Chapter 35

Root Square Scale of Analytic Hierarchy Process (AHP) as a New Approach to Solve Project Selection Problem

Nor Faradilah Mahad[a*], Noreha Mohamed Yusof[a], Busyra Latif[a], Norul Fadhilah Ismail[b] & Suriana Alias[c]

[a]Faculty of Computer and Mathematical Sciences (FSKM)
Universiti Teknologi MARA (UiTM) Cawangan Negeri Sembilan, Kampus Seremban 3, Persiaran Seremban Tiga/1, Seremban 3, 70300, Seremban, Negeri Sembilan, Malaysia
[b]Faculty of Computer and Mathematical Sciences (FSKM)
Universiti Teknologi MARA (UiTM) Cawangan Negeri Sembilan, Kampus Kuala Pilah, Parit Tinggi, 72000, Kuala Pilah, Negeri Sembilan, Malaysia
[c]Faculty of Computer and Mathematical Sciences (FSKM)
Universiti Teknologi MARA (UiTM) Kelantan, Kampus Machang, Bukit Ilmu, 18500, Machang, Kelantan, Malaysia

Abstract

Project selection is a process of evaluating a proposed individual project or a group of projects within an organization and then choosing to execute the most potential project so that the objectives of the organization can be achieved. Analytic Hierarchy Process has been used widely to solve multi criteria decision making whereas the Saaty scale, a scale of 1 – 9 is used to indicate how many times more strongly one alternative project is over another alternative project with respect to the criteria they are compared with. For this project, square root scale is used to do pairwise comparison instead of Saaty scale. Thus, the objectives of this project are (1) to implement the root square scale of AHP to solve the project selection problem and (2) to select the most potential alternative project by using AHP. A real-life empirical example about supplier selection is used to demonstrate the application of root square scale of AHP as new approach which are expected to be useful to solve the project selection problem. An interview process was conducted to collect the relevant information from a group of decision makers. This approach is expected to be helpful and efficient for the organization since is it simple and cost effective since the most potential project is prioritized. The method discussed here can be extended to solve any type of project selection problem.

Introduction

Project selection is a process of evaluating a proposed individual project or a group of projects within an organization. The aim of the project selection process is to evaluate the alternatives based on a list of conflicting criteria. The selection should be made since not all of the projects should be implemented especially if the organization have to deal with limited resources (people, time and money). The Analytical Hierarchy Process (AHP) is a method developed by Saaty (1977) which is a widely used method focusing on a decomposition multiple criteria decision making (MCDM). AHP has been used by researchers to analysis the pairwise comparison in various fields such as management, technologies, health, sport sciences, tourism, mathematics, and computer sciences. Saaty's scale represent the verbal statements with a scale from one to nine. However, theoretically there is no reason to be restricted to these numbers and verbal gradation (Franek

& Kresta, 2014), and this lead to the improved judgmental scale used in AHP. Ishizaka & Labib (2011) discussed several types of judgment scale which are linear, power, geometric, inverse linear, asymptotical, balanced, logarithmic and as well as root square.

In this paper, AHP-Root Square scale is used as a new approach to solve project selection problem. Root square has been introduced by Harker and Vargas in 1987 (Ishizaka & Labib, 2011). They investigated not only root square but also a quadratic scale mainly in a simple example. In root square, the approximate scale has been improved to the square root of *x* values.

Objectives

The objectives of the study are:

1) To implement the root square scale of Analytic Hierarchy Process (AHP) to solve the project selection problem.
2) To select the most potential alternative project by using Analytic Hierarchy Process (AHP).

Novelty

A new approach for AHP weighted is introduced to rank the criteria and to evaluate the best alternative identified by the experts and the AHP-Root Square scale is successfully adopted in decision making for project selection problem.

Methodology

In this paper, Analytic Hierarchy Process (AHP) approach is used to solve the project selection problem while the root square scale is used as the judgement scale in AHP. Step 1 – 5 explains about the computation of the weighted using (AHP) approach.

Step 1: Construct a hierarchy. The objective of the study should be placed on the top of the hierarchical structure, then the criteria or the sub-criteria (if any) is determined and placed on the second level of the hierarchy. Lastly, the alternatives must be identified and placed on the bottom level of the structure.

Step 2: Set up the pairwise comparison matrix, C_{nxn} of criteria and alternatives. The root square scale from Table 1 is used instead of Saaty's scale. The Saaty original 9 point linear scale is set as a benchmark for root square scale. The decision maker(s) is requested to tell how many times criteria *i* is preferred than criteria *j* which result is denoted by c_{ij} (Bozóki & Rapcsák, 2008) when the pairwise comparison is made. One need to enter the square root number in appropriate position and its reciprocal is automatically entered in the transpose position. This can be defined by,

$$c_{ij} = \frac{1}{c_{ji}}, \tag{1}$$

for any pair of indices (i, j) for i , $j = 1, 2, 3, ..., n$ (Bozóki & Rapcsák, 2008).

Table 1
Scale of Relative Important

Definition	Saaty's Scale	Root Square Scale
Equal importance	1	1
Weak	2	$\sqrt{2}$
Moderate importance	2	$\sqrt{3}$
Moderate plus	4	$\sqrt{4}$
Strong importance	5	$\sqrt{5}$
Strong plus	6	$\sqrt{6}$
Very strong	7	$\sqrt{7}$
Very, very strong	8	$\sqrt{8}$
Extreme importance	9	3

Step 3: Set up the normalized matrix, N_C . The sum of each column of normalized matrix, N_C will be equal to one.

Step 4: Calculate the weighted of the criteria and alternatives.

Step 5: Check the consistency of the judgment matrix by computing the Consistency Ratio, *CR*. *CR* can be expressed as:

$$CR = \frac{CI}{RI} . \tag{2}$$

Consistency Index, *CI* can be expressed as

$$CI = \frac{\lambda_{\max} - n}{n-1}, \tag{3}$$

The judgment is consistent if the value of $CR < 0.1$.

Result and Discussion

A real-life empirical example about supplier selection is used to demonstrate the application of root square scale of AHP. The weighted of the criteria is computed by using AHP – Root Square scale and the result is shown in Table 2.

Table 2
Ranking of Criteria for Medicine Supplier

No	Criterion	Weight %	Rank
1	Delivery time	21.8	2
2	Service	20.9	3
3	Price	44.1	1
4	Payment term	13.0	4

In this project, there are four criteria suggested by the experts which are delivery time, service, price, and payment term. Price has the highest weight of 44.1% and the last rank is payment term which has a weight of 13%.

This paper also evaluates the three alternatives for supplier selection which are Supplier A, Supplier B, and Supplier C. The result is shown in Table 3.

Table 3
Alternative Evaluation for Medicine Supplier

No	Alternative	Weight %	Rank
1	Supplier A	20.5	3
2	Supplier B	54.7	1
3	Supplier C	24.8	2

Supplier B has the highest weight of 54.7% and the Supplier A has the lowest weight of 20.5%. The result showed that the criteria and alternative are successfully ranked by using AHP – Root Square scale. Thus, the first objective which is to implement AHP- Root Square scale to solve the project selection problem is fully achieved.

The result shows the highest different percentage weight between the first ranked alternative with the other alternatives. It increases the level of confident for decision maker to make decision for alternative or project selection. Therefore, the second objective which is to select the best alternative project by using AHP- Root Square scale is also fully achieved.

Conclusion

AHP is a mathematical device used in MCDM that summarizes the problems in hierarchical structure and requires ratio scale to perform pairwise comparisons. This paper had proposed a root square scale to obtain the weight of each criteria and alternative and to do pairwise comparison to solve project selection problems. Selection of root square scale is based on number of criteria and alternatives that have been set by experts' opinion in this project. This scale gave consistent results and shows high consistency in terms of sensitivity compared to other scale (Franek & Kresta, 2014). Root square scale can be a good alternative scale if the decision maker prefers better higher consistency compared to the most favorable Saaty scale. The use of AHP method in project selection problem will benefit the organization since it is simple, cost effective and less time consuming to make profitable selection.

References

Bozóki, S., & Rapcsák, T. (2008). On Saaty's and Koczkodaj's inconsistencies of pairwise comparison matrices. *Journal of Global Optimization*, *42*(2), 157–175.

Franek, J., & Kresta, A. (2014). Judgment Scales and Consistency Measure in AHP. *Procedia Economics and Finance*, *12*, 164–173.

Ishizaka, A., & Labib, A. (2011). Review of the main developments in the analytic hierarchy process. *Expert Systems with Applications*, *38*(11), 14336–14345.

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. *Journal of Mathematical Psychology*, *15*(3), 234–281.