Final Report
On
A Comparative Study of AHP and Fuzzy AHP Method for Inconsistent Data

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Summary :
AHP and Fuzzy AHP methods are useful tools in decision making when there are multiple criteria and multiple solution alternatives in a situation. If we have n criteria as in Table 1 and preference selection is substituted in the matrix, firstly, the pairwise comparison matrix is created. Table 1 matrix is written as equation in equation. By dividing each element of the matrix by the column sum, the normalized matrix is created, then the new N matrix is created and we get the values of the W row matrix, from which the row averages of the N matrix are obtained, the highest values ǯ200bǯ200b from which the final result is obtained. This is all about the AHP method that Taha is discussing. Both AHP and Fuzzy AHP deal with stochastic data. Fuzzy logic allows for the quantification of uncertainty and the generation of the decision outcome.

	C 1	C 2	…	C *n*
C 1	A11	A1 2	…	A 1n
C2	A21	A22	…	A2n
.	.	.		.
.	.	.		.
.	.	.		.
Cn	An1	An2	…	Ann

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & & a_{nn} \end{pmatrix} \quad (1)$$

Fig. 1. Table 1: Fuzzy pair wise decision criteria evaluation matrix for some criteria

fuzzy AHP, A set of decision maker evaluations using fuzzy ratings are tabulated in Table 3, normalized using Fuzzy normalization in Table 4 and AHP normalization in Table 5. Similarly, the mean values of each row of the AHP normalized matrix in Table 5 are also listed in Table 6. These two sets of results are compared and graphically shown in Figure 1. The whole process is repeated from Table 7 to Table 35 and Figure 2 to Table 2.

	ENG	PIS	RMG	STF	SRT
ENG	0.053	0.263	0.111	0.278	0.350
PIS	0.263	0.053	0.333	0.167	0.150
RMG	0.211	0.211	0.056	0.056	0.050
STF	0.316	0.421	0.056	0.056	0.400
SRT	0.158	0.053	0.444	0.444	0.050

Fig. 2. Table 2: Suggested numbers for maturity grading [4]

Figure 9 respectively. Since these data sets are used in purchasing system analysis and the parameters do not change, various parameters are used in Data Analysis. Descriptions of these parameters are not required in this research article. We can see the ups and downs of the curves in the figures and we have summarized the changes and similarities-differences in Table 36. We tried to draw the conclusion of this research study in Table 37 and Table 38.

Result:

AHP curve properties. As the fuzzy data is increased, we see that the AHP data for the fuzzy reduction increases and decreases successively, and in most cases, except for a few samples, the jitter of both curves is the same for many samples.

I. Proposed Methodology

These methods have been extensively used in various studies in maintenance management. Decision making in the selection of maintenance factors influencing sustainable

	Increase in AHP, Increase in Fuzzy	Increase in AHP, Decrease in Fuzzy	Decrease in Fuzzy, Increase in AHP	Decrease in AHP, decrease in Fuzzy	Increase/Decrease in AHP, Fuzzy unchanged	Increase/Decrease in Fuzzy, AHP unchanged	Total observations
Risk Identifier	2	2	3	3	4	×	14
Customer	×	×	1	2	1	×	4
Organization	3	1	×	2	×	×	6
Policy	2	×	×	2	2	×	6
Process	1	1	1	2	×	1	6
Staff	3	2	2	1	×	×	8
Tools	1	2	3	3	3	1	13
Vendors	1	1	1	2	×		5
Few decision ratings	1	×	2	3	×	×	6

Fig. 3. Table 36: Observation records of AHP and Fuzzy MCDM comparison graphs

Increase in AHP, increase in Fuzzy MCDM	20.59%
Increase in AHP, decrease in Fuzzy MCDM	13.24%
Decrease in AHP, increase in Fuzzy MCDM	19.12%
Decrease in AHP, decrease in Fuzzy MCDM	29.41%
Increase or decrease in AHP, Fuzzy remain unchanged	14.71%
Increase or decrease in Fuzzy, AHP remain unchanged	2.94%

Fig. 4. Table 37: Observation summery of AHP and Fuzzy MCDM comparison curves

production is very complex due to many factors related to the industry, company-specific processes, needs, and business goals.

In order to choose the most appropriate maintenance factors, the MICMAC analysis in this research was proposed. MICMAC allows one to determine interactions between factors and by grouping factors into clusters it helps to reduce the size of some complex problems, making them more manageable and revealing hidden relationships between various considered factors. After the most important maintenance factors were identified, the fuzzy AHP (analytical hierarchy process) method and fuzzy TOPSIS (technique for order preference by similarity to ideal solution) were used to determine the right judgment of maintenance factors affecting sustainable manufacturing based on the company specific requirements. In this respect, F-AHP can be very useful in involving several decisionmakers with multiple conflicting criteria to reach a consensus in the decision-making process.

On the other side, the F-TOPSIS technique is used to calculate alternatives ratings. The choice of the TOPSIS is due to its capability of ranking a wide number of alternatives. This approach can be considered as a driver in implementing the alternative that represents the best trade-off according to the various considered criteria. Considering the above, the aim of this paper is to analyze the maintenance factors influencing the implementation of sustainable manufacturing challenges from a tactical perspective, to determine the relationships between them, and to rank them taking into account the specificity of an operational context of an enterprise. This paper is a continuation of the previously undertaken work .

II. Advantage and disadvantage

Advantages :

1. The authors provided a good introduction at the very beginning of the paper that gives an idea of the basic concepts.
2. There is a solid data analysis that proves the point authors tried to make.

3. Heavy usage of keywords like - AHP, Fuzzy AHP, MCDM makes the paper more appealing.

4. Good explanations of used methods (AHP, Fuzzy AHP) are helpful for easy understanding.

5. At the end of the paper, a very good conclusion and summary of results are given which reflects on the whole study.

6. A good number of references.

7. Well organized.

Disadvantages :

1. The uses of some words were seemed grammatically incorrect to us.

2. Unfortunately, the authors didn't address the future works of the study.

III. terminology

The analytic hierarchy process (AHP), also analytical hierarchy process, is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s; Saaty partnered with Ernest Forman to develop Expert Choice software in 1983, and AHP has been extensively studied and refined since then. It represents an accurate approach to quantifying the weights of decision criteria. Individual experts' experiences are utilized to estimate the relative magnitudes of factors through pair-wise comparisons. Each of the respondents compares the relative importance each pair of items using a specially designed questionnaire.
AHP has particular application in group decision making, and is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare and education.
Rather than prescribing a "correct" decision, the AHP helps decision makers find one that best suits their goal and their understanding of the problem. It provides a comprehensive

and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions.

IV. Experimental Result section explanation

The authors used AHP method and Fuzzy AHP method, which is also known as Fuzzy MPDM (Multi-person decision making) or more specifically MPPC (Multi-person preference criteria), to reach a conclusion and a result.

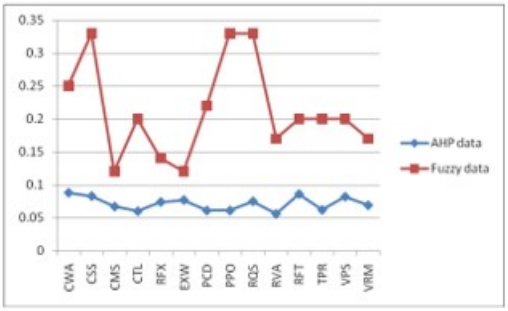

Fig. 5. Comparison of AHP and may MCDM for PMM attribute 'Tools'

Different parameters are used in Data Analysis because these data sets have been used in procurement system analysis and the parameters do not change. Explanations of these parameters are not required in this research paper. We should remember that all data sets considered for analysis are inconsistent, i.e. all panel data have consistent metric values that fall outside the acceptable range. Various parameters are used from the shopping case here.

Respected authors observed the results of AHP and Fuzzy MCDM comparison on a table. Table content stated as follows-

1. Increase or decrease in AHP makes an increase or decrease in Fuzzy respectively 50%.
2. Increase or decrease in AHP makes reverse swing in Fuzzy 32.36%.
3. Either AHP or Fuzzy remain unchanged for any slope of Fuzzy or AHP respectively17.64%.

Their analysis of the results tells us Fuzzy Curve and AHP curve have similarities in nature. For most of the cases of this study, an increase or decrease in Fuzzy data creates a successive increase and decrease in AHP data. It can also be seen that the vibration of both curves is the same for most of the samples.

V. Conclusion

Characteristics of the AHP curve. When the fuzzy data is increased, we see that the AHP data is successively increased and decreased for the fuzzy decrease and the vibration of both curves is the same for many samples in most cases except a few.

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