Evaluate and rank the performance of total quality management in manufacturing organizations whith approach fuzzy ANP

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Abstract: The aim of the present study was to evaluate and rank the performance of TQM in the manufacturing organization by using fuzzy network analysis process. The research of Type was applied and research method is quasi-experimental. To select a group decision was used multistage cluster sampling method. in this study was used Paired comparisons of TQM questionnaire. And after training sessions, questionnaires were distributed among the sample. Information Analysis Process by Fuzzy Network was evaluated using Super Dicision software.
The results showed that the main criteria of the organization and management between the four main criteria, won first place. And also subcriterias of identify and training and Top management support and leadership in the organization and Human Resource Management to were ranked first and third respectively. And finally the strategic plan subcriteria was in the last place.
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1. Introduction

Iran's strategic position as a free and sovereign state, national determination to increase production, distribution improvement, and successful presence in international markets requires that quality literature should be considered specially. By these means, what needs to researchers, professionals, executives and entrepreneurs in the fields of economy is to be provided; furthermore the independence movement in the shortest possible time with the best conditions reaches to desired position. So it is necessary for managers and strategists of production and service units to equipping the own ascertained forces into initiating corporate operations by targeting the quality of products, processes, and procedures, and this purpose is obtained only with the help of scientific management methods and approaches such as Total Quality Management (TQM).

The Total Quality Management is a tool to establish an organization (Newman, 2001). Also, the Total Quality Management is an approach that many organizations have adopted in organizations to survive in the competition (Faghihi, 1999), and many of them have entertained this approach widely and get noticeable results by using of this approach (Abdul, 2000; Chadwick, 1995; Coat, 1993; Ledbeter, 1996). Different studies showed that there is significant difference between the two groups in terms of familiarity with the total quality management tools and techniques and application of them (Waal, 2005). Organizations managers need to have information about the level of this in their organizations (Mahdavi et al, 2010).

A review of various studies on the implementation of Total Quality Management in organizations shows that most organizations which have used TQM's principles in their activities, have enjoyed the benefits of its implementation in various contexts (Mehraban, 2004). The author of this paper tries to identify and rank the most important criteria of total quality management in manufacturing industries.

Problem Statement

TQM is an integrated management approach to meet the needs of customers that can be achieved with the participation of all employees (Chin et al, 2002). Many organizations around the world have accepted it and now this principle opens its position in the community speedily(Faraji, 2003). The investigation of three constituent words of Total Quality Management helps to deeper understanding of this phrase. The word of management means that quality is managed in organization and the word of quality means providing what customers and managers need and expect. Also, the word of total means that a comprehensive quality management is surrounding all individuals and all organization matters and refers to any person engaged in this process (Sahney et al, 2004). However, its implementation requires true understanding, insight, planning, patience and stamina (Lamei, 2002).

Due to the high activity of the organization, the ranking and prioritization of activities is required in order to improvement and promotion of these, because different parts of any organization acts such as links of the chain, so weakest link of the chain must be identified to enhance total strength of chain. Otherwise, the weakest link of the chain will be affected (Goldratt, 1997).

Now the questions arise, what is the position of the system in manufacturing organizations? And also to better establishment of this system, which criteria are more important? And does this system attract the attention of someone to itself and what are the observed weaknesses in using of this system? The following cases show the researchers' attractiveness reasons to use this system in enterprises and organizations, especially in manufacturing organizations.

The importance and necessity of research

Human could understand the issues by analytical method. That is, he (she) can divide problems into smaller parts and investigates each part individually and then combines them with each other and gains access the whole. This line of thinking about new issues is important, complex, and inefficient, and should there be a system of thought (Karuppusami & Gandhinathan, 2007). Specific theory of TQM extended in management communities and now it has come of age as an issue has been controversial (Faghehi, 1999). In this research by building a model of comprehensive quality management, we ranked these criteria into multi-criteria decision making technique (fuzzy analytic network process). Given that most research about Total Quality Management investigated variables of the theoretical theory and didn't study the ranking the criteria of Total Quality Management by a fuzzy analytic network process, therefore, in order to cover this gap, investigation, comparison and ranking of Total Quality Management standards seems to be necessary.

Research Objectives

- According to views of components and sub-components experts, how should be the Total Quality Management process in this industry?
- What is the experts' opinion on the significance of each of these criteria and sub-criteria?
- Which measure does get highest score among of parameters?
- Which measure does get minimum score among of parameters?

Research process

This study was conducted in six phases:

First phase: identifying the components and sub-components of Total Quality Management; In this part of the research, by using of library research, the literature of subject and research in this field is investigated and 4 main criteria and 17 sub-criteria were identified totally.

Second phase: localization of criteria and sub-criteria in the studied industry; the criteria and sub-criteria identified in the first stage localized by using of interviews and the consensus of experts in the studied industry. Expert team consists of 10 people from the industry experts. Finally, the consensuses about the criteria and sub-criteria, as well as interactions between them are obtained.

Third phase: assessing the importance of elements by using of fuzzy analytic network process: the fuzzy matrix is a method which is used to qualitative data and became them into quantitative data (Hwang, 1994). The team expressed their opinion about each criterion and sub-criterion as paired comparison in Lin (2009) 9-numerary spectrum from identical to more highly important. In classical method ANP that introduced by Saati (1996), have been wanted experts to doing paired comparisons of level characteristic in a network structure by means of numbers and precise ratios. Ratios provided by an expert constituted paired comparisons matrix that the weight of each level characteristics was obtained by calculating the eigenvalues of the matrix. Many experts believe that due to the lack of confidence in the experts to doing paired comparison and assigned the rate to it, making this decision-making loose and the non-reliability. Hence, in the collection stage of experts' views, we used the tangible and common expression dialect in the fuzzy paired comparisons ANP questionnaire in addition to the common certain ratios in traditional ANP. Verbal scales corresponding with fuzzy numbers are shown below.

Table 1: Verbal scales corresponding with fuzzy numbers (Lin, 2009)

Lingual variables	Fuzzy numbers	Fuzzy numbers scale
(1,1,1)	1	Equal
(1,2,3)	2	Between
(2,3,4)	3	Low-important
(3,4,5)	4	Between
(4,5,6)	5	More important
(5,6,7)	6	Between
(6,7,8)	7	Slightly more important
(7,8,9)	8	Between
(9,9,9)	9	Important severely

Fourth phase: summing up the results of the questionnaires; by gathering of questionnaires, all the data encode in EXCEL software and by given of

paired group comparisons, the geometric mean of the responses were obtained. Because while taking the individual judgment, the geometric mean provides mean mathematically (Mehrgan, 2004).

$$A_{ij} = \left[\prod_{k=1}^{N} a_{ij}^{(k)}\right]^{1/N}$$

Fifth phase: defuzzifying matrices of paired comparisons; Obtained data from the fourth step has been defuzzifying. Numbers using a formula of converting fuzzy numbers into the definitive Minkowski fuzzy ($x = m + (b - a)/4$ (2)) convert into definitive numbers (Hung et al, 2011).

Sixth phase: determination of the final priority of criteria and sub-criteria using the software; by entering the information in Super-Decision software that is powerful software in prioritization and ranking application, the weights of all criteria and sub-criteria have been obtained.

Research background and identifying the effective measures on Total Quality Management

In a research that has been done on prioritization of the key success factors of TQM reduce the performance gap by using fuzzy AHP, 4 components and 16 sub-components were investigated generally; Sub-components of teamwork, **employee's involvement** and reward have allocated first to three priorities to themselves (Nazemi et al, 2010).

Many authors have expressed several definitions about the Total Quality Management (Tenner,1992). For example, Deming believed that this phenomenon has 14 dimensions. Also, Anderson et al began their work with Deming's 14 dimensions and after reviewing of research background (Crosby, 1984; Das,2008) and by using of experts views that were using of Delphi approach, obtained 7 dimensions, finally. The effective factors on Total Quality Management had completed in the last years and developed as key factors in Total Quality Management. By reviewing of 76 studies, we obtained the following Total Quality Management factors: top management support, social responsibility, strategic planning, feedback and customer satisfaction, information quality and performance, benchmarking, human resource management, training, **employee's involvement**, employee empowerment, employee satisfaction, teamwork, employee evaluation, rewards and recognition, process management, process control, product or service design, supplier management, continuous improvement, quality assurance, non-compliance, quality culture, relationships, quality systems, timely production, flexibility (Sebastianelli & Tamimi, 2003).

Elmary et al (2007) were examined 16 following criteria in their study: top management support, strategy, continuous improvement, benchmarking, **customer's feedback**, human resources management, quality systems, encouragement and rewards, problem analysis, product design, staff, service culture, social responsibility, quality assurance and technical service(1)

In most studies in a field of affecting sub-components and components on the overall quality, network analysis has not been used properly. Hence, the main basis of this study is the past researches of researchers, which was identified by the experts of the relevant criteria. According to the latest research as well as the experts' views of the target population, we examine the 4 main criteria and 17 sub-criteria to assess quality management in an organization, which are described as below:

1- Management and Organizing: Organizing and management include the factors that are involved in TQM, that organizing requires leadership and commitment of the organization's senior management and senior management roles (Chin et al, 2002). Lack of leadership support can lead to problems in the implementation of TQM. Successful implementation of quality management needs to change the culture of the organization (García et al, 2008). The plan should be clear and quality objectives are to be considered. Also, coordination of quality programs with other programs are the essential tips in the field of strategic plans (Jun et al, 2004). Sub-criteria such as support and leadership of organization's senior management, strategic planning, and culture of quality are examples of these.

2- Employees: some parts of Total Quality Management problems back to staff, because some factors such as teamwork and **employee's involvement** also arise (Chin et al, 2002; Park, 1997). Increase employee participation in work is resulting from human resources. Strategies such as teamwork, training and empowerment increase responsibility, authority, decision-making and motivation. The four sub-criteria were identified: encourage employees, identifying and education, **employee's involvement**, teamwork.

3- Assessment and Feedback: assessment and feedback is in company with strategy and practice link (Sinclair & Zariri, 1995). Quality-related information and received information from process, including information received from our customers, suppliers, employees, competitors, and other stakeholders must be assessed (Rao et al, 1997). Assessment is a tool that tool that usually is used to identifying quality problems, explanation of strengths and identifying the improvements (Chin et al, 2002). This factor includes communication, performance evaluation, and data analysis.

Table 2: Criteria identified in previous research

Criterion	Researcher
Obligation and support of managers	(Chin et al, 2002); (Tari et al, 2004); (Tamimi, 1998) ; (Zehir & Sadikoglu, 2010); (Tari et al,2004); (Llusar et al, 2009); (Jun et al, 2004); (Karuppusami & Gandhinathan, 2007) ; (Bayraktar et al, 2008); (Baidoun, 2004); (Rahman & Bullock, 2005) ; (Das et al, 2008); (V-H. Lee et al, 2010); (Huai, 2012); (Zehir, 2012); (Naghshbandi etal,2012); (Motwani, 2001);(Antony et al, 2002); (Awan et al, 2008); (Bayraktar et al, 2008); (Baidoun, 2004); (Faisal etal, 2012)
Strategic planning	(Chin et al, 2002); (Jun et al, 2004); (Karuppusami & Gandhinathan, 2007); (Das & et al, 2008); (Tari et al, 2004); (Zehir & Sadikoglu, 2010); (Llusar et al, 2009); (V-H. Lee et al,2010); (Huai, 2012); (Hung Yi Wu,2011)
Customer-oriented	(Chin et al, 2002); (Jun et al, 2004); (Fuentes et al, 2004); (Zehir & Sadikoglu, 2010); (Karuppusami & Gandhinathan, 2007); (Das et al, 2008); (Bayraktar et al, 2008); (Sit et al., 2009); (V-H. Lee et al,2010); (Huai, 2012); (Zehir, 2012); (Naghshbandi etal,2012); (Motwani, 2001); (Antony et al, 2002); (Awan et al, 2008); (Bayraktar et al, 2008); (Baidoun, 2004); (Tari et al, 2004); (Rahman & Bullock, 2005); (Hung Yi Wu, 2011); (Faisal etal, 2012)
Criterion	**Researcher**
Training and identification	(Chin et al, 2002); (Pun, 2001); (Tari et al, 2004); (Jun et al, 2004); (Llusar et al, 2009); (Karuppusami & Gandhinathan, 2007); (Bayraktar et al, 2008); (Das et al, 2008); (Huai, 2012); (A. Aylin Can & Ü. Kubilay Can, 2009); (Naghshbandi etal,2012); (Motwani, 2001); (Antony et al, 2002); (Awan et al, 2008); (Baidoun, 2004); (Rahman & Bullock, 2005)
Teamwork	(Chin et al, 2002); (Fuentes et al, 2004); (Das et al, 2008); (Bayraktar et al, 2008); (Llusar et al, 2009); (Zehir & Sadikoglu, 2010); (Jun et al, 2004); (Tari et al, 2004); (Fuentes et al, 2004); (Naghshbandi etal,2012); (Awan et al, 2008); (Baidoun, 2004); (Karuppusami & Gandhinathan, 2007); (Rahman & Bullock, 2005); (Huai, 2012)
Information and analysis	(bayraktar et al, 2008); (Llusar et al, 2009); (Karuppusami & Gandhinathan, 2007); (Zehir & Sadikoglu, 2010); (Das et al, 2008); (Bayraktar et al, 2008); (Tamimi, 1998); (Jun et al, 2004); (Tari et al, 2004); (Ooi et al., 2006); (V-H. Lee et al, 2010); (Huai, 2012); (Zehir, 2012); (Naghshbandi et al, 2012)
Quality assurance and processes' management	(Chin et al, 2002); (Zehir & Sadikoglu, 2010); (Das et al, 2008); (Karuppusami & Gandhinathan, 2007); (Sinclair & Zairi, 1995); (Rao et al, 1997); (V-H. Lee et al, 2010); (Huai, 2012); (Zehir, 2012); (Naghshbandi etal,2012); (Motwani, 2001); (Antony et al, 2002); (Awan et al, 2008); (Bayraktar et al, 2008); (Baidoun, 2004); (Hung-Yi Wu,2011)
continuous improvement	(Chin et al, 2002); (Zehir & Sadikoglu, 2010); (lusar et al, 2009); (Chin et al, 2004); (Tari et al, 2004); (Das et al, 2008); (Fuentes et al, 2004); (Rao et al, 1997); (Huai, 2012);(Arawati, 2011); (Cemal Zehir, 2012); (Naghshbandi etal,2012); (Voon-Hsien Lee, 2010); (Antony et al, 2002); (Awan et al, 2008); (Bayraktar et al, 2008); (Baidoun, 2004); (Rahman & Bullock, 2005)
Criterion	**Researcher**
supplier management	(Chin et al, 2002); (Tari et al, 2004); (Tamimi, 1998); (Jun et al, 2004); (Antony etal, 2002); (Awan et al, 2008); (Das et al, 2008); (Chin et al, 2002); (Tari et al, 2004); (Zehir & Sadikoglu, 2010); (Karuppusami & Gandhinathan, 2007); (Rahman & Bullock, 2005); (Huai,2012); (Naghshbandi etal,2012); (Zehir, 2012); (Hung-Yi Wu, 2011)
employee's involvement	(Chin et al, 2002); (Tari et al, 2004); (Motwani, 2001); (Antony et al, 2002); (Awan et al, 2008); (Bayraktar et al, 2008); (Baidoun, 2004); (Das et al, 2008); (Jun et al, 2004); (Karuppusami & Gandhinathan, 2007); (Huai, 2012); (Naghshbandi etal,2012)
Quality systems	(Huai,2012); (Naghshbandi etal,2012)
Operation analysis	(Chin et al, 2002); (Tari et al, 2004); (Tamimi, 1998); (Bayraktar et al, 2008); (Baidoun, 2004); (Jun et al, 2004); (Karuppusami & Gandhinathan, 2007); (Naghshbandi etal,2012)
quality culture	(Hung-Yi Wu, 2011); (Faisal Talib etal,2012)
human resources management	(Jinmei Huai,2012); (Naghshbandi et al, 2012); (Voon-Hsien Lee, 2010); (Hung-Yi Wu,2011); (Faisal Talib et al,2012)

Staff encouragement	(Chin et al, 2002); (Bayraktar et al, 2008); (Das et al, 2008); (Jun et al, 2004); (Karuppusami & Gandhinathan, 2007)
product or service design	(Chin et al, 2002); Motwani, 2001) ; (Antony et al, 2002); (Bayraktar et al, 2008); (Baidoun, 2004); (Baidoun, 2004)
Relationships	(Chin et al, 2002); (Tari et al, 2004); (Antony et al, 2002); (Awan et al, 2008); (Hung-Yi Wu, 2011)

4- Systems and Techniques: Total Quality Management encompasses a wide range of approaches and instruments. Systems and techniques is a key component in quality management. Analysis process helps organizations to assessing how organizations achieve desired results and monitoring efforts in order to correct the continuous improvement (Chin, 2002). Nonaka (1991) believes that successful organizations consistently create new knowledge, and have the ability to publish new knowledge throughout their organizations. By reviewing of past research and experts' views, there are indentified 7 sub-criteria as follows: the feedback from the customer, the continuous improvement and innovation, quality systems, product or service design, supplier management, processes management, and human resource management. Finally, the Total Quality Management standards and the standards identifying signs are showed in the following tables. Also, the diagram (1) shows the corresponding model.

Table 3: Table of Total Quality Management standards identified in the research

Management and Organizing		**Employees**	
Management support	C_1	Customer's feedback	C_2
Quality culture	C_{11}	Identifying and training	C_3
Strategic planning	C_{13}	Employee's involvement	C_6
Systems and Techniques		Employees encouragement	C_{14}
Continuous improvement and innovation	C_4	Teamwork	C_{15}
Supplier management	C_5	**Assessment and Feedback**	
Processes management	C_8	Information and analysis	C_7
Quality systems	C_9	Quality culture	C_{10}
Human resource management	C_{12}	communication	C_{17}
product or service design	C_{16}		

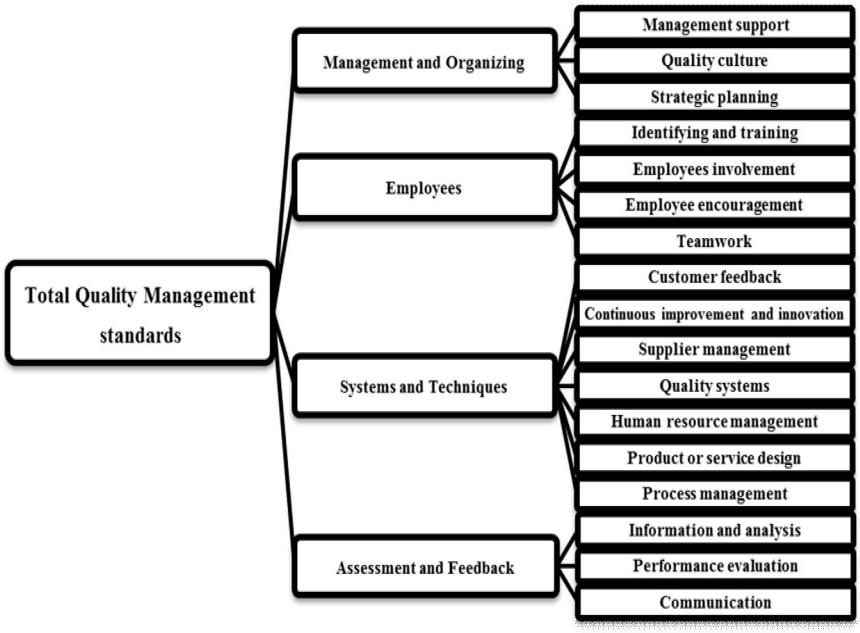

Diagram 1: Total Quality Management standards model

After group discussions and exchange views with experts of statistical population (the expert team) and after of the identification of criteria and sub-criteria of Total Quality Management, by using of the table (4) that is designed to identify interactions, dependencies and interactions between the four main criteria and 17 sub-criteria, are studied together and this result is obtained in the framework of interactions and dependencies table.

Table 4: Matrix of interactions between the main criteria of Total Quality Management

Criterion	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}
C_1			*														
C_2	*				*	*	*	*	*							*	*
C_3	*	*		*		*	*		*	*	*		*				
C_4	*	*	*				*	*	*						*		
C_5							*		*							*	
C_6			*							*			*	*			
C_7			*							*							
C_8	*										*						
C_9		*		*	*		*	*							*		
C_{10}											*						
C_{11}	*		*							*							
C_{12}	*	*									*						
C_{13}						*					*						
C_{14}	*					*							*				
C_{15}		*		*	*	*	*										
C_{16}	*		*			*								*			
C_{17}	*		*			*			*								

Analytical network process and its application in Total Quality Management

In 1971, analytical network process was developed by Saati. Also, The aim of this process needs structuring the decision-making process with respect to a scenario influenced by independent multiple factors (Saaty, 1980). Analytical network process will not impose a hierarchical structure on the issue, solely. We can represent a system with feedback with a network, where the nodes indicate the surfaces or components. All of these communications are evaluated by a super-matrix and paired comparisons. Super-matrix is the matrix which contains influences between the factors and is derived by these the priorities vectors (Saaty & Vargas, 1998). Analytical network process is considered the dependence of in-cluster and mid-cluster (Figure 1), and has the non-linear structural network analysis process. In other words, in a network, feedback and interaction between and among clusters are possible (García et al, 2008). For these reasons, in recent years application of network analysis rather than hierarchical analysis in many areas has increased (Jharkharia & Shankar, 2007).

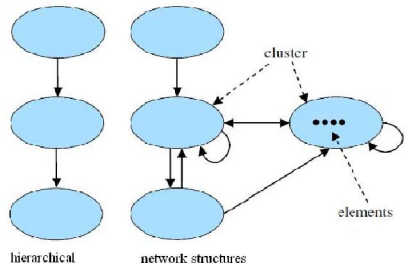

Figure 1: The difference between hierarchical and network structures

Investigation stages of the ANP Method

In according to Saati theory, Decision flowchart of this method has the following steps:

- Determination the effective criteria in Total Quality Management
- Network structure
- Fulfillment the paired comparisons and obtaining the priority vectors

In the network analysis method is asked of the decision-makers in the framework of a series of paired comparisons, what effect the two elements compared with each other in their superior standards (Meade, 1997).

- Calculating the special matrices

The concept of super-matrix is as like as a Markov chain. A super-matrix can limit the coefficients to compute all of the preferences and thus aggregation effect of each element with other interacting elements (Saaty & Vargas, 1998).

- Rating

If the super-matrix formed in the previous step can cover all networks, priority weights can be found in column options in a normal matrix. Finally, the option with greatest priority is known as the first option.

Application of fuzzy logic in Total Quality Management

More data are required in the operation and quality express as the natural language. For example, the expectations of customers in terms of product as "easy to use", "safe" and "convenient to use" as they all are irrational and closed. Obtaining the amount of tension and ambiguity in requirements is an important issue (Azar & Faraji, 2002). The theory of fuzzy sets theory is an important method for dealing with uncertainty (Zadeh, 1965). A linguistic variable is a numeric variable that is distinct from a numerical variable which its value is displayed with terms or phrases instead of numbers (Zadeh, 1975). One of the features of fuzzy sets is membership function in which each member is entitled to a membership degree between zero and one (Zhu et al, 1999).

Sample size and sampling method

Fuzzy Logic is one of the newest methods in theses and papers of prioritization of criteria, and the largest of expert's statistical population is, the better it is. In this weighting method, if expert's statistical population have at least 7 to 8 people, a better result is obtained, if this population have 30 people, it is excellent (Zimmerman, 1990). The samples in this study, 30 subjects were selected among the staff of target community.

In this study, sampling method was multistage clustering. As research community was not homogeneous, as well as the educated people of this community were distinct, there is significant difference between the variable of amounts of people education with the various components of Total Quality Management (Siavoshi, 2007). Also, education is a key component of the research, thus it has been used of equal stratified sampling as in Table (5) is.

Table (5): The sample of this research

Organizational position	Top manager	Middle manager	Supervisor	Expert	Technician	Total
Expert team	3	3	-	4	0	10
Decision team	3	5	5	5	2	20
Sample volume demography by considering of education						
Education	Diploma and low literate	Associate's degree		Bachelor	Master degree	Total
Team	13	5		10	2	30
Sample volume demography by considering of experience						
Experience	Less than 3 years	3- 10		10- 20	20- 30	Total
Team	2	5		10	13	30

The research instrument and stability and validity

The paired comparisons questionnaire has been used in this research, which is a developed test to measure the rating by the analytic network process. For comparing among the identified criteria by the network analysis, a questionnaire was prepared that consists of 15 sections.

- Part I: Paired comparisons between the main criteria with the target
- The second, third, fourth and fifth parts: paired comparisons of the sub-criteria with the target
- The Sixth to fifteenth parts: the paired comparisons of sub-criteria with the others

The validity of the questionnaire was approved by advisor and co-advisor and the stability of this questionnaire was approved by the inconsistency rates of responses. If this rate is higher than 0.1, the matrix is inconsistent (Ying & Chang, 2009). To avoid any confusion and to facilitate understanding of network analysis model in the distribution stage of the questionnaire, a researcher using a combination of interviews and questionnaires and educational methods, visits some of the respondents personally to accelerate the understanding of the meaning and contents of the questionnaire for respondents.

Data analysis method

In this study, by using fuzzy analytic network process, data obtained from a Total Quality Management questionnaire is analyzed. After the data

collection, coding and information defuzzify, the information were ranked using Super-Decision software of criteria.

Data expression

To ensuring data validity which collected from questionnaire, in addition to inconsistency rate of the questionnaires, the responses received from the questionnaires were analyzed by SPSS19 software. In general, if the range of skewness and elongation be in (-2, 2), then the curve data has the normal distribution (Tabachnick & Fidell, 2007), and all data are normally distributed with a skewness in the relevant range. The consistency ration is a means that determines the consistency of the judgments and shows that what extent we can rely on preferences resulted from comparisons (Mehrgan, 2004).

$$CI = (\lambda_{max} - n)/(n - 1)$$

$$CR = CI/RI$$

Then value is the number of elements that are being compared. Also, RI is a function of n; if n= 4, then RI is equal to 0.9.

Table (6): The paired comparisons matrix of the main criteria

Criterion	Management	Employees	Systems and techniques	Evaluation and feedback
Management	1	6.6	4.48	7.05
Employees	0.15	1	0.43	0.26
Systems and techniques	0.22	2.31	1	2.01
Evaluation and feedback	0.14	3.84	0.5	1
Total	1.51	13.75	6.41	10.32

Table (7): The paired comparisons normalized matrix in relation to the main criteria

Criterion	Management	Employees	Systems and techniques	Evaluation and feedback	Weight	Consistency vector
Management	0.66	0.48	0.7	0.68	0.63	4.5
Employees	0.1	0.07	0.07	0.03	0.07	3.9
Systems and techniques	0.15	0.17	0.16	0.19	0.17	4.4
Evaluation and feedback	0.09	0.28	0.08	0.1	0.14	4.3
Total	1.51	13.75	6.41	10.32		

$$\lambda_{max} = (4.5 + 3.9 + 4.4 + 4.1)/4 = 4.3$$

$$CI = (4.3 - 4)/3 = 0.08$$

$$\text{Inconsistency rate} = 0.08/0.9 = 0.09$$

The following table is the other of inconsistency rate matrix.

Table (8): The criteria matrices' inconsistency rates of Total Quality Management

Matrix	Weight
The main criteria matrix in relation to the target	0.09
The management sub-criterion matrix in relation to the target	0.097
The employees sub-criteria matrix in relation to the target	0.009
Matrix	Weight
The evaluation and feedback sub-criterion matrix in relation to the target	0.045
The systems and techniques sub-criteria matrix in relation to the target	0.024
The employees sub-criteria matrix in relation to the quality culture sub-criterion	0.00
The systems and techniques sub-criteria matrix in relation to the identification and training sub-criterion	0.018
The performance evaluation sub-criteria matrix in relation to the identification and training sub-criterion	0.00
The employees sub-criteria matrix in relation to the employees' involvement sub-criterion	0.024
The employees sub-criteria matrix in relation to the teamwork sub-criterion	0.00
The customer's feedback sub-criterion matrix in relation to the organizing and management sub-criterion	0.00
The customer's feedback sub-criterion matrix in relation to the systems and techniques sub-criterion	0.00
The customer's feedback sub-criterion matrix in relation to the evaluation and feedback sub-criterion	0.064

The continuous improvement sub-criterion matrix in relation the systems and techniques sub-criterion	0.0027
The quality systems sub-criterion matrix in relation the systems and techniques sub-criterion	0.034
The product design sub-criterion matrix in relation the systems and techniques sub-criterion	0.027
The supplier management sub-criterion matrix in relation the feedback and evaluation sub-criterion	0.00
The communication sub-criterion matrix in relation the systems and the employees criterion	0.021

If this rate is higher than 0.1, the matrix is inconsistent (Ying & Chang, 2009). Since the incompatibility rate of responses is less than 0.1, then all the matrices are compatible.

Matrices of paired comparisons

After collecting of questionnaire by Excel software, the entire data was encoded and by considering of the group paired comparisons, the geometric mean of the responses were obtained.

$$A_{ij} = \left[\prod_{k=1}^{N} a_{ij}^{(k)}\right]^{1/N}$$

That the fuzzy paired matrices were extracted as follows. Table 9 shows the typical phase paired comparisons.

Table (9): Fuzzy paired comparisons of the main criteria in relation to target

Criterion	Management	Employees	Systems and techniques	Evaluation and feedback
Management	(1,1,1)	(5.66,6.64,7.6)	(2.44,4.48,5.5)	(6.08,7.05,8.01)
Employees	(0.13,0.22,0.18)	(1,1,1)	(0.34,0.43,0.62)	(0.21,0.26,0.36)
Systems and techniques	(0.18,0.22,0.29)	(1.6,,2.31,2.95)	(1,1,1)	(1.57,2.01,2.38)
Evaluation and feedback	(0.12,0.14,0.16)	(2.81,3.84,4.86)	(0.42,0.5,0.64)	(1,1,1)

The numbers in this table describes, for example, in the first row and second column of the table, sub-criteria fuzzy paired comparisons of personnel showed in relation to the management sub-criteria of these numbers (Table 9): (5.66, 6.64, 7.6). By considering of fuzzy paired comparisons rules(Mehrgan, 2004), the reverse cell of this cell; that is the first column's the second row of the table; is reversed as follows:

$$(5.66, 6.64, 7.6) \rightarrow \left(\frac{1}{7.6}, \frac{1}{6.64}, \frac{1}{5.66}\right) \rightarrow (0.13, 0.22, 0.18)$$

Defuzzifying of the paired comparisons matrices

By considering of the conversion formula of fuzzy numbers into Minkowski certain numbers, all numbers were converted to certain numbers. For example, the paired comparison's fuzzy numbers of the management in relation to the staff (5.66,6.64,7.6) are as follows, that was used $x = m + (b - a)/4$ formula for the conversion of this:

$$X = 5.66 + (7.6 - 6.64)/4 = 5.9$$

Table (10): Defuzzified paired comparisons matrices of the main criteria in relation to target

Criterion	Management	Employees	Systems and techniques	Evaluation and feedback
Management	1	5.9	3.19	5.84
Employees	0.14	1	0.39	0.23
Systems and techniques	0.2	1.44	1	1.48
Evaluation and feedback	0.13	2.55	0.46	1

Finally, by using the Super-Decision software, the matrices were solved and the weights of all components were obtained.

Super-matrix calculating

The gathering of all calculated weights is presented in an unweighted super-matrix, that it is called an unweighted super-matrix. This super-matrix is the unweighted super-matrix of the evaluated Total Quality Management model. In this super-matrix, the sum of the rows is less than one.

Since by adding some specific values and by helping Super-Decision software, we can extend the all columns' weight sum into one, then this new super-matrix is called the weighted super-matrix. Then we

can obtain the restricted super-matrix from weighted super-matrix. To avoiding from prolonging of this research.

The weights and ranks of Total Quality Management sub-criteria

The weights and ranks of the main criteria of Total Quality Management extracted from Super-Decision software is shown in the table (12).

Table (12): Weight and rank of the main criteria of Total Quality Management

Criterion	Weight	preference
Organizing and management	0.45	1
Employees	0.0912	3
Systems and techniques	0.276	2
Evaluation and feedback	0.0182	4

The weights and ranks of Total Quality Management sub-criteria

The weights and ranks of Total Quality Management sub-criteria extracted from Super-Decision software is shown in the following table 13.

Table (13): Weight, rank and the preference of Total Quality Management sub-criteria

Criterion	Weight	Preference
Strategic planning	0.001	17
Top management support	0.22	2
Quality culture	0.0014	16
Employees encouragement	0.0745	5
Identification and training	0.268	1
Employees involvement	0.0418	7
Teamwork	0.0095	10
Customer's feedback	0.0055	11
Continuous improvement and innovation	0.0142	9
Quality systems	0.0248	8
Product or service design	0.0034	12
Supplier management	0.0033	13
Processes' management	0.0029	14
Human resource management	0.171	3
Communication	0.0017	15
performance evaluation	0.0979	4
Information and analysis	0.0591	6

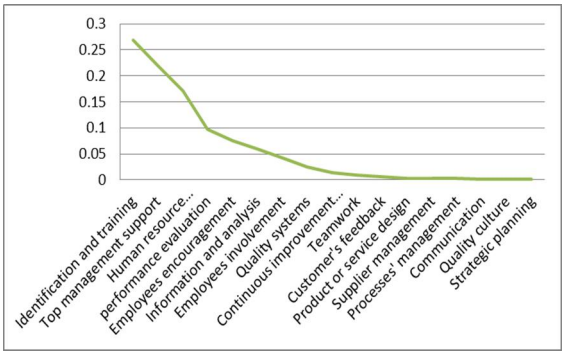

Diagram (2): Criteria prioritizing diagram by considering of sub-criteria weights of Total Quality Management, which are extracted from fuzzy network analysis process

Discussion of Results

The main objectives of this research are identical with the findings of researches (Nazemi et al, 2010; Ariful & Anwarul, 2012; Huai, 2012; Shahin & Dabestani, 2011) and with the results of (Lamei, 2002; Pual, 2002; Townes et al, 1995). The results of this study indicate that to make a permanent change in an organization, we must have special attention to system organization and the amount of accepting it by top managements. The sub-criteria of these main criteria include that: top management support, strategic planning and quality systems, which indicate of manager responsibility for the success of the organization. In addition to this main criterion allocates first place to itself, top management support sub-criterion has achieved high weight and rank, which indicate their interest in the establishment of the organization's management systems. The belief of organization's top management to this subject that system can increase the efficiency and effectiveness of the organization is the most important tool to achieve this. In addition, it can show the direction of motion for the organization. The sub-criteria such the identification and training of staff, top management support and human resource management have allocated the first to three rank that indicate the complementary relationship between the organization and the management and staff in making of change quality.

Research limitations

1- In this study due to lack of mobility and changes in the geographic areas under normal conditions, only a random selection was done and their random assignments was not possible for the researcher; Thus in this study, the semi-experimental method was used and this satisfies that researcher control over some variables decrease.

2- Due to lack of suitable time for training, which will affect the final result of the research, we require

more time and resources that actually affect performance results.
3- Due to the severity of Total Quality Management criteria, the number of inquiries was numerous and it is suggested that the researchers in future studies have less number of criteria of their choice.
4- Due to low numbers of specialized experts in the organization, as well as being specializing of paired comparisons, we are forced to select a smaller sample size.

Practical suggestions

- Since the main criterion of organizing and organization management is in the first place, thus any change in the organization system must be transferred from the top to the bottom of the organizational pyramid.
- Since the main criterion of systems and techniques is in the second place, thus it suggested that the systems and techniques must be identified and be paid attention.
- According to the first priority of employee identifying and training, using of training courses are necessary for establishment of Total Quality Management.
- Using of appropriate incentive mechanisms to boost morale and employee and managers involvement is recommended. Paying salaries, bonuses based on merit and performance of employee is an important action that senior management staff of the organization should implement. Also, the participation of the employees by executing of the staff's selected proposals is an important motivational tool. It is obvious that this importance can effect on the commitment, teamwork, mutual respect and accountability as well as improving staff efficiency of employee.
- Establishing a strong statistical section in order to realistic decisions (based on data), is recommended.
- According to the prioritization of criteria and factors of this research, it is recommended to managers to using of the priority of these factors when establishing quality management systems in the future.
- The importance of the factors that have the highest ranking in terms of overall quality management is essential.

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