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A Study and Rank Reversal Technique for Analytical Hierarchy Process

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ABSTRACT

This paper manages choice making utilizing the AHP AND MCDM techniques, presented by Thomas L.Saaty in the year 1980. In spite of the fact that the AHP technique is amazingly generally utilized, it has been liable to feedback on a few checks. Commentators have attracted consideration regarding issues with the numerical scale utilized as a part of AHP and in addition the issue of rank inversion in AHP. This paper presents the AHP technique and attracts regard for discussions and open issues encompassing the calculation.

KEY WORDS: COTS, Multi Attribute utility Theory, Brain Research, MCDM.

1. INTRODUCTION

The AHP is the one of the Multi-Criteria Decision-Making-MCDM strategy, which was presented by Thomas L. Saaty in the year 1980. This technique is incompletely a subjective methodology with an endeavor to fuse rationale, brain research, and past encounters. It tries to lessen an intricate issue into a more organized arrangement that is ideally all the more simple to fathom. This strategy contains a chain of importance of levels which comprises of aim situation Some Criteria ,and others. This method comprises of an arrangement of sayings which characterizes an arrangement of networks and relegates need through pairwise examinations to criteria and choices. It is connected in numerous building, investigative and business fields. In the field of pharmaceutical it has been utilized for medication determination, picking the right organ transplant beneficiaries, ripeness treatment choices, for picking in the middle of angioplasty and coronary detour surgery, etc. It has been utilized to rank games team. It has been connected to software engineering regions, for example, choice of working frameworks, inserted frameworks, determination of COTS programming, and so forth AHP has been utilized as a part of atomic applications, for example, atomic waste administration. A general study on AHP applications has been completed, among others, by Omkarprasad Vaidya & Sushil Kumar (2004). A standout amongst the most acclaimed employments of the Eigenvector methodology that AHP depends on is the Page Rank calculation utilized by Google for positioning websites. A pre-imperative is a chief who can comprehend the space of the issue. In this manner MCDM Method for taking care of some intricate issues. Different ways to deal with such problems include outranking methods, multi- attribute utility theory, etc. However, the AHP method is the most widely used and researched approach with over 25,000 citations in the literature. Despite its widespread use many aspects of AHP remain controversial in nature. In particular the problem of reversal of ranks when an alternative is added or deleted has attracted attention.

Genesis of AHP: In Earliest Day Saaty, said to some Comments in operation research and demilitarization, for unique examination venture for U.S State. Some of the spending plan empowered some contract specialists in diverse fields including legal advisors, and Mathematician deodorized to some problem in the field.

Practical approach to problems and were faced with communication difficulties and different perspectives. He was also convinced of the limitations of conventional decision making approaches such as utility theory. This observation sometimes made to be modalities for decision making and prompted to develop a method to help in AHP.

- The basic practices when using AHP:
- Issue Representation
- Pairwise Comparison
- Developing Local Priority
- Checking Consistency
- Determining Global Priority
- Sensitivity Analysis.

(a) **Issue Representation:** The all Decision making process is assumed to be Knowledgeable person in the problem structure that can be in to three parts : aim, criteria , sub-criteria (if required) and alternatives. AHP leads to a hierarchical shape of some objective situation and alternatives which help a decision-maker reduce the complexity of a problem.

(b) **Pairwise Comparison:** The core of the AHP is compare to both of tangible and intangible factors to arrive at decision.

Give us a chance to consider an illustration: Consider three understudies A, B, and C. An educator makes pairwise examinations and observes B to be somewhat superior to anything An and C to be marginally superior to anything

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B. Along these lines from the Saaty scale given in world records over the educator would observe B to be 3 times superior to anything An and C to be 3 times superior to anything B. In the event that the leader was flawlessly predictable, this would suggest that C is 9 times superior to anything A. By and by, irregularities are permitted. Despite the fact that various different scales have been proposed, the Saaty scale is the most much of the time utilized. Some other dubious parts of the Saaty scale are taken up in conclusion, of this paper.

Axioms of AHP: These maxims were characterized by Saaty (1983 and 1987) to enhance the nature of the last result and got from reactions from distinctive experts.

Aphorism 1 is named as the Reciprocal maxim; it expresses that if amid a pairwise correlation.

Aphorism 2, the homogeneity maxim, expresses to the components being analyzed ought to contrast by just a couple variables; generally, there will be certainly a mistake in the judgment. In the event that both these components are similarly diverse, i.e., say one component being a completely magnificent evaluation in a subject and the other component an extremely horrible score, then there is no reason for performing the examination.

Aphorism 3, named as union adage, expresses that the components let down the chain of importance don't impact components at more elevated amounts, i.e. such turn around criticism is not permitted. Adage 4, named as the desire saying, expresses that it is important to guarantee that the chief's contemplations are appropriately reflected and impact how the issue is organized and pairwise examinations are completed all together that the last result adjusts to the inalienable convictions of the leader.

Algorithm of AHP:

Step (1): Issue the problem as aim Criteria and alternatives.

Step (2): The nxn matrix to be construct.

Step (3): Determine the pairwise comparisons of criteria. This is the judgment matrix.

Step (4): Determine the priority vector.

There are several methods to obtain the priority vector. Among them:

a) Saaty's method tell us the nxn matrix to sufficiently large power. Sum over rows and normalize to get an estimate of the eigenvector.

b) Take the geometric mean of each of the rows of the pairwise comparison matrix and normalize.

Determine the maximum Eigenvalue (\lambdamax) of the pairwise comparison matrix: Calculate the product of the vector of the total of each column of the judgement matrix with the corresponding priority vector.

Step.5: To calculate the following value for given table.

			/	
1	2	3	4	5
0.00	0.00	0.58	0.90	1.12
6	7	8	9	10
1.24	1.32	1.41	1.45	1.49
11	12	13	14	15
1.51	1.48	1.56	1.57	1.59

Table.1. RI values for different values of n, where n is the order of the matrix

Some Mathematical Basics in AHP:

Eigenvector technique: While there are numerous techniques for acquiring the need vector, Saaty has asserted that the Eigenvector system is better than every single other strategy in saving rank request.

Consistency of framework: In the pairwise examinations, if the correspondence property holds and if the value B and B is linked to C, implies an liked to C then the grid predictable. A grid is predictable if and just if the main eigenvalue $\lambda max = n$, the request of the lattice. The entirety of the eigenvalues of a network is equivalent to its follow, the aggregate of its inclining components, and for this situation the hint of an is equivalent to n. In this way every one of its eigenvalues with the exception of one are zero. In genuine practice we consider a little measure of irregularity (Consistency Ratio (C.R) under 10 percent) and λ max will be somewhat more prominent than the worth n.

Legitimization of Saaty's eigenvector methodology: Presently , a property of a predictable framework An is that the condition Ak = nk-1 A, where n is the request of A, holds .But this condition does not matter for strength of a conflicting network .Instead , as Saaty focuses out , one must consider needs got from direct predominance of article i over item j from the (i,j)th component in the grid A, second request strength of item i over item j from the (i,j)th component in the predominance intensities of every one of the 2-strolls from item i to protest j , and so on .

The aggregate strength of every article is got as the standardized whole of its columns. Accordingly the ith estimation of the Perron need vector got from A^k can be seen as a strength of article i over different items along all k-strolls i.e. all k length ways from article i to different items. This outcomes in a progression of need vectors every giving an alternate level of strength.

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The point of confinement of the normal of this arrangement of need vectors is indistinguishable to the furthest reaches of the succession of forces of the grid. At long last, from an outcome because of Perron this arrangement Ak joins to a framework whose segments after standardization are indistinguishable and yields the key eigenvector of A to inside of a variable of extent. Subsequently, it is asserted, takes after the legitimacy of Saaty's strategy. Geometric Mean Method (i.e. the logarithmic minimum squares strategy): Critics have, on the other hand, called attention to that the positioning by the eigenvector methodology is predominantly ordinal in the AHP system as the genuine estimations of pairwise coefficients assume a lesser part than their relative qualities. Numerous scientists have consequently contended for the geometric mean strategy (i.e. the logarithmic slightest squares strategy) to get the new vector and it has been claimed that this method does not have the drawback of rank reversal. Saaty has claimed the opposite and argues that the geometric mean method can lead to rank reversal. The two methods give the same priority vector for 3 by 3 matrices. The eigenvector approach is known to the problem of rank reversal if the left rather than the right eigenvector were to be used. Furthermore, some feel the eigenvector approach lacks clarity. This lack of clarity also leads to an opaque and mechanical process of churning out priority values, especially by novices in this area.

A Numerical Example: The DM is focused with the issue of purchasing one alternative out of a choice of a total of three alternatives, As per Saaty, the scale communicates a request, in light of the chief's state of mind. It is essential to stretch that for Saaty elusive elements like the level of bolster or thoroughness of guarantee gave are likewise critical. Further, and dubiously as contended in the Conclusion Section of this paper, pairwise examinations are asserted to gauge the power or degree by which one option is superior to anything another on these immaterial variables.

Phenomenon of Rank Reversal: As of now specified AHP experiences the issue of rank inversion. The paper by Belton and Gear demonstrated that positions can change if even a duplicate of a current option were to be added to the decision set. Resulting studies uncovered that positions can change if a close option were to be included. An energetic open deliberation has subsequent to followed with , however , no agreement on essential issues, for example, the reasons for rank inversion or significantly whether rank inversion is a characteristic, not completely undesirable wonder or something to be dodged at all cost. While Saaty and his gathering have tried to legitimize the inversion of positions specifically cases and have even asserted as favorable position that AHP utilized fittingly takes into consideration rank inversions , different specialists find rank inversions a noteworthy issue . On the off chance that another option Alternative-4(A4) is included, then the accompanying are the judgment lattices with four options as far as a model: For occasion, the judgment grid as for the "C1" paradigm is Table 8; The judgment framework as for the "C2"; The judgment network concerning the "C3" rule. The Global Priority inferred by collecting nearby needs. Thus it is seen from the above count that the overhauled positions are A3 > A2 > A1 > A4. It is in this way seen the positions have changed.

2. RESULT

For three alternatives the final result in table 5. If the new alternative value A4 is added to the previous three alternatives, then the final result is shown in Table 5. Thus it is seen from the calculation that the revised ranks are A3 > A2 > A1 > A4. The results from Table 4 and Table 5 indicate that rank reversal occurs in both the original AHP and the revised-AHP (RAHP) it is when new alternative A4 is added. Other experts have introduced other modifications of the original AHP. Other methods proposed such as multiplicative AHP (MAHP) are also seen to suffer from drawbacks.

Criteria	C1	C2	C3	Final	After
Options	0.769	0.104	0.127	Priorit	Normaliza
				У	tion
A1	0.146	1.000	1.000	0.343	0.183
A2	1.000	0.200	0.250	0.822	0.439
A3	0.854	0.200	0.250	0.709	0.378

Table.2.Global Priority (using Belton-Gear method)

Criteria	C1	C2	C3	Final Priority	After Normalizati
Options	0.769	0.104	0.127		on
A1	0.177	1.000	1.000	0.367	0.162
A2	0.988	0.227	0.249	0.815	0.360
A3	1.000	0.227	0.353	0.837	0.370
A4	0.095	0.775	0.707	0.243	0.107

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Rank	Original AHP	Ideal Mode AHP (RAHP)
1	A2	A2
2	A3	A3
3	A1	A1

Table.4.Final result for three alternatives

Table.5.Final result for four alternatives

Rank	Original AHP	Ideal Mode AHP (RAHP)
1	A3	A3
2	A2	A2
3	A1	A1
4	A4	A4

3. CONCLUSION

Accordingly it is seen that AHP is a generally utilized choice making regardless of downsides, for example, the issue of rank inversion and inquiries concerning the propriety of the numerical scale utilized as a part of AHP. Triantaphyllou and Mann alert that "when the AHP or the overhauled AHP strategies are utilized as a part of mix with the eigenvalue approach for handling the info information, then extreme option positioning disappointments are conceivable. There has been no agreement in the writing on the reasons for rank inversion. Contention and open issues stay on the subject of estimation scales, the decision of strategy for computing need vectors, and the fitting technique to total neighborhood needs into a worldwide one. Dodd and Donegan attracted directed consideration toward the shortcomings of AHP: (1). The Saaty scale is unclear and not shut under duplication. (2). Saaty utilizations number-crunching which is not substantial (3). Saaty neglects to value the pivotal contrast between qualities taken from an interim scale and the proportion scale. (4)Saaty disregards the effect of adjusting judgment proportions into numbers. Consider the case given before where an educator observes understudy B to be somewhat superior to anything understudy An and C to be marginally superior to anything C. Although just a little distinction isolates the two sets of understudies, the proportion between understudies An and C could be 9 on Saaty's scale showing a to a great degree better execution by C when contrasted with A. Essentially , if two progressive pair insightful correlations yield estimations of 3 and 4 separately , their item brings about the estimation.

The significance connected by researchers to the issue of rank inversion has, maybe, served to divert consideration from other major issues with the AHP methodology. At the very center of the AHP system is the case that pairwise correlations of both unmistakable and elusive elements can be made prompting a relative proportion scale. This proportion scale, by Saaty's own confirmation, needs both a zero worth and a unit value. Saaty's proportion scale subsequently is entirely not the same as the basic use of the term "proportion scale "in the writing. Subsequently in positioning autos for buy both unmistakable components like the expense, mileage possible, and immaterial variables like the power of inclination in view of the nature of administration gave by the merchant, the tasteful offer of the auto, and so on could be considered. To quote Saaty: "We require an approach to evaluate emotions and intensities of sentiments. The capacity to do that (something thought to be unimaginable by a great many people) permits us to gauge a urgent variable in choice making (italics included for accentuation) in offering supremacy to such mental wonders Saaty refers to physicists like David Bohm and Arthur Eddington and even Swami Muktananda. It is not by any stretch of the imagination passable to finish up utilizing a scale that needs both a genuine zero worth and a unit measure that the power of one's inclination for An is some various of that of B. On the Centigrade scale that is without a genuine zero, for instance, it is not right to presume that city An at 300 Centigrade is twice as hot as city B at 150 Centigrade. In spite of the way that Saaty himself surrenders that by far most don't concur with his perspective on estimation of intangibles, most researchers have evaded such essential issues and this has prompted the colossal number of references to his work. As per Saaty, the scale utilized as a part of AHP is a direct one. Human emotions are changed over into numerical numbers, i.e., evaluated keeping in mind the end goal to suit this scale. Human emotions contrast from individual to individual. It is hard to evaluate human sentiments. To quote the mathematicians Davis, furthermore, Hersh (1986), "On the off chance that you are to a greater degree a person, you will know there are such things as feelings, convictions, states of mind, dreams, aims, desire, envy, longing, misgiving, yearning, displeasure, empathy and numerous others. These things - the inward universe of human life can never be mathematized". (Cited by Saaty in. Saaty, obviously does not concur with this perspective, and trusts that even intangibles and sentiments can be measured). Despite these disadvantages, the introductory period of AHP may at present fill the need of comprehension the issue structure. Inasmuch as the numbers or numerical results are translated with great alert, the various leveled disintegration technique might toss light on the issue space. Consequently the various leveled deterioration period of AHP utilized alongside different methodologies and a

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comprehensive perspective may clear up a choice circumstance. In choosing method of transport for urban communities , for e.g. , if contamination control or maintainability were likewise included as criteria , the arrangement choices might involve autos as well as open transport or even bikes. As Milan Zeleny focuses out it is frequently important to move past choosing so as to take a choice among distinctive formulas of bread and inquire as to why bread and not croissant. Saaty can be given kudos for spreading mindfulness that the eigenvector methodology can be utilized for positioning wonders. His work might have even contributed limitedly to the improvement of the PageRank calculation of Google. Nor can one truly scrutinize Saaty's push to bring mental wonders inside of the space of science. He even refers to refers to physicists like David Bohm and Arthur Eddington and even Swami Muktananda in backing of his quest. In any case, his case through his broad compositions that mental marvels can be measured merit a closer basic examination. Maybe it is noting so as to fit to end Einstein's perception in this setting: "Not all that matters that tallies can be checked and not all that matters that can be numbered tallies ".

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