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A hybrid approach based on FAHP and FIS for performance evaluation of employee

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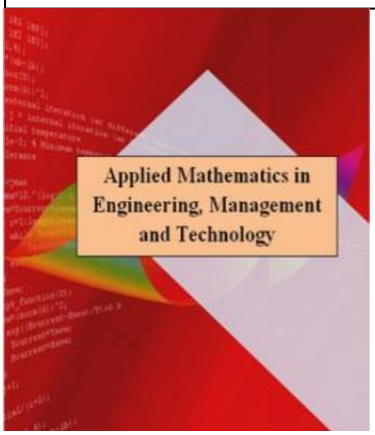

Abstract

Human resources are the most important assets for every organization and their ways of behavior, operation, activities and functions could lead to the improvement the organization. The main aim of this study is to evaluate the performance of employees in an airline organization in Iran. The model of the study is tested on a sample of 14 employee of the mentioned organization in Iran using Fuzzy Analytic Hierarchy Process (FAHP) and Fuzzy Inference System (FIS).

Keywords: Performance evaluation; FAHP; FIS; Fuzzy theory.

1. Introduction

In today's world, organizational governance cannot be achieved solely by ingenuity and personal judgment, but decisions must be made based on scientific investigations, accurate and timely information and according to certain principles and procedures. Performance evaluation provides an appropriate context for both motivation and achievement of organizational goals by which one may be able to measure or assess the relationship between an individual's working hours and the amount of his/her work done. Evaluation has also been considered a highly effective tool for personal and professional enhancement of employees by which job distribution and delegation of authority may be accomplished based on the staff's merit.
Kececi et al. (2015) offer a model for evaluating the performance of the naval officers, using Fuzzy Analytic Hierarchy Process (FAHP). They decide to evaluate the crew's performance by this model, due to their important role in maritime transport. Physical features of the workplace, job satisfaction, accessibility, competition, customs and working relationships are among the measures employed in their study.
Chamoli (2015) presents a model by integrating the methods of Fuzzy Analytic Hierarchy Process (FAHP) and TOPSIS in a fuzzy environment and then applies it to evaluate the performance of air conditioning ducts. In order to find the optimal mode of air conditioning channels, several factors including the rate of air leakage, friction, and their efficiency and effectiveness, were investigated in this approach.
Visalakshmi and Lakshmi (2015) offer a hybrid model based on DEMATEL and TOPSIS approaches in a fuzzy environment in order to evaluate economic performance of eco-friendly industries.
Escrig-Olmedo et al (2015) propose a fuzzy TOPSIS to evaluate the performance of clothing industry with the aim of addressing the shareholders' problems with the stability of the assets value and finally concluded by using specified measures.
Hu et al (2015) provide a hybrid model using the fuzzy analytic network process (FANP) and DEMATEL to assess the qualitative performance of computer accessories suppliers in order to help the process of determining, comparing and ranking suppliers' quality and finding the strengthening center of supply chain.
Chen et al (2015) present a hybrid model of DEMATEL and fuzzy analytic network process (FANP) and employ the model to evaluate the performance of new product developments.

2. The main concern and the proposed approach for evaluation

In this the section, a new approach based on AHP and Fuzzy Inference System is presented for personnel evaluation. Due to hierarchical structure underlying the criteria and sub-criteria, AHP method was employed and for transferring the experts' knowledge to the proposed approach, Fuzzy Inference System was used to create a decision support system. Fuzzy theory has also been used in order to import ambiguity and uncertainty in the problem. The proposed approach is implemented as follows:

Step One: In this step, the effective criteria for evaluating the performance of staff should be selected.

Step Two: In this step, we will determine the weight of each sub-criterion related to each adapted criteria using AHP.

We use pairwise comparison matrix to specify the weight of sub-criteria and then determine the importance of the pairwise comparisons, using the table 1.

Table 1: linguistic scales to determine the significance of paired comparisons

Linguistic scales for difficulty	Linguistic scales for importance	Triangular fuzzy scale	Triangular fuzzy reciprocal scale
Just equal	Just equal	(1, 1, 1)	(1, 1, 1)
Equally difficult(ED)	Equally importance(EI)	(1/2, 1, 3/2)	(2/3, 1, 2)
Weakly more difficult(WMD)	Weakly more importance(WMI)	(1, 3/2, 2)	(1/2, 2/3, 1)
Strongly more difficult(SMD)	Strongly more importance(SMI)	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very strongly more difficult(VSMD)	Very Strongly more importance(VSMI)	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Absolutely more difficult(AMD)	Absolutely more importance(AMI)	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)

After the questionnaires were filled and pairwise comparison matrix extracted, each local weight factors will be obtained through a non-linear model which is given below. This model has been developed by Dağdeviren and Yuksel (2010):

$$\max \lambda$$

$$s.t \quad (m_{ij} - l_{ij}) * \lambda w_j - w_i + l_{ij} w_j \leq 0$$

$$(u_{ij} - m_{ij}) * \lambda w_j + w_i - u_{ij} w_j \leq 0$$

$$\sum_{k=1}^{n} w_k = 1, w_k > 0, k = 1,2, \dots, n$$

$$i = 1,2, \dots, n-1 \ , j = 2,3, \dots, n \ , j > i$$

In this nonlinear model (l, m, u) represents three triangular fuzzy numbers in the paired comparisons while w_k indicates the weight of k^{th} criterion. The optimum value of λ may be a positive or negative number. Positive values of λ imply that there is a compatibility in the pair comparison matrix which shows that comparisons have been properly judged. Negative values of λ, however, denote for incompatibility of the given matrix which

. means that the experts should be asked to reconsider their judgments

. This way, once the model is dissolved, we can obtain the local weight related to each criterion

Step Three: In this step any of the employees' score would be calculated for each criterion. To this end experts .are asked to apply linguistic terms using the table 2

Table 2: linguistic terms used in performance evaluation

Linguistic values for positive sub-factors	Linguistic values for negative sub-factors	Triangular fuzzy numbers	The mean of fuzzy numbers
Very weak	Very strong	(0,0,0)	0
Weak	Strong	(0,0.167,0.333)	0.167
Weak-Mid	Mid-Strong	(0.167,0.333,0.5)	0.333
Mid	Mid	(0.333,0.5,0.667)	0.5
Mid-Strong	Weak-Mid	(0.5,0.667,0.833)	0.667
Strong	Weak	(0.667,0.833,1)	0.833
Very strong	Very weak	(1,1,1)	1

3. Case study

According to the steps mentioned in previous section, the related results will be discussed in this section. These steps are given below:
Step One: As mentioned above, in this step performance evaluation criteria will be identified and extracted for airline employees. These criteria and sub-criteria are listed in table 3.

Table 3: criteria and sub-criteria for performance evaluation

Abbreviation	Sub-criteria	Criteria
N1	Ability to reaching agreement with	Innovation, Creativity and Teamwork
N2	Ability to communicate within the organization	
N3	Ability to participate in teamwork	
N4	Obligation to organization benefits	
N5	Ability to creative thinking	
N6	Caring about company assets	
S1	Implementing client satisfaction plan	Customer satisfaction/ job quality
S2	Speed-up in client job	
S3	The way of answering to clients	
C1	Being patient	Personality and performance factors
C2	Dealing with criticism	
C3	Accepting the changes	
C4	Responsibility and dutifulness	
C5	Being on-time in work place	
C6	caring about appearance	
C7	Hygiene in work environment (implementing 5s)	
C8	Regarding safety, rules and regulation relating to organization	

Step two: in this step the sub-criteria presented in the previous step are weighted. To this end, we distribute the pairwise comparison questionnaires among the experts to complete them using the linguistic terms listed in table 1.
Then, we will obtain the weights of the each sub-criteria using the Dağdeviren model (2010) discussed in the previous section and fuzzy pairwise comparison matrix.
The weights of sub-criteria are listed in the following table:

Table 4: Weight of sub-criteria

Weight	Sub-criteria
0.342	Ability to reaching agreement with
0.031	Ability to communicate within the organization
0.162	Ability to participate in teamwork
0.162	Obligation to organization benefits
0.252	Ability to creative thinking
0.051	Caring about company assets
0.465	Implementing client satisfaction plan
0.211	Speed-up in client job
0.324	The way of answering to clients
0.182	Being patient
0.126	Dealing with criticism
0.128	Accepting the changes
0.188	Responsibility and dutifulness
0.014	Being on-time in work place
0.184	caring about appearance
0.154	Hygiene in work environment (implementing 5s)
0.024	Regarding safety, rules and regulation relating to organization

Step three: in this step each of the employees will be evaluated for each of the criteria and then the scores obtained from evaluation will be calculated for everyone.
Now, each employee's score should be calculated for each criterion. These scores which are listed in table 5, equal to the sum of sub-criteria weights multiplied by their numerical values.

Table 5: the score obtained from performance evaluation for each criterion

Employee	Personality and performance factors	Customer satisfaction/ job quality	Innovation, Creativity and Teamwork
Employee 1	0.4102	0.4325	0.3527
Employee 2	0.6254	0.5714	0.483
Employee 3	0.5377	0.833	0.5962
Employee 4	0.6838	0.69	0.672
Employee 5	0.4297	0.4628	0.4352
Employee 6	0.4694	0.6155	0.7126
Employee 7	0.7459	0.7205	0.6949
Employee 8	0.6458	0.8003	0.8659
Employee 9	0.5447	0.575	0.4988
Employee 10	0.6103	0.647	0.5918
Employee 11	0.6511	0.722	0.7029
Employee 12	0.5673	0.593	0.6101
Employee 13	0.6323	0.593	0.5036
Employee 14	0.616	0.668	0.5036

Step Four: In this step, the final score of each employee is calculated with the use of a decision support system based on fuzzy inference system. The development process of the fuzzy inference system is given below:
In this step, we aim to create a decision support system based on fuzzy inference system. Therefore, in the first place, it is necessary to determine the input and output of the system and extract the fuzzy inference rules using the experts' opinions.
In this report, Score performance evaluation (Q) is the output while the inputs of the fuzzy inference system are:
1. Originality, creativity and teamwork (Q1)
2. Client satisfaction / quality of work (Q2)
3. Personality and functional factors (Q3)

The fuzzy inference rules are then extracted from the knowledge of experts and implemented in MATLAB. Using the data related to every employee (table 5) derived with the help of a support system, we calculate the score gained from performance evaluation for each employee. These results are given in Table 6.

Table 6: The final score of each employee

Employee	Personality and performance factors	Customer satisfaction/ job quality	Innovation, Creativity and Teamwork	Final score
Employee 1	0.4102	0.4325	0.3527	**0.414745**
Employee 2	0.6254	0.5714	0.483	**0.5482**
Employee 3	0.5377	0.833	0.5962	**0.680445**
Employee 4	0.6838	0.69	0.672	**0.65333**
Employee 5	0.4297	0.4628	0.4352	**0.474315**
Employee 6	0.4694	0.6155	0.7126	**0.59864**
Employee 7	0.7459	0.7205	0.6949	**0.71299**
Employee 8	0.6458	0.8003	0.8659	**0.782625**
Employee 9	0.5447	0.575	0.4988	**0.565345**
Employee 10	0.6103	0.647	0.5918	**0.610355**
Employee 11	0.6511	0.722	0.7029	**0.68241**
Employee 12	0.5673	0.593	0.6101	**0.59828**
Employee 13	0.6323	0.593	0.5036	**0.584405**
Employee 14	0.616	0.668	0.5036	**0.6287**

These scores are numbers between 0 and 1. Decision makers, with the help of these scores would be able to classify their employees according to which they develop their goals and strategies based on human resources strategies, including motivational and promotional strategies, bonuses, fines and etc.

4. Conclusion

This paper develops a performance evaluation model for airline. This model is then applied to a case study for the performance evaluation of 14 employee's airlines in Iran.
We establish the procedures for identifying the most important criteria for assessment of employee of airline in Iran. The evaluation procedures consists of the following steps: (1) identify the evaluation criteria for airline; (2) assess the average importance of each criterion by Analytic Hierarchical Process over all the respondents. (3) Represent the performance assessment of employee for each criterion by fuzzy numbers. Finally, the final score of each employee are calculated by fuzzy inference system.

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