REVIEW AND EVALUATE THE PERFORMANCE OF THE FACTORY RADIATOR VALVES WITH FUZZY INFERENCE SYSTEM

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Abstract. Using of formal evaluation systems comes back to 19th century. Change and development of evaluation indexes in the form of providing universal principals for evaluating the organizations to total quality management represents the course of evaluation systems development. In one hand, organizations spend lots of cost and time to develop, formulate and implement strategies to be able to achieve long-term objectives and perspectives. Therefore, knowing the performance and the situation of the organization in today's complex and dynamic environment is of great importance for managers. Hence, we want to evaluate the most important factors of radiator valves manufacturers in this study including financial and economic index, customers' index and environmental factors index.

Keywords: formal evaluation systems, situation of the organization, managers, financial and economic index

1 Introduction

Doing useful, effective and objective evaluations is the driving engine and starter of each improvement project. Performance evaluation is the most important tool for ensuring of precise and timely implementation of strategy in an organization. Conditions, scope, criteria, indexes and features of a performance evaluation system should be set based on the organization's conditions, strategy and features. If a performance evaluation system and its indexes are not proper for a given organization and can't meet the demands and needs of its stakeholders, managers and staff, it not only won't help to the problem solution but also won't be supported and will fail. If performance evaluation is done with processing, continuous and correct view, it will enhance the accountability of executive organizations, public trust to organizations and efficiency and effectiveness of government in governmental section. It also will improve resource management, customer satisfaction, national development, and will help to create new power, stability, and improve of world class of companies and institutions.

Shortage in traditional systems of performance evaluation led to a revolution in performance management so that researchers and users moved toward the creation of systems that consider the current objectives and environment. In this way, multiple processes were created to be used in various organizations. Many frameworks also suggested for supporting these processes, which their objectives were to help organizations in correct and proper evaluation of their performance. By developing and increasing the complexity, the definition of "performance" extended and gradually included all the dimensions of the organization and its processes.

Performance evaluation is one of the main duties of any organization and aspects of performance management. Organizations have complex nature, which is emanating from creative, unique and unstructured activities of this area and needs dynamic management for improving its situation. This management structure should be able to transfer continuously macro level decisions to operational layers and evaluate the results according to defined objectives. For doing so, we seek to evaluate the performance of radiator valves manufacturers and we believe that performance evaluation of this factory will increase the productivity, effectiveness, efficiency and motivation of staff. Since the part of needed information in evaluations are imprecise and descriptive and it is needed to reflect the spectral impacts of many indices quantitatively in evaluation, Fuzzy logic has been used for solving some of the problems (Qolamreza Tabarsa, 2008).

2 Performance Evaluation

Evaluation is one of important and effective management tools for achieving needed information for decision-making about the performance of an organization's staff. By correct use of this tool, not only objectives and missions of organization will reach optimal efficiency, but also the interests of staff and society will be met. In other words, it can be said that evaluation is the secret of management's success.

Perhaps, nothing is more difficult for managers than evaluating the performance of subordinates. However, performance evaluation is one of the features of today's professional world and can help to create efficient work force (Ashish & Zachary, 2004). In fact, the main objective of performance evaluation is to stimulate the employees for doing the tasks and the organization's mission. Improvements, assigned tasks, selection for training and increasing the salary based on evaluation can stimulate the motivation (Swansburg, 2002). Recognition of expected consequences of performance evaluation in health care systems can help managers to focus on evaluation process for achieving those consequences (Shah & Layman, 2005).

Expected consequences of performance evaluation contain:

- Performance improvement
- Knowing the educational needs and optimizing human resources
- Providing a basis for rewards and motivation.

It is expected that a valid and reliable performance evaluation system provide information about strengths and weaknesses and the needs of evaluated person for managers and the person itself. If this information is used for reinforcement of evaluated person's strengths and planning for progress in needed fields, it can improve performance, motivation and productivity.

Azadeh et al., (2015) addressed in a research the performance evaluation of electrical distribution units with random data envelopment analysis-based approach. In this research, network length, transfer capacity and staff number have been selected as input and a number of customers, total sold electricity are random output. Also in this research, the best electrical distribution unit is selected based on efficiency scores in random environment. The results of this research showed that network length is the most important and effective input factor.

Nana and Zhao (2016) in a research evaluated the performance of compatible thermal power stations with industrial environment using the combination of GRA-VIKOR in Fuzzy setting. They presented an effective algorithm in this model, which contains the decider's attitude in performance rating of criteria and integrating of objective information and subjective ideas in defining the weight criteria based on Fuzzy analytic hierarchy process and Shannon entropy. The research results showed that dependent criteria to trash recycling and pollutant emission are the most effective factors in this industry.

Khakpour and Zafarqandi (2015) in a research presented the safety performance evaluation based on organizational factors effective on industry safety using Fuzzy inference system. The research findings indicated that formulated model has the ability to evaluate the safety performance in industries and based on it, we can calculate the score, which shows the safety performance of industries. Using of the model in a company as the model's test place shows that safety performance score was calculated as 0.607. This amount is considered desirable with membership of 0.528 and average with membership of 0.472.

3 Fuzzy Inference System

For the first time in 1965, Lotf-Ali Asgarzadeh raised the fuzzy set theory. Since then this theory has been applied as an important research tool in many fields of engineering problems including decision-making, monitoring and forecasting issues. The fuzzy theory means all theories that use the basic concepts of fuzzy set with membership functions so that fuzzy decision-making, fuzzy systems, fuzzy logic and fuzzy mathematics are among them.

Fuzzy math as a starting point in the fuzzy set theory provides a primary language for fuzzy systems. Fuzzy math alone is a vast field in which mathematical principles by replacing the fuzzy sets instead of classical mathematics collections have been developed. In this way all the branches of classic mathematics are converted in the form of fuzzy.

The main thing in the expression of fuzzy mathematics is the concept of fuzzy set. In practice classical sets are defined by specific membership condition. Against the fuzzy set there is a set of elements belonging to a space that its boundaries have not been defined precisely. In this case the membership condition of set isn't ascertained and precise.

Therefore, in the case of fuzzy sets, membership of element X in the A set isn't as binary type (element X belongs to set or does not belong to the set A), and this membership function is called (x) Aμ. The membership function presents the amount of members' belongs to a set whose value is between the real deal of zero and one. Membership value close to one, indicates a high element of their belonging to set A and vice versa closer to zero, the less belong in the field. Membership value close to one indicates a high belongs of element X to the set A and vice versa approaching it to zero indicates less belongs to set. Using the concept of fuzzy set linguistic terms can be expressed mathematically. Oberguggenberg has offered a way to define a fuzzy set. In this way, the value of each parameter with the membership value of α has been defined by the interval of $0 \leq \alpha \leq 1$.

The definition of α, is expressed by designer engineer or one who makes decision but remain constant during the whole process of modeling.

In the framework of fuzzy set method if the parameter value is between X_a and X_B and close to X_b, as well as is defined as membership in Equation 1, the fuzzy set will be a triangular fuzzy number (Figure 1).

$$\mu_A(x) = \mu_A(x; a, b, c) = \begin{cases} (x-a)/(b-a) : a \leq x \leq b \\ (c-x)/(c-b) : b \leq x \leq c \\ 0 \qquad x > c \, or \, x < a \end{cases} \qquad (1)$$

The cutting surface of α, and the corresponding interval values of variable X that the membership degree of α is corresponding to it, has been shown in the Figure 1. The corresponding interval of α=0 is the abutment of fuzzy numbers and the cutting surface for α= 1 for triangular membership function, the range of values are reduce to an absolute number (lowest).

Figure 1 Triangular fuzzy number

4 Research goal

The aim of this study is to evaluate the performance of radiator valves plant in terms of three dimensions: financial, customer and an environment for optimal allocation of resources, controlling, directing, organizing and more.

5 Types and methods of research

In terms of research purpose, regarding the present study evaluate the performance of radiator valves plant, is classified in the applied research area. Also, the present study in terms of collection of the required data is classified as "exploratory research".

To collect research data in addition to the study of literature, the researcher made questionnaires were used and to prepare questionnaire, a meeting with the participation of seven experts and elites of factories was held and using Delphi technique, 12 components affecting the performance evaluation were recognized and classified in three dimensions, and ultimately, the recognized dimensions using the software MATLAB 2013, based on the Mamdani's mini-max fuzzy inference fuzzy and non-fuzzy of center of gravity method were analyzed.

The study population consisted of all employees of radiator valves factory (plant) with 180 people.

According to the population and using Cochran formula, the calculated sample size was calculated 122 people that these people were randomly selected.

$$n = \frac{\dfrac{z^2 pq}{d^2}}{1 + \dfrac{1}{N}\left(\dfrac{z^2 pq}{d^2} - 1\right)} \qquad (2)$$

6 Reliability and validity

To analyze the obtained data through the questionnaire, two methods of reliability and validity have been used.

▪   The validity: In this study, to ensure the validity of the questionnaire the face validity has been used. In this stage to begin the process of determining the face validity, the questionnaire was submitted to two specialists to examine the questionnaire in terms of desirability of statements about its clearness (using simple and understandable terms), the use of a common language (avoid using the term technical) and some changes were made in the items of the questionnaire to be easier and increase clients understanding. The face validity from the perspective of target group will respond to these questions: Is the designed tool relevant ostensibly to study purpose? Are people who are supposed to respond tools agreed with phrases and wording of tool? Is the perception of lay people (target group) is the same perception that researcher has? Are the components and the totality of tool acceptable for respondents? According to the description provided, the questionnaire in this study was shown to several professors as well as experts and eventually after the correction of errors was approved.

▪   Reliability: Several methods exist to measure the reliability and Cronbach's alpha is the most common technique and in this study to assess the internal consistency of items of questionnaire the Cronbach's alpha technique has been used. In the present study SPSS software was used to calculate it. The more Cronbach's alpha value, the more reliability of questionnaire, also if the Cronbach's alpha value is more than 0.7, the reliability would be good and in the case of 0.5 to 0.7 the validity is the average and less than 0.5 indicates the questionnaire lacks necessary reliability. According to

information obtained from the questionnaire, Cronbach's alpha for the questionnaire was (0.794), which is good and reasonable.

Table 1 The reliability of the whole questionnaire

Cronbach's alpha values	The number of questions
0.794	12

7 Results

The evaluation of the economic and financial performance of radiator valves manufacturing plant the financial and economic dimension has the following four criteria shown in Table 2. Each of the following criteria is considered an input for the fuzzy system.

Table 2 The sub-criteria of financial and economic dimension

Sub-criterion	Criterion
How much the savings in the financial resources and equipment's of the company	Financial and economic dimension
To what extent is it reasonable rate of sales growth reasonable	
To what extent is it reasonable rate of return on investment	
To what extent is reasonable the Shareholders of the company dedicated income	

The fuzzy system in this section has four inputs and one output. The first input is related to save financial resources, the second input for sales growth rate, the third input for the rate of return on investment and forth input related to specific income of stockholders that are shown in Figure 2.
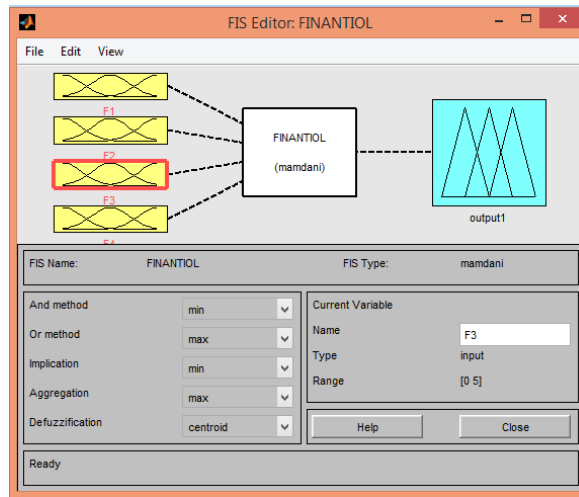
Figure 2 The Toolbox of Logic fuzzy for Financial and Economic dimension

The figure 3-9 (2) represents the amount of each of the fuzzy inputs and outputs of the financial and economic criteria.
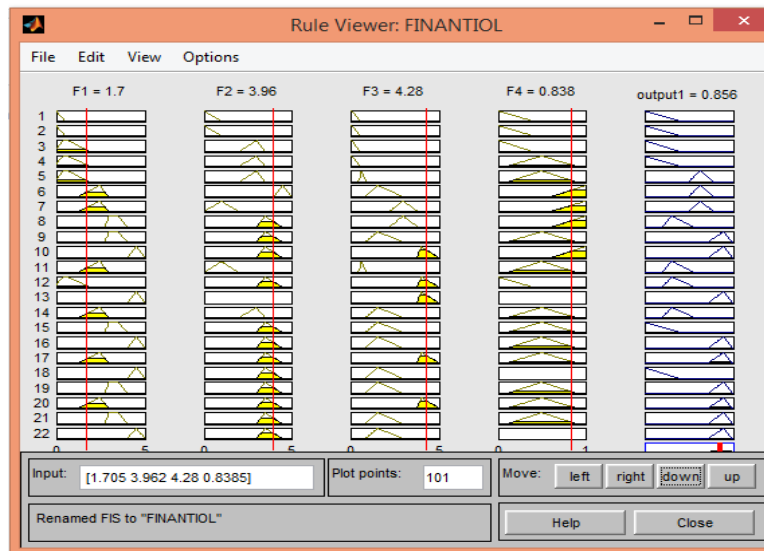
Figure 3 The relationship between the inputs and outputs of financial and economic dimension (criterion)

Figure 4 shows the fuzzy relationship made between inputs and outputs of financial and economic dimension (criterion).
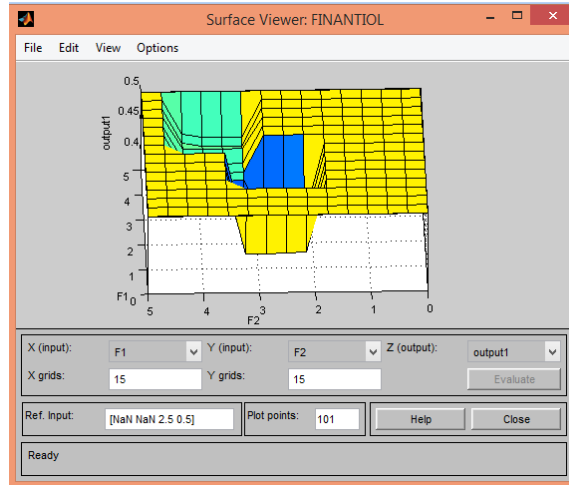
Figure 4 The results of fuzzy making of financial and economic dimension (criterion)

Performance evaluation of the financial and economic dimension based on the four sub-criteria was equal to 0.85 that with the membership degree of 0.34 belongs to higher class and 0.66 belongs to good class.

Performance evaluation of the radiator valves manufacturing factory (plant) in the customer dimension (criterion)

The developmental dimension (criterion) has five sub-criteria are shown in Table 3. Each of these sub-criteria is an input for the fuzzy system.

Table 3 The sub-criteria of costumer dimension

Sub-criterion	Criterion
To what extent is important for this company maintaining (retention) the costumer	
To what extent is timely the delivery of goods and service	
To what extent is desirable the quality of delivered services	Costumer dimension
To what extent is reasonable the variety of products delivered by this company	
To what extent is the citizens' satisfaction desirable about products delivered	

The output of the fuzzy rules implementing related to inputs and outputs related to the customer dimension are shown in Figure 5.
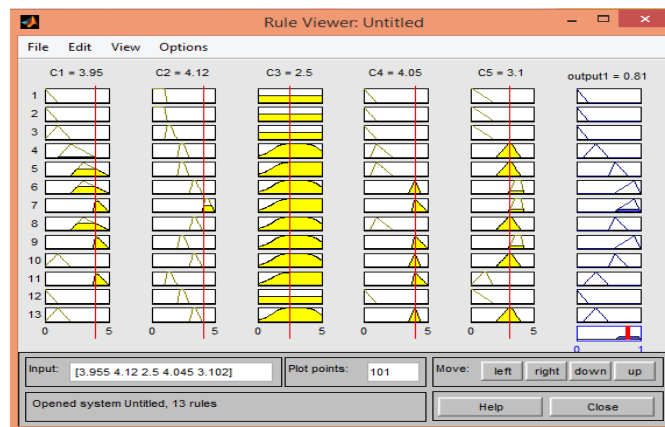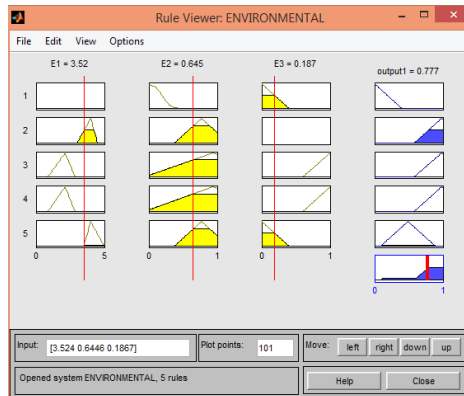

Figure 5 The relationship between the fuzzy inputs and outputs of customer dimension

Fuzzy relationship made between output and inputs related to customers dimension is shown in Figure 6.
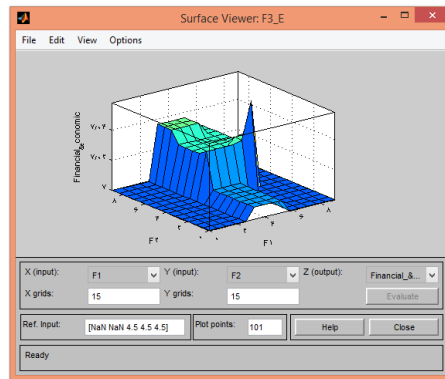
Figure 6 Results of the fuzzy making of the customer dimension

Performance evaluation of costumer dimension based on the five sub-criteria was equal to 0.81 that with the membership degree of 0.29 belongs to good class and 0.71 belongs to higher class.

Performance evaluation of the radiator valves manufacturing factory (plant) in the environmental factors dimension (criterion)

The environmental factors dimension (criterion) has three sub-criteria are shown in Table 4. Each of these sub-criteria is an input for the fuzzy system.

Table 4 environmental factors dimension

Sub-criterion	Criterion
To what extent is reasonable the company's ability to compete with its competitors	Environmental factors dimension
To what extent is this company compatible with technological changes	
To what extent this company has attempted to implement the new technology	

The output of the fuzzy rules implementing related to inputs and outputs related to the environmental factors dimension are shown in Figure 7.

Figure 7 The relationship between input and output fuzzy of environmental factors dimension
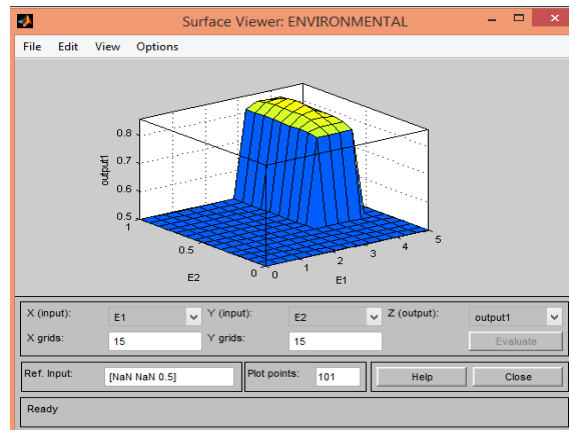

Figure 8 Results of the fuzzy making of the environmental factors dimension

Performance evaluation of environmental factors dimension based on the three sub-criteria was equal to 0.77 that with the membership degree of 0.45 belongs to good class and 0.55 belongs to average class.

8 Conclusion

The pundits and researchers believe that performance evaluation is the main theme in all the institutional analyzes and organizational perspective that includes evaluation and performance measurement is difficult. The evaluation and performance measurement lead to smarter system and motivate people to desirable behavior and the main part of organizational policy formulation and implementation, so if an organization wants to have a good performance should assess its operability. In this study, the performance of radiator valves plant was evaluated and the results show, the evaluation of financial and economic performance of this plant is placed in the higher and good class and based on costumer dimension (indicator) is good and excellent and based on environmental factors dimension (indicator) placed in the good and average category.

References

1. Ashish, C., Zachary, F., *Utilization of performance apprasisal system in health care organizations and improvement strategies for supervisor*. Health Care Manga, 2004. Vol. 22(2), p. 117-127.
2. Azadeha, S., Motevali Haghighia, M., Zarrina, S.: *Performance evaluation of Iranian electricity distribution units by using stochastic data envelopment analysis. International Journal of Electrical Power & Energy Systems*. 2015, vol. 73, p. 919–931.
3. Khakpoor, A., Zafargandi S., S*afety performance evaluation model based on organizational factors affecting the industry safety using Fuzzy Inference System*. Journal to promote safety and prevent injuries. 2016. Vol. 3, p. 25 - 34.
4. Nana Lia, B., Huiru Z.: *Performance evaluation of eco-industrial thermal power plants by using fuzzy GRA-VIKOR and combination weighting techniques.* Journal of Cleaner Production 2016. Vol. 135, p. 169–183.
5. Shah MA., Layman E.: *Using a multipronged approach to implement organizational performance improvements*". Health Care Manage (Frederrick) 2005. Vol. 24 (1), p. 48-54.
6. Swansburg R.C., Swansburg RJ.: *Introduction to management and leadership for nurse managers*". Sudbury, Massachusetts: Jones and Bartlett publishers. 2002. p. 593.
7. Tabarsa, G. R.: *The investigation and clarify the role of strategic requirements in choosing an evaluation pattern of governmental organizations, First Conference on Performance Evaluation machines with executive,* management and programming organization, 2009.