

## A Hybrid Approach Using Fuzzy Multi-Criteria Techniques to Evaluate the Performance of In-Service Training Courses (Case Study: Mazandaran and Golestan Regional Electricity Company)

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PAPER INFO	ABSTRACT
<p><b>Chronicle:</b> Received: 13 June 2017 Revised: 18 July 2017 Accepted: 27 July 2017 Available : 24 August 2017</p>	<p>Due to the increased attention to training and improving the training level, its evaluation requires special procedures. In this paper, a novel approach is proposed to evaluate the performance of training courses using different evaluation and rating techniques. In order to identify the criteria affecting the assessment, the Delphi hourly method is used. To determine the severity of impact and the importance of model elements, the revised method proposed by Dalalah et al was used in FDEMATEL. Using the FVIKOR technique, the in-service training courses held in Mazandaran and Golestan Regional Electricity Company were prioritized. The findings of this study indicate the high importance of universality of training materials compared to other model criteria. They also suggest that setting a short-term in-service training course yields the best training performance.</p>
<p><b>Keywords :</b> Performance Evaluation. Training Courses. FDEMATEL. Fuzzy Set. FVIKOR.</p>	

### 1. Introduction

In our era, organizations do not boast about their mass production, financial reserves, and abundant human resources anymore. Rather, organizational development depends on their knowledge and intelligent capital. Today, in the words of management thinkers like Peter Drucker, manual labor has been replaced by knowledge work and knowledge workers occupied workers place. In such conditions, one cannot be successful except one values an organization intelligent capital and knowledge and further attempts to develop and consolidate it in the organization [1]. Contemporary thinking in the field of performance management systems also seeks to obtain multiple performance indices in order to reflect the

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value adding organization activities [2]. Some researchers believe that an appropriate performance evaluation tool should be able to encompass a wide range of performance measures [3].

## 2. The research problem

In order to provide feedback to managers in relation to the achievement of strategic objectives, organizations need to rely on performance evaluation [4]. Although several methods are proposed for service performance evaluation, most companies are still using old and traditional methods [5-8]. Of course, some factors have a greater impact on the quality of training courses. However, the application of current methods gives equal weight to each index which is considered the drawback of training courses performance evaluation. In addition, in cases where respondents do not have a definite opinion, this is not considered an appropriate method. Rather, a range of choices should be considered for respondents, and this in turn is regarded as another disadvantage of current methods of evaluation.

In this study, the main problem concerns the relations between the variables affecting the performance evaluation of training courses held in Mazandaran and Golestan Regional Electricity Company. It also focuses on the identification of factors affecting the evaluation and their importance level. In addition, it evaluates the success rate of the courses according to these criteria. The present study seeks to identify and determine the best course held in Mazandaran and Golestan Regional Electricity Company in the year 2014. For this purpose, a comprehensive and multidimensional questionnaire (Fig 1) among the studies conducted thus far is produced that is titled the evaluation of the quality of education at the University of Western Sydney in Australia. Its effectiveness as a useful means of educational improvement is confirmed in different studies [5].

In this study, the same criteria with some modification were used to answer the basic questions below using some MCDM methods and fuzzy sets theory.

- 1) What are the appropriate indices to evaluate the performance of educational courses held in Mazandaran and Golestan Regional Electricity Company?
- 2) How are the relationships and feedback of factors involved (impact severity criteria) in the performance evaluation of Mazandaran and Golestan Regional Electricity Company?
- 3) To what extent are each criterion and the performance evaluation indices of the training courses important?
- 4) What is the prioritization of each training course under study like?

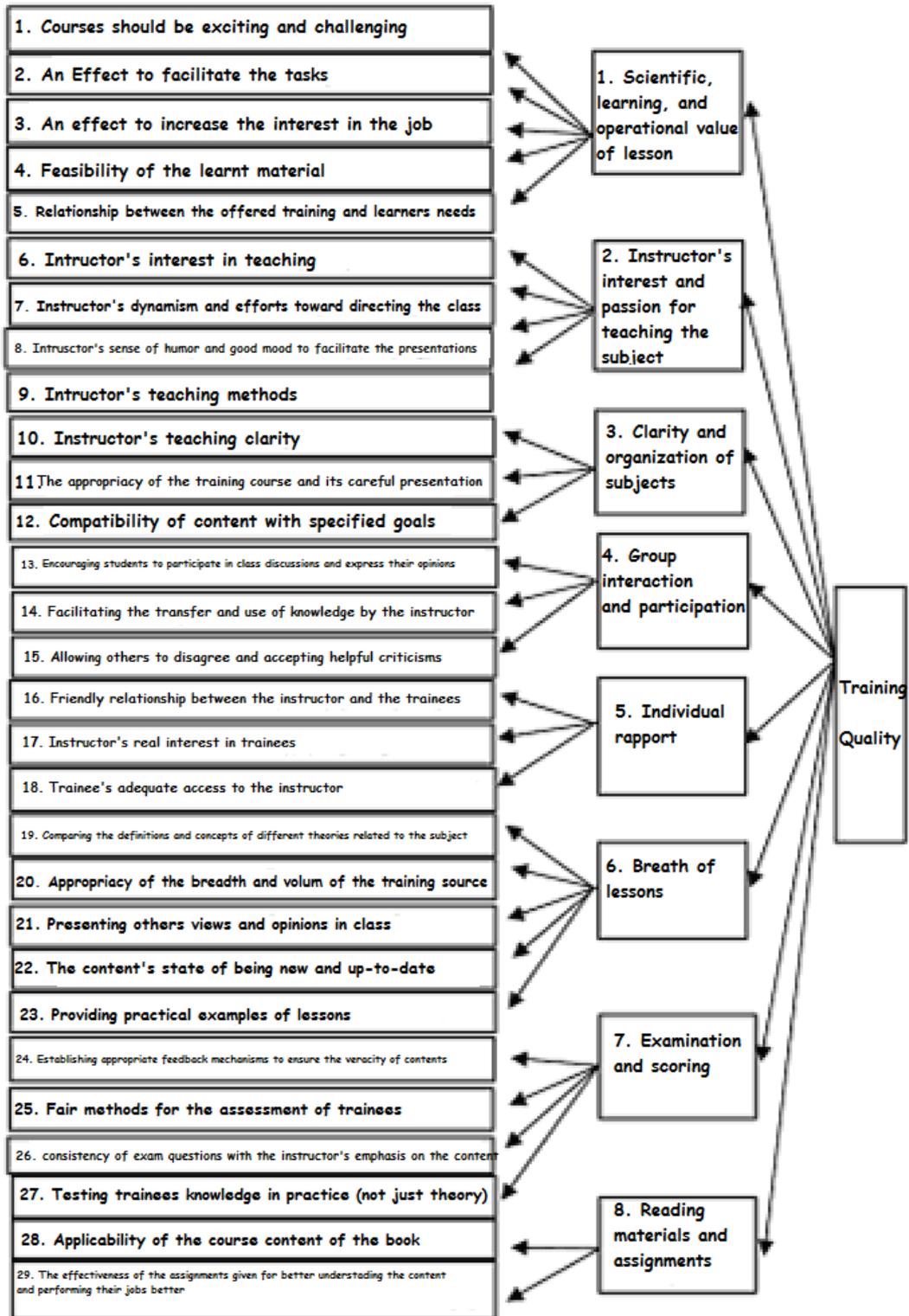


Fig 1. Qualitative Criteria to Evaluate the Training Courses [5].

### 3. Research method

The procedure used to evaluate the performance of training courses in this research consists of the following main steps summarized in Fig 2. They are as follows:

**Step One:** The hourly spectrum and a questionnaire were used after visiting experts in Mazandaran and Golestan Regional Electricity Company and academic experts so that the sub-criteria outlined in each of the main criteria could be reviewed or revised using the Delphi hourly method and their effectiveness could be determined based on the experts opinion.

**Step Two:** Using the revised FDEMATEL technique, the model impact-severity relationships are determined.

**Step Three:** Using the FVIKOR technique, training courses were evaluated.

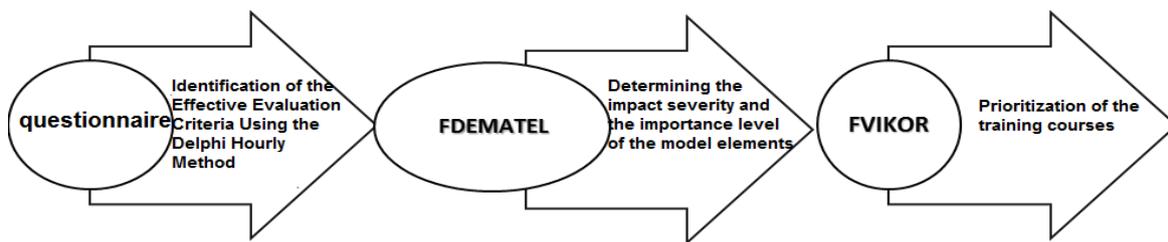


Fig 2. Map of the Research Process.

### 4. The population under study

Regarding the purpose of this study that is an evaluation of the performance of in-service training in Mazandaran and Golestan regional Electricity Company during the year 2014, the population under study were participants in in-service training courses held in Mazandaran and Golestan Regional Electricity Company. These courses consist of the following 10 elective courses that are:

High voltage cables, mobile Metrel Software for evaluation with statements coding, testing capacity and the thermal efficiency rate of gas units, transient overvoltage, the dispatching and communications and telemetry systems, transmission line workshops, Primary GIS, GIS in the power industry, working procedure and ergonomics.

To collect the training experts and professors' opinions of determining the importance of each criterion and index, comments of 15 people including experts responsible for the in-service training of Mazandaran and Golestan Regional Electricity Company and some university professors have been used. The experts in this research consisted of 53 percent male and the rest were female. Half of the experts held a doctorate and master's degree the rest were bachelors. 70 percent of experts had over ten years of experience and 74 percent of them were over 30 years of age.

## 5. Data analysis

### 5.1. Model adjustment

The first research question is to determine appropriate indices to assess the performance of training courses. In order to reconsider the conceptual framework of Mazandaran and Golestan Regional Electricity Company, a questionnaire was handed to the experts.

**Table 1.** Adjusted Model of Training Courses Performance Evaluation

Performance evaluation indice sub-criteria	Sub-criterion number	The main criteria for evaluating the performance	Criterion Number
Effective in increasing interest in the job	1.1	Scientific, learning, and operational value of lessons	1
Feasibility of the learnt material	1.2		
Relationship between the offered training and learners needs	1.3		
Instructor's dynamism and efforts toward directing the class	2.1	Instructor's interest and passion for teaching the subject	2
Instructor's sense of humor and good mood (cheerfulness)	2.2		
Instructor's teaching methods	2.3		
Instructor's teaching clarity	3.1	Clarity and Organization of Subjects	3
Encouraging students to participate in class discussions	4.1	Group interaction and cooperation	4
Participants being at the same level scientifically	4.2		
Appropriacy of the breadth and volume of the training course	5.1	Universality of materials taught	5
The content's state of being new and up-to-date	5.2		
Providing practical examples of lessons	5.3		
Providing appropriate feedback mechanisms to ensure the veracity of contents	6.1	Examination and scoring	6
Testing trainees knowledge in practice	6.2		
Reception, course location, course packages	7.1	Executive management of the course	7

In this regard, the experts were asked to evaluate the appropriateness of performance indices of training courses based on a range of 1 to 10 with 1 being the least important and 10 being the most important. The experts were further asked about the important indices for the evaluation of the training courses which do not exist in this model.

They were also required to order these indices on a scale of 1 to 10 with 1 being the least and 10 the most important. All the indices with an importance level of above 7 were selected. According to the experts views, the adjusted criteria and sub-criteria are shown in Table 1.

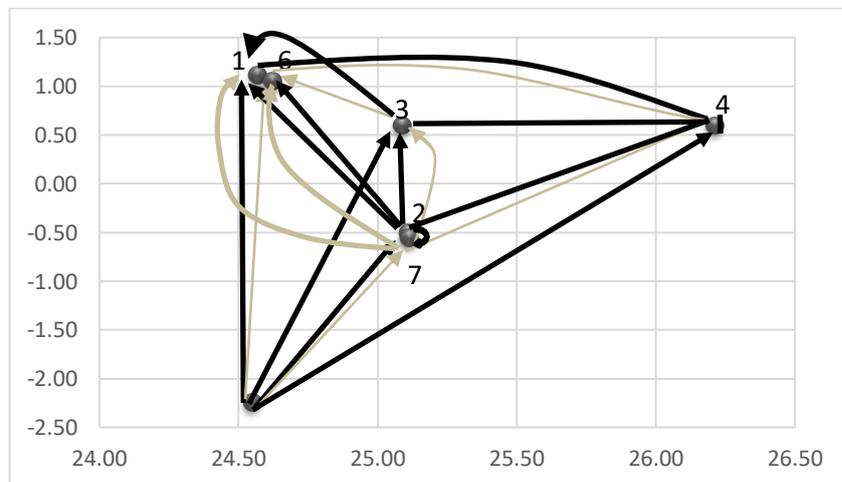
### 5.2. Structural relationship between model elements

The second research question involves the study of the relationships and feedback from factors involved (impact-severity criteria) in performance evaluation.

Using the fuzzy DEMATEL technique, the internal relationships between the model components are calculated.

**Table 2.** Matrix directly after applying a threshold value

criteria	$T$	$c_1$	$c_2$	$c_3$	$c_4$	$c_5$	$c_6$	$c_7$
The scientific, learning and operational value of the lessons	$c_1$	0	0	0	1.82	0	0	0
Instructor's interest and passion for teaching the subject	$c_2$	1.9	0	1.9	1.97	0	1.9	1.82
Clarity and organization of the subjects	$c_3$	1.82	0	0	1.89	0	1.82	0
Group interaction and cooperation	$c_4$	1.9	1.82	1.9	1.85	0	1.9	1.82
Breadth of the lessons	$c_5$	1.98	1.9	1.98	2.06	0	1.98	1.9
Examination and scoring	$c_6$	0	0	0	1.83	0	0	0
Executive management of the course	$c_7$	1.9	0	1.9	1.98	0	1.9	0



**Fig 3.** The causal Cartesian graph related to the main criteria cluster.

According to the model, the main criteria cluster, the scientific, learning and operational value sub-criteria cluster, the instructor's interest and passion sub-criteria cluster, group interaction and cooperation sub-criteria cluster, instructor's availability sub-criteria cluster, breadth of the lessons cluster, examination and scoring cluster, and the must-read material and assignments clusters have internal relationships. For example, the internal relationships related to the main criteria cluster are shown below.

### 5.3. Calculating the final weight

The third research question focuses on determining the importance of each criterion and index of evaluation of training courses performance.

In the present study, Dalala et al. [6] was used to determine the weight of the model elements. Using equations (1) and (2), the criteria weights and calculated weights were normalized respectively. It should be noted that the weights obtained show the local weight of each of these criteria. Therefore, to calculate the total weights, i.e. the weight of each sub-criterion the sum of which must equal 1, the calculated importance level should be multiplied by the weight vector of the main criteria previously calculated, and the obtained weight should further be normalized. The total weight of the model sub-criteria is given in Table 3.

$$W_j = \sqrt{(D_j + R_j)^2 + (D_j - R_j)^2} \quad (1)$$

$$W_i = \frac{w_i}{\sum_{i=1}^n w_i} \quad (2)$$

### 5.4. Ranking

The fourth research question is regarding the prioritization of each of the training courses.

In this problem, the number of options is 10 ( $m = 10$ ), and the number of criteria is fifteen ( $n = 15$ ). When the decision matrix was formed, the best ( $\tilde{f}_j^+$ ) and worst ( $\tilde{f}_j^-$ ) related to the criteria functions values (ideal positive and ideal negative) were determined. After calculating the fuzzy values  $\tilde{S}_i$ ,  $\tilde{R}_i$ ,  $\tilde{Q}_i$  their defuzzified values were calculated for each option using the center of area method. Subsequently, the options were ranked based on the lowest values  $S$ ,  $R$ , and  $Q$  and the two final conditions for the FVIKOR were checked. Finally, Table 4-17 gives the results of the performance evaluation of training courses held in Mazandaran and Golestan Regional Electricity Company with  $\nu = 0.5$

**Table 3.** The normalized local weight of all criteria and sub-criteria and the sub-criteria total weight .

Total weights of the sub-criteria	Local weight of the sub-criteria	Sub-criteria of the performance evaluation index	Sub-criterion number	The sub-criteria local weight	The main criteria for performance evaluation	Index number
0.0478	0.337	Effective in increasing interest in the job	1.1	0.14	Scientific, learning, and operational value of lessons	1
0.0462	0.326	Feasibility of the learnt material	1.2			
0.0478	0.337	Relationship between the offered training and learners needs	1.3			
0.0488	0.337	Instructor's dynamism and efforts toward directing the class	2.1	0.143	Instructor's interest and passion for teaching the subject	2
0.0472	0.326	Instructor's sense of humor and good mood (cheerfulness)	2.2			
0.0488	0.337	Instructor's teaching methods	2.3			
0.1448	1	Instructor's teaching clarity	3.1	0.143	Clarity and Organization of Subjects	3
0.076	0.5	Encouraging students to participate in class discussions	4.1	0.15	Group interaction and cooperation	4
0.076	0.5	Participants being at the same level scientifically	4.2			
0.05	0.35	Appropriacy of the breadth and volume of the training course	5.1	0.141	Universality of materials taught	5
0.0328	0.32	The content's state of being new and up-to-date	5.2			
0.0471	0.33	Providing practical examples of lessons	5.3			
0.0709	0.5	Providing appropriate feedback mechanisms to ensure the veracity of contents	6.1	0.14	Examination and scoring گذاری	6
0.0709	0.5	Testing trainees knowledge in practice	6.2			
0.143	1	Reception, course location, course packages	7.1	0.143	Executive management of the course	7

**Table 4.** Final ranking of the options

options	ranking
Ergonomics	1
Transient overvoltage	2
Metrel Software	3
Working procedure	4
GIS in the power industry	5
Transmission line workshops	6
Dispatching and telemetry	7
Capacity and efficiency rate testing	8
High voltage cables	9
Primary GIS	10

## 6. Conclusion and Recommendations

The normalized local weights of all criteria and sub-criteria and the total weights of sub-criteria are given in Table 3 in which the sub-criterion "Instructor's teaching clarity" has the highest weight (0.1448) among other sub-criteria. In addition, the sub-criterion "The content's state of being new and up-to-date" had the lowest weight (0.0328) among the other sub-criteria. The structural relationships between the main criteria are shown in Fig 3. According to the map of network relationships, it can be seen that the criterion, "Universality of materials taught" has the greatest effectiveness. Table 4 shows the courses with the best performances in the year 2014 in order of the degree of success. It should be noted that the ergonomics course, transient overvoltage, Metrel Software, working procedure, GIS in the power industry, workshops transmission lines, dispatching and telemetry, capacity and efficiency rate testing, high voltage cables, and primary GIS Preliminary show successful performance, respectively.

According to Table 1, with regards to the employees and managers views, it was decided that participants state of being at the same scientific level should be considered, since the causal relationships in the criterion cluster of group interaction and cooperation, facilitating the implementation of training courses, and participation in class discussions are influenced by participants state of being at the same scientific level. Although the instructor and tutor's role is key in every training program, the effectiveness of which can be seen in Figure 3 in terms of the emphasis the experts lay especially during short-term and specialized training courses, and leaving aside the fact that this is highly dependent on the instructor's sense of

humor and good mood based on cause-effect relationships between the second criterion clusters, attention must be paid to the selection of instructors based on their training expertise and the ability to communicate with adult learners.

## 7. Suggestions for future research

For further research, the following topics are suggested:

- ✓ Conducting a research to assess the superior training courses resulting from the present study together with superior training courses that are held in other similar organizations.
- ✓ Using other multi-criteria decision-making techniques such as ORESTE, PROMETHEE, and MULTIMOORA to choose the best option.
- ✓ Using other performance evaluation indicators along with existing indicators for evaluating training courses

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