Identifying and Ranking the Quality Dimensions in Virtual Organizations Using Fuzzy DEMATEL Technique

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ABSTRACT

Significant advances in communication and information technologies have created new forms of organizations. One of these organizational forms is the virtual organization that has emerged in two recent decades. On the other hand, quality, as a factor creating competitive advantage, has been always noted by all organizational forms. Hence, this research was conducted with the purpose of identifying and analyzing the relations between the dimensions of quality management in the virtual organizations. In this research, first using library studies, 39 dimensions were identified in three classes of product quality, process quality and partners' quality for the quality in the virtual organizations, and then, asking the opinions of the experts, the final dimensions were extracted from the initial dimensions. In the next step, using Fuzzy DEMATEL Technique and the opinions of the experts, the relations between the identified dimensions were analyzed. According to the results from the analysis of the relations between the dimensions, in the class of product quality, the dimensions including viability, features and reliability were in the cause group; in the class of process quality, the dimensions including communication, commitment and trust were in the cause group; and in the class of partners' quality, the dimensions including interdependency, qualitative strategies and culture were in the cause group. It means that they have the highest effect on the quality management in the virtual organizations.

KEYWORDS: Virtual Organization, Quality, Fuzzy DEMATEL Technique

1 INTRODUCTION

Undoubtedly today, successful organizations are those being able to adapt themselves to the environmental conditions; conditions that are quickly changing. These quick changes of the conditions and the environmental variables have made new forms and structures emerge in the field of organizations. One of these modern organizational forms is the virtual organization. A virtual organization is an organization temporally formed by two or more partners and gathers the required resources from various fields to achieve a certain purpose (Kerschbaum & Robinson, 2009). Globalization, the advance of the communication technologies and the increase of the level of the general literacy are the most important drivers of the movement toward virtual structures (Igbaria & Mahatanankoon, 2003). In fact, virtual organizations are the result of the integration of the information and the growth of the intermediating abilities of technology such as information systems that divide the business activities reasonably into two parts of absolute obligations and the task processes required to satisfy these obligations (Mowshowitz, 2003). Virtual structures make the organizations able to overcome the spatial and temporal constraints and create coordination in new forms in the organization. These structures help the organizations, sectors and people share the resources effectively and economically (Van Do, 2010). Although virtual organizations have different features according to the type of their business, they have generally some common features as follows: 1) these organizations are tailored by independent members and based on common benefits; 2) they have an extensive operational domain that covers several executive fields; 3) partners are variable, so that at any moment, a member may be added or removed; 4) the resources are shared among the partners in a definite and controlled way (Zuo & Panda, 2008). So far, various researches are conducted about the virtual organizations. In past researches, these organizations are examined in different aspects including their information and security (Zuo & Panda, 2008;Norman et al, 2004), their management (Afsarmanesh et al, 2009; Grabowski et al, 2007; Van Do, 2010; Hertel et al, 2005; Khalil & Wang, 2002), the way of choosing the partners (Ahoonen et al, 2009; Xiang et al, 2008; Li et al, 2010), designing the virtual organizations (Slomp et al, 2005; Igbaria & Mahatanankoon, 2003; Werther, 1991), the way of creating coordination in such organizations (Huang et al, 2004) and many other aspects.

But what is less explored is the issue of quality in the virtual organizations. Today, quality management is very important at the global level. The ability of quality to obtain the competitive advantage for the organizations has made it be considered one of the most determinant factors of the success of the organizations in the competitive markets of the world. Hence, the research is to identify the dimensions of the quality management in the virtual organizations and determine the most important dimensions. In fact, the main purpose of the research is to identify and rank the dimensions of the quality management in the virtual organizations and answer the question that what the most important dimensions of quality management in the virtual organizations

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are. This issue is very important because the non-establishment in a unique complex like the traditional systems and the basic differences between the virtual and the traditional organizations on one hand, and the need of today's society and customers to receive quality and creative products and services on the other hand have made the role of quality management more critical than ever. Hence, in this research, the dimensions of quality are identified in the virtual organizations as a critical concern.

2 LITERATURE OF THE RESEARCH

1.2 virtual organizations

Some researchers think the virtual organizations are rooted in the ideas of Oliver Williamson that believed that instead of using domestic suppliers, it was better that the big organizations use the products and the services of the foreign suppliers more. This belief made the managers and the researchers welcome the concept of outsourcing in 1980s. Outsourcing made the big organizations able to reduce their costs and remove their inefficient sectors and units and focus more on their main competencies. Decentralization became also common at the same time with outsourcing. In fact, these streams provided the conditions for the emergence of the virtual organizations (Afsarmanesh et al, 2005). Any virtual organization is a networked organization, but any networked organization is not a virtual organization. A virtual organization is a temporary network of independent organizations that using information and communication technologies, they cooperate with each other. These organizations try to embed their main and operational competencies in an organization to be able to attain the competitive advantages (Jagers et al, 1998). The main feature of the networked organizations is the cooperation between people and organizations and this feature exists in all of the virtual organizations. According to many researchers, outsourcing and information and communication technologies (ICTs) are two main factors of the success of the virtual organizations in today's competitive environments. ICTs make an organization able to respond to the needs from the globalization of the markets better. On the other hand, outsourcing makes an organization able to use the skill of other organizations to produce the products and provide services (Corvello & Migliarese, 2007).

2.2 Quality

Quality is today one of the most important concepts discussed by the managers and the experts and it can be even said that it plays a major role in business. Quality creates stable competitive advantages for an organization through reducing the costs and increasing the product's value (Germain & spears, 1998).

Juran (1990) has defined quality in two views.

Quality is the features of a product matched with customer's expectations that creates their satisfaction. This definition of quality is income-oriented and the aim of increasing the quality is to increase customers' satisfaction and the income. Although increasing the quality needs more investment and finally leads to the increase in the costs, quality is to get free from the defects, the production errors that lead to reworking, it decreases the probability that the product breaks down, and increases customers' satisfaction. In this view, quality is cost-oriented and higher levels of quality usually have lower costs. In his book, "quality is free", Crosby (1979) defines the quality as meeting the needs stated clearly as designing characteristics. According to him, a product not matched with the needs is quality free. Taguchi (1987) defines the quality as a disadvantage of a product to the society from when it is sent to the customer. In fact, Taguchi notices a very important dimension of the quality that is the social disadvantage. In his book, exiting the crisis, in 1986, Deming notices another important dimension of quality, i.e. dynamics. He states that a product must be matched with the current and future needs of a customer. Emphasizing the word, "future", he implies that quality is a dynamic concept.

3. METHOD OF THE RESEARCH

This research includes three stages. In the first step, doing extensive and comprehensive library studies, the dimensions of quality are identified and the result of this stage is the identification of 39 dimensions in three subgroups including product quality, process quality and partners' quality. Then in the next step, the opinions of the experts were asked to regulate and summarize the identified indexes and to extract the final dimensions. And for this purpose, the questionnaire no.1 was used. This questionnaire was based on Likert's five point scale that was designed based on the dimensions extracted and the professors and the students of PhD helped validate its validity and for determining its reliability, Crobanch's alpha coefficient was used. After collecting the questionnaires, Cronbach's alpha coefficient was obtained 0.78 based on the data obtained that shows its suitable reliability. For extracting the final dimensions, the score of any dimension was determined based on the data obtained from the questionnaire no. 1, and then the dimensions whose scores were more than 60% of the total score, i.e. 3, were considered as the final dimensions. Finally, in the last step after extracting the final dimensions, Fuzzy DEMATEL method was used to determine the relations between these dimensions, the intensity of the effect of these dimensions on each other and the way they affected on each other. For analyzing the relations of these dimensions using Fuzzy DEMATEL technique, the data must be collected using the questionnaire from the experts, and for this purpose, the questionnaire no. 2 was used. Here, for analyzing the data, MATLAB Software was used. In this

research, 15 professors and experts of this field were chosen as the statistical sample. In this research, professors were considered as the experts who were aware of the field of the virtual organizations and similar paradigms such as agile production and were familiar with the newest subjects about these paradigms.

3.1 Fuzzy DEMATEL

The steps of Fuzzy DEMATEL method that is used in this research are as follows:

First, the questionnaire was used to collect the required data that was filled out by related experts. In this questionnaire, the experts were asked to determine the binary relations between the dimensions by one of the scores including non-effect (NO), very low effect (VL), low effect (L), high effect (H), and very high effect (VH). Then, these linguistic evaluations were converted into fuzzy numbers according to table 1. After converting the data to fuzzy numbers to obtain the initial fuzzy matrix A, the average of the evaluations conducted by the experts must be obtained as follows.

Then the initial direct relation matrix A can be obtained.

In this matrix, $Z_{ij} = (l_{ij}, m_{ij}, u_{ij})$ are as triangular fuzzy numbers.

After obtaining the initial matrix, the matrix X can be obtained by normalizing the initial direct-relation matrix Z as follows.

After obtaining the matrix X, the total relation matrix T can be calculated as follows.

After calculating the total relation matrix, the values of the vectors R and D can be calculated.

After calculating these values, the indices ($D_i + R_i$) and ($D_i - R_i$) can be calculated. Of course, these indices are as fuzzy numbers and they must be converted to crisp scores. After defuzzificating these indices, the cause-effect diagram can be plotted.

Table 1 Corresponding relationship between language and fuzzy number

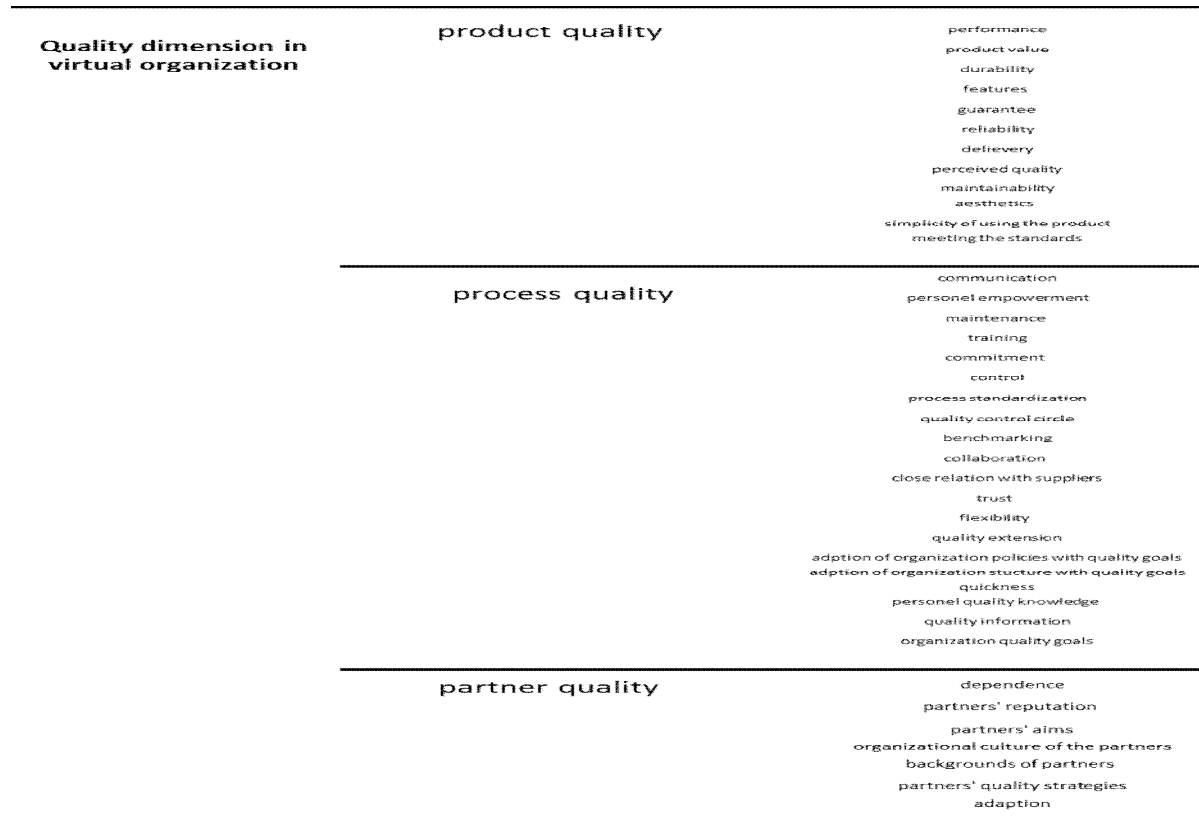| Linguistic judgments	Corresponding tringular fuzzy number
No influence	(0, 0, 0.25)
Very low influence	(0, 0.25, 0.5)
Low influence	(0.25, 0.5, 0.75)
High influence	(0.5, 0.75, 1)
Very High influence	(0.75, 1, 1)

Fig. 1. quality dimension in virtual organization

4. DATA ANALYSIS

According to the results obtained from the questionnaire no. 2, among the dimensions identified, the scores of 17 dimensions were more than 3 (60% of the total score). These dimensions included: communication (4.41), Collaboration (3.26), features of the product (3.54), partners' aims (3.69), trust (3.51), Dependence (3.74), performance (3.84), organizational culture of the partners (3.27), reliability (3.73), flexibility (4.23), simplicity of using the product (3.34), aesthetics (3.86), durability (3.62), partners' quality strategies(4.01), backgrounds of partners (4.03), meeting the standards (4.13) and commitment (3.84). These dimensions were considered the final dimensions and the relations between them were analyzed.
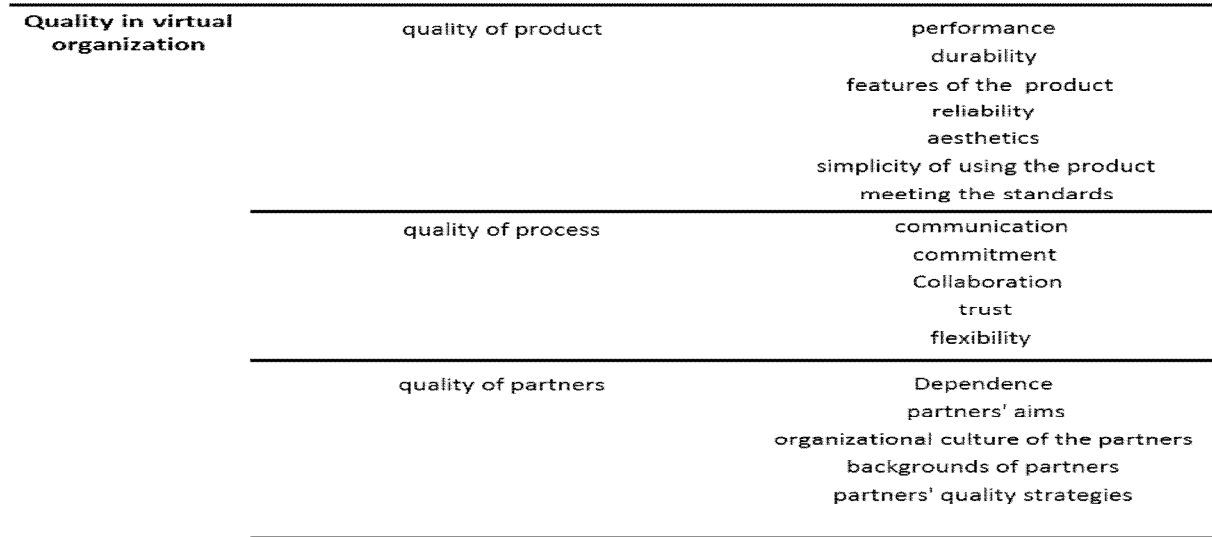
Quality in virtual organization	quality of product	performance
		durability
		features of the product
		reliability
		aesthetics
		simplicity of using the product
		meeting the standards
	quality of process	communication
		commitment
		Collaboration
		trust
		flexibility
	quality of partners	Dependence
		partners' aims
		organizational culture of the partners
		backgrounds of partners
		partners' quality strategies

Fig. 2. Final quality dimension in virtual organization

4.1 Analysis of the dimensions of the product quality

Using the data collected, the initial direct-relation matrix of the dimensions of the product quality were obtained (table 2). Then based on this matrix, the total relation matrix (table 3) was obtained. Then after obtaining the total relation matrix, the values of R and D were determined and then, the indices (D-R) and (D+R) were obtained (table 4). After obtaining these indices, the dimensions were classified into two cause and effect groups and the cause-effect diagram was plotted according to figure 3.

4.1.1 The cause group

The dimensions of the product quality are as follows: performance (X_1), durability (X_2), features (X_3), reliability (X_4), aesthetics (X_5), simplicity of using the product (X_6) and meeting the standards (X_7). Dimensions whose index values (D-R) are positive go into the cause group. Being in this group shows their importance and their effect on the product quality. According to the results from the data analysis, the dimensions including durability (X_2), features (X_3), and reliability (X_4) go into the cause group. Among the dimensions being in the cause group, the dimension of durability (X_2) has the highest index value (D-R) (1.65) that shows that this dimension has the highest effect on the product quality. On the other hand, the prominence index value (D+R) of this dimension is the highest value that shows the high effect of this dimension on other dimensions of the product quality. The second dimension

having the highest index value (D-R) is features (X_3). The index value (D-R) of this dimension is 0.53. The prominence index value (D+R) of this dimension is 2.98 that is the highest value among all of the dimensions of the cause group and shows the rather high effect of this dimension on other dimensions of quality. The last dimension being in the cause group is reliability (X_4). The index value (D-R) of this dimension is 0.04 that although it is positive and shows that it effects on the product quality, it must be noticed that the level of its effect is negligible. The prominence index value of this dimension (D+R) is 2.78 that after the dimension X_3, it is the highest value in this group and shows that although the effect of this dimension on the product quality is negligible, its effect on other dimensions is significant.

Table 2 The initial direct-relation matrix of product quality dimension

	X1	X2	X3	X4	X5	X6	X7
XX1	0.51 0.53 0.57	0.18 0.17 0.14	0.16 0.11 0.10	0.15 0.13 0.09	0.02 0.01 0.00	0.22 0.17 0.12	0.23 0.18 0.14
XX2	0.18 0.14 0.10	0.33 0.40 0.46	0.33 0.25 0.22	0.12 0.11 0.08	0.30 0.28 0.23	0.36 0.25 0.22	0.31 0.23 0.19
XX3	0.22 0.15 0.14	0.29 0.26 0.22	0.57 0.55 0.55	0.25 0.21 0.19	0.11 0.05 0.03	0.34 0.24 0.17	0.11 0.05 0.03
XX4	0.09 0.06 0.05	0.02 0.00 0.00	0.27 0.19 0.16	0.27 0.33 0.39	0.24 0.22 0.19	0.29 0.2 0.17	0.27 0.21 0.16
XX5	0.18 0.13 0.13	0.23 0.21 0.17	0.05 0.02 0.00	0.20 0.17 0.14	0.36 0.38 0.43	0.26 0.17 0.15	0.19 0.13 0.11
XX6	0.12 0.12 0.09	0.03 0.01 0.02	0.13 0.11 0.11	0.06 0.06 0.04	0.10 0.08 0.07	0.37 0.43 0.46	0.12 0.11 0.11
XX7	0.23 0.18 0.16	0.04 0.01 0.01	0.12 0.01 0.08	0.13 0.12 0.13	0.21 0.16 0.15	0.13 0.09 0.07	0.44 0.44 0.49

4.1.2 The effect group

Dimensions with a negative index value (D-R) go into the effect group. Being in this group means that these dimensions are easily affected by other dimensions. Of course, being in this group does not mean that these dimensions must not be considered at all. Among the dimensions of the effect group, two dimensions of performance (X_1) and meeting the standards (X_7) are noticeable. The index value of (D-R) of performance (X_1) is -0.062 that is a bit lower than zero, but its prominence index value (D+R) is 4.48 that is the highest value among all of the dimensions of the product quality and shows that although this dimension is in the effect group and is affected by other dimensions, it has the highest effect on other dimensions. The dimension of meeting the standards (X_8) with the index value (D-R) -0.12 is noticeable because its index value (D-R) is a bit lower than zero and its prominence index value is 2.62. The dimension of aesthetics (X_5) has the second rank in terms of being affected by other dimensions and its index value (D-R) is -0.51. This value shows that it is strongly affected by other dimensions. The last dimension in the effect group is the simplicity of using the product (X_6) that is the most strongly affected by other dimensions.

Table 3 The total-relation matrix of product quality dimension

	X1	X2	X3	X4	X5	X6	X7
X1	0 0 0	0.23 0.36 0.45	0.42 0.58 0.65	0.24 0.37 0.51	0.51 0.64 0.75	0.56 0.68 0.84	0.31 0.39 0.51
X2	0.41 0.52 0.76	0 0 0	0.27 0.38 0.51	0.61 0.74 0.87	0.18 0.25 0.36	0.41 0.57 0.69	0.26 0.34 0.47
X3	0.58 0.73 0.82	0.17 0.27 0.34	0 0 0	0.26 0.39 0.47	0.52 0.67 0.75	0.55 0.69 0.80	0.65 0.76 0.83
X4	0.53 0.67 0.81	0.46 0.59 0.71	0.31 0.45 0.57	0 0 0	0.18 0.25 0.34	0.43 0.57 0.68	0.29 0.37 0.51
X5	0.38 0.51 0.64	0.15 0.26 0.38	0.58 0.69 0.84	0.18 0.26 0.39	0 0 0	0.43 0.57 0.68	0.28 0.37 0.49
X6	0.19 026 041	0.20 0.35 0.42	0.17 0.28 0.35	0.12 0.20 0.31	0.16 0.28 0.34	0 0 0	0.17 0.24 0.29
X7	0.25 0.37 0.53	0.35 0.51 0.67	0.48 0.54 0.71	0.15 0.21 0.29	0.17 0.29 0.38	0.58 0.69 0.85	0 0 0

Table 4 The scores of each factor and related values for cause and effect groups of product quality dimension

|	X1	X2	X3	X4	X5	X6	X7
D	1.64 1.43 1.28	2.02 1.69 1.55	2.01 1.61 1.39	1.67 1.39 1.28	1.62 1.34 1.25	0.98 0.97 0.94	1.46 1.44 1.2
R	1.75 1.46 1.38	1.31 1.22 1.15	1.79 1.37 1.33	1.41 1.33 1.25	1.54 1.35 1.23	2.26 1.78 1.56	1.74 1.38 1.23
D-R	-0.11 -0.03 -0.1	0.71 0.47 0.4	0.22 0.24 0.06	0.26 0.06 0.03	0.08 -0.01 0.02	-1.28 -0.81 -0.62	-0.28 0.06 -0.03
D+R	3.39 2.89 2.66	3.33 2.91 2.7	3.79 2.98 2.72	3.08 2.72 2.53	3.16 2.69 2.48	3.24 2.75 2.5	3.2 2.82 2.43
D-R $^{(def)}$	-0.062	1.65	0.53	0.04	-0.51	-0.76	-0.12
D+R $^{(def)}$	4.48	2.75	2.98	2.78	2.77	2.81	2.62
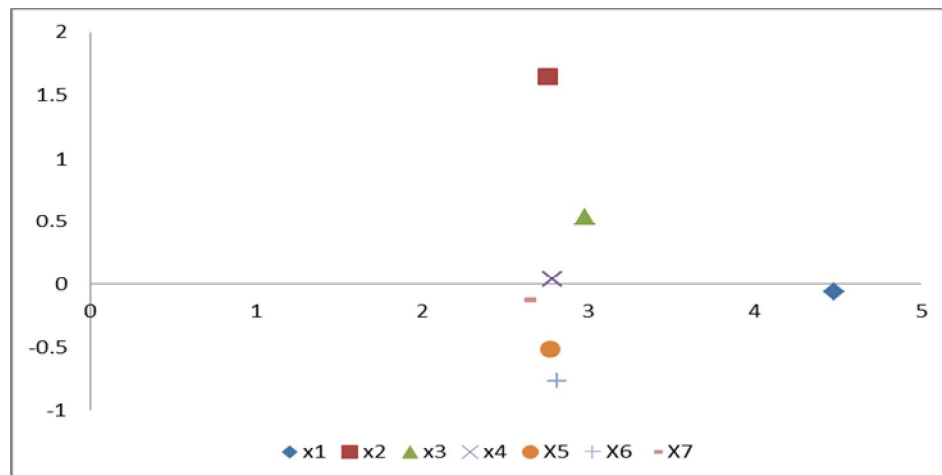
Fig. 3. The cause-effect relationship diagram of product quality dimension

4.2 Analysis of the dimensions of the process quality

Table 5 shows the initial direct-relation matrix of the dimensions of the process quality that is obtained by the initial data. According to this matrix, the total relation matrix (table 6) is obtained. The dimensions of the process quality are as follows: communication (X_1), Collaboration (X_2), commitment (X_3), trust (X_4) and flexibility (X_5). According to the index values obtained from the total relation matrix (D-R) and (D+R) that are presented in table 7, the dimensions including communication (X_1), commitment (X_3) and trust (X_4) go into the cause group and the dimensions including Collaboration (X_2) and flexibility (X_5) go into the effect group.

Table 5 The initial direct-relation matrix of process quality dimension

	X1	X2	X3	X4	X5
X1	0 0 0	0.24 0.36 0.41	0.21 0.29 0.37	0.47 0.58 0.68	**0.18 0.29 0.37**
X2	0.68 0.75 0.91	0 0 0	0.34 0.48 0.58	0.59 0.67 0.72	**0.63 0.78 0.92**
X3	0.58 0.72 0.87	0.67 0.81 0.93	0 0 0	0.23 0.31 0.43	**0.34 0.46 0.57**
X4	0.62 0.78 0.89	0.64 0.78 0.88	0.68 0.82 0.94	0 0 0	**0.35 0.48 0.55**
X5	0.21 0.35 0.41	0.12 0.21 0.26	0.13 0.18 0.24	0.17 0.24 0.31	**0 0 0**

5.2.1 The cause group

The dimensions including communication (X_1), commitment (X_3) and trust (X_4) that have positive index values (D-R) go into the cause group. The dimension of communication (X_1) has the highest index value (D-R) among the dimensions of the process quality. Its index value is 1.09 that shows the highest effect of this dimension on the process quality. The prominence index value (D+R) of this dimension is 3.52 that has the third rank among the dimensions and shows the relative effect of this dimension on other dimensions. A dimension with the second rank in terms of the index value (D-R) is trust (X_4). The index value (D-R) of this dimension is 0.61 and is after the dimension of communication in terms of its level of effect on the process quality. But what is noticeable about this dimension is its prominence index value (D+R) that is the highest value among the dimensions of process quality. Its value is 3.92 that is equal to that for the dimension of Collaboration (X_2). This value shows that trust has the highest effect on other dimensions of the management of the process quality. Having the second rank in terms of the index value (D-R) and the first rank in terms of the prominence index value (D+R) have given a special position to the dimension of trust. Hence, a special attention must be given to this dimension. The last dimension being in the cause group is commitment (X_3). The index value (D-R) of this dimension is 0.34 and its prominence index value (D+R) is 1.97. Although this dimension is in the cause group and effects on the process quality, it does not have a significant effect on other dimensions, because its prominence index value is the lowest value among all of the dimensions.

Table 6 The total-relation matrix of process quality dimension

	X1	X2	X3	X4	X5
X1	0.72 0.66 0.65	0.37 0.27 0.23	0.30 0.23 0.19	0.24 0.15 0.11	0.40 0.32 0.28
X2	0.64 0.43 0.34	0.89 0.77 0.73	0.5 0.34 0.28	0.46 0.29 0.25	0.41 0.27 0.2
X3	0.56 0.37 0.31	0.37 0.24 0.19	0.72 0.65 0.65	0.53 0.38 0.32	0.46 0.37 0.3
X4	0.75 0.51 0.41	0.53 0.36 0.27	0.41 0.26 0.2	0.94 0.79 0.75	0.63 0.48 0.42
X5	0.23 0.17 0.16	0.22 0.19 0.17	0.17 0.16 0.14	0.17 0.14 0.12	0.32 0.37 0.40

5.2.2 The effect group

Among five dimensions of the process quality, two dimensions of Collaboration (X_2) and flexibility (X_5) go into the effect group. As it is shown in figure 4, these dimensions are in the lower part of the cause-effect diagram of the dimensions of the process quality. As it was mentioned before, being in the effect group means that these dimensions are affected by other dimensions and they don't have a significant effect on the process quality. Among these two dimensions in the effect group, Collaboration (X_2) is more noticeable, because its index value (D-R) is -0.02 that is a bit lower than zero and it has made it be in the effect group, and its prominence index value (D+R), together with that of trust (X_4), are the highest among the dimensions. This value shows that although this dimension is affected by other dimensions and does not have a direct effect on the process quality, it has a high effect on other dimensions. Another dimension in the effect group is flexibility

(X_5). The index value (D-R) of this dimension is -0.92 that shows that it is strongly affected by other dimensions. Of course, it must be noted that the prominence index value (D+R) of this dimension is significant. Its value is 3.51 that is higher than that of commitment (X_3) that is in the cause group.

Table 7 The scores of each factor and related values for cause and effect groups of process quality dimension

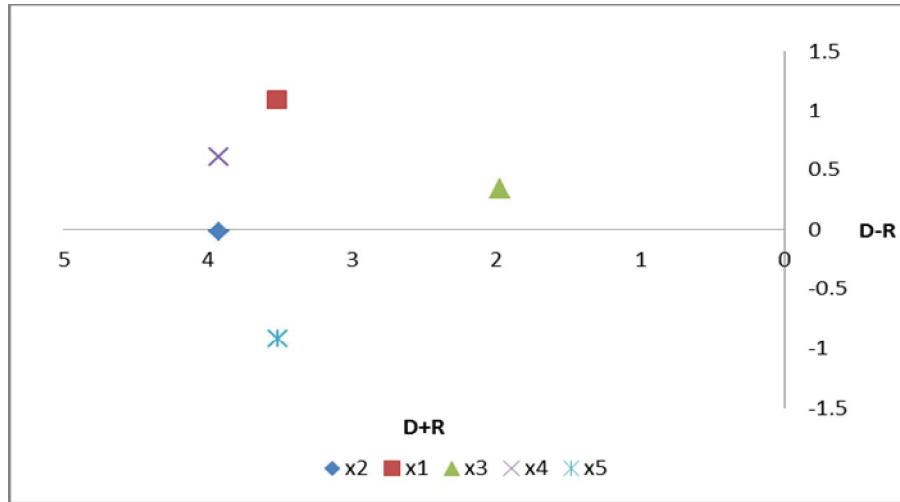|	X1	X2	X3	X4	X5
D	2.03 1.66 1.48	2.9 2.13 1.83	2.64 2.01 1.8	3.26 2.42 2.08	1.11 1.06 1.01
R	2.22 2.16 1.9	2.34 1.86 1.62	2.1 1.65 1.49	2.38 1.78 1.58	2.9 1.81 1.62
D-R	-0.19 -0.5 -0.42	0.56 0.27 0.21	0.54 0.36 0.31	0.88 0.64 0.5	-1.79 -0.75 -0.61
D+R	4.25 3.82 3.38	5.24 3.99 3.45	4.74 3.66 3.29	5.64 4.2 3.66	4.01 2.87 2.63
D-R$^{(def)}$	1.09	-0.02	0.34	0.61	-0.92
D+R$^{(def)}$	3.52	3.92	1.97	3.92	3.51

Fig. 4. The cause-effect relationship diagram of process quality dimension

4.3 Analysis of the dimensions of the partners' quality

In tables 8 and 9, the (initial) direct relation matrix and the total relation matrix of the dimensions of the partners' quality are presented. As it was mentioned before, the initial direct-relation matrix is obtained based on the initial data and the total relation matrix is obtained based on the initial matrix. According to the total relation matrix, the index values (D-R) and (D+R) are calculated and presented in table 10. The dimensions of the partners' quality are as follows: interdependency (X_1), partners' quality strategies(X_2), backgrounds of partners (X_3), culture (X_4) and partners' aims (X_5). According to the index values (D-R), among these dimensions, interdependency (X_1), partners' quality strategies (X_2) and culture (X_4) go into the cause group and backgrounds of partners (X_3) and partners' aims (X_5) go into the effect group.

Table 8 The initial direct-relation matrix of partners' quality dimension

	X1	X2	X3	X4	X5
X1	0 0 0	0.61 0.78 0.89	0.21 0.38 0.43	0.28 0.37 0.48	0.53 0.68 0.84
X2	0.31 0.38 0.47	0 0 0	0.21 0.35 0.41	0.65 0.81 0.91	0.67 0.75 0.91
X3	0.26 0.35 0.45	0.39 0.48 0.56	0 0 0	0.25 0.36 0.47	0.38 0.49 0.61
X4	0.39 0.52 0.67	0.65 0.78 0.92	0.31 0.39 0.48	0 0 0	0.23 0.35 0.46
X5	0.46 0.62 0.71	0.53 0.68 0.88	0.17 0.25 0.35	0.25 0.38 0.42	0 0 0

4.3.1 The cause group

According to the index values presented in table 10, three dimensions have positive index values (D-R) and are in the cause group. A dimension with the highest effect on the partners' quality is the partners' quality strategies (X_2) with the index value (D-R) 0.34 and the prominence index value (D+R) 3.48 that is not very high compared to other values. Hence, it must be said that although this dimension has the highest effect on partners' quality, it does not have a high effect on other dimensions. The second dimension having the highest effect on the partners' quality among other dimensions is interdependency (X_1). The index value (D-R) of this

dimension is 0.17 that shows its relative effect on partners' quality. Its prominence index value (D+R) is 4.19 that has the second rank among all of the dimensions and shows the high effect of this dimension on other dimensions. The last dimension in the cause group is culture (X_4). The index values (D-R) and (D+R) of this dimension are 0.015 and 4.47, respectively. The index value (D-R) of this dimension is a bit higher than zero that shows its slight effect on partners' quality. But its prominence index value is highest among the dimensions of the partners' quality and shows its highest effect on other dimensions.

Table 9 The total-relation matrix of partners' quality dimension

	X1	X2	X3	X4	X5
X1	0.69 0.63 0.63	0.52 0.31 0.28	0.29 0.2 0.19	0.48 0.35 0.29	0.45 0.26 0.22
X2	0.48 0.31 0.28	0.98 0.8 0.77	0.31 0.22 0.20	0.35 0.17 0.14	0.48 0.28 0.24
X3	0.35 0.23 0.21	0.47 0.31 0.29	0.39 0.42 0.43	0.38 0.25 0.22	0.39 0.23 0.22
X4	0.40 0.24 0.21	0.49 0.28 0.26	0.21 0.16 0.15	0.69 0.62 0.61	0.60 0.38 0.36
X5	0.29 0.16 0.16	0.48 0.29 0.24	0.27 0.23 0.2	0.43 0.3 0.27	0.74 0.65 0.66

4.3.2 The effect group

Two dimensions of backgrounds of partners (X_3) and partners' aims (X_5) are in the effect group. The index values (D-R) of backgrounds of partners (X_3) is -0.65. It shows that it is strongly affected by other dimensions and shows that this dimension does not have a direct effect on partners' quality. However, this dimension effects on other dimensions and its prominence index value is significant. Another dimension in the effect group is partners' aims (X_5). The prominence index value of this dimension is 2.58 that is the lowest value among the dimensions of the partners' quality. This value shows that this dimension has a negligible effect on other dimensions. Its index value (D-R) is -0.24 and it means that not only it does not have a direct effect on partners' quality, but also it is strongly affected by other dimensions.

Table 10 The scores of each factor and related values for cause and effect groups of partners' quality dimension

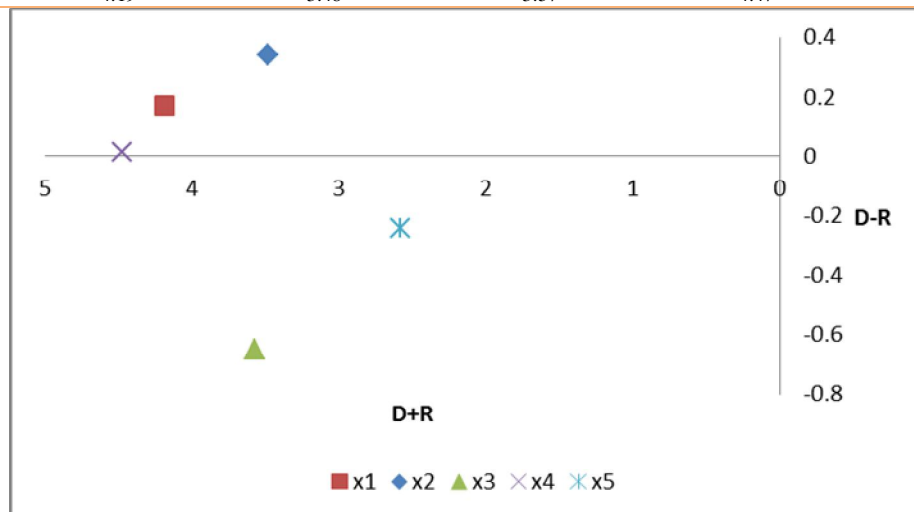|	X1	X2	X3	X4	X5
D	2.43 1.75 1.61	2.6 1.78 1.63	1.98 1.44 1.37	2.39 1.68 1.59	2.21 1.63 1.53
R	2.23 1.57 1.49	2.97 1.99 1.84	1.50 1.23 1.17	2.36 1.69 1.53	2.69 1.8 1.7
D-R	0.2 0.18 0.12	-0.37 -0.21 -0.21	0.48 0.21 0.2	0.03 -0.01 0.06	-0.48 -0.17 -0.17
D+R	4.66 3.32 3.1	5.57 3.77 3.47	3.48 2.67 2.54	4.75 3.37 3.12	4.9 3.43 3.23
D-R$^{(def)}$	0.17	0.34	-0.65	0.015	-0.24
D+R$^{(def)}$	4.19	3.48	3.57	4.47	2.58

Fig. 5. The cause-effect relationship diagram of partners' quality dimension

5 CONCLUSIONS

The primary purpose of this research was to identify the dimensions of the quality management in the virtual organizations that based on the library studies, 39 dimensions were first identified for the quality management in the virtual organizations. The initial dimensions extracted based on their types were classified into three groups of product quality, process quality and partners' quality and then, using the questionnaire no. 1, the importance of any of the dimensions was determined by the experts and based on the scores of the dimensions, 17 final dimensions were extracted. The second purpose of this research was to analyze the relations between the dimensions of the quality management. This was achieved using Fuzzy DEMATEL Technique. According to the results obtained from the mentioned technique, the dimensions including durability, features and reliability related to the product quality (table 4), those including communication, commitment and trust related to the process quality (table 7) and those including interdependency, partners' quality strategies and culture related to the partners' quality (table 10) are the most important dimensions of the quality management in the virtual organizations. In their research, Qin and Bei (2000) developed the quality management in the virtual businesses based on a model including only the process of working and in fact, they focused on the process of doing the affairs in the virtual organizations and on identifying the quality dimensions in it. In fact, the similarity of this research and their research is paying attention to the dimensions of the process quality. In both researches, the importance of communication is emphasized. In the present research, according to the results obtained (table 7), the dimension of communication is in the cause group among the dimensions of the process quality and it has the highest effect on the process quality. The research by Qin and Bei(2000) has also emphasized the importance of communication. They concluded that the quality of interchanging information is the most important factor of the quality in the virtual organizations. Another point emphasized by them was the importance of the associative management in the virtual organizations. They believe that management in the virtual organizations must be associative and this factor is effective on the quality. According to the results of the present research (table 7), although the dimension of Collaboration does not have a direct effect on the process quality and is not in the cause group, it has the highest effect on other dimensions of the process quality and in fact, it has an important non-direct effect on the process quality. Although these two researches have important similarities, there are also differences. As it was mentioned before, the present research is more comprehensive than that by Qin and Bi(2000). It has defined the dimensions of the quality management in three fields of product, process and partners and indeed, it can be said that a kind of systemic view is dominant on it and it is tried to take all of the aspects of the virtual organizations into account. However, the research by Qin and Bei(2000) has merely emphasized the process quality and in this regard, it can be claimed that the present research is more comprehensive than their research. Another difference between these two researches is that in the present research, the production organizations are only emphasized, while Qin and Bei(2000) have regarded virtual (production and service) businesses. In this regard, their research is more comprehensive than the present research. These results show that Fuzzy DEMATEL Technique is able to analyze the complicated relations between the dimensions very well. So it can be concluded that as it is previously used effectively and successfully in some cases, this technique can be also used in other management contexts such as production and operations, information systems and technology.

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