895$, $\lambda_3 = 6.26420$, $\lambda_4 = 6.59554$, $\lambda_5 = 6.30897$ is calculated is using equation -(7).

$$\text{So, } \lambda_6 = \frac{(6.45744 + 6.69995 + 6.23895 + 6.26420 + 6.59554 + 6.30897)}{6}$$

$$= 6.39121$$

Now, consistency index and Ratio is calculated using equation (8) and (9).

$$\text{Now consistency index (C.I)} = \frac{\lambda_{max} - n}{n(n-1)}$$

$$= \frac{6.391216 - 6}{6(6-1)}$$

$$= 0.078242$$

R. I for 6 =1.26

$$\text{So, Consistency Ratio (C.R)} = \frac{\text{C.I}}{\text{R.I}}$$

$$= \frac{0.078242}{1.26}$$

$$= 0.0620$$

So, the Consistency Ratio $0.062 < 0.10$. As it is less than 0.10 so, the criteria weight have accurately measured.

Calculation of selecting the most optimal site:

To simulate the best route the fuzzy value should be selected of the criteria. it depends on the type of the criteria. it depends on the type of the criteria. And table 4.1 has shown it already.

The fuzzy value is for numerical criteria type. And the values are shown in table –

Table 4.5 Fuzzy value

Medium	4
Strong	7
Low	2

Now, all the value of the criteria has been put in table according to their respective location which is L1 (Gulistan), L2 (Sadarghat), L3 (Demra), L4 (Naranganj), L5 (Motijheel).

Table – 4.6 MULTIPLE ALTERNATIVE TABLE

	T.P.(M)	U.R.	C.C.(M)	S	E.R.	U
L1	0.21582	0.7688	0.3125	4	0.489	1
L2	0.4302	0.6377	0.203125	7	0.30	1
L3	1.532808	0.6645	0.140625	2	0.22	0
L4	0.71794	0.5639	0.109375	2	0.39	0
L5	1.25586	0.6028	0.15625	4	0.289	1

In this above table Total Population and Construction Cost have been counted in million. Utilities in Boolean number if there is then 1 which is yes and if there is not then 0. Security refers to fuzzy value whether strong, medium or low. And Urbanization rate and Entrepreneurship rate provide the percentage.

Table – 4.7 MINIMUM VALUE TABLE

	T.P.(M)	U.R.	C.C.(M)	S	E.R.	U
L1	0.21582	0.7688	0.3125	4	0.489	1
L2	0.4302	0.6377	0.203125	7	0.30	1
L3	1.532808	0.6645	0.140625	2	0.22	0
L4	0.71794	0.5639	0.109375	2	0.39	0
L5	1.25586	0.6028	0.15625	4	0.289	1
Minimum	0.21582	0.5639	0.109375	2	0.22	0

Now in table the minimum has been selected among every criteria.

Table – 4.8 Difference from minimum value

	T.P.(M)	U.R.	C.C.(M)	S	E.R.	U
L1	0	0.2049	0.203125	2	0.269	1
L2	0.21438	0.0738	0.09375	5	0.08	1
L3	1.316988	0.1006	0.03125	0	0	0
L4	0.50212	0	0	0	0.17	0
L5	1.04004	0.0389	0.046875	2	0.069	1

Now in table the differences has been calculated.

Table – 4.9 Multiplied by weight from weight matrix

	T.P.(M)	U.R.	C.C.(M)	S	E.R.	U	Scoring Σ
L1	0	0.0420045	0.0270	0.166	0.018292	0.037	0.290
L2	0.1007	0.015129	0.01246875	0.415	5.44×	0.037	0.5857
L3	0.6189	0.020623	4.15625×	0	0	0	0.643623
L4	0.2359964	0	0	0	0.01156	0	0.2475564
L5	0.4888188	7.9745×	6.234375×	0.166	4.692×	0.007	0.710692

The weight of every criteria has been multiplied with the value of table. The summation of every criteria in each location has been calculated. Among them the most optimal site is the one which has the height value .

4.3 Result Analysis

Five alternatives have been selected by the decision makers to find the optimal one among them on this research paper. The optimal one would be selected with the highest AHP score. On this research paper five alternatives are named by L1 (Gulistan), L2 (Sadarghat), L3 (Demra), L4 (Naranganj), L5 (Motijheel). The optimal location for the bank branch is L5 with the highest AHP score 0.710692. The second optimal location has taken place by alternative L2. And thus, $L5 > L2 > L1 > L4 > L3$.

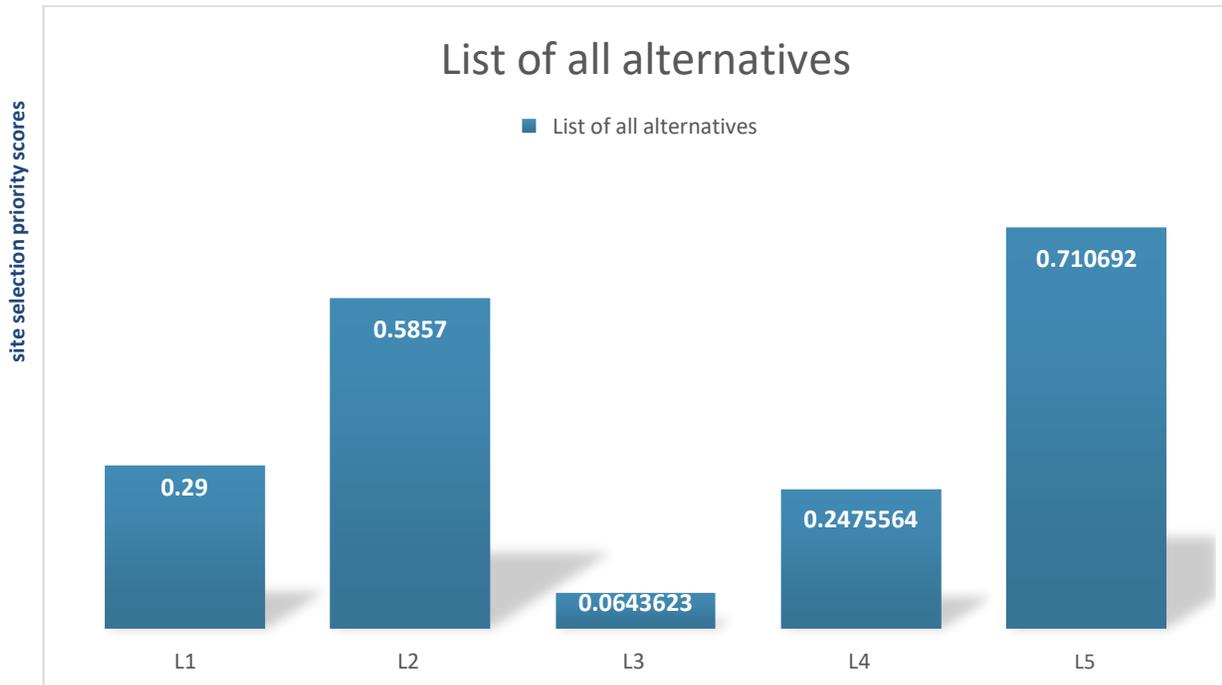


Figure 4.1: Graphical overview for site selection scores

Figure 4.1 shows the scoring of Analytic Hierarchy Process result. AHP system selected “L5 “as the best optimal site to select to set up bank branch. So, this research has the ability to select the best location and now it will be able to solve the investors problems. Table 4.7 finalizes the scores for AHP.

TABLE 4.10: SUMMARY OF SITE SELECTION USING AHP

Bank Branch location selection final score		
Alternatives	Priority (AHP score)	AHP Rank
L1	0.29	3
L2	0.5857	2
L3	0.0643623	5
L4	0.2475564	4
L5	0.710692	1

CHAPTER 5

CONCLUSION AND FUTURE WORKS

5.1 Conclusion

Along with the different parameters are calculative and the scientific information is very important to get the accurate solution in any decision-making problem. Inefficient background analysis, lack of identification of problems, lack of importance of hierarchy model, lack of the information about the attributes, alternative can result into wrong decision making. Without the absolute Knowledge on various criteria any investors business might fall down. But this research paper describes the best or optimistic way to make deism on any business criteria or sphere. This paper uses the AHP methodology for selecting the best site. Using AHP an optimal result has been selected. This research paper can be milestone for any situation that has anything like decision making problem. This work creates a rank of AHP scores for all the location. And among those alternatives who has the high score in rank is the most optimistic one. And AHP methodology is the best technique to select the best solution. The decision makers selected five arbitrary location to examine the result. And the best result has come out by the decision makes team as they used AHP on these five alternatives. And the optimal location to construct a bank branch is the L1.IT has the highest AHP score. However, this research paper shows the tentative and substantive scenario in selecting the most optimal alternative and also can handle the multi criteria decision making problems based on the analytical hierarchy process.

5.2 Future Works

With the use of AHP method this paper can extract the best site. For problems like multi-attributes decision making, AHP will be using in future extensively as it has the greater importance in selecting sites in decision support system that has already shows in this research paper. Analytical hierarchy process that has been used in this paper helps the investors, to a great extent to make decisions in any problem.so, this paper is very useful to provide knowledge to those people who are eager to work in such fields.it creates the chance for future works in decision making with the scope of solution

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