ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 5, May 2017

Selection of Personal Computer using Modified Fuzzy Analytical Hierarchy Process

Sonika Sharma[1], Mohinder Singh [2]

M. Tech Student, Dept. of CSE, Maharishi Ved Vyas Engineering College, Kurukshetra University, Haryana, India[1]

Associate Professor, Dept. of CSE, Maharishi Ved Vyas Engineering College, Kurukshetra University, Haryana, India[2]

ABSTRACT: The main purpose of this research paper is to design and develop an automatic decision making and evaluation system for selecting different types of personal computer for specific industrial task using adaptive fuzzy analytic hierarchy process. The proposed system will initially, calculate the weights of pairwise comparison generated by administrator. Then, system will retrieve different criteria of input parameter of personal computer. Every computer system has a pre decided criteria eg.Computer speed (CS), latency (L), number of available resources(NOAR) and available bandwidth (AB). On the basis of above discussed criteria, it can be easily analyzed that a specificpersonal computer is better for specific task and its hierarchy is also generated. The system will compare it with basic analytical hierarchy process weight calculated from pair matrix and show a result. The result in this research is in form of computer number, which shows the best computer to the specific task.

KEYWORDS:FAHP, AHP, Latency, NOAR, Computer Speed, Bit Error Rate.

I. INTRODUCTION

Today, several organizations face fast changes excited by technological innovations and dynamical client demands. These organizations notice that the hassle to get merchandise at the correct price, within the right amount, with the correct quality at the correct time from the correct supply is crucial for his or her survival [1].

The AHP is meant to resolve complicated multi-criteria call issues. It's supported the innate human ability to create sound judgments concerning tiny issues. It facilitates higher cognitive process by organizing perceptions, feelings, judgments, and reminiscences into a framework that exhibits the forces that influence a choice [2]. The size used for comparisons in AHP allows the decision-maker to include expertise and information intuitively and indicate what percentage times a part dominates another with regard to the criterion [3].

Human beings create many selections each day. Some selections area unit trivial, like what to eat for lunch, a way to get to figure, and that program to observe. Alternative selections area unit additional vital and happen solely often, like that school to attend, wherever to measure, and what to try and do for a living. Individuals cannot survive while not creating selections. Creating sensible selections may be a crucial technique for survival. The selections individuals create each day have an effect on their lives within the gift and their life within the future.

Many studies are conducted on higher cognitive process to grasp however individuals create selections and to produce techniques for creating sensible selections.

Decision making is that the study of characteristic and selecting alternatives supported the values and preferences of the choice maker. creating a choice implies that there are an unit various decisions to be thought of, and in such a case we wish not solely to spot as several of those alternatives as potential however to settle on the one that most closely fits with our goals, objectives, desires, values, so on [5].

Good higher cognitive process implies that we tend to area unit au courant which we've relevant and acceptable data on that to base our decisions [6]. The choice creating method is directly associated with data processing: a way to collect data and analyze the gathered data [6].

Understanding however individuals create selections and what area unit effective techniques in higher cognitive process will facilitate manufacture higher selections. In creating selections, call ways area unit wont to compare alternatives with each other and to pick out the simplest possibility supported comparison results [7]. People at large

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area unit adaptation call manufacturers within the sense that they'll apply totally different call ways and switch among them betting on the characteristics of the choice task, like the quantity of alternatives and attributes [8-11]. The additional alternatives and criteria call manufacturers have, the additional difficult and tougher higher cognitive process are going to be [12].

II. LITERATURE REVIEW

According to the Nobel Laureate Herbert Simon [4], deciding is substitutable with managing. Simon divides the choice method into 3 phases: a) the intelligence, throughout that DMs establish understanding of the present conditions that decision for corrective measures. b) The look activity, wherever DMs set the required future state and conditions, and develop a spread of alternatives to achieve them (brainstorming phase). c) The selection activity, wherever DMs choose the one different that best meets the particular wants and attains the target. Simon's theories on deciding, in conjunction with his analysis in different areas of the social sciences (public social science, psychology, engineering science, public administration, management, etc.), not solely resulted in his 1978 accolade Award in social science, but also, to the institution of a brand new manner of thinking and managing complicated issues regarding decision-making (The accolade Organization, 1978).

Clearly influenced by Simon's approach, Thomas Saaty was involved concerning the apparent lack of setting priorities and simplifying mental processes in decision-making. Thus, he developed the Analytical Hierarchy method within the Seventies whereas he was functioning on issues concerning contingency coming up with for the U.S. DoD [2]. His objective was to model issues during a manner that features and measures "…all vital tangible and intangible, quantitatively measurable, and qualitative factors". The tactic begins with the identification of the target (i.e. select the most effective policy or effectively and with efficiency assign funds amongst competitive activities). Next, DMs structure the hierarchies. This is often merely the standards determination section (i.e. that factors area unit vital to the decision?). The standards area unit dampened into subcriteria so as to divide massive amounts of knowledge into manageable parts (analysis phase).

PA Walking, and Health is outlined as "any bodily movement created by skeletal muscles that end in energy expenditure" (Caspersen, Powell, & Christenson, 1985). Walking, a selected mode of PA, is outlined as "an act or instance of occurring foot particularly for exercise or pleasure" (Merriam-Webster's lexicon, 1993). As a moderate PA, walking may be a generally suggested activity to the majority for its health advantages. In 1995, the Centers for wellness management and interference (CDC) and therefore the yank school of medicine (ACSM) printed a PA recommendation primarily based upon the scientific accord that substantial health advantages will accrue from moderate-intensity PA (3-6 METs) of a minimum of thirty min per day. One MET (metabolic equivalent) is outlined as a unit of RMR (Resting Metabolic Rate) and therefore the energy price of a PA may be calculated as multiplies of the RMR, weight, and time spent (Ainsworth et al., 1993).

III. MULTICRITERIA DECISION MAKING TECHNIQUE

Multi criteria higher cognitive process may be a methodology to contend with the method of constructing call among variety of alternatives with conflicting criteria on them. AHP is one in every of the very fashionable MCDM methodology associate degreed fuzzy AHP is an extension of original AHP methodology recommended by saaty [2] to contend with qualitative and quantitative knowledge.

Analytic Hierarchy method (AHP):

One of the foremost trendy analytical techniques for advanced decision-making drawback is that the analytic hierarchy technique (AHP).Analytic Hierarchy technique (AHP) projected by Saaty(1980,2000), is degree approach for higher data that involves structuring multiple selection criteria into a hierarchy, assessing the relative importance of those criteria, comparison alternatives for every criterion, associate degreed determinative associate degree overall ranking of the alternatives.

An AHP hierarchy will have as several levels as needed to completely characterize categorical call state of affairs. Style of useful characteristics build, AHP a helpful methodology.

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So the AHP is most terribly regarded and wide used higher data methodology. It's going to efficiently subsume tangible (i.e. objective) likewise as non-tangible (i.e. subjective) attributes. The main procedure of AHP exploitation the unconventional root methodology (also referred to as the mean value method) is as follows:-
Step 1: Decide the output parameters and therefore the analysis of input parameters.
Step 2: decide the comparative importance of various input parameters with reference to the objective.
Construct a pair-wise comparison matrix employing a scale of relative importance. The judgments area unit entered exploitation the basic scale of the analytic hierarchy method. An attribute compared with itself is always assigned the value 1, so the main diagonal entries of the pair-wise comparison matrix are all 1 and the rating is based on Saaty's nine point scale shown in table 1.

Table 1:Saaty's Nine Point Scale

Priority	Rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Intermediate judgment between two adjacent judgment	2,4,6,8

N attributes, the pair–wise comparison of an attribute $i$with attribute j generates a square matrix $A_{N\times N}$ where b_{ij}denotes the comparative importance of attribute $i$with respect to attribute j. In the matrix $a_{ij} = 1$ when $i = j$and $a_{ji} = \frac{1}{a_{ij}}$.

Find the relative normalized weight (wj) of each attribute by -
(i) Calculating the geo metric mean of the i_{th}row, and
(ii) Normalizing the geo metric means of rows in the comparison matrix. This can be represented as:-

$$HN_j = \left[\prod_{i=1}^{N} a_{ij}\right]^{1/N} \text{eq. (1)}$$

Weights can be calculated as

$$b_j = \frac{HN_j}{\sum_{i=1}^{N} HN_j} \text{eq. (2)}$$

Calculate matrices B3 and B4 such that

$$B_3 = B_1 \times B_2$$

And $B_4 = B_2 \times B_3$
Where $B_2 = [b_1, b_2, \dots\dots\dots b_i]^T$.
Determine the maximum Eigen value $\lambda_{maximum}$ that is the average of matrix B4.

Calculate the consistency index $CI = \frac{\lambda_{maximum-N}}{N-1}$ eq. (3)

Obtain the random index (RI) for the number of attributes used in decision making.
Calculate the consistency ratio CR =CI/RI. Usually, a CR of 0.1 or less is considered as acceptable and is reflects an informed judgment attributable to the knowledge of the analyst regarding the problem understudy.
Step 3: The next step is to compare the alternatives pair-wise with respect to how much better they are in satisfying each of the attributes, i.e., to ascertain how well each alternative serves each attribute.
Step 4: This step is to obtain the overall or composite performance scores for the alternatives by multiplying the relative normalized weight (a_i) of each attribute (obtain in step two) with its corresponding normalized weight value for each alternative (obtain in step three) and summing over the attributes for each alternative.

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Fuzzy Analytic Hierarchy Process (FAHP) Technique:

The FAHP methodology is a complicated analytical methodology that is developed from the AHP. In spite of the recognition of AHP, this methodology is usually criticized for its inability to adequately handle the inherent uncertainty and impreciseness related to the mapping of the decision-maker's perception to precise numbers. In FAHP methodology, the fuzzy comparison ratios square measure accustomed be able to tolerate unclearness. There's a haul with AHP that in some things, chief needs to use the uncertainty whereas playing the comparisons of the alternatives. For taking uncertainties into contemplate ration fuzzy numbers square measure used rather than crisp numbers.

For the estimation of the importance of these criteria, we used the FAHP. Let A represent a fuzzified reciprocal nxn judgment matrix containing all pairwise comparisons a_{ij} between elements i and j for all.

$$A = \begin{bmatrix} (1,1,1)a_{12} \dots\dots\ a_{1n} \\ \vdots \\ a_{21}(1,1,1)a_{2n} \\ a_{n1}a_{n2}(1,1,1) \end{bmatrix} \text{ eq. (4)}$$

Where $a_{ji} = \frac{1}{a_{ij}}$ and all are triangular fuzzy numbers (TFN) $a_{ij} = (l_{ij}, m_{ij}, u_{ij})$with the l_{ij}lower and $u_{ij}$the upper limit and $m_{ij}$is the point where the membership function.

In the following, first the outlines of the analysis method on Fuzzy analytical hierarchy process are given and then the method is applied to a computer selection problem. Let $L = \{l_1, l_2, l_3 \dots\dots . l_n\}$ and $P = \{p_1, p_2, p_3 \dots\dots . p_n\}$ be object set, and be a goal set. According to the method of Chang [7], each object is taken and analysis for each goal g_i, is performed, respectively. Therefore, m extent analysis values for each object can be obtained, with the following signs:

$$M_{gi}^1, M_{gi}^2, \dots\dots\dots . M_{gi}^M \qquad i = 1,2 \dots\dots\dots . . n$$

Where all the (i=1,2,……..,m)are triangular fuzzy numbers whose parameters are represented as (a,b,c), describing least, most and largest possible values respectively.

Step 1: The value of fuzzy synthetic extent with respect to the i_{th} object is defined as:

$$S_i - \sum_{j=1}^m M_{g1}^j \left[\sum_{i=1}^n \sum_{j=1}^m M_{g1}^j\right]^{-1} \text{ eq. (5)}$$

to $\sum_{j=1}^m M_{g1}^j$ calculate we perform the "fuzzy addition operation" of m extent analysis values for a particular matrix.

Step 2: The degree of possibility of $M_1 \geq M_2$ is defined as:

$$V(M_1 \geq M_2) = SUP_{x,y}[\min(\mu_{M1}(x), \mu_{M2}(y)] \text{ eq. (6)}$$

Where $SUP_{x,y}$represents supremum and when a pair (x, y) exists such that $y \geq x$ and $\mu_{M1}(x) = \mu_{M2}(y)$ then we have $V(M_1 \geq M_2) = 1$. Given that M_1 and M_2 are convex fuzzy numbers, so $V(M_1 \geq M_2) = 1$ if $n_{11} \geq n_{21}$. And

$$V(M_1 \geq M_2) = \mu_{M2}(d) = \begin{cases} 1 & m_2 \geq m_1 \\ 0 & l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & else \end{cases} \text{ eq. (7)}$$

Where d is the ordinate of the highest intersection point D between μ_{M1} and μ_{M2}.

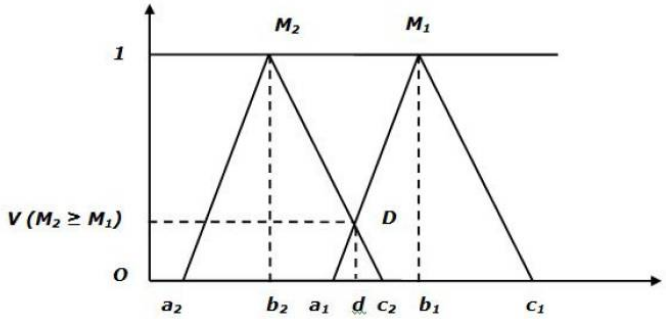

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Fig. 1 Intersection between M_1 and M_2[13]

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ISSN (Print): 2320-9798

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Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy numbers $M_i(i = 1,2, \dots \dots . k)$ can be defined by

$V(M \geq M_1, M_2, \dots M_k) = V[M \geq M_1 and M \geq M_2 and \dots M \geq M_k] = minV(M \geq M_i)\ , i = 1,2 \dots . k$ eq. (8)

Assume that equation 7 is

$$d'(A_i) = minV(S_i \geq S_k) \quad \text{eq. (9)}$$

For k=1,2…..m, $k \neq i$. Then the weight vector is obtained as follows

$$W^i = (d'(A_1), d'(A_2) \dots \dots d'(A_n))^T \text{eq. (10)}$$

Where i=1,2…..n.

Step 4: After normalization, the normalized weight vectors are given in the equation 11

$$W = (d(A_1), d(A_1), \dots . . d(A_n))^T \text{eq. (11)}$$

Where$W$ is not a fuzzy number.

In this methodology, we have determined the criteria as given in Table 1. The fuzzy conversion scale is shown in Table 2. Different scales can be found in the literature as in Abdel-Kader and Dugdale's study.

Table-2: Triangular Fuzzy Conversion Scale

Linguistic Scale	**Triangular Fuzzy Scale**	**Triangular Fuzzy reciprocal Scale**
Just Equal	(1,1,1)	(1,1,1)
Equally Important	(1/2,1,3/2)	(2/3,1,2)
Weakly Important	(1,3/2,2)	(1/2,2/3,1)
Strongly More Important	(3/2,2,5/2)	(2/5,1/2,2/3)
Very strong more important	(2,5/2,3)	(1/3,2/5,1/2)
Absolutely more important	(5/2,3,7/2)	(2/7,1/3,2/5)

IV. RESULTS & DISCUSSION

In this research paper we consider a problem of selecting best computer system for specific industry. Three input parameters are taken into consideration (a) Computer Latency (b) Available Bandwidth (c) No. of Available resources (d) Computer speed

In this project matrix input is A.

AB = [1 1 1] [1 2 3] [3 4 5] [1/4 1/3 1/2]
[1/3 1/2 1] [1 1 1] [6 7 8] [1/7 1/6 1/5]
[1/5 1/4 1/3] [1/8 1/7 1/6] [1 1 1] [1/3 1/2 1]
[2 3 4] [5 6 7] [1 2 3] [1 1 1]

Now fuzzy analytical hierarchy process is applied and weights of available bandwidth for four different system is calculated using matlab software and listed below

AB_weights = 0.2387 0.2958 0 0.4655

Weights of Computer speed for four computers are calculated and listed below

CS = [1 1 1] [7 8 9] [4 5 6] [1/7 1/6 1/5]
[1/9 1/8 1/7] [1 1 1] [6 7 8] [1/5 1/4 1/3]
[1/6 1/5 1/4] [1/8 1/7 1/6] [1 1 1] [6 7 8]
[5 6 7] [3 4 5] [1/8 1/7 1/6] [1 1 1]

CS_weights = 0.5642 0.0471 0.0411 0.3476

Third parameter computer latency is calculated and listed below

L = [1 1 1] [1 2 3] [1/3 1/2 1] [9 9 9]
[1/3 1/2 1] [1 1 1] [6 7 8] [1/5 1/4 1/3]
[1 2 3] [1/8 1/7 1/6] [1 1 1] [1/4 1/3 1/2]
[1/9 1/9 1/9] [3 4 5] [2 3 4] [1 1 1]

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L_weights = 0.5527 0.2406 0 0.2068
Forth parameters number of available resources are calculated and listed below
NOAR = [1 1 1] [9 9 9] [1/9 1/8 1/7] [1/7 1/6 1/5]
[1/9 1/9 1/9] [1 1 1] [3 4 5] [1/5 1/4 1/3]
[7 8 9] [1/5 1/4 1/3] [1 1 1] [6 7 8]
[5 6 7] [3 4 5] [1/8 1/7 1/6] [1 1 1]
NAOR_weights = 0 0 0.7631 0.2369
A new parameter known as scaling factor for computer system is selected and its weights are calculated.
C_weights = 0.2425 0.2982 0.0719 0.3874
Finally weights are concatenated and saved in variable WTs
WTs = 0.2387 0.5642 0 0.5527
0.2958 0.0471 0 0.2406
0 0.0411 0.7631 0
0.4655 0.3476 0.2369 0.2068

Now computer weights are saved to Cs.
Cs = 0.2425 0.2982 0.0719 0.3874
WEIGHTS = Cs*WTs
WEIGHTS = 0.4402 0.1790 0.0672 0.3137
So from weights it can be conclude that Personal computer number 1 is best.
Np = 1

V. CONCLUSIONS

In this research paper a personal computer selection based problem is solved successfully. A novel technique modified fuzzy AHP system is used to solve the problem. Four different parameters latency of computer, computer speed, available bandwidth and number of available resources are considered main criterion. In this application four different computers are taken into consideration. After applying modified fuzzy AHP system number 1 found best.

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