Prioritize Improvement Opportunities Identified In Self-Assessment Using Multi-Criteria Fuzzy Group Decision

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ABSTRACT: Efforts to improve the quality are one of the prerequisites for the success of individual companies and for the competitiveness of all whole companies. In the field of improvement and excellence, business excellence models answer to the question that what the better organization is; what goals and concepts they follow, and according to what standards they behave. The EFQM excellence model can be transition from multiplicity to unity of different existing models. The most important approaches of these models are self-assessment and identifying improvement areas in an organization. On the other side, organizations which are at lower level of total quality management, will encounter so many areas to improve when using this model and implementing of self-improvement. Choosing the most important key problems are always the main challenges and because of resource constraints and strategic goals, organizations have to prioritize identified improvement opportunities. This paper introduces a model for prioritizing and choosing the most significant improvement opportunities using the organization Business Excellence team members and because the analysis and decision making atmosphere for excellence team members is not generally complete with accurate information, it seems using of fuzzy decision can be very helpful.

Index Terms: Excellence Model EFQM, self-improvement opportunities, group decision making, Fuzzy

1- INTRODUCTION

National Quality Awards emphasizes the fact that survival in global competition requires improved performance on a global scale. These models provide the evaluation criteria, guidelines for organizations to measure the progress and performance the quality and organizational excellence. The EFQM Excellence Model is a systematic framework for evaluating both process and results of this process in organizations. The results obtained from the evaluation of this model include organizational strengths and areas of improvement to obtain a list of priorities for program improvements. However, because the EFQM Excellence Model is a comprehensive and total model. Based on what learned from total quality management, attention to the values and eight basic concepts contact all organizational angles. Therefore, organizations with low maturity level of TQM would face a large number of ground improvements in the process of self-assessment or evaluation.

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Addressing all these questions simultaneously is neither logical nor possible because of the limited available resources. Therefore, the organizations have to Prioritize to find the most important improvement opportunities. Unfortunately, there is no scientific basis for correct and logical approach in this regard, which leads to wrong decision-making in the selection and implementation of improvement projects [1]. Prioritize improvement opportunities have to consider all standards and principles and the basic concepts of TQM and Excellence Model. Therefore, the multi-criteria decision making would - be covering this topic. Factors such as inaccurate and incomplete information, concerns and individual subjectivity, which involved in real life, show that decision-making is inevitable in a fuzzy environment. Due to the reasons mentioned in this paper, a brief introduction of the EFQM, Delphi fuzzy multiple criteria decision-making methods for prioritizing and selection of improvement opportunities offered.

2- E SEARCH LITERATURE

2.1 CONCEPTS OF EXCELLENCE MODEL

The EFQM Excellence Model is a non- prescriptive model that consists of nine criteria. The first five criteria`s are enablers and the four other criteria are called the results. Enablers indicate success factors in organization، and results indicate the success factors achieved from proper implementation. Fundamental Concepts of Excellence in Table 1 are the concepts, which the model built based on them and indeed are the base and foundation of the model. This concept derived from the core beliefs of the excellent organizations in twentieth century. In practice, these organizations make some companies that persistent. Meanwhile, research shows that these concepts with thinkers` and experts in management science` ideas about achievement of organizational goals are consistent and compatible. Therefore, the basic requirement for excellent organizations is the belief and the practice of these concepts throughout the organization, especially among the senior executives. Therefore, in priority and choosing opportunities for improvement considering these concepts as selection criteria would be reasonable. In this paper, the basic concepts of the EFQM model as the main decision - making criteria proposed. Moreover, considering the relationship among these concepts with model`s criteria, that criteria from

the model which directly associated with each of the concepts is considered as a sub Decision-making and it is shown in Table 1. These eight basic values form the core concepts of planning and implementing [1], [2].

TABLE(1) *FUNDAMENTAL CONCEPTS OF EXCELLENCE MODEL CRITERIA AND SUB CRITERIA DECISION*

Sub Decision		**Fundamental concepts of the main criteria (level 1) Decision**	
Policy and strategy 2a,2b,2c,2d Customer Results 6a,6b People Results 7a,7b society Results 8a,8b Key Performance Results 9a,9b	C_{11} C_{12} C_{13} C_{14} C_{15}	**Results -oriented**	C_1
Policy and strategy 2a,2c Processes 5c,5d,5e Customer Results 6a,6b	C_{21} C_{22} C_{23}	**Customer-focus**	C_2
Leadership 1a,1b,1,c,1d,1e Policy and strategy 2c People Results 7a	C_{31} C_{32} C_{33}	**Leadership and constancy purposes**.	C_3
Policy and strategy 2a,2c People 3a,3b,3c,3d,3e People Results 7a,7b	C_{41} C_{42} C_{43}	**People development andinvloment**	C_4
Leadership 1d Policy and strategy 2a,2b,2d Partnerships and Resources 4e Processes 5c,5d,5e Results 6a,6b,7a,7b,8a,8b,9a,9b	C_{51} C_{52} C_{53} C_{54} C_{55}	**Management by processes and facts**	C_5
Leadership 1a,1,c,1d,1e People 3b,3c,3d Processes 5c,5d	C_{61} C_{62} C_{63}	**continuous learning improvement and innovation**	C_6
Leadership 1c Partnerships and Resources 4a Key Performance Results 9a,9b	C_{71} C_{72} C_{73}	**Partnership and development**	C_7
Leadership 1a,1,c,1d Policy and strategy 2a,2b,2c People 3a3e Partnerships and Resources 4a,4b,4c,4d Processes 5a society Results 8a,8b	C_{81} C_{82} C_{83} C_{84} C_{85} C_{86}	**Corporate social responsibility**	C_8

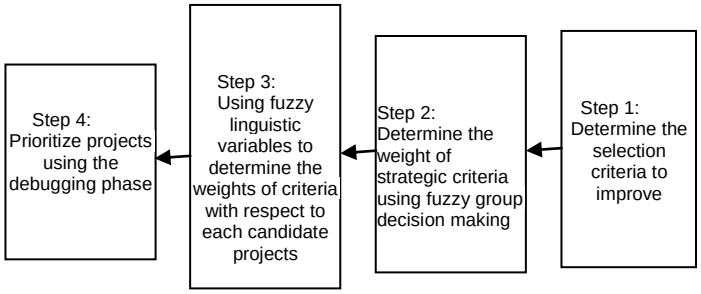
2.2 DELPHI FUZZY MULTIPLE CRITERIA DECISION MAKING GROUP

Multi-criteria decision-making models used to choose the best choice among several candidates and generally with regard to quality standards. In these models, the imprecise and fuzzy concept applied to estimate the parameters and structure of the model. In general, there are m options to consider n criteria, which are in C collection to benchmark, investigate, and choose the best option. In classical decision-making, decider is aware of his steps the state. Therefore, the chose option has the most desirability. While decision-making in a fuzzy environment, decider is not aware of what will happen in the future and only know the probability function in future status. Fuzzy objective function is defined by its membership function in elderly and the limitation of the Fuzzy is characterized by its membership function. Therefore, in the fuzzy decision making, sharing (“and" rational) among the constraints and the objective function is proposed to select the optimal objective function. Consequently, 'a decision' in the fuzzy environment achieved from the subscription between the objective function and fuzzy constraints. Analysis of complex problems requires effort - and several expert opinions. Their comments describes using fuzzy logic and fuzzy set. And since it seems unlikely to be identical views Normally they should be combined or implement together to make a decision. This method of decision-making using opinion of several experts called consensus and achieved through fuzzy average. Fuzzy Delphi method by Coffman and Gupta (1988) was introduced to regulate the experts. In this approach, highly qualified experts in a subject matter asked to provide their option separately and independently. The intellectual property information by calculating the mean of fuzzy statistical analysis and results announced to other experts. And experts evaluate results and provide new estimates will be re- analyzed. Ultimately, this process happens several times to ensure convergence to a reasonable point of view [3]. Trapezoidal standard fuzzy numbers (STFN) by Zheng and colleagues (2007) in order to obtain information and transformation to fuzzy and subjective perceptions of experts in fuzzy multi-criteria group decision-making problems used. The decision-making in a variety of different numbers of values to suit your personal knowledge and perceptions of their choice STFN applied to convert personal interpretations for the combined group to a general format. Fuzzy aggregation (consensus) used for making group decision. Finally, in DE fuzzy, fuzzy scale used to change numerical scale to calculate the desirable weights.

3. THE PROPOSED METHOD

3.1 FUZZY SETS

The proposed method consists of four stages, as shown in Figure 1. The first step is determining the criteria to improve project selection. Then, measure the weight of the Strategic criteria using STFN approach as a method of group decision-making (FMCDM) Fuzzy Delphi determined. After that, the weight of sub criteria with concern to every option (projects) using fuzzy linguistic variables evaluated. Fuzzy Delphi method by Chang and Lin (2002) adopted for this assessment. Finally, the project`s decision selection done through Fuzzy complex analysis [4].



(1) The selection of proposed improves method

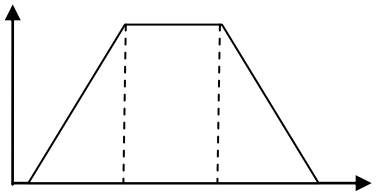
If X is the set of elements, which shows by x, then fuzzy set $\tilde{A}$ در x, the set of pairs as follows.

Where $\mu_{\tilde{a}}(x)$is a function of membership or membership degree of x in$\tilde{A}$. Membership function shows the set X to M space. If the space membership function M only includes the numbers zero and one, the desired set is a classic set. Moreover, if the real numbers are between zero and one, the desired set, is a fuzzy set.

$$\tilde{A} = \{(x, \mu_{\tilde{a}}(x)) | x \epsilon X\}$$

Trapezoid fuzzy membership function defined by the following four parameter $\tilde{a} = (a_1, a_2, a_3, a_4)$ و $a_1 \le a_2 \le a_3 \le a_4$ and that the schematic view is in Fig (2).

$$\mu_{\tilde{a}}(x) = \begin{cases} 0, & x \le a_1 \\ \frac{x-a_1}{a_2-a_1}, & a_1 \le x \le a_2 \\ 1, & a_2 \le x \le a_3 \\ \frac{x-a_4}{a_3-a_4}, & a_3 \le x \le a_4 \\ 0 & x \ge a_4 \end{cases} \quad (1)$$



Trapezoidal fuzzy membership function Figure (2) The main operations on trapezoid fuzzy numbers showed in equations (2) and (3) sets:

$$\tilde{a} \times \tilde{b} = (a_1 \times b_1, a_2 \times b_2, a_3 \times b_3, a_4 \times b_4) \quad (2)$$
$$\tilde{a} + \tilde{b} = (a_1 + b_1, a_2 + b_2, a_3 + b_3, a_4 + b_4) \quad (3)$$

3.2 PROJECT SELECTION CRITERIA:

Decision-making criteria for Level 1 are the fundamental concepts of the EFQM Excellence Model, which through multiple criteria decision-making Delphi fuzzy (Delphi FMCD) evaluated. The second level contains the standards of excellence, which are in direct communication with each of the basic concepts the model that evaluated by FMCDM. Based on these criteria and sub- criteria decision-making may result in three phases:

1) Group decision-making criteria ,
2) Evaluation of sub - criteria ,
3) To select prioritize projects [4].

3.3 WEIGHTS THE MAIN CRITERIA

$\widetilde{W}_i$: Weight of the i -th criterion . P :The present numbers of excellence team for decision-making. CF: coefficient to determine each team member in a decision-making group. E_k:: K -th expert member in the team , in this study, 5 organization mangers have with different CF They are introduced in Table 3 as the selected decision-making team members. C_k:: K -the member's opinion, as the$C_k \epsilon [0,1]$ and $C_1 + C_2 + \cdots + C_p = 1$

P_j:j-th opportunity to improve the ranking and evaluation, where(j = 1,2, ..., m)), in this study, after removing the quick recovery of the key improvement opportunities , the 8 key projects have been selected for Ranking . If U belongs to the interval $U \epsilon [0,u]$where u is an integer. STFN Defined as a $A^* = (a^l, a^r, a^s, a^u)$

Therefore $0 \le a^l \le a^r \le a^s \le a^u \le u$ and its membership function showed as below:

$$u_A^*(x) = \begin{cases} (x-a^l)/(a^r-a^l), & a^l \le x \le a^r \\ 1, & a^r \le x \le a^{rr} \\ (a^u-x)/(a^u-a^s), & a^s \le x \le a^u \\ 0 & \text{سایر موارد} \end{cases} \quad (4)$$

Once$a^l = a^r = a^s = a^u$, a STFN a small amount. And when$a^l = a^r$ and $a^s = a^u$, a STFN earned small amounts and if$a^r = a^s$ STFN is a fuzzy number trapezoid and finally direct the expert can select trapezoid fuzzy number. The choice between these evaluation methods and performance will be different depending on the level of assurance experts. For example, if sufficient information is provided And criteria can be measured and an expert from a team members can easily produce a exact bit or a range of small quantities. However, in some cases it will be difficult to complexities bit integer values or attribute values, which cannot measure. And in this case , fuzzy numbers can be used. There are four comments in Evaluation and considered that u is equal to 10 And evaluating a detailed numerical rating from zero to 10.
A numerical rating of the assessment by the integer zero, one, or fuzzy linguistic variables - is characterized by triangular fuzzy numbers. In Table 2 A triangular membership function of the fuzzy linguistic variables are listed.

If $\tilde{S}_{ik}$ ، is a STFN for the i -th criterion is assessed by expertE_k

And S_i^* (i = 1,2, ..., n) consensus phase (aggregation) for the i-th criterion ,finally in S_i^* with average fuzzy weight according to equation (5) can be achieved And therefore S_i^* is the weight of i-th which usually rank from 0 to 1, Therefore, S_i^* with the equation of nine turn to $\widetilde{W}_i$. In this study, all the weight by five experts, using the definition of equation (4) turns to STFN By equation (5), the consensus occurred and finally with equation (6) normalized to a rating between zero and one. Criteria weigh gained from the process of group decision-making are summarized in Table (4) is shown [4], [5].

$$S_i^* = \tilde{S}_{i1} \times C_1 + \tilde{S}_{i2} \times C_2 + \cdots + \tilde{S}_{ik} + \cdots + \tilde{S}_{ip} \times C_p \quad (5)$$

$$\widetilde{W}_i = \frac{\tilde{S}_{i1}}{\sum} , i = 1,2, \dots, n \quad (6)$$

Triangular fuzzy numbers for the main assessment criteria .Table (2)

Membership function	Linguistic variables
(0 , 0 , 2.5)	Very low (VL)
(0 , 2.5 , 5)	Low (L)
(2.5 , 5 , 7.5)	Middle (M)
(5 , 7.5 , 10)	High (H)
(7.5 , 10, 10)	Very high (VH)

Table (3) *Members of team decision making*

CF	Corporate responsibility	Teammate Expert
$C_1 = 0.30$	manager	E_1
$C_2 = 0.25$	، Assistant Successor	E_2
$C_3 = 0.15$	Production Manager	E_3
$C_4 = 0.15$	Quality Manager	E_4
$C_5 = 0.15$	Project Manager	E_5

Table (4) *weight of main criteria*

	E_1 Score $C_1 = 0.30$ STFN	E_2 Score $C_2 = 0.25$ STFN	E_3 Score $C_3 = 0.15$ STFN	E_4 Score $C_4 = 0.15$ STFN	E_5 نمره $C_5 = 0.15$ STFN	Normalized weights
C_1	2 (2,2,2,2)	Low (0,2.5,2.5,5)	(2,4) (2,2,4,4)	4 (4,4,4,4)	(2,4,6) (2,4,4,6)	(0.18,0.27,0.3,0.4)
C_2	7 (7,7,7,7)	Low (0,2.5,2.5,5)	(7,9) (7,7,9,9)	(6,7,8) (6,7,7,8)	(6,8,10) (6,8,8,10)	(0.5,0.6,0.63,0.74)
C_3	6 (6,6,6,6)	Middle (2.5,5,5,7.5)	(3,5) (3,3,5,5)	6 (6,6,6,6)	(4,5,7) (4,5,5,7)	(0.44,0.52,0.55,0.64)
C_4	8 (8,8,8,8)	High (5,7.5,7.5,10)	(4,8) (4,4,8,8)	10 (10,10,10,10)	(3,6,8) (3,6,6,8)	(0.62,0.73,0.79,0.88)
C_5	3 (3,3,3,3)	Low (0,2.5,2.5,5)	(2,5) (2,2,5,5)	5 (5,5,5,5)	(1,3,5) (1,3,3,5)	(0.21,0.3,0.35,0.44)
C_6	9 (9,9,9,9)	Middle (2.5,5,5,7.5)	(3,7) (3,3,7,7)	(6,7,8) (6,7,7,8)	(5,7,9) (5,7,7,9)	(0.54,0.65,0.71,0.82)
C_7	2 (2,2,2,2)	Middle (2.5,5,5,7.5)	(0,2) (0,0,2,2)	3 (3,3,3,3)	(1,2,3) (1,2,2,3)	(0.18,0.26,0.29,0.37)
C_8	8 (8,8,8,8)	High (5,7.5,7.5,10)	(6,9) (6,6,9,9)	6 (6,6,6,6)	(4,7,10) (4,7,7,10)	(0.61,0.71,0.76,0.87)

3-4 *The weight of the sub-criteria and rating projects*

The Weight of sub- criteria is by defined Management project through the success of the project. In this paper, project management trapezoid fuzzy numbers for measuring the weight of the 31sub- criteria that classified in eight main criteria decision making used. Linguistic variables that have been used for project evaluation system, include five variables with the membership function in the table (5) has been determined. Figure 3 shows Ranking system created by the membership trapezoid [7] .

Table (5) *Trapezoidal fuzzy numbers, evaluation of sub-criteria for making a decisions*

Membership function	Linguistic variables
(0 , 0 , 1 , 2)	Very low (VL)
(1 , 2 , 3 , 4)	Low (L)
(3 , 4 , 5 , 6)	Middle (M)
(5 , 6 , 7, 8)	High (H)
(7 , 8 , 9 , 10)	Very high (VH)

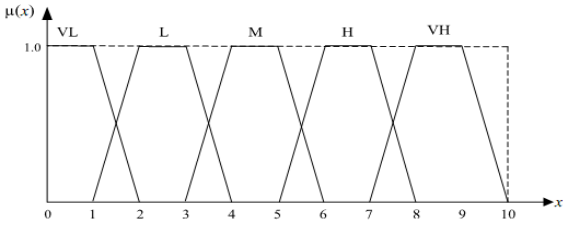


Table (3) *Membership function for evaluation of sub-criteria*

Suppose that m is an opportunity for Improvement rating of project selection and there is an improvement and (j = 1, 2,..., m) and (i = 1, 2,..., n) X_{ij}^{*} the desirability of fuzzy j -th project taking into account the main criteria of i-th. For every $X_{ij}^{*}$the average consensus (aggregation) of ‹main criteria the relevant sub (row) to be itself For example, the average consensus of fuzzy numbers criteria by equation (7) achieved. By equation (8) normalized to a value between zero and one. Here we avoid to show the weight projects` tables which is evaluated by project manager and also avoid the normalized project table due to their high volume.

$$\mathbf{mean}(\tilde{a}+\tilde{b})=\left(\frac{a_1+b_1}{2},\frac{a_2+b_2}{2},\frac{a_3+b_3}{2},\frac{a_4+b_4}{2}\right) \qquad (7)$$

$$\tilde{x}_{ij}=\frac{x_{ij}^{*}}{u}, \quad i=1,2,\dots,n \qquad j=1,2,\dots,m \qquad (8)$$

Fuzzy weight consensus $\tilde{A}_j$ from j-th projects , multiplied by the weight of the main criteria $\tilde{W}_i$, in the average weight for a $\tilde{X}_{ij}$ projects per the criteria C_i in accordance with equations (9) and (10) can be achieved Finally consensus project weight is $\tilde{A}_j=(a_1^j,a_2^j,a_3^j,a_4^j)$, and $\tilde{A}_j$ through the De fuzzy center of gravity (Eq. 11) will changed to $R(\tilde{A}_j)$ which replaced by Jaeger (1980) [4] .

$$\tilde{A}_j=\tilde{W}_i\times\tilde{X}_{ij} \quad i=1,2,\dots,n \qquad (9)$$

$$\begin{bmatrix}\tilde{A}_j\\ \vdots\\ \tilde{A}_j\end{bmatrix}=[\tilde{W}_1\ \dots\ \tilde{W}_n]\times\begin{bmatrix}\tilde{x}_{11} & \dots & \tilde{x}_{n1}\\ \vdots & \vdots & \vdots\\ \tilde{x}_{1m} & \dots & \tilde{x}_{1m}\end{bmatrix}=\begin{bmatrix}\tilde{W}_1.\tilde{x}_{11}+\tilde{W}_2.\tilde{x}_{12}+\dots+\tilde{W}_n.\tilde{x}_{1m}\\ \vdots\\ \tilde{W}_1.\tilde{x}_{n1}+\tilde{W}_2.\tilde{x}_{n2}+\dots+\tilde{W}_n.\tilde{x}_{nm}\end{bmatrix} \qquad 10)$$

$$R(\tilde{A}_j)=\left(\frac{a_1^j+a_2^j+a_3^j+a_4^j}{4}\right), \quad j=1,2,\dots,m \qquad (11)$$

A higher value in De fuzzy means a higher priority and utility of the proposed project, and in this way ranking improvement opportunity to select and implement performance improvement. With using the equation 9, 13 and 14, we will have the following data:

$$\begin{bmatrix}\tilde{A}_1\\ \tilde{A}_2\\ \tilde{A}_3\\ \tilde{A}_4\\ \tilde{A}_5\\ \tilde{A}_6\\ \tilde{A}_7\\ \tilde{A}_8\end{bmatrix}==\begin{bmatrix}(0.86,1.03,1.54,2.31)\\ (1.19,1.86,2.45,3.39)\\ (1.22,1.89,2.49,3.46)\\ (1.54,2.25,2.86,3.85)\\ (0.71,1.14,1.68,2.49)\\ 0.22,0.36,0.85,1.55)\\ 0.88,1.44,1.99,2.87)\\ (1.13,1.72,2.30,3.22)\end{bmatrix} \quad \text{و} \quad \begin{cases}R(\tilde{A}_1)=1.39\\ R(\tilde{A}_2)=2.22\\ R(\tilde{A}_3)=2.27\\ R(\tilde{A}_4)=2.63\\ R(\tilde{A}_5)=1.51\\ R(\tilde{A}_6)=0.74\\ R(\tilde{A}_7)=1.79\\ R(\tilde{A}_8)=2.09\end{cases}$$

Ranking Results compliance and improvement opportunities to perform in accordance with the proposed method is preferred P4 > P3 > P2 > P8 > P7 > P5 > P1 > P6 Therefore, the management of organization in order to use the resources and align activities with improvement of concepts and standards organizations such as the level of excellence model and award winners, their focus is on high-priority improvement will projects.

4. Conclusion

The results of this study, a mathematical model for screening priority ground improvement is the result of a process of self-assessment based on the EFQM Excellence Model. It should be noted that members of the elite teams (team decision-making) are selected from those expert organizational members who had comprehensive understanding of the fundamental concepts and models of excellence. Since the self-assessment process several opportunities for improvement is identified Nature of the project and some of them are not only fast - executive programs that need to be removed from the list of key improvement opportunities And fast action to be performed. Using Expertise in the decision-making criteria weights are calculated leads to actual weights in decision-making criteria which calculated according to the conditions and requirements of each organization. In real space of the industrial organizations, the decision-making generally in the form of fuzzy and imprecise data are considered closed, Therefore, considering the natural language and the real business environment with imprecise and vague information, needed decisions can be taken for ranking improvement opportunities is the key question. That is why in this ranking, a group Fuzzy Delphi decision-making techniques used. It is recommended to calculate the weights of criteria for decision making and prioritization of the mathematical methods used in place of fashion experts.

5. appreciation and thanks

The authors consider that the duty a warn thank, from strict and unwavering efforts of practitioner , academics and members of the International Journal of Scientific & Technology Research

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