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A COMPILATION MODEL FOR THE SELECTION OF QUALITY MANAGEMENT SYSTEM BASED ON THE BENEFITS OF THEIR APPLICATION IN THE AUTOMOTIVE INDUSTRY BY USING DEMATEL FUZZY AND ANALYTIC NETWORK PROCESS

Abstract: *Today, for a variety of reasons, including high level of safety in the vehicle, the establishment of a proper quality management system in car companies has become very important. Therefore, this study tries to integrate ANP and Fuzzy DEMATEL techniques into the Alpha Automotive Company to help in selection the most appropriate quality management system that is more in line with reality. For this purpose, firstly by reviewing the literature and a survey of experts, the most important quality management systems in the automotive industry, as well as the benefits derived from their application, were identified. Then, in the framework of ANP the paired comparisons of the different elements were studied. To evaluate the relationship between the indicators and the costs, the fuzzy DEMATEL technique has been used. The results show that the error analysis system and its effects, ISO standard and quality control loops are the best quality management system for Alpha Company.*

Keywords: *Quality management systems, Dematel fuzzy technique, Analytic network process, Automobile industry.*

1. Introduction

Profitability is one of the most important factors in the success of any organization. High profitability is achieved by increasing sales and reducingcosts in all organizational processes. Top Selling is largely the result of high quality and reasonable price. Improving quality and reducing costs are the most important organizational tasks (Montgomery, 2002). The quality is what the customer expresses as his own desires and without doubt, it is the shortest way to achieve productivity with minimal cost. Different people have different definitions of quality. Joseph Juran has defined the quality as "fitness for use"(2003). Iso 9000 defines quality as an ability to meet declared or implied needs. Along with changing environmental conditions, only organizations that can provide customer satisfaction are successful .Therefore, another definition of quality is: "Achieving customer loyalty" (Purushothama, 2010). In order to achieve quality as a culture, quality management systems have emerged the quality as a process in organizations. Quality management system is a philosophy of

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continuous improvement that can provide scientific tools and techniques to meet the needs and expectations of each organization. Today, the quality of a product is not only dependent on the quality of the process, but also depends on the quality of the quality management system. If the organizations management does not support the improvement activities, the continuous improvement of products and processes will not be possible.

Research shows that the use of quality management along with statistical methods is a good guarantee for the success of organizations' quality management programs. It seems that organizations which use these tools more than others have a higher performance (Ahmed and Hassan, 2003). Organizations with quality systems have a significant difference compared to those which have not in terms of commitment to quality, quality structure, effectiveness assessment in relation to customers, employees and suppliers, teamwork, and quality assurance systems compared (Drew and Healy, 2006). The results of the research on the quality performance in manufacturing companies show that quality systems have an overall effect on performance of the business (Sun and Cheng, 2002). Studying the performance of 164 organizations using quality systems shows that they have much higher performance than organizations with no quality systems (chow.chua et al 2003). Companies with ISO certification and total quality management (TQM) experience have a better performance in terms of defective products, customer complaints, profitability, finance and productivity (Sun 2000, Drew and Healy, 2006; Stuart and Podolny, 1996). Previous studies show that the implementation of systems and quality management tools reduces waste, mitigates errors, improves financial performance and generally improves the quality of products and services, which ultimately leads to increased customer satisfaction and improved relationships between employees (Forza and Flippini, 1998; Samson and Terziovski, 1999; Flynn et al. 1995; Demirbag et al., 2006). Quality management systems are focused on meeting customer needs, and achieving the goals of the organization (Kumar et al., 2009). By implementing quality management, companies record the manufacturing cycle time more efficiently, and this leads to a concentration on customers and their needs. In addition to improving the product quality, the quality management activities can reduce rework, waste and the amount of safety stock (Sitki Ilkay & Aslan 2012). In a research done by Lloyd's company in 1992 the results of implementing quality management systems were described as follows: (Putri and Yusof, 2009).

- 68% of respondents have mentioned the quality improvement, control, and organizational planning as a result of implementation of ISO9000 systems.
- 73% of respondents have reported that providing better service for customers and compatibility between different departments of an organization as the advantage of implementing these systems.
- 53% of respondents said that reducing waste was considered as one of the implications of implementing these systems.
- 50% of respondents have reported that the quality system increases employee motivation and reduces their exit from the company.
- 40% of respondents have identified cost reductions as a consequence of implementing these systems.

Considering a study on 115 top British managers (that 49% of them were from non-manufacturing companies), the benefits of implementing the ISO 9000 standards are as follows: the benefits of implementing the ISO 9000 standards are as follows : Increasing management control, increasing customer satisfaction, achieving motivated workforce, increasing opportunities for success in work, Increasing productivity / efficiency, reducing waste, improving effective and efficient marketing, reducing costs, increasing market share. Quality techniques and toolsplay a key role in the organization for continuous improvement. The benefits of using these tools can be, the monitoring and evaluation of processes, the participation of all individuals in the recovery process, the development of continuous improvement thinking, and the strengthening of teamwork through problem solving (Dale and McQuater, 1998; Bunny and Dale, 1997; Grover, 1997). Quality management systems can help organizations to increase customer satisfaction with products or services. They also encourageorganizations to identify customers' demands and determine processes for obtaining an acceptable product or service for customers. A quality management system can provide a framework for continuous improvement of organization to increase the probability of customer satisfaction (Wilson & Collier, 2000). The key factor in implementing quality management systems and tools is how to use themto make sure they are used consistently and continuously in the continuous improvement of organizations.

This is interesting that these methods are still not widely used in the expectations. The important thing to keep in mind is that even similar organizations have different needs and, as a result, use different tools and methods (Susa et al., 2005). On the other hand, it cannot be accepted that all organizations benefit from any tool or method.

Prioritization is a convenient way to summarize a large set of data and describe a pattern of similarity between goals and topics. Prioritization can help manager to understand organizational phenomena and examine useful concepts for existing clusters and test hypotheses (Everitt, 1993). It is also a tool for studying patterns of data and facilitating communication between different groups of research works (Everitt & Dunn, 2001). Today, large-scale industries are operating globally. One of them is the automotive industry, which is the most important manufacturing industry in the world. The automotive industry is a sample of industries that has a set of characteristics such as sophisticated products, high quality, safety requirements, a massive sales market, and significant job creation rates. Taking all the features into account, the quality management system chosen for a car manufacturer or its component parts must be able to meet all the above requirements. The mismanagement of the Iranian automobile industry in recent years has led to a decline in the quality and cost of car production, but due to the rapid technological developments in the world, the industry should be able to obtain customer satisfaction by making the necessary improvements. The main problem with Alpha's quality system is that the quality systems have implemented regardless of quality costs, especially human resource costs, and the quality requirements associated with each stage of the production process. In fact, the application of quality systems at the design stages and adaptation of customer requirements with product specification before starting production is very low and the organization's emphasis is on using quality systems at the production stages. This lack of attention has imposed a lot of costs on the organization. It is unnecessary to use some inspections in the production process in parallel. The present research can help Alpha company managers making informed choices about the quality system by providing prioritization of quality management systems based on the benefits of using them in this company.Therefore, the research question is as follows: What is the most appropriate quality management system in alpha company based on the benefits of using it.

2. Literature review

Today, several companies have implemented total comprehensive quality management as an important technique for improving quality to achieve business success. This technique is defined according to ISO standard: "A management approach which is focused on quality in order to achieve long-term success through customer satisfaction and profitability. It is based on the activities of all organization members." The Japanese industrial standard sees quality as "a set of characteristics or functions determining whether a product or service has its own application or not." The definition of quality according to European organization for quality control (EOQC) is: "the totality of characteristics of a product or service that bear on its ability to satisfy stated and needs." According to Deming and Fegenbaum, quality is “a broad concept that all parts of the organization are committed to and it aims at increasing the efficiency of whole set. Quality is an image representing the organization role to customers. "Quality management is an aspect of overall management that defines and implements quality policies. The structure, responsibilities, procedures and organizational resources are referred to as the quality system for the implementation of quality management. In fact, quality system is a set of various factors including human resources, raw materials, equipment, activities and communications that work together to produce a product or service in accordance with customer demands and satisfy his requirements. A quality management system is a philosophy of continuous improvement that provides a set of scientific tools and techniques to meet the needs, expectations and expectations of each organization (International Standard 8402-1986: Quality Vocabulary).

According to a review paper written by McQuater et al. (1995), techniques and tools are practical methods, skills, means or mechanisms that can be applied to particular tasks. they play a key role in continuous improvement of a company by allowing monitoring and evaluation of process, Involvement of everyone in recovery process, Enhancement of problem solving ability, develop a continuous improvement mind set and Reinforcement of team work through problem solving.A research is done by Fotopoulos and Psomas (2009) in order to examine the level of use of quality management tools and techniques as well as staff training in ISO 9001: 2000 certificated. The data collection tool in this empirical research is a questionnaire. It can be concluded that the Greek companies, despite their relatively small size, have responded to the demand for a modern market in terms of a certified quality management system. The techniques and tools of quality are misused in terms of knowledge, skills and experience. Due to the fact that continuous improvement, cost reduction and customer satisfaction are required, quality should be assured at the earliest possible stage. The design of products, processes, and production conditions is the beginning of the earliest stage. Drew and Healy (2006), in their research, provided quality plans, including quality standards, adopted by Irish organizations, and compared the results of this study with the results of the survey in 1995. The results show that TQ organizations are significantly different from non- TQ organizations in relation to having ISO 9000 certification. However, statistically, there are significant differences between TQ and non-TQ organizations, in relation to commitment to quality, quality structure, measures to evaluate the effectiveness in relation to customers, employees and suppliers, team working, quality assurance systems, use of quality tools and techniques and investment in training. Yeung and et.al (2003) state that the purpose of their study is to examine various patterns of quality management systems (QMS) and the relationship between these patterns and organizational performance. In this study, a cluster analysis is identified from the results of the survey data of four patterns of the quality management system which are named as undeveloped quality system, frame quality system, accommodating quality system, and strategic quality system. It should be remembered that the classifications have been one according to the characteristics of each pattern. Since choosing implementing and classifying engineering tools and methods for continuous improvement is difficult, Putri and Yousef (2009), used AHP method for ranking key factors in the success of quality engineering. Based on the results of this research, the important factors in achieving the goals of quality engineering is categorized. The implementation of quality engineering on the basis of this ranking seems necessary to promote continuous improvement in the organization. Sun (2000) conducted a research in Norway. The results indicate that TQM criteria such as quality leadership, human resource development, quality information, and etc., improve customer satisfaction and business performance. ISO9000 standards are may contribute in the implementation of TQM and business process improvement. The purpose of a research done by Tari and et.al (2007) is to identify the relationships between quality management activities and the direct and indirect effects of these activities in Spanish companies. The results of the research show that quality management activities have a positive impact on quality implications. In this research, the criteria of profitability, delivery of products with desirable quality and according to customer needs, increase customer satisfaction, increase productivity / efficiency, reduce costs and increase market share are mentioned. Samson and Terziovski (1999), examined the total quality management activities and operational performance of a large number of Australian and New Zealand manufacturing companies and to determine the relationship between these activities and companies performance quality.

This study addresses the benefits of increasing customer satisfaction, continuous improvement, and reducing waste and error studying previous researches that there has been no study done on prioritization and selection of quality management systems in automotive industry, and limited studies done on prioritization of quality management systems in other manufacturing organizations have not used network analysis process and fuzzy Dematel. In this research, the Dematel fuzzy method is used to identify the relationship between systems as well as the relationship between the benefits of their application. Fuzzy sets have more compatibility with linguistic and ambiguous descriptions. Therefore, it is better to use long-term prediction and real-world decision using fuzzy sets and fuzzy numbers. The network analysis process is used to determine the relationship between quality systems and the benefits of them. Table 1 shows the benefits of implementing quality management systems along with their respective backgrounds.

Table 1. Benefits of implementing quality management system

	Benefits of implementing quality management systems	References
1	Preventing waste of resources	Putri and Yousef 2009
2	Profitability	Sun 2000, Drew and Healy 2006, Tari and et. al 2007
3	Delivering products and services with optimal quality and in accordance with customers requirements	Tari and et.al 2007, Terziovski et.al 2003

Table 1. Benefits of implementing quality management system (continued)

	Benefits of implementing quality management systems	References
4	Enhancing customer satisfaction	Grover 1997, Putri and Yousef 2009, sun2000, Drew and Healy 2006, Fotopoulos and Psomas 2008, Anderson et. al 1995, Susa et. al 2005
5	Increasing productivity / efficiency	Grover 1997, Sun 2000, Tarı and et.al 2007
6	Improving effective and efficient marketing	Grover 1997, Tarı and et.al 2007, Terziovski et al. 2003
7	reduction in costs	Thia 2005, Fotopoulos and Psomas2008, grover 1997, Tarı and et.al 2007
8	Increasing market share	grover 1997, Tarı and et.al 2007, Hendricks and Singhal 1996, Nicolau and Sellers 2002
9	Increasing staff motivation and reducing their exit from the company	Grover 199, Dale and McQuater 1998
10	Process correction	Dale and McQuater 1998, Putri and Yousef 2009, sun 2000
11	Reduce Trial / Inspection	Zeitz and et.al 1997
12	Possibility to assess the transparency and documentation of processes	Dale and McQuater 1998 , Putri and Yousef 2009
13	Assess the performance of processes and determine the range of problems	Dale and McQuater 1998 , Putri and Yousef 2009
14	reinforcing teamwork spirit in problem solving	Dale and McQuater 1998, Putri and Yousef2009, McQuater and et.a 1995, Drew and Healy 2006, Susa et.al, 2005
15	Ensure the correct execution of the tasks when done for the first time	Dale and McQuater 1998
16	Increasing employee satisfaction	Drew and Healy 2006
17	Continuous improvement	Putri and Yousef 2009, McQuater and et.al 1995, Fotopoulos and Psomas 2008, Bunny and Dale1997
18	Improving the quality of suppliers	Putri and Yousef 2009, Susa et.al 2005
19	Reducing cautious storage	Sitki Ilkay and Aslan 2012
20	Reducing production cycle time	Sitki Ilkay and Aslan 2012
21	Reducing product return rates	Sitki Ilkay and Aslan 2012
22	Meeting the needs and expectations of the organization	Grover 1997
23	Benefits of return on capital	Dale and McQuater 1998
24	The ability to understand concepts by individuals and teams is facilitated and measured so that the process moves towards a comprehensive quality management system.	Dale and McQuater 1998

3. Methodology

3.1. Proposed process model

Figure 1 shows the proposed research steps.

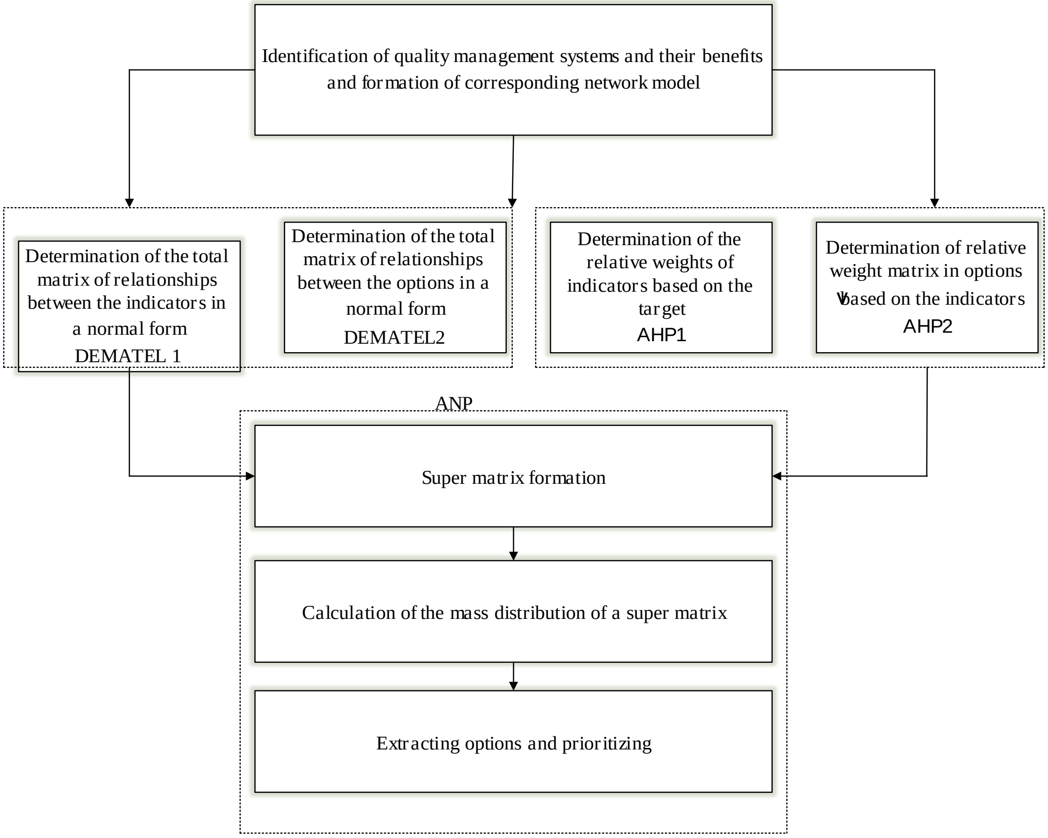

Figure 1. Shows the proposed research steps

3.2. Method and tools for data collection

In this research, questionnaire was used to collect data. To this purpose, three questionnaires were developed and distributed among ten experts in the automotive industry and academia. The first questionnaire is used for screening of quality management systems and the benefits of using them and their adaptation to this study, which were identified from previous researches at the beginning of the study. Finally, 8 quality management systems were selected as options and 12 benefits as indicators. The second questionnaire is related to the Dematel fuzzy technique. Based on the nature of the problem, the options and criteria are not completely independent from each other. Consequently, this questionnaire was developed to calculate the internal relations between the options (quality management systems) and the internal relations between the criteria (benefits of quality management systems). This questionnaire uses the triangular fuzzy spectrum, presented in Table 2.

Table 2. Language Scales for Paired Comparisons (Lee, 1999)

Words for comparisons Paired	Language values
Very high impact	(0/75، 0/75 ،1)
High impact	(0/5، 0/75 ،1)
Low impact	(0/25، 0/5 ،0/75)
Very little impact	(0 ،0/25،0/5)
Effectless	(0، 0،0/25)

The third questionnaire is related to the network analysis process technique. This questionnaire was designed to achieve the ultimate goal of the research (Selecting Quality Management System for alpha company). The third questionnaire related to the network analysis technique has been designed to achieve to the ultimate goal of the research. Then, considering this comparison, it is determined which criteria or option is preferable. Also the amount of preference can be checked. The questionnaire has been designed according to the scale of relative importance (Saaty, 1980), which should be given to each question, a score between 1 and 9. The explanation of numbers in the tables is given in Table 3.

Table 3. Scale of relative importance (Saaty, 1980)

Intensity of importance	Degree of importance in a pair comparison
1	The same preference
2	Identical to fairly preferred
3	Relatively better
4	Fairly strongly preferred
5	Strongly preferred
6	Strongly so much stronger
7	Very strong preference
8	Too much to no avail
9	Extremely preferable

The content validity of the questionnaires has been approved by university professors and automotive industry experts. The reliability of them is measured by Saaty at an inconsistency rate, so that at first the highest amount of the final matrix is calculated, and then the fixed value matrix is proposed as the randomization matrix incidence index. The final value of the incompatibility rate, which is the same as the reliability value, is obtained from the outside of the amount of the incompatibility index on the randomly matched incompatibility index. If the result is less than 0.1, we say that compatibility and reliability has been accepted (Saaty, 1996). In this research, the incompatibility rate for all paired comparison tables is less than 0.1 (at least 0 and at most 0.09).

3.3. Data analysis

3.3.1. Fuzzy dematel technique

The DEMATEL method was first introduced at the Geneva Research Center. This methodology was used to solve complex issues such as famine, energy, environment protection, and etc. (Wei et al 2005). The DEMATEL method is one of the multi-criteria decision-making tools based on the graph theory that enables us to plan and solve problems (Kumar et al 2009).

The final product of the DEMATEL process is providing an image which helps respondent to organize his activity and identify the relationships between the criteria (Lee et al., 2009; Wu, 2008). Experts' opinion is necessary for using the Dematel method, and these comments contain ambiguous verbal phrases. In order to integrate and eliminate ambiguities, it is better to turn these phrases into fuzzy numbers. For this purpose, Lin and Wu (2008) presented a model that uses the Demetal method in a fuzzy environment. The fuzzy Dematel steps are similar to the typical Dematel, with the difference that verbal scale proposed by Lee (1999) is used in fuzzy Dematel method. Table 3-6 shows the correlation between verbal expressions and triangular fuzzy values. As stated, in this way respondents answer the questions on the basis of verbal expressions. Then the encoding method is converted to fuzzy triangular numbers, which is proposed and approved by Lee et al (2009), and the data is confirmed through fuzzy dematel. In recent years, a large number of studies have confirmed the method of Dematel and diphasization (Yen et al., 1999; Yang et al., 2008). Dematel technique has two major functions: 1. considering mutual relationship; the advantage of this approach over network analysis is its clarity in reflecting interactions between a wide range of components. So that professionals can be more fluent in expressing their opinions about the effect of factors (direction and severity of effects). It should be noted that the matrix derived from the fuzzy Dematel (internal communication matrix) is a part of the matrix. In other words, the Dematel technique works dependently, but as a subsystem of a larger system such as ANP. 2. Structuring complex factors in the form of cause and effect groups; this is one of the most important functions and reasons for its extensive use in problem solving processes. In this method, the decision maker understands the relationships better by dividing a wide range of complex factors into cause and effect groups. This leads to better understanding of the factors and their role in mutual interaction.

3.3.2. Network analysis process and its combination with Dematel

The ANP is an extension of the AHP method and its general form. ANP manages dependency on a criterion (internal affiliation) and between different criteria (external affiliation) (Wu, 2008). AHP structures a decision problem into a hierarchy using indirect relationships between the criteria, while ANP provides an opportunity to examine more complex internal relations among the criteria. The ANP method can be defined as follows: In the first step, the ANP uses the criteria to create super matrix. This will begin with two-dimensional comparisons by asking how much this criterion is important/ relevant compared to other criteria in relation to interests and preference? Relative importance can be defined using 9- point Likert scale (Saaty, 1980). The general form of the final matrix can be defined as:

$$
\begin{array}{cc}
 & \begin{array}{ccccccccc} e_{11} & \overset{c_1}{\cdots} & e_{1m_1} & e_{21} & \overset{c_2}{\cdots} & e_{2m_2} & \cdots & e_{n1} & \overset{c_n}{\cdots} \; e_{nm_n} \end{array} \\
W = \begin{array}{c} c_1 \\ c_2 \\ \vdots \\ c_n \end{array}
\begin{array}{c} e_{11} \\ e_{12} \\ \vdots \\ e_{1m_1} \\ e_{21} \\ e_{22} \\ \vdots \\ e_{2m_2} \\ \vdots \\ e_{n1} \\ e_{n2} \\ \vdots \\ e_{nm_n} \end{array}
& \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1n} \\ W_{21} & W_{22} & \cdots & W_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ W_{n1} & W_{n2} & \cdots & W_{nn} \end{bmatrix}
\end{array}
$$

Figure 1. Super Matrix (Saaty, 1980)

That C_n represents the n^{th} group, e_{nm} represents the m^{th} element in the n^{th} group, and W_{ij} is a special vector of effect of the elements in comparison between i^{th} and j^{th} group. Additionally, if the j^{th} group does not have an effect on the i^{th} group, then $[W_{ij}]=0$. Subsequently, the weighted super matrix is obtained by multiplying the super-impact matrix made according to the DEMATEL method. The weighted super matrix is created by changing the sum of all the columns into a single column. This step is more similar to the concept of the Markov chain; in which we ensure that the sum of these probabilities in all conditions is equal to 1. Although we know that the impact of each criterion may vary according to the results of the Dematel method. If the impact degrees of this criterion are considered equal, the mean method can be used to obtain a weighted super matrix. The results of the reviewed weights will be higher and lower than the actual position. For this reason, we use the DEMATEL method to overcome the constraints and assume that the super-impact matrix is determined according to the results of the DEMATEL method.

4. Results

4.1. Research procedure

Initially, considering the previous studies, a number of quality management systems and their benefits were identified. Eventually, according to Expert reviews, 8 quality management systems were chosen as the options and 12 benefits of using QMSs as criteria. Figure 3 shows the network model for the problem.

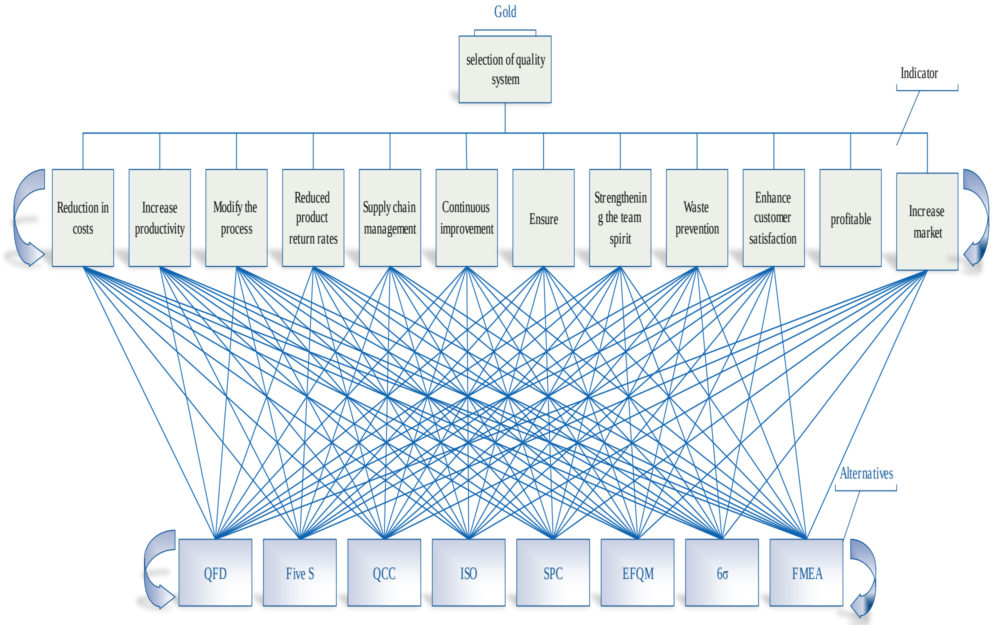

Figure 3. Network model

Then, the Dematel questionnaire is completed and collected by Alpha Car manufacturing experts and academia. In this step, the respondent is asked to determine the effect of any quality management system on other identified systems, as well as the effect of each of the benefits of QMSs on other benefits. After performing the fuzzy Dematel steps, analyzing it and using fuzzy data, the CFCS method is used to re-convert fuzzy numbers to verbal expressions.

Opricovic and Tzeng (2003) proposed the CFCS method based on the determination of left and right limits using fuzzy minimum and maximum, and the overall limit is determined on the basis of the weighted average according to the membership functions. The output of the defuzzification is shown in Tables 4 and 5. These tables are placed in the super matrix of network analysis process.

Table 4. Diffused matrix of options

	FMEA	6σ	EFQM	SPC	5S	ISO	QFD	QCC
FMEA	0/045	0/115	0/105	0/119	0/113	0/120	0/137	0/130
6σ	0/128	0/009	0/097	0/122	0/104	0/107	0/106	0/140
EFQM	0/130	0/022	0/041	0/112	0/131	0/123	0/101	0/139
SPC	0/118	0/026	0/113	0/038	0/142	0/114	0/108	0/143
5S	0/118	0/020	0/128	0/083	0/040	0/122	0/100	0/145
ISO	0/154	0/026	0/138	0/112	0/139	0/045	0/118	0/165
QFD	0/146	0/025	0/119	0/104	0/103	0/107	0/037	0/139
QCC	0/152	0/058	0/128	0/127	0/132	0/120	0/118	0/075

Table 5. Dimensional matrix of criteria

	PW	P	ICS	RC	PI	BM	ECI	CI	SCM	ROI	IP	IMS
PW	0.061	0.081	0.074	0.088	0.083	0.081	0.084	0.083	0.081	0.083	0.085	0.075
P	0.070	0.052	0.068	0.070	0.075	0.074	0.071	0.073	0.072	0.071	0.070	0.071
ICS	0.079	0.086	0.062	0.078	0.085	0.082	0.083	0.084	0.084	0.084	0.082	0.093
RC	0.077	0.082	0.075	0.057	0.074	0.075	0.080	0.081	0.078	0.076	0.079	0.073
PI	0.096	0.094	0.099	0.097	0.072	0.099	0.097	0.098	0.097	0.097	0.096	0.096
BM	0.093	0.088	0.097	0.092	0.094	0.070	0.097	0.097	0.094	0.095	0.094	0.094
ECI	0.083	0.080	0.083	0.082	0.082	0.082	0.061	0.080	0.080	0.082	0.083	0.080
CI	0.098	0.098	0.104	0.101	0.106	0.104	0.100	0.076	0.104	0.103	0.101	0.104
SCM	0.096	0.093	0.098	0.095	0.093	0.092	0.091	0.094	0.070	0.095	0.095	0.097
ROI	0.088	0.085	0.084	0.088	0.083	0.081	0.085	0.083	0.087	0.063	0.086	0.082
IP	0.087	0.086	0.087	0.088	0.085	0.088	0.086	0.085	0.086	0.085	0.063	0.085
IMS	0.069	0.074	0.069	0.064	0.068	0.068	0.066	0.067	0.066	0.065	0.066	0.050

The final stage of the Dematel process is the calculation of $D_i - R_i$ & $D_i + R_i$ (Tables 6 and 7). R_i & D_i are obtained from the sum of each row and column of the matrix V, respectively (Yang et al., 2008). $D_i + R_i$ is placed on the X axis, while $D_i - R_i$ is on the Y axis. $D_i + R_i$ values represent the importance of each factor, and higher values of a factor indicate the higher importance of it (Lee et al., 2009). In the present study, the significance index has been used for the final screening of options and criteria and consequently inputs of the network analysis process.

Table 6. $D_i + R_i$ & $D_i - R_i$ Values and Options

	D	R	D+R	D-R
FMEA	0/909	1/076	1 /985	-0/167
QCC	0/883	0/991	1/874	-0/108
6σ	0/897	0/857	1/754	-0/04
SPC	0/799	0/868	1/667	-0/069
QFD	0/756	0/905	1/661	-0/149
EFQM	0/802	0/817	1/619	-0/015
5S	0/78	0/824	1/604	-0/044
ISO	0/813	0/301	1/114	-0/512

Subsequently using the network analysis process, the relative weights of each of the indicators are determined on the basis of their two dimensional comparisons and

Saaty's nine-point scale. Finally, a column vector representing the relative weight of the indicators is obtained, which is used as the relative weight matrix of the indicators based on the goal in the super matrix.

The relative weights of indicators are shown in Table 8. The special vector of options based on indicators is also shown in Table 9.

Table 7. $D_i + R_i$ & $D_i - R_i$ Values and Criteria

	D	R	D+R	D-R
CI	1/2	1	2/2	0/2
PI	1/14	1	2/14	0/14
SCM	1/11	0/998	2/11	0/11
BM	1/11	0/998	2/1	0/11
IP	1/01	0/999	2/01	0/01
ROI	0/99	0/999	1/99	-0/01
ICS	0/98	0/999	1/98	-0/02
ECI	0/96	1/001	1/96	-0/04
PW	0/96	0/999	1/96	-0/04
RC	0/91	0/999	1/9	-0/09
P	0/84	0/999	1/84	-0/16
IMS	0/79	0/999	1/79	-0/21

Table 8. Relative weight of indicators based on the target

Indicators	Relative weight of indicators based on the goal
Process modification	0/11228
Increasing Productivity	0/0486
Enhancing customer satisfaction	0/2694
Increasing market share	0/0804
Continuous improvement	0/0884
Improving teamwork	0/0619
Ensure the correct implementation of the tasks	0/0474
profitability	0/0764
Supply chain management	0/0506
Waste prevention	0/0631
Reducing product return rates	0/0513
reduction in costs	0/0504

Table 9. Special vector of options based on indicators

metrics	Modify the process	Increase productivity	Enhance customer satisfaction	Increase market share	Continuous improvement	Strengthening the team spirit	ensure	profitable	Supply chain management	Waste prevention	Reduced product return rates	Reduction in costs
6σ	0/248	0/300	0/291	0/218	0/228	0/238	0/129	0/293	0/256	0/183	0/243	0/178
EFQM	0/247	0/070	0/213	0/245	0/177	0/143	0/135	0/148	0/174	0/152	0/103	0/119
5s	0/082	0/069	0/056	0/085	0/057	0/092	0/077	0/075	0/050	0/081	0/057	0/078
FMEA	0/085	0/114	0/068	0/056	0/142	0/048	0/226	0/062	0/045	0/166	0/198	0/260
ISO	0/071	0/167	0/118	0/117	0/118	0/172	0/126	0/118	0/195	0/095	0/116	0/105
QCC	0/092	0/102	0/084	0/092	0/076	0/136	0/144	0/095	0/096	0/124	0/082	0/092
QFD	0/082	0/056	0/072	0/103	0/044	0/074	0/088	0/083	0/072	0/076	0/078	0/083
SPC	0/093	0/121	0/096	0/083	0/156	0/096	0/104	0/125	0/113	0/121	0/123	0/084

Ultimately, Super matrix is formed. Super matrix is a matrix of relationships between the network components deriving from the priority vectors of these relationships. This matrix provides a framework for determining the relative importance of options after two dimensional comparisons. It should be noted that due to the type of communications in the problem model structure, some of these matrices may have zero values, indicating the ineffectiveness of the elements at the intersection of the rows and columns on each other. Table 10 shows the weighted super matrix.

Table 10. Weighted super matrix

cluster		purpose	Criteria												Options							
group		purpose	PI	IP	ICS	IMS	CI	BM	ECI	P	SCM	PW	ROP	RC	6σ	EFQM	5S	FMEA	ISO	QCC	QFD	SPC
	purpose	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Criteria	PI	0.11	0	0.07	0.07	0.08	0.07	0.13	0.06	0.07	0.88	0.07	0.07	0.07	0	0	0	0	0	0	0	0
	IP	0.04	0.06	0	0.07	0.07	0.06	0.11	0.06	0.06	0.07	0.06	0.06	0.06	0	0	0	0	0	0	0	0
	ICS	0.26	0.06	0	0	0.08	0.06	0	0.06	0.06	0.08	0	0.06	0	0	0	0	0	0	0	0	0
	IMS	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CI	0.87	0.08	0.07	0.07	0.09	0	0.13	0.06	0.07	0.08	0.07	0.08	0.07	0	0	0	0	0	0	0	0
	BM	0.06	0.07	0.07	0.07	0.08	0.07	0	0.06	0.07	0.08	0.07	0.07	0.07	0	0	0	0	0	0	0	0
	ECI	0.04	0	0.06	0.06	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0
	P	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SCM	0.05	0.07	0.07	0.07	0.08	0.07	0.12	0.06	0.07	0	0.07	0.07	0.07	0	0	0	0	0	0	0	0
	PW	0.06	0.06	0.06	0	0	0.06	0	0.05	0	0	0	0.06	0.06	0	0	0	0	0	0	0	0
	ROP	0.05	0.06	0.06	0.06	0	0.06	0	0.59	0.06	0.07	0.06	0	0.06	0	0	0	0	0	0	0	0
	RC	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 10. Weighted super matrix (continued)

cluster		purpose	Criteria												Options							
group		purpose	PI	IP	ICS	IMS	CI	BM	ECI	P	SCM	PW	ROP	RC	6σ	EFQM	5S	FMEA	ISO	QCC	QFD	SPC
	purpose	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Options	6σ	0	0.12	0.15	0.14	0.10	0.11	0.11	0.06	0.14	0.12	0.09	0.12	0.08	0	0	0.12	0.13	0.13	0.14	0.13	0.17
	EFQM	0	0.12	0.03	0.10	0.12	0.08	0.07	0.06	0.07	0.08	0.07	0.05	0.06	0	0	0.15	0.13	0.15	0.13	0.12	0.16
	5S	0	0.04	0.03	0.02	0.04	0.02	0.04	0.03	0.03	0.02	0.04	0.02	0.03	0	0.17	0	0.12	0.15	0.14	0.12	0
	FMEA	0	0.04	0.05	0.03	0.02	0.07	0.02	0.11	0.03	0.02	0.08	0.09	0.13	1	0.14	0.13	0	0.14	0.13	0.16	0.17
	ISO	0	0.03	0.08	0.05	0.05	0.05	0.08	0.06	0.05	0.09	0.04	0.05	0.05	0	0.18	0.16	0.16	0	0.15	0.14	0.16
	QCC	0	0.04	0.05	0.04	0.04	0.03	0.06	0.05	0.04	0.04	0.06	0.04	0.04	0	0.17	0.15	0.16	0.14	0	0.14	0.18
	QFD	0	0.04	0.28	0.03	0.05	0.02	0.03	0.04	0.04	0.03	0.03	0.03	0.04	0	0.16	0.11	0.15	0.13	0.14	0	0.14
	SPC	0	0.04	0.06	0.04	0.04	0.07	0.04	0.05	0.06	0.05	0.06	0.06	0.04	0	0.15	0.16	0.12	0.14	0.14	0.14	0

5. Discussion and conclusion

Managers face complex and multilateral decisions when choosing quality management systems that can have significant implications for their business success over the years. In this situation, a decision-making technique is needed that can cover all the effective criteria in selection and their results in the business. Therefore, the integrated model presented in this study can help managers in choosing a quality management system. In this study, an appropriate solution was found to fit the reality using a combination of network analysis process and fuzzy Dematel in the form of a multi-factor decision model. In the first stage, the importance and relationship between the criteria (the benefits of implementing quality management systems) and the importance and relationship between options (quality management systems) are calculated using the fuzzy dematel technique. It is clear that considering these relationships will bring the problem closer to the real situation. In fact, by computing the values of $D_i + R_i$ (the axis of importance) and $D_i - R_i$ (the axis of the relationship), the order of the criteria in terms of Significance index is as follows: Continuous improvement, reforming processes, supply chain management /improving supplier quality, reinforcing teamwork, increasing productivity, reducing product return rates, increasing customer satisfaction, ensuring the correct execution of tasks when done for the first time, avoiding waste of resources, reducing costs, profitability, increasing market share. Given the $D_i + R_i$ value of the options, the order of the options in terms of the significance index can be stated as follows: FMEA (failure modes and effects analysis), QCC (quality control circles), 6σ (Six Sigma), SPC (Statistical Process Control), QFD (Quality Function Deployment), EFQM (European Foundation for Quality Management), Five S (Adornment System) And ISO (ISO standards). In the second phase of the research, using the network analysis technique, weighting and prioritizing of quality management systems based on the benefits of their implementation were done. The final prioritization of quality management systems using super decision software shows that failure modes and effects analysis system has the first priority. FMEA is an analytical technique of identifying and preventing system, product and process problems before they occur. It is focused on enhancing safety, and increasing customer satisfaction. A wide range of industries, such as aerospace, nuclear and automotive, use this powerful system to analyze the safety and reliability of products and processes (Liu et al., 2011; Sharma et al., 2005; Chang et al., 2001). The main purpose of this system is to allow analysts to identify potential problems and prevent the transmission of this problem to the customer (Liu et al., 2011; Sharma et al., 2005). The ISO system is the second priority. The ISO TS and ISO 9001 standards are applicable to the automotive industry. At least six procedures must be developed in ISO 9001. Procedures describe a specific to carry out an activity or a process. These mandatory procedures are: 1. Control of documents 2. Control of records 3.Control of nonconforming product 4. Corrective action 5.Preventive action 6.Internal audit. In order to implement the ISO 9001 Quality System, all activities undertaken, including production, inspection, testing, etc., must be recorded in forms that are appropriate to each organization.

Registering activities in forms helps you track all products that are produced. This International Standard is based on the principles of quality management described in the ISO 9000 standard. These descriptions include the description of each principle, the reason for the importance of each of the principles for organization, examples of the benefits associated with these principles and examples of common practices to improve the performance of the organization when applying these principles (ISO 9001: 2015 quality management system requirements). The ISO TS standard aims to create a quality management system that provides continuous improvement with emphasis on preventing defects and reducing changes and losses in the cycle. This standard, along with the specific requirements of customers, determines the basic requirements of the quality management system for those who use these documents. The standard intends to prevent multiple audits to certify and provides a single approach for quality management system in automotive manufacturing organizations and related equipment and services. The ISO TS standard can be applied in locations where components specified by customers for production or delivery of services are made (Quality Management Systems, specific requirements for the application of the ISO / ISO 9001 standard for productive organizations and related Spare parts). The third priority is the quality control circle. This is a collaborative management approach in which volunteer groups of employees in an organization are trained by a team leader or themselves to discover, analyze, and solve problems related to work and provide solutions for management (Russell & Richard, 2002). This methodology was discovered in Japan by Edward Deming and consists of 4 to 15 members. The members of the group share common interests and problems and hold a meeting an hour a week (Griffin, 1998). A quality control circles is a concept that encourages people's workforce and allows them to play their role in improving quality through teamwork. The fourth priority is the Quality Function Deployment system. QFD is a highly effective and efficient way to achieve customer satisfaction in the organization. The purpose of QFD as a programming tool is to reduce two types of inconsistencies in the organization: First, if the product features do not meet the customer's predetermined needs, and second, the final product does not correspond to the technical characteristics of the product. To overcome the first item, this tool communicates between the product features and the voice of customers, and finally reduces the second conflict by shifting and transferring technical characteristics to product components, details, processes, and production characteristics (kahraman et al., 2006). European foundation for quality management is the fifth priority. An investigation carried out on the EFQM in 1994, showed that 60% of companies used this self-assessment model. Another study also shows that this model has a positive impact on the performance of organizations (Eskildsen et al., 2002). Any organization, regardless of its type of activity, size, structure or success rate, needs a model to meet its organizational goals and evaluate its success in achieving its goals and objectives. By applying business excellence models, while an organization evaluates its success rate in executing improvement programs at different times, it can compare its performance with other organizations, and especially with the best one. The control of the statistical process is the sixth priority. The purpose of SPC is to quickly detect deviations with their reason, before a large number of defective product is produced. As the purpose of this system shows, this quality system should not be placed in the first priority because the goal of quality management in today's organizations is to prevent errors and deviations before the beginning of the process. In this research, based on experts opinion Six Sigma has the seventh priority. In Six Sigma, the goal is to reduce the defects and achieve a maximum of 3.4 defects per million, in this condition 99.99966 percent of products are produced healthy. At the end, five S is the last priority. considering the results of the research, it is suggested that alpha company puts the FMEA system priority in the quality management department. According to a survey conducted in the organization, this quality system has been neglected. application of this system can be used to identify failure factors and increase the security rate and ultimately lead to customer satisfaction. The manufacturer of parts needed for the organization participate in the design process, by doing this, the parts have been made in accordance with the needs of the organization and design team. Also, the costs of manpower and inspection of inputs are greatly reduced. Based on the relative weight of the benefits of quality management systems, increasing customer satisfaction, processes modification, continuous improvement, market share, and profitability are of great importance. It is suggested that they pay more attention to these benefits.

5.1. Innovations

Previous researches have shown that few studies have been done using MCDM techniques and compilation models to prioritize and select quality management systems in the automotive industry. Also, in researches, the interactions of options have not been measured while the interactions of options are assessed in this study by using the fuzzy Dematel technique.

5.2. Future researches

In this study, quality management systems are only prioritized based on the benefits of system implementation. Other researches can prioritize according to other criteria such as their proportionality with production and operations system. In order to increase the accuracy of ANP results, it is recommended that this technique can be performed in fuzzy or gray conditions.

It is suggested that Copras technique should be used to determine the priority of the options and the effectiveness of each one in the future researches.

5.3. Limitations

In ANP technique, the relative weight of the criteria based on the target and the relative weight of the options are measured based on the criteria and are specified in the super matrix. But their interrelations means the relative weight of the target based on the criteria and the relative weight of the criteria based on the options are not measured.

The results of this study are specific to Alpha automotive company and can not be generalized to the automotive industry.

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