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Analytical Hierarchy Process and PROMETHEE as Decision Making Tool: A Review

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Abstract. Journal reviews published on a typical topic are called review literature. AHP is a multi-criteria decision that is widely used that makes research tools in various fields and continues to improve its use, so we can conduct a review of AHP and PROMETHEE to get the most commonly studied topics. AHP provides a proven and effective way to handle complicated decision making and can assist in analyzing collected data and speeding up decision making methods and identifying and weighing criteria. Rating Organization Method Preference for Enrichment Evaluation (PROMETHEE) is an established decision support system that deals with the assessment and selection of a series of options based on several criteria with the aim of obtaining rank among them. Simultaneously can deal with qualitative and quantitative criteria. The purpose of this paper is to find out about the use of PROMETHEE and Analytical Hierarchy processes as decision-making tools.

1. Introduction

AHP is a multi-criteria decision making tool that is widely used. In contrast to other conventional methods, AHP uses paired comparisons that allow verbal judgment and improve the accuracy of results. Pairwise comparisons are used to reduce the ratio and accurate priority scale. Developed by Thomas Saaty [1], the AHP method has a proven and effective way to handle complicated decision making and can help in analyzing the data collected and speeding up the decision making process and identifying and weighing available selection criteria.

AHP helps determine the steps of subjective and objective evaluation of alternative choices, providing a mechanism that is useful for examining alternative consistency thereby reducing bias in decision making [2]. When making complex decisions involving many criteria, the first stage is to describe the main objectives of the AHP into sub-objectives of the constituents or sometimes called goals, progressing from the general to the specific. In its simplest form, this structure consists of objectives, criteria or objective and alternative levels. Each set of criteria will then be subdivided into the right level of detail, recognizing that the more criteria entered, the less important each individual criterion. [3]

Each hierarchical structure of AHP methodology can measure and synthesize various factors from complex decision-making processes in a hierarchical manner, making it easy to combine parts as a whole and in their entirety. A bibliometric study [4] found that the number of publications related to MCDM - Multi Criteria / MAUT Decision Making - Multiattibute Utility Theory increased by 4.2 times than before, from 1992 to 2006. This event was largely due to continued growth of publications increase in AHP and EMO. - Evolutionary Multi-Purpose Optimization.

So, there are three functions of AHP's main research methodology, namely: synthesis, measurement, and structuring of complexity. For the first function of the AHP, Saaty said that to resolve the complexity of the decision process, at this stage we need to identify all the factors that have differences that influence decisions and regulate them in the hierarchical structure of "homogeneous factor groups". Measurements on the ratio scale are obtained by comparing these alternatives in pairs. The weight of each factor in the hierarchy will be found in the process in which each factor is compared to the parent factor. The priority (weight) at all levels of the hierarchy will be found by multiplying the priority of one factor at each factor level to prioritize the factor with the first connected (parent factor). This method is important because of its ability to measure and synthesize many factors in the hierarchy to get the best alternative, even though the AHP method has an analytic name, because AHP separates abstract entities into its constituent elements. [5].

An Organization's Assessment of Enrichment Evaluation Preference Methods (PROMETHEE) is an established decision support system that deals with the assessment and selection of a series of choices based on several criteria with the aim of ranking among factors. PROMETHEE can simultaneously handle qualitative and quantitative criteria. This method can process information that is uncertain and unclear. Founded by Brans & Vincke in 1985. Organizational methods rank preferences for enrichment evaluation methods (PROMETHEE) analysis decisions. In solving facility location problems where there are eight criteria for four alternative location solutions usually using the PROMETHEE II Method (Athawale and Chakraborty, 2010).

This method will eventually produce the best alternative from several choices with the lowest cost and ranking. Maragoudaki and Tsakiris (2005) argue that those who can handle the MCDA method are the PROMETHEE method, this method is used for flood mitigation plans in the evacuation process and evaluated using the AHP method and PROMOTHEE criteria (Anagnostopoulos et al., 2005) [36].

2. Research Methods

This paper discusses the most common topics in Analytical Hierarchy Process as Decision Making Tool, by reviewing the literature that has been published in a systematic way.

2.1. Approach and phase of research

In this paper, the approach includes four processes in conducting systematic literature review as shown below :

a. Planning review : make research objectives and aims, develop research protocol

b. Conduct reviews : setting the relevant criteria, search and retrieve paper, paper selection, Quality assessment for relevant studies, data output.
c. Document review : Reporting systematic review literature as well as detailed reviews results and publishing the review.

2.2. The criteria

Journals in research articles are conducted through academic journals in the AHP field which are published in the best database journals. Databases include Elsevier, Taylor and Francis, Emerald Insight, Springer, and Inderscience. Journal reviews must be made for articles that discuss the Analytical Hierarchy Process as a decision-making tool for its decision. Research articles related to Analytical Hierarchy Processes as decision-making tools are defined as research criteria. Based on existing data, it was found that most articles explained the AHP method and the PROMETHEE method and their applications were published since 2000.

Table 1. Information of AHP Papers in Academic

Id	Problem Type	Industry	Tecnique Used	Year
[6]	Selection	Food Indusrty	AHP, ANP	2011
[7]	Selection	Textile Industry	AHP	2011
[8]	Selection	Oil Industry	AHP	2010
[9]	Ranking	Small Industry	ANP	2015
[10]	Selection	Aluminum Industry	AHP	2016
[11]	Ranking	Healthcare Industry	Fuzzy AHP	2012
[12]	Ranking	Telecommunications	AHP	2012
[13]	Ranking	Education	Fuzzy AHP	2012
[14]	Selection	Public Adminstration	Fuzzy AHP	2012
[15]	Selection	Electronics Industry	Fuzzy AHP	2012
[16]	Selection	Shipping Industry	Fuzzy AHP	2012
[17]	Ranking	Education	AHP	2011
[18]	Ranking	Public Adminstration	Fuzzy aHP	2011
[19]	Ranking	Manudacturing Industry	Fuzzy AHP	2013
[20]	Ranking	ICT Industry	Fuzzy AHP	2015
[32]	Evaluate	Harvesting	Stochastic PROMETHEE	2005
[33]	Evaluate	Environment	Fuzzy PROMETHEE	2003
[34]	Evaluate	Credit Risk	PROMETHEE	2002
[35]	Evaluate	Environment	Fuzzy PROMETHEE	2000

2.3. Paper selection

The search literature is derived from academic databases including Elsevier, Taylor and Francis, Emerald Insight, Springer, and Inderscience. String search is used as follows AHP, decision making, hierarchy, etc. The literature search is only in English. Selection is done in two stages, with the first step is to select the journal by looking at the contents of the abstract of the journal. The second stage reads the journal as a whole.

After the selection of journals, the journal obtained 19 journals from 30 AHP and PROMETHEE journals in accordance with the criteria. We review journals published not only in one country but some countries such as Arab, USA, Turkey, Italy, India, Taiwan, China.

2.4. Data output

Journal that has been selected as many as 19 journals will be read back to consider the implementation of AHP and PROMETHEE, and founded 19 case study journals. Information about 19 journals on AHP and PROMETHEE as decision making tool can be seen in Table 1.

3. Results

After research into the AHP and PROMETHEE journal collected, point of problem has been found. This section will present the most common topics in the manufacturing sector based on the collected journals.

3.1. Define the problem

As shown in Table 1, a study discussing the palm oil industry has several alternative problems and choices. The problem specified will be solved by this method. Some studies discuss the importance of problem-solving methods using applied mathematics. Then this method is influenced by expert systems and applications. As far as the purpose of the article (column type problem in Table 1) is related, seven choose alternatives and eight aim to rank alternatives.

3.2. Structure the decision hierarchy

In general, the factors of influence are the criteria in the group. However, they are also called aspects [6,11] attributes [7], classes [12], and dimensions [19]. In the previous case, as can be seen in table 1, the process of selecting criteria sources was based on a literature journal; in a number of other relevant cases, the process is based on selecting criteria that are considered relevant for the organization. Only in four cases was the source to choose criteria supported by external specialist contributions.

Before applying the AHP method several criteria must be selected beforehand. But in the previous study there were only 2 cases that identified alternatives to assess existing strengths and criteria: The screening method used 6 variables, including 7 suppliers out of 10 analyzed; in this journal the criteria chosen are many because the criteria do not meet the organization's terms and conditions. The previous three articles analyzed the criteria from 109 to 20, from 109 to 60, then 44 to 5 in the end. A good criterion that the AHP remains consistent and redundancy is recommended the number of criteria is 7 or less. This suggestion was taken from several studies taken as guidelines, as can be seen in point a in Figure 1, according to the pattern structure. In 3 studies there were levels of structure. At the first level the hierarchy is the goal or goal in solving a problem. At the second level there are 2 or 20 criteria that can be observed in making a comparison of criteria. The average is 4.76 criteria and mode 3 criteria. The third level has ten sub-criteria and the average and other methods. Often the imbalance of the criteria with one another will occur in the discussion of the problem. In contrast to the other 8 cases where there were no alternatives that met the terms and conditions, because basically this method was to identify and evaluate criteria, a maximum of 117 average 11 and 3 studies were the objectives. b duck in Figure 1 was built to represent the hierarchical structure of standards and mode values for layers, criteria, subcriteria and alternative structures.

3.3. Construct matrices

The first step is to calculate a set of paired comparisons and calculate the weights for each element of the criteria. Table 1 refers to ways to develop group assessments as individuals separate. The individual assessment aggregation method (AIJ) is used in the initial situation, identity and decision for each pair of criteria. Nine methods of adopting AIP were not included in the criteria for analysis. In some cases such as qFD, approach methods (AM), and similarity aggression methods (SAM), all methods can measure the degree of conformity. AHP has 2 ways of evaluating observed alternatives; Absolute assessment is usually used, criteria and quantitative analysis and relative assessment. There are only 16 cases that use this problem as a means of eradicating pests. The previous two methods discuss situations where many are needed, but this method requires a predetermined scale.

The method often used to evaluate criteria is AHP and FAHP with other techniques can be seen in table 1, In solving AHP solutions only calculates the weight of criteria and selection of the best alternatives. Different techniques can also use AHP. At 14 AHP is the only one used in 7 studies and fuzzy logic, and can be added with TOPSIS to compare weights. Saaty said that the consistency ratio (CR) of pairwise comparison matrices for each criterion is a measure used in AHP to increase the validity of accurate calculation results, that is, when the comparison matrix has inconsistencies, decision makers must change their opinion. about several comparisons to improve the consistency of results. In the FAHP, this inconsistency cannot be shown in the results and the inconsistency of decisions remains. "AHP has a level of uncertainty successfully corrected by using intermediate values on a scale of 1-9 combined with a verbal scale and that seems to work better to get accurate results than using obscurity to change numbers for convenience and somewhat arbitrarily". However, the purpose of this article is not to assess the use of methods, but what methods are used.

From several articles, there are 7 problems that use alternative methods as in table 1, Analytic Network Process (ANP) is a network structure to see the nature of dependence of alternatives and the available criteria are often called AHP evolution, complex proportional assessment (COPRAS), which "work on ranking and stepwise evaluation procedures of alternatives in terms of significance and utility level." [31]; . Elimination and Revealing Reality Options (ELECTRE) is an evolutionary process of criteria for setting alternatives (decision matrix), maximum limits, criteria values (weights) and other parameters. "This method develops preference modeling with higher relationships, followed by exploitation procedures" [18]; Gray Relational analysis (GRA) compares "reference schemes and optional and closer schemes to be chosen as the best treatment alternative"; . One way to identify solutions from a limited number of alternatives, where "the optimal solution must have the shortest distance from a positive Ideal solution and the farthest from a negative ideal solution" is often called Technique for sequence performance by similarity with the ideal solution (TOPSIS). the compromise ranking method (called VIKOR) "is a multi-attribute decision making technique that has a simple calculation procedure that allows simultaneous consideration of proximity to ideal and anti-ideal alternatives"; The Maximum Approach that "this weighted criterion is to maximize and minimize operator performance" and in the same article "testing of non-parametric statistics to identify a series of effective operators".

3.4. Comparison

Multi criterion Decision-Making (MCDM) is increasingly important over time as a tool that has the ability to analyze complex real problems because of the inherent ability of this method to assess the various alternatives available (options, strategies, policies, scenarios can also be used synonymously) on various criteria for possible selection. best / suitable alternative (s). These selected alternatives can be explored more deeply for their final implementation. Decision makers clearly need to carry out a final examination of the impact of their overall alternative choices on the entire evaluation matrix, but a systematic and active assessment of all elements, even those that are excessive, such as the characteristics for AHP, can be avoided. [36].

Table 2. Comparison Between Characteristics of Diffetent Decision Models

Characteristic	AHP	PROMETHEE
Handle real data	NO	YES
Different weight between criteria	YES	NO
Provide multi preference structure	NO	YES
Best choice	NO	NO

Table 3. Methods: Strength and Weaknesses

Method	Strength	Weakness
AHP	In accordance with the Group Decision Matrix Addressing several complex criteria Doesn‟t involve complex mathematics. A certain value of consistency is allowed Easy to capture and convenient	Perfect consistency is very difficult. Time consuming with large numbers. Doesn‟t take into account the uncertainty.
PROMETHEE	Trade-offs are avoided. The dominance relation is enriched rather than impoverished. It does not provide structuring possibility. PROMETHEE needs much less inputs.	The partial ranking is forced into a complete ranking of the alternatives; this may also lead to the loss of data. General criteria really need to be determined so that it is possible for inexperienced users to be easily reached.

4. Conclusion

In 19 articles, it will be compared to the rest, the easy start and the type of knowledge in the journal is the technique. The selected criteria use number 07 or there are 2 or 3, the substantiates reduce the number of criteria. From the results of several cases that are initiated, for example 109 analyzed, decision making will build other people so that the criteria become the best choice. Method ii uses individual aggression research.. However, how consensus is obtained and whether inconsistencies in AHP applications occur are not commented on. To calculate criteria weights, AHP or Fuzzy AHP is used in all cases, while authors prefer to use other techniques to assess alternatives, such as TOPSIS, COPRA, ELECTRE. Another technique that is rarely used AHP is rating or rating, also called absolute valuation, which can make AHP applications faster and easier. The number of cases using Fuzzy AHP is relevant, even though AHP's father, Saaty, does not agree with that. Comments about the results of implementing AHP only rely on the adequacy of the models and techniques

used for that. This finding can support recommendations for future studies on the difficulty in applying AHP to choose the best criteria, to get consensus, and whether the results meet stakeholder expectations or whether the structure must be changed and use other methods.

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