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Operations Management Strategy of Selecting Business Location using AHP

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Abstract

The choice of location is of paramount importance in modern business decision. It has become one of the most important operational strategies in managing operations of large business organizations. The three common approaches of location selections are Factor-Rating Method, the Centre of Gravity Approach and the Transportation Model approach. While these approaches are common to the practitioners of operations management, there may be other quantitative tools that can be adopted in deciding location strategies. This paper attempts to highlight the use of Analytic Hierarchy Process (AHP) approach in selecting business location.

Keywords: Operations Strategy, AHP, MCDM, pair-wise comparison, consistency ratio.

1. Introduction

Operational managers often resort to their decisions on selecting plant locations using the two popular approaches. These are the factor-rating method and the centre of gravity methods.They prefer these approaches because it is straight-forward and easy to use. For instance, in the former they need only to know the factors and the factor weights assigned to each factor. In the latter, on the other hand, they need to know the positions or coordinates of the desired locations with respect to the parent plant and the demand of the product in a given period of time. The third approach, which is the transportation model approach, is applicable only when data of supply and demand as well as cost per unit of product transported from a supply sources to their destinations are available (Heizer J, et al 2006)..

This paper discusses an alternative approach of selecting business location using quantitative tool via the MCDM (Multiple-Criteria Decision Making) Approach.

2. MCDM Approach

MCDM is generally an approach of solving decision problems which involve many goals or objectives. These goals are normally conflicting with one another.

Basically, MCDM can be classified into four main categories, namely: Multiple- Criteria Mathematical Programming (MCMP). Multiple- Criteria Discrete Analysis (MCDA), Multiple-Attribute Utility Theory (MAUT) and Negotiation Theory (NT) (Zionts S ,1990).

The classic examples of MCMP are the MOLP(Multiple Objective Linear Programming) and GP (Goal Programming). However, MFEP (Multiple Factor Evaluation Process) and AHP (Analytic Hierarchy Process) are classified under the MAUT category. NT which is a further extension of MAUT Approach has more than one group of decision-makers (see Sawiran ,1997 and Pruitt, D ,1981).

3. The AHP Methodology

The AHP Approach was first developed by Saaty in 1973 and further refined in 1980 [see Saaty T.L;1980). It is used whenever the decision-makers find difficulties in determining the factor or criteria weights. As in factor-rating method, which is commonly used by operational managers, as well as the MFEP approach by quantitative analysts; the assigning of weights is very subjective in nature and generally it is pre-assigned. However, in AHP, it is determined through the process itself. The only subjective phenomenon is the assigning of the Likert-scale on the preference of a pair-wise comparison.

3.1 General Principles of AHP

The general principle of AHP methodology involves the pair-wise comparison of various alternatives of which the best decision to be chosen (see Render B; et al 2002). The decision-makers begin by laying out the overall hierarchy of the decision, i.e the goal of a given problem which is normally considered as level-1. Then the hierarchy reveals the factors or criteria to be used in evaluating the situation and is given by level-2. They may be sub-criteria to be evaluated and this sub-criteria is in level-3 of the hierarchical structure. Finally, the various alternatives to which the final decision would be selected in the decision process is given as level-4.

The number of levels in the AHP decision hierarchy depends on the complexity of a given problem. It can be 3, 4 or more levels required to evaluate the problem situation (see Pak, P.S et al; 1992).

The use of pair-wise comparison helps the decision-makers to compare different alternatives using Likert-type scale. The Expert Choice (an AHP software) normally takes into account nine scales ranging from equally preferred to extremely preferred choice. However, it can be modified to other relevant values `or scales. For instance, Lan .L.W et al, 1992) suggested 5 scales.

What is important in AHP is that the factor or criteria evaluations and the factor weights are calculated through the process itself, thus removing the element or connotation of too much subjectivity. Furthermore, consistency ratio (CR) is used in order to test the consistency of the entire hierarchical structure caused by the varied importance of each hierarchy. The normal acceptable level for the CR is that it is less than 0.1.

3.2 Applying AHP in Selecting Business Location.

As an example, we can consider the hypothetical problem of selecting locations in building private hospitals as given in the following scenario. Southern Hospital (SH) has its headquarters in Batu Pahat, Johore. It has already one branch in Melaka. Due to the high demand of hospital services, the management of SH is planning to build a new hospital in the southern region, south of Kuala Lumpur. Demographic study analysis had narrowed down the proposed locations to three different towns, namely:

Location 1 (L1): Kluang
Location 2 (L2) : Johor Bahru
Location 3(L3) : Nilai

Four factors are the main criteria in selecting the location as follows:
Criterion 1 (C1) : Community Average Income.
Criterion 2 (C2) : Land Cost.
Criterion 3 (C3) : Accessibility to Major Roads/Highways.
Criterion 4 (C4) : Preference of SH Employees.

Thus, in order to decide which location is best for Southern Hospital , the problem can be formulated as an AHP problem as follows:

Level-1 : THE BEST LOCATION FOR SH

Level-2 : CRITERIA : C1 , C2, C3 , C4.

Level-3 : CHOICE: L1, L2, L3.

In this exercise, we are using the following seven likert scales for the preferences in the pair-wise comparisons:

1 : Preferred
2 : Equally to Moderately Preferred
3 : Preferred
4: Moderately to Strongly Preferred
5: Strongly Preferred
6: Very Strongly Preferred
7: Extremely Preferred.

The data of the pair-wise comparison for the 4 criteria mentioned earlier can be shown in Table 1 below:

Table 1: Pair-wise Comparisons of Each Location Under Criterion 1(C1) to Criterion 4 (C4)

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Criterion 1 (C1)

Pair	Preference
L1 - L2	1
L1 - L3	6
L2 - L3	3

Criterion 2(C2)

Pair	Preference
L2- L1	3
L3- L1	5
L3- L2	2

Criterion 3 (C3)

Pair	Preference
L2 – L1	6
L2 - L3	3
L1 - L3	1

Criterion 4 (C4)

Pair	Preference
L1- L2	4
L1- L3	3
L2- L3	2

4. Results

4.1 Criteria or Factor Evaluations.

From the preceeding data of pair-wise comparisons, we use to evaluate each criterion in terms of the given performance in the AHP analysis. The results of the factor or criteria evaluations and the respective consistency ratio (CR) are given in Table 2.

Table 2: Results of Factor Evaluations

CRITERIA	Location 1	Location 2	Location 3	CR
Criterion 1	0.4996	0.3996	0.1065	0.08
Criterion 2	0.1096	0.3091	0.5612	0.04
Criterion 3	0.1053	0.6722	0.1824	0.04
Criterion 4	0.6337	0.2278	0.1607	0.07

Since all values of the CR for each of the criteria is below 0.1, the evaluation for each of the four factors or criteria are acceptable.

4.2 Factor Weights Determination.

The weights of each criterion can be determined by taking into account the decision-makers preference on the pair-wise comparison of the factors, rather than the pair-wise of the locations. Suppose that the decision-makers preference on the factor pair is given in Table 3 below:

Table 3: Decision-Maker Factor Preference

Factor- Pair	Preference
C2 - C1	2
C3 - C1	6
C4 - C1	4
C3 - C2	5
C4 - C2	3
C4 - C3	2

Then, the factor weights resulting from the above preference are depecited in the following Table 4:

Table 4: Values of Factor Weights

Factors	Factor-Weights
C1	0.0846
C2	0.1200
C3	0.3820
C4	0.4132

* CR = 0.07

Thus, by multiplying the results of factor evaluations in Table 2 and the factor-weights of Table 4 above, the results can be summarised in Table 5 as follows:

Table 5: Results Summary of the Product of Factor Evaluation and Factor Weights

CRITERIA	LOCATION 1	LOCATION 2	LOCATION 3
C1	0.0421	0.0336	0.0090
C2	0.0130	0.0382	0.0697
C3	0.0555	0.2567	0.0697
C4	0.2607	0.0941	0.0660
TOTAL	0.3713	0.4226*	0.2148

The above results show the overall ranking of the three locations. Since LOCATION 2 has the largest value (0.4226), it is obvious that it is the best location to be selected. This means that JOHOR BAHRU is the best choice of location for Southern Hospital to build the next branch of its hospital.

5. Conclusion

From this exercise, it reveals that AHP methodology can be applied to make decision in selecting plant location. It is an advantageous approach because it reduces the influence of too much subjectivity from the data entry given by management. As an example of our case, we see from the factor evaluation (FE) in Table 2, Location 1 has the highest value (0.6337) for Criterion 4. Similarly, in Table 4, the highest value of factor-weight (FW) of 0.4132 comes from Criterion 4. Intuitively, if we use the normal Factor-Rating Method, the best location should be Location 1, which is KLUANG. However, by using the AHP approach , it was noted that C2 (JOHOR BAHRU) is selected instead. Hence, the AHP approach is more reliable as it removes some degree of biasedness on the preferences.

In addition, the use of Consistency Ratio (CR) is a further advantage of AHP as compared to the conventional factor-rating approach in selecting business location. Therefore, it is suggested that operations managers today should not only depend on the approaches available within their own perspective or domain but may resort to any other available quantitative approaches which are more meaningful in making strategic business decisions.

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