Z E S Z Y T Y N A U K O W E P O L I T E C H N I K I P O Z N A Ń S K I E J
Nr 75 Organizacja i Zarządzanie 2017

Mahtab AFSARI[*], Hesam Javadi VASIGH[**]

EVALUATION OF THE CRITICAL SUCCESS FACTORS IN THE IMPLEMENTATION OF KNOWLEDGE MANAGEMENT USING FUZZY ANP AND FUZZY DEMATEL TECHNIQUES. A CASE STUDY OF THE TEHRAN FIRE DEPARTMENT

DOI: 10.21008/j.0239-9415.2017.075.01

Today, knowledge and information are considered as determining factors in the success and competitiveness of organizations. Products and services of those businesses that can efficiently obtain knowledge in organization and use it in business processes will have a competitive advantage on the market. In this study, the fuzzy DEMATEL technique was used to examine the causal relationships between factors affecting the implementation of knowledge management, and the fuzzy ANP technique was used to determine the priority of factors. The case study in this research is of the Tehran Fire Department (TFD). The results showed that during the implementation of the fuzzy DEMATEL method, "specified strategies and objectives in the use of knowledge management" was the most influential factor and the factor of "designing effective processes to apply KM" was the most impressible one. Finally, using fuzzy ANP, “strategies and specific objectives in the use of knowledge management” was determined as the most important factor.

Keywords:KM, fuzzy DEMATEL, fuzzy ANP, Tehran Fire Department (TFD)

1. INTRODUCTION

Today, knowledge and information have become a decisive factor in the success and competitiveness of organizations, and knowledge management has been referred to in management science as one of the organizational issues. Business or-

[*] PhD student in Mechanical Engineering, Hannover, Germany.
[**] MSc in Industrial Management, Tehran, Iran.

ganizations that act solely based on obvious organizational advantages, such as money, machinery and equipment, etc. will not be able to achieve a competitive advantage in the knowledge-based economy. However, a knowledge-based business environment needs a method and a system that includes intangible assets such as the knowledge and competencies of people, innovation, customer communication, organizational culture, systems and processes, organizational structure. Understanding and utilizing these intangible resources in organizations are vital to gain and maintain competitive advantage. In the knowledge-based economy, the most successful organizations use their intangible assets better and faster. Studies have shown that organizational intangible assets are really a resource to improve business performance. It is noteworthy that the market has diagnosed the value of knowledge and other intangible factors in the process of value creation. The amount of this "hidden value" is increasingly changing (Rezaeian et al., 2009).

Many factors can be involved in the implementation of knowledge management systems and addressing these underlying factors can pave the way for success in implementing these systems in organizations (particularly in the Tehran Fire Department as a case study). Taking into account the relationships between these factors can play an important role in better understanding the key factors. The categorization of these factors into two categories of influential and impressible on the one hand, and the importance of these factors on the other hand, lead us to focus time, money, energy and plans on important factors influencing the other factors in order to improve the system. Therefore, this study is of particular significance because it categorizes factors into two groups of effective and impressible in the implementation of knowledge management systems in the TFD (using the fuzzy DEMATEL technique) as well as determining the importance of those factors (using fuzzy ANP technique).

2. LITERATURE REVIEW

2.1. Definitions of Knowledge Management

Knowledge management is a concept about which many definitions have been provided. Nickel King is one of those who define the knowledge management process as the creation, organizing, promoting and ensuring the understanding of the required knowledge to perform a task (King, 1999). Stamp has considered knowledge management to be more practical and has designated an active role for knowledge managers. He defines knowledge management as providing the knowledge required in a given time and place for the person in need. He also believes that the best thing is not to have knowledge about a particular topic, but knowing where and how to access it (Stamp, 1999). Knowledge management is

a process through which organizations generate wealth from their intellectual property (Bukowitz andWilliams, 1999). Bhatt defines knowledge management as a process to evaluate, distribute and apply knowledge (Bhatt, 2001).

Knowledge management is a structured and planned point of view to create, share, store and apply knowledge as an organizational asset to enhance the capabilities, speed and effectiveness of the organization in providing clients with products or services (Plessis, 2008).

However, the current study considers the definition of Nonaka and Takeuchi (1995), which is among the most widely used definitions. They believe there are two types of tacit and explicit knowledge in organizations. First, Polanyi (1958 and 1966) distinguished between tacit and explicit knowledge, and later Nonaka and Takeuchi acknowledged that the things often ignored in organizations and companies are points such as insight, intuition, thought, unconsciousness, values, imaginations, metaphors and comparisons (Nonaka, 1994).

2.2. The importance of knowledge management

The basic characteristic of the Smart organizations in the 21st century is the emphasis on knowledge and information. Unlike in the past, today's organizations have advanced technologies and require capturing, management and exploitation of knowledge and information to improve efficiency and management and to track never-ending changes. Knowledge is a powerful tool which can create changes in the world and make innovations possible. Bailey and Clarke (2000) claim that knowledge, especially tacit knowledge, is the key to sustainable competitive advantage in the future. Tobias (2000) argues that there are two major assets which organizations own: the people who work in organizations and the knowledge they possess. So the task of knowledge management is to create, store and apply the knowledge. Knowledge management is an important tool through which organizations can manage their knowledge and information. Unlike other techniques, it is not easy to define knowledge management because it includes a vast field of concepts, management tasks, technologies and associated practices (Rezaeaian et al., 2009).

Although knowledge capital can be quantified by difficulties, it is crucial for the growth and long-term survival of the company. Success in today's competitive market is dependent on the quality of knowledge and knowledge processes for organizations to perform key activities. The application of knowledge capital to create competitive advantage has been proposed as a critical factor (Ghelich Li, 2015).

2.3. The role of knowledge management in organizations

Today, in literature on economics and management there is an emphasis on the role of knowledge as a vital resource to maintain the competitiveness and profitability of organizations (Nonaka, 1994).

Knowledge management helps organizations to have effective knowledge processes. In order to choose markets, organizations should benefit from existing knowledge, and new knowledge creation and knowledge management is of great help in this matter. However, companies should bear in mind that the implementation of any system in the organization requires special preparation according to different requirements of organization and if they are not provided, its successful implementation will not be possible (Salavati and Haghnazar, 2009).

Knowledge management in the new era is not confined only to codified and documented knowledge, but many organizations and companies in the world rely on their tacit and explicit knowledge to promote their competitive position and to increase their effectiveness and efficiency. In order to achieve these objectives, knowledge management seeks to capture value-added knowledge, wisdom and experience of the staff and implementation, recovery and maintenance of knowledge as the assets of the organization.

Undoubtedly, today, knowledge is the most important competitive tool in the present and future markets. Although many organizations have already invested in the development of knowledge at different levels and have been successful, many organizations have also failed. The lack of a proper mechanism to evaluate and implement knowledge management has made these types of investments in the minds of managers only an additional cost (Rezaeian et al., 2009).

Today, the creation and application of knowledge are essential for the competitiveness and survival of organizations and industries. Knowledge cannot be simply saved or be acquired like other resources; it cannot be simply and systematically managed and used as well. So far, in most organizations, including the various sectors of the oil industry, IT has had the most essential role in knowledge management, as information technology has been hidden behind all activities of knowledge management. However, it should be noted that information technology is not the only component of knowledge management, and developments in different processes of decision-making, organizational structure and performance quality are also its components. Organizing based on knowledge can be fundamentally different from organizing based on traditional competitive advantages (Badriazarin et al., 2013).

2.4. Literature review

Gold et al. (2011) investigated the effects of knowledge on organizational performance. They aimed at the experimental verification of the ability of knowledge management to improve organizational performance. The results showed that collecting and sharing new knowledge can provide a competitive advantage for the organization and finally lead to the better performance of the organization.

Choi and Lee (2011) in a study entitled "Knowledge management styles and their impact on organizational performance" explored this issue. The results showed that among the KM styles, including dynamic, systemic, humanistic and static, the dynamic style with emphasis on tacit and explicit knowledge management had the greatest impact on organizational performance.

Sandhawalia and Dalcher (2011) in research entitled "Developing the knowledge management capabilities: a structured approach" addressed the issue that knowledge management requires a systematic method to develop capabilities to accelerate the enhancement of knowledge as a resource for corporations. The results showed that when organizations implement knowledge management, their infrastructure and processes become more developed. According to the results, the knowledge management infrastructure (information technology, organizational structure, organizational culture, mission, vision, etc.) and knowledge management processes (knowledge acquisition, knowledge sharing, knowledge accumulation and application of knowledge) progress concordantly with each other. Valmohammadi (2010) examined 12 key success factors of knowledge management in small and medium Iranian organizations with a review of knowledge management literature. He prepared a questionnaire consisting of 12 key factors and provided it to knowledge management experts and the questions were answered based on the Likert scale. From the collected data, it was indicated that factors such as the support of senior management and organizational culture are the most important, and motivational factors, compensation and benchmarking are less important.

With a study on 414 project-oriented organizations from a variety of industrial, construction, information technology companies in Germany and using the method of the least squares method, Lindler and Wald (2010) assessed the effects of process-driven, structural, cultural and organizational factors on the success of knowledge management. The population included managers and project leaders, project staff and headquarter personnel. They concluded that besides the factors of IT support, cultural factors affect the success of knowledge management in organizations.

Zack et al. (2009), in the research entitled “Knowledge Management and performance of organization,” prepared a report based on the results of preliminary analysis of the organizational effects derived from knowledge management. In fact, this research examined the relationship between knowledge management and organizational performance. The results of this survey show that knowledge man-

agement methods are directly related to organizational performance, and organizational performance is directly related to financial performance. No direct relationship was found between methods of knowledge management and financial performance. Different sets of knowledge management are related to three sub-sets of function of organization performance value (i.e. customer orientation, product development and operational excellence). The difference between knowledge management methods is important from the perspective of companies and is directly related to organizational performance. In this study in which a total of 12 methods were considered, KM methods were defined as "visible organizational activities related to knowledge management."

Wong and Aspinwall (2005) studied the critical success factors for the adoption of knowledge management in small and medium-sized firms. They created a questionnaire consisting of 11 factors and 66 elements and, for the development of a more general view of the critical success factors, sent it to small and medium firms in England and also a group of professors, consultants, and experts of knowledge management. Then, a series of statistical analyses were applied on the data collected, and a list of factors that were important for the implementation of knowledge management was established. These factors consisted of: strategy and objectives, education, support and leadership of management, culture, information technology, resources, human resource management, evaluation, organizational infrastructure, and motivational support. Davenport et al. (1998) conducted a study on 31 knowledge management projects across 24 companies. The study identified eight major factors that had contributed to the successful implementation of knowledge management. Holsapple and Joshi (2000) expressed three general categories (management, resources, and environment) that affect the knowledge management in organizations. Each of these categories includes different factors. Wong and Aspinwall (2005) expressed managerial factors that are effective in the successful implementation of knowledge management in the form of 11 cases as follows: leadership and leadership support, culture, information technology, targets and strategy, assessment, organizational infrastructure, organizational activities and processes, incentives, resources, training, and human resource management.

2.5. Research Methodology

This research is, in terms of purpose, an applied study and in terms of data collection, a survey – descriptive. In this research, first by comparative studies and literature review, factors affecting the implementation of knowledge management in the Tehran Fire Department were obtained. Then, using fuzzy DEMATEL, relations between the factors as well as their influence and impressibility were obtained. In addition, the weight (importance) of each factor was obtained using the fuzzy ANP technique.

Table 1. Factors affecting the implementation of knowledge management in the Tehran Fire Department

Factor Name	Abbreviation
IT infrastructure	C1
Staff attitudes towards the use of knowledge management	C2
Training of staff	C3
Senior management support towards KM	C4
Strategies and objectives identified in the application of knowledge management	C5
Knowledge management performance assessment	C6
Designing effective processes to implement knowledge management	C7

3. EVALUATION OF FACTORS USING FUZZY DEMATEL

Fuzzy DEMATEL technique

Fontela and Gabus (1972, 1976) presented the DEMATEL method in 1971. The method, which is a decision-making method based on paired comparisons, uses the judgment of experts on extraction and organization of the elements of the system and by applying the principles of graph theory, offers the hierarchical structure of factors in the system along with their mutual interaction and determines the impact of these relationships as a numerical score (Ebrahimi Samani, Makooyi, Sadre Larijani, 2008). But the failure of this approach to decision-making in situations of uncertainty has paved the way for the emergence of the fuzzy DEMATEL method that is described below.

Steps for solving by the fuzzy DEMATEL method

Step One: To quantify the association between indicators and factors, decision-making groups including p experts and p fuzzy matrices ($\tilde{z}^1, \tilde{z}^2 \cdots \tilde{z}^p$) are asked to express their ideas in verbal expressions. Elements of these matrices are triangular fuzzy numbers and they are used for forming the average matrix also known as the initial direct relation matrix.

Table 2. Linguistic and fuzzy DEMATEL variables

Values of linguistic scales	Triangularfuzzy numbers
Very high influence	(3,4,4)
High influence	(2,3,4)
Low influence	(1,2,3)
Very low influence	(0,1,2)
No influence	(0,0,1)

$$\begin{bmatrix} 0 & \tilde{z}_{12} & \cdots & \tilde{z}_{1n} \\ \vdots & & \ddots & \vdots \\ \tilde{z}_{n1} & \tilde{z}_{n2} & \cdots & 0 \end{bmatrix} \quad (1)$$

$$z = \frac{\tilde{Z}^1 + \tilde{Z}^2 + \cdots + \tilde{Z}^p}{p} \quad (2)$$

Table 3. Fuzzy average of expert opinions about the direct influence of factors on each other

	C1			C2			C3			C4			C5			C6			C7		
C1	0	0	0	1.3	2.3	3.1	1.7	2.7	3.4	1.6	2.6	3.3	1.1	2	2.7	2.6	3.6	4	2.6	3.6	3.9
C2	0.7	1.7	2.6	0	0	0	2	3	3.6	2	3	3.7	2	3	3.7	0.7	1.6	2.6	2.1	3.1	3.7
C3	1.6	2.4	3.1	2.4	3.4	4	0	0	0	0.7	1.7	2.7	1.1	2.1	3	1.3	2	2.9	2.1	3.1	3.7
C4	2.3	3.3	3.7	2	3	3.7	2.6	3.6	4	0	0	0	2.7	3.7	4	2.1	3.1	3.7	2.3	3.3	3.9
C5	1.9	2.9	3.4	1.7	2.7	3.4	2.1	3.1	3.7	2.6	3.6	4	0	0	0	2.3	3.3	3.9	2.4	3.4	3.7
C6	2.1	3.1	3.9	1.9	2.9	3.7	2.1	3.1	3.9	1.9	2.9	3.6	2	3	3.6	0	0	0	2.4	3.4	3.9
C7	2.1	3.1	3.7	1.7	2.7	3.4	2	3	3.7	1.9	2.9	3.4	0.4	1.3	2.3	1.6	2.6	3.4	0	0	0

Step two: Obtaining a normalized direct relation matrix: to normalize the obtained matrix, we use the following equation.

$$\tilde{H}_{ij} = \frac{\tilde{Z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right) = \left(\acute{l}_{ij}, \acute{m}_{ij}, \acute{u}_{ij}\right) \quad (3)$$

$$r = max_{1 \le i \le n} \left(\sum_{j=1}^{n} u_{ij}\right) \quad (4)$$

Table 4. Normalized fuzzy average of experts' opinions about the direct influence of factors on each other

	C1			C2			C3			C4			C5			C6			C7		
C1	0	0	0	0.06	0.1	0.14	0.07	0.12	0.15	0.07	0.11	0.14	0.05	0.09	0.12	0.11	0.16	0.17	0.11	0.16	0.17
C2	0.03	0.07	0.11	0	0	0	0.09	0.13	0.16	0.09	0.13	0.16	0.09	0.13	0.16	0.03	0.07	0.11	0.09	0.14	0.16
C3	0.07	0.11	0.14	0.11	0.15	0.17	0	0	0	0.03	0.07	0.12	0.05	0.09	0.13	0.06	0.09	0.12	0.09	0.14	0.16
C4	0.1	0.14	0.16	0.09	0.13	0.16	0.11	0.16	0.17	0	0	0	0.12	0.16	0.17	0.09	0.14	0.16	0.1	0.14	0.17
C5	0.08	0.12	0.15	0.07	0.12	0.15	0.09	0.14	0.16	0.11	0.16	0.17	0	0	0	0.1	0.14	0.17	0.11	0.15	0.16
C6	0.09	0.14	0.17	0.08	0.12	0.16	0.09	0.14	0.17	0.08	0.12	0.16	0.09	0.13	0.16	0	0	0	0.11	0.15	0.17
C7	0.09	0.14	0.16	0.07	0.12	0.15	0.09	0.13	0.16	0.08	0.12	0.15	0.02	0.06	0.1	0.07	0.11	0.15	0	0	0

Step three: To obtain the total relation matrix: t_{ij} element in the matrix shows the indirect influence on the components of i on j. The T matrix can reflect the relationships between the pairs of systemic factors. The total relation fuzzy matrix is calculated as follows.

$$T = lim_{k\to\infty}\left(\tilde{H}^1 + \tilde{H}^2 + \cdots + \tilde{H}^k\right) \tag{5}$$

In each element the fuzzy number is as $\tilde{t}_{ij} = \left(l_{ij}^t, m_{ij}^t, u_{ij}^t\right)$ and is calculated by the following formula.

$$\left[l_{ij}^t\right] = H_l \times (I - H_l)^{-1} \tag{6}$$

$$\left[m_{ij}^t\right] = H_m \times (I - H_m)^{-1} \tag{7}$$

$$\left[u_{ij}^t\right] = H_u \times (I - H_u)^{-1} \tag{8}$$

Table 5. The total direct and indirect relations matrix (lower fuzzy)

	C1	C2	C3	C4	C5	C6	C7
C1	0.07	0.12	0.15	0.13	0.1	0.17	0.19
C2	0.09	0.06	0.15	0.14	0.13	0.09	0.16
C3	0.12	0.15	0.06	0.09	0.09	0.11	0.16
C4	0.17	0.17	0.2	0.08	0.18	0.17	0.2
C5	0.15	0.15	0.18	0.18	0.07	0.17	0.2
C6	0.16	0.15	0.17	0.15	0.14	0.07	0.19
C7	0.14	0.13	0.15	0.13	0.07	0.12	0.08

Table 6. The total direct and indirect relations matrix (intermediate fuzzy)

	C1	C2	C3	C4	C5	C6	C7
C1	0.3	0.4	0.44	0.4	0.35	0.43	0.49
C2	0.35	0.29	0.43	0.39	0.37	0.34	0.45
C3	0.36	0.41	0.3	0.34	0.33	0.34	0.44
C4	0.48	0.48	0.53	0.35	0.46	0.46	0.54
C5	0.45	0.45	0.5	0.47	0.31	0.46	0.53
C6	0.45	0.45	0.48	0.44	0.41	0.32	0.52
C7	0.4	0.39	0.43	0.39	0.31	0.37	0.33

Table 7. The total direct and indirect relations matrix (high fuzzy)

	C1	C2	C3	C4	C5	C6	C7
C1	1.32	1.5	1.55	1.46	1.36	1.46	1.59
C2	1.39	1.35	1.52	1.44	1.36	1.39	1.55
C3	1.38	1.46	1.36	1.38	1.31	1.36	1.52
C4	1.6	1.67	1.73	1.48	1.54	1.6	1.75
C5	1.55	1.61	1.67	1.58	1.35	1.56	1.7
C6	1.57	1.63	1.69	1.58	1.49	1.43	1.71
C7	1.43	1.48	1.53	1.43	1.32	1.42	1.42

In these tables, H_l, H_m and H_u are n × n matrices, the elements of which are respectively low, intermediate, and upper numbers of triangular fuzzy numbers (Jasbi et al., 2011).

Step four: Obtaining the sum of rows and columns of the matrix T and determining the importance of indicators, the relationship between them benchmarked as fuzzy and crisp numbers:

$$\tilde{D} = (\tilde{D}_i)_{n\times 1} = \left[\sum_{j=1}^{n} \tilde{T}_{ij}\right]_{n\times 1} \tag{9}$$

$$\tilde{R} = (\tilde{R}_i)_{1\times n} = \left[\sum_{i=1}^{n} \tilde{T}_{ij}\right]_{1\times n} \tag{10}$$

Where $\widetilde{D}$ and $n \times 1$are $\tilde{R}$ andatrices, respectively.m $1 \times n$

Then, the interaction between the factors $\widetilde{D}_i + \tilde{R}_i$ and the influence and impressibility of them $\widetilde{D}_i - \tilde{R}_i$ are determined. If $\widetilde{D}_i - \tilde{R}_i \geq \cdot$, then that factor is an influential factor, and if $\widetilde{D}_i - \tilde{R}_i \leq \cdot$, then it is an impressible factor.

In the final step, the numbers from $\widetilde{D}_i + \tilde{R}_i$ and $\widetilde{D}_i - \tilde{R}_i$ obtained in the previous stages are defuzzified based on equation 11.

$$B = \frac{a_1 + 2 \times a_2 + a_3}{4} \tag{11}$$

Table 8. Defuzzified total relation matrix

	C1	C2	C3	C4	C5	C6	C7
C1	1	1.3	1.41	1.29	1.15	1.39	1.56
C2	1.14	0.98	1.38	1.29	1.21	1.11	1.45
C3	1.19	1.33	0.99	1.1	1.08	1.12	1.41
C4	1.53	1.54	1.68	1.16	1.49	1.5	1.72
C5	1.44	1.46	1.59	1.52	1.03	1.47	1.68
C6	1.45	1.46	1.56	1.42	1.35	1.07	1.66
C7	1.31	1.29	1.38	1.27	1.03	1.22	1.09

Table 9. Influence and impressibility of factors

	D	R	D+R	D-R
C1	9.1	9.07	18.2	0.04
C2	8.56	9.35	17.9	–0.8
C3	8.22	10	18.2	–1.8
C4	10.6	9.04	19.7	1.58
C5	10.2	8.33	18.5	1.86
C6	9.95	8.87	18.8	1.08
C7	8.59	10.6	19.2	–2

4. STEPS TO OBTAIN THE WEIGHTS OF THE FACTORS INFLUENCING KNOWLEDGE MANAGEMENT USING FUZZY ANP

Based on the super matrix, steps to calculate the weights of components include:

First step: To bring together the experts' ideas, a geometric mean is taken from the paired comparisons of respondents.

Table 10. Fuzzy range and corresponding verbal expression

Code	Verbal expression	Fuzzy number
1	same priority or importance	(1,1,1)
2	lower priority or importance	(2,3,4)
3	strong priority or importance	(4,5,6)
4	very strong priority or importance	(6,7,8)
5	quite strong priority or importance	(8,9,10)

Second step: Special vector calculation. To calculate the specific vector of each of the tables of integrated paired comparisons, according to equation 12, the logarithmic least squares method is used.

$$w_k^s = \frac{\left(\prod_{j=1}^{n} a_{kj}^s\right)^{1/n}}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}^m\right)^{1/n}}, \quad s \in \{l, m, u\} \tag{12}$$

$$\tilde{w}_k = (w_k^l, w_k^m, w_k^u) \quad k = 1,2,3,\ldots,n$$

Where:

The following table shows the geometric mean of experts' opinions. The special vector is shown in the last column of the tables.

Table 11. Average paired comparisons compared to the target

Target	c1	c2	c3	c4	c5	c6	c7	Special vector
c1	(1,1,1)	(0.31, 0.349,0.4)	(0.732, 0.855, 0.983	(0.176, 0.208,0.246)	(0.111, 0.125,0.144)	(1.086, 1.384,1.694)	(0.298, 0.358,0.427)	(0.05, 0.057,0.066)
c2	(2.502, 2.863,3.221)	(1,1,1)	(1.098, 1.274,1.472)	(0.418, 0.496,0.585)	(0.316, 0.376,0.445)	(1.042, 1.228,1.426)	(0.354, 0.409,0.472)	(0.095, 0.109,0.123)
c3	(1.017, 1.17,1.366)	(0.679, 0.785,0.911)	(1,1,1)	(0.34, 0.39,0.46)	(0.739, 0.865,1.032)	(0.828, 0.953,1.094)	(0.906, 1.049,1.219)	(0.095, 0.107,0.122)
c4	(4.068, 4.81,5.685)	(1.71, 2.015,2.393)	(2.175, 2.567,2.945)	(1,1,1)	(0.572, 0.672,0.813)	(1.801, 2.115,2.43)	(1.784, 2.14,2.517)	(0.204, 0.235,0.27)
c5	(6.954, 7.983,9.005)	(2.246, 2.661,3.168)	(0.969, 1.156,1.354)	(1.23, 1.489,1.749)	(1,1,1)	(1.919, 2.219,2.517)	(1.346, 1.601,1.931)	(0.22, 0.254,0.29)
c6	(0.59, 0.723,0.921)	(0.701, 0.815,0.96)	(0.914, 1.049,1.208)	(0.412, 0.473,0.555)	(0.397, 0.451,0.521)	(1,1,1)	(0.472, 0.54,0.635)	(0.076, 0.087,0.1)
c7	(2.34, 2.792,3.357)	(2.119, 2.447,2.826)	(0.82, 0.953,1.104)	(0.397, 0.467,0.56)	(0.518, 0.624,0.743)	(1.575, 1.853,2.119)	(1,1,1)	(0.132, 0.152,0.174)

Step three: The formation of special vector matrices. These matrices contain special vectors that are obtained from the paired comparisons in the second step.
In general, these matrices can be divided into two categories:

1. Matrices that include special vectors showing vertical relations. If there is no vertical relationship between two components, (0, 0, 0) will be placed at the confluence of these two components. In other elements, also with respect to the vertical relationship between the components, special vector values obtained in the second step are placed.
2. Matrices that include special vectors showing horizontal relations. These are square matrices the main diagonals of which are (1,1,1). If there is no horizontal relationship between two components, (0, 0, 0) will be placed at the confluence of these two components. In other elements, also with respect to the horizontal relationship between the components, special vector values obtained in the second step are placed.

Notice: If in a special vector matrix, one or more elements in the main diagonal are not (1,1,1) it is due to normalization in that column. Normalization means that all fuzzy numbers of a column are divided by the sum of intermediate fuzzy numbers of that column. The following tables show the special vector matrices.

Table 12. Special vector matrix of Level 2 to Level 1

	Target
c1	(0.05,0.057,0.066)
c2	(0.095,0.109,0.123)
c3	(0.095,0.107,0.122)
c4	(0.204,0.235,0.27)
c5	(0.22,0.254,0.29)
c6	(0.076,0.087,0.1)
c7	(0.132,0.152,0.174)

Table 13. Special vector matrix of Level 2 to Level 2

	c1	c2	c3	c4	c5	c6	c7
c1	(1,1,1)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
c2	(0,0,0)	(1,1,1)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
c3	(0,0,0)	(0,0,0)	(1,1,1)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
c4	(0,0,0)	(0,0,0)	(0,0,0)	(1,1,1)	(0,0,0)	(0,0,0)	(0,0,0)
c5	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(1,1,1)	(0,0,0)	(0,0,0)
c6	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(1,1,1)	(0,0,0)
c7	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(1,1,1)

Step four: Calculation of the final weight of levels. To calculate the final weight of the components of each level (W_i^*) the multiplication of the special vector matrix of same level interrelations' special vector must be multiplied by the final weight of a higher level.

$$W_i^* = W_{ii} \times W_{i(i-1)} \times W_{i-1}^* \tag{13}$$

If there is no W_{ii} matrix for a level, it will be necessary to replace it with a same degree matrix. In other words, the following formula should be used.

$$W_i^* = I \times W_{i(i-1)} \times W_{i-1}^* \tag{14}$$

Table below shows the final weights.

Table 14. Final weight matrix of components to target

The final crisp weight	**The final fuzzy weight**	**Component**
0.057	(0.05,0.057,0.066)	c1
0.109	(0.095,0.109,0.123)	c2
0.108	(0.095,0.107,0.122)	c3
0.236	(0.204,0.235,0.27)	c4
0.254	(0.22,0.254,0.29)	c5
0.087	(0.076,0.087,0.1)	c6
0.152	(0.132,0.152,0.174)	c7

5. CONCLUSION AND SUGGESTIONS

Based on the results of this research the following suggestions are offered:

According to the results of fuzzy DEMATEL and fuzzy ANP techniques, the "specified strategies and objectives in the use of knowledge management" is the most influential and the most important of the factors.

Therefore, first of all, it is suggested to determine both the strategic and the operational objectives for the use of knowledge management in the Tehran Fire Department. Then, the correct and transparent relationship between the macro strategies of the Tehran Fire Department and the use of knowledge management should be established. Also, it is recommended to develop operational and formulated planning in an organization's goals and strategies to enhance knowledge management. According to the results of both techniques, after "specified strategies and objectives in the use of knowledge management", "senior management support towards KM" is the most influential and important factor; it is proposed to increase managerial knowledge toward knowledge management and its potential benefits. In fact, managers serve as a model for all staff and need to have sufficient information on knowledge management and its benefits. In addition, they should also express their support for the use of knowledge management in practice. It is recommended to hold specialized round tables about the appropriate approach to informing managers about the use of knowledge management in the Tehran Fire Department. Also, one of the secrets of success of managers in creating a powerful knowledge management system is to communicate and cooperate sincerely with their staff. The manager must create an atmosphere of trust and confidence in the organization in such a way that the staff trusts them and considers them as support.

According to the results of the fuzzy DEMATEL technique, which showed that "knowledge management performance assessment" is the third factor influencing the other factors, it is recommended to create a comprehensive and systematic measurement system for evaluating knowledge management performance in the Tehran Fire Department. The system should be able to link individual and organizational performance to knowledge management and evaluate all the processes and benefits of knowledge management in the form of an integrated system.

Other practical suggestions:

- Mechanisms should be developed to update the knowledge stored in the organization.
- Professional staff should be encouraged to transfer knowledge to less experienced employees and newcomers.
- Information should be organized regularly and transparently to support decision-making.
- Managers should value for creativity and new ideas in the Tehran Fire Department.

- In the Tehran Fire Department, morale, collaboration and improvement should be emphasized.
- Ideas should be discussed and the results should be organized during official meetings.
- There should be an appropriate atmosphere to implement new theories and ideas in the TFD.
- The Tehran Fire Department must use the knowledge acquired by people toward organizational objectives.
- Teamwork must be developed in the organization.
- Continued regular meetings and an exchange of information between authorities and staff should be held.

Recommendations for future research:

- It is recommended to do studies consistent with this research in other organizations and compare the results with this study.
- In future research, the influence of elements of knowledge management on organizational variables such as productivity, efficiency, effectiveness in the TFD or other organizations can be discussed.
- It is recommended to use multi-criteria decision making techniques such as Vikor, Electre, etc. to assess knowledge management factors in the Tehran Fire Department.
- Using simulation models, it is recommended to determine the influence of knowledge management on the future status of the Tehran Fire Department.

LITERATURE

Badriazarin, Y., Seyyed A., Ahvaz, M.H., Imanpour, A. (2013). Regression analysis of the relationship between knowledge management components and practice of human resources. *Sport Management*, 15, 190-175.

Rezaeian, Ali-Ahmadvand, Ali Mohammadi-Tavallaei, Rouhollah (2009). Examining models of knowledge management strategy and strategy of knowledge in organizations. *Police Human Development Magazine*, 27, 28-17.

Salavati, Adel, Hagnazar, Fereshteh (2009). Analysis of factors affecting the establishment of a knowledge management system in headquarters of National Iranian Oil Company. *Beyond the Management*, 3/10, 45-32.

Bukowitz, W.R; Williams, R.L. (1999). *The Knowledge Management Fieldbook*. Harlow: Pearson Education.

Bhatt, G.D. (2001). Knowledge management in organizations: examining the interaction between technologies, techniques and people. *Journal of Knowledge Management*, 5, 1, 68-75.

Nonaka, I, Takeuchi, H. (1995). *The knowledge creating company*, New York: Oxford University Press, 181.

Nonaka, I. (1994). A Dynamic theory of organizational knowledge creation. *Organizational science*. 14-37.

Plessis, M.D. (2008). What bars organiations from managing knowledge successfully. *International Journal of Information Management*, 28(1), 285-292.

Stamps, D. (1999). Is the knowledge management a fad. *Training*, 36/3, 37.

King, N. (1999). Knowledge management: applying manufacturing theory in knowledge based industries. *Management accounting*, 77, 3.

Choi, B., Lee, H. (2011). Knowledge management enablers, process and organizational performance: an integrative view and empirical examination. *Journal of management information systems* (20:1), 179-228.

Davenport, T.H., De Long, D.W., Beers, M.C. (1998). Successful Knowledge Management Projects, *Sloan Management Review*, 39(2), 43-57.

Gold, A., Malhotra, A., Segars, A. (2011). Knowledge management: an organizational capabilities perspective. *Journal of Management Information Systems,* 18/1, 185-214.

Holsapple, C.W., Joshi, K.D. (2000). An investigation of factors that influence the management of knowledge in organizations. *Journal of Strategic Information Systems*, 9(2/3), 235-261.

Lindler, F., Wald, A. (2010). Success factors of knowledge management in temporary organizations. *International Journal of Project Management*.

Valmohammadi, C. (2010). Identification and prioritization of critical success factors of knowledge management in Iranian SMEs: An experts' view. *African Journal of Business Management*, 4/6, 915-924.

Zack, M., Mckeen, J., Singh, S. (2009). Knowledge management and organizational performance: an exploratory analysis, *Journal of Knowledge Management*, 13/6, 392-409.

Wong K.Y., Aspinwall E. (2005). An empirical study of the important factors for knowledge-management adoption in the SME sector. *Journal of Knowledge Management*, 9(3), 64-82.

Polanyi, M. (1958). *Personal Knowledge: Towards a Post-Critical Philosophy*. University of Chicago Press, Chicago.

Sandhawalia B., Dalcher D. (2011). Developing knowledge Management capabilities: a structure approach, *Journal of Knowledge Management*, 15(2), 313-328.

Likert, R. (1932). A Technique for the Measurement of Attitudes. *Archives of Psychology* 140(1/55).

Ghelich, L. (2015). Investigation of management knowledge and innovation on business performance of small and medium enterprises (case study: center of growth and technology and entrepreneurship of Shahid Beheshti University). *Training and development of human resource*.

Fontela, E., Gabus, A. (1976). *The DEMATEL observer*. Geneva: DEMATEL Battelle Geneva Research Center, .

Gabus, A., Fontela, E. (1972) *World Problems an Invitation to Further Thought within the Framework of DEMATEL*. Geneva: Battelle Geneva Research Centre.

Ebrahimi Samani, Makooyi, Sadre Larijani (2008). Strategy development for Iran's steel industry supply chain using systems dynamics analysis, *Research Journal Sharif*.

OCENA KRYTYCZNYCH CZYNNIKÓW SUKCESU W REALIZACJI ZARZĄDZANIA WIEDZĄ Z WYKORZYSTANIEM METOD ROZMYTYCH ANP I DEMATEL. STUDIUM PRZYPADKU: STRAŻ POŻARNA W TEHERANIE

Streszczenie

Dziś wiedza i informacja są uważane za czynniki decydujące o sukcesie i konkurencyjności organizacji. Produkty i usługi firm, które mogą skutecznie zdobywać wiedzę w organizacji i wykorzystywać je w procesach biznesowych, będą miały przewagę konkurencyjną na rynku. W badaniu zastosowano techniki rozmyte DEMATEL w celu zbadania zależności przyczynowych między czynnikami wpływającymi na wdrożenie zarządzania wiedzą i techniki rozmytej ANP w celu określenia priorytetu czynników. Studium przypadku w tym badaniu jest Straż Pożarna w Teheranie. Wyniki wykazały, że w trakcie wdrażania metody rozmytej DEMATEL za najistotniejszy czynnik uznano "strategie i cele w zarządzaniu wiedzą", a czynnik "projektowanie skutecznych procesów stosujących KM" był najbardziej wrażliwy. Ostatecznie, przy użyciu metody rozmytej ANP, za najważniejszy uznano czynnik strategii i celów w zakresie zarządzania wiedzą.

Słowa kluczowe: KM, DEMATEL, ANP, Straż Pożarna w Teheranie