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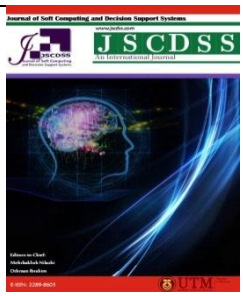

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Evaluating the Knowledge Management Practices in State Welfare Organization (Behzisti): Application of Fuzzy MCDM Approach

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Abstract

This study aims to evaluate the most important knowledge management practices in Behzisti organizations through integrating fuzzy set theory with both qualitative and quantitative approaches. The most important criteria for the evaluation of knowledge management practices are gathered through the literature survey. This study suggests a model based on fuzzy multiple criteria decision making, including the fuzzy Delphi method and Fuzzy Analytic Hierarchy Process (FAHP). In the fuzzy Delphi method step of the study, 21 practices were selected from among a total of 74 knowledge management practices and categorized from four perspectives. The fuzzy analytic hierarchy process was used for the ranking of knowledge management practices in three Behzisti organizations. Results of this study indicated that the information technology infrastructure from a technological perspective was ranked as the first most important factor and human resource management from organizational perspective as the second.

Keywords: Knowledge management, Fuzzy Delphi method, Fuzzy analytic hierarchy process, Fuzzy hybrid multiple-criteria decision-making approaches.

1. Introduction

Several Knowledge Management (KM) practices with different groups have identified by previous scholars such as organizational, technological, people or human perspectives, there are a lot of troublesome problems that most of those enterprises have to face up in such a distributed, increasingly changing environment. The implementation of knowledge management in those business enterprises is hindered by the limitations of the business organizational environment, though it has its strengths. Environmental perspectives related to knowledge management helps organizations to achieve their environmental, business, and economic goals. Since it classifies and describes actions related to all relevant environmental knowledge areas, from suppliers, society, government etc. On the other hand, use of KM to tackle environmental issues can help companies to better understand what can be done about environmental problems and how to realize the benefits of environmentally responsible actions (Frick, Kaiser, & Wilson, 2004). Most of the literature on environmental knowledge management focuses on informational and softer decision-making tools rather than on appropriate understanding of specific environmental knowledge areas and their connection to organizational structure and culture (Heeney & Murphy, 1999). Environmental knowledge management should combine tools, mechanism, processes, structures, strategies, data, and information with people's experiences and ideas to enable the creation, capture, sharing, acquisition, and use of knowledge (Huang & Shih, 2009). In addition; organizations need to manage environmental knowledge in order to make it useful for their business activities. However, includes two further concepts, namely, the skills and competencies to implement environmental knowledge. Detailed analysis of these concepts is out of the scope of this research, we believed that there is lack between previous studies which did not attention to importance of KM system related to environmental perspectives; therefore as the first study, we attempted to introduce environmental perspective as a new perspective of KM system in three Behzisti organizations in Iran.. KM in the organizations needs to use a structure for loading knowledge in excessive sizes and for inference and learning requirements for computational capability. Hence, it has a great capability for providing KM facilities that can be used widely for economic and commercial intelligence. However, due to the important role of KM in Behzisti organizations, previous studies have drawn attention to this issue. Therefore, this present study attempted to fill this gap by applying greater focus on the role of KM in Iranian Behzisti organizations.

The literature contains numerous factors that have an effect on the successful implementation of KM; on the other hand, adequate systematic research on KM implementation in Iranian Behzisti organizations is lacking. The list of practices should be well decomposed to be useful for practical purposes. Determining the significance of critical factors is a qualitative problem and certainly involves the imprecision and subjectivity of human judgments (W.-W. Wu, 2012). Therefore, regarding the critical factor segment, an effective method should be employed which can address vague human judgments and make a model of the underlying relationships among the critical factors. A theory that is able to handle vagueness in decision-making is the fuzzy set theory (Bellman & Zadeh, 1970; Zadeh, 1965). It takes time for KM implementation to fully show its effects in an organization. As a result, decision making on KM implementation can be facilitated through a successful implementation and an efficient decision-making approach.

This study mainly involves quantitative and qualitative measures that are presented by Triangular Fuzzy Numbers (TFNs) and defuzzified into a crisp value in order to analyze the cause and effect decision-making model. This research aims at investigating, ranking, and classifying the most important KM practices in Behzisti organizations. The existence of several factors affecting KM's success shows that the prediction issue is a multiple-criteria decision-making problem (Sachin Krishnath Patil, 2014; Sachin K Patil & Kant, 2014b; Wang & Chang, 2007a). T.-H. Chang and Wang (2009), employed the fuzzy multiple-criteria decision-making approach for measuring the possibility of successful KM. Note that, in a decision-making process, human judgment is often not clear, and it cannot be easily estimated by exact numerical values. For that reason, fuzzy logic is required to handle the problems that are vague and/or imprecise. In the present study, a framework is proposed based on Fuzzy Delphi Method (FDM) and fuzzy analytic hierarchy process (FAHP). This study uses FAHP because even though much merit has been provided by conventional Delphi methods, the problems of uncertainty and ambiguity still exist, as in many other survey techniques. These problems may appear not only in survey questions, but also in response (Sackman, 1974). However, the fuzzy set theory is able to deal with these problems. In the present study, the most important key factors for KM success are implemented in knowledge-oriented companies in order to extract and prioritize practices in Iranian Behzisti organizations. Therefore, this study identifies and ranks practices and investigates the success of KM carried out in Iranian Behzisti organizations.

2. Overview on knowledge management

KM is one of the emerging topics of academic and professional discourse in many fields of knowledge, consulting (Datta, 2000), technology (A. H. Lee, Kang, & Chang, 2011; Perumal & Woods, 2007), culture (Lim, 2002), information technology (Phatak, 2000), education (SA Hasan, AK Pal, SC Dhawan, & Rajesh Luthra, 2008) learning (Bhardwaj, 2000) and Human Resource Management (HRM) (SA Hasan, AK Pal, SC Dhawan, & R Luthra, 2008). KM has been recognized as one of the most critical factors for obtaining organizational competitive advantage (Hirai, Uchida, & Fujinami, 2007; Sugiyama, 2007). The major goal of KM implementation is to frequently accrue maximum benefit and achieve competitiveness (Gupta, Iyer, & Aronson, 2000; Sharma, 2000). To obtain sustainable competitive advantages, companies must consider what everyone in the organization knows and how they use their knowledge. Its proponents argue that KM system is applicable to all organizations and industries: consulting (Taminiau, Smit, & De Lange, 2009), service (C.-N. Liao, 2013), manufacturing (Choudhury, 2000; Seethamraju, 2000).

Many scholars have indicated that MCDM is a very effective method for decision-making in complex situations (Mardani, Jusoh, MD Nor, et al., 2015; Mardani, Jusoh, & Zavadskas, 2015; Mardani, Jusoh, Zavadskas, Cavallaro, & Khalifah, 2015; Mardani, Jusoh, Zavadskas, Kazemilari, et al., 2016; Mardani, Jusoh, Zavadskas, Khalifah, & Nor, 2015; Mardani, Jusoh, Zavadskas, Zakuan, et al., 2016; Mardani, Zavadskas, Govindan, Amat Senin, & Jusoh, 2016; Mardani, Zavadskas, Khalifah, Jusoh, & Nor, 2015; Mardani, Zavadskas, Khalifah, et al., 2017; Mardani, Zavadskas, Streimikiene, Jusoh, & Khoshnoudi, 2017; Mardani, Zavadskas, Streimikiene, et al., 2016; Zavadskas, Mardani, Turskis, Jusoh, & Nor, 2016; Ahmadi et al., 2015; Nilashi and Ibrahim, 2014; Nilashi et al., 2015a; Nilashi et al., 2015b; Nilashi et al., 2015c; Nilashi et al., 2016; Zare et al., 2016; Dalvi-Esfahani et al., 2017). A number of researchers working on KM issue employed (Sachin K Patil & Kant, 2014a) fuzzy sets in order to evaluate the factors of KM and put them in a proper ranking (Banerjee, 2008). According to Luxhøj, Riis, and Stensballe (1996), several commonly-used qualitative models have no systematic structure and judgment, leading to inaccurate final results. N.-B. Chang, Chen, and Ning (2001), believe that because the fuzzy number of each factor is capable of clearly explaining the way the independent variables remain in fuzzy predicting frameworks and modeling, FDM is capable of dealing with the fuzzy relations of forecast cases. If FDM is used for selecting the evaluation factors, two issues should be taken into consideration: (1) collected factors should be correct and (2) an expert group should be selected appropriately. However, no study has been found in literature which specifically applies FDM as one stream of the FMCDM family to the evaluation of practices of KM. As a result, this study takes into account FMCDM and the Delphi method and uses FDM for evaluating different KM practices.

3. Research Method and Framework

The analytic structure of this study is presented in Fig. 1. In this paper qualitative and quantitative approaches in fuzzy set theory are combined for the evaluation of the KM practices. In order to select the KM in three Iranian Behzisti organizations, a survey was done on the literature

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to find the primary factors for evaluating KM practices. A total of 74 practices were collected from the previously-conducted studies (Table 2). Two fuzzy questionnaires were provided for this study. In the first phase, the questionnaire was formed using 74 practices of KM gathered from the literature. In the second phase, the questionnaire was distributed among KM experts for their evaluation, suggestions and opinions. The use of expert questionnaires is a useful tool for gathering required data in a Delphi survey when, due to time and distance, face-to-face interviews cannot be held (Dalkey & Helmer, 1963). The questions were extracted from literature and some of them were suggested by the experts in an open format. Group size affects the efficiency of group decision-making; according to (Anderson, Liam, Garrison, & Archer, 2001), experts' forecasting suggest that from 5 to 20 experts should participate. Accordingly, an appropriate size for a decision-making group should be roughly between 5 and 50 (Gumus, 2009).

3.1. Sample selection

In order to conduct interviews with experts, the author spent three days participating in the 7th conference on knowledge management, held 17- 18February 2014 (http://www.bahamayesh.com/cnf/1480). Before the conference, the authors attempted to connect with experts selected from the conference database by online survey in order to collect the experts' information and their consent. In the present study, 15 experts were invited and consented to participate for interview. We selected 10 available experts, including 29 industry experts and 9 academic experts in the field of KM. These experts had over five years of experience in KM. The procedure of evaluation can be explained as follows. The respondents had to meet two criteria before being invited to participate in the survey: (1) have extensive work experience within the KM in Iran, and (2) have past involvement in the implementation of KM in Iran or have gained comprehensive knowledge of the information system studies.

Then, weights for the 74 practices were transformed into fuzzy sets based on the responses of experts on a 9-level evaluation measure (see Table 1). Along with traditional Delphi process, FDM was combined with the fuzzy theory. The Fuzzy Delphi process takes vague concepts and helps to gather opinions to reach a consensus with the benefit of ensuring that the analysis was performed in a careful way. To generally understand the opinions of experts concerning fuzziness, FDM is capable of taking the decisions of the group (Garai, 2013). After the calculation of FDM, 21 practices were selected. According to literature and the suggestions of experts, the 21 practices were categorized from four different perspectives (human, organizational, environmental, and technological).

In the third step, the FAHP approach was used for the calculation of relative weight of the KM practices in three Behzisti organizations, namely B1, B2, and B3. We selected these three organizations because they had been using the KM system for several years. In the present study, FAHP is used because many researchers (D.-Y. Chang, 1996) who have investigated FAHP have shown that FAHP provides a more scientifically based decision making processes in comparison with the conventional AHP methods, in which numerical values of linguistic variables are directly evaluated in terms of fitness criteria.

In cases where the decision-making process is fuzzy in the environment, fuzzy numbers are employed for the purpose of evaluation through taking into consideration the deviations of decision makers. The current complex economic conditions have caused most decisions to be of this sort. Therefore, FAHP or other similar methods are commonly employed in spite of their complexity in the calculation process (Özdağoğlu & Özdağoğlu, 2007).

3.2. Evaluation of KM Practices Criteria Framework

The most important factors for evaluation of KM practices were extracted by a literature survey. A total of 74 practices were extracted from the previously-carried out studies. Subsequent to FDM calculation, 21 practices were selected by the experts and classified into four different perspectives, such as; human, organizational, environmental and technological. According to the classification performed by the experts, the organizational perspective consisted of six practices (C41-C46): culture (C41), leadership (C42), HRM (C43), organizational structure (C44), and organizational strategy (C45), benchmarking (C46); the human perspective included five practices (C31-C35): employee involvement (C31), employee training (C32), trustworthy teamwork (C33), employee empowerment (C34), and employee motivation (C35); the technological perspective consists of five practices (C21-C25), IT infrastructure (C21), E-learning (C22), measurement (C23), job security (C24), information technology (C25); and the environmental perspective is composed of five practices (C11-C15): government (C11), collaboration (C12), society (C13), communication (C14), suppliers (C15). Hierarchical framework of this classification is presented in Framework Fig. 3.

Table 1

The definition of fuzzy number

Definition	Fuzzy number
Extremely important	$\tilde{9}$= (7, 9, 9)
Intermediate value between extremely and very strongly important	$\tilde{8}$= (6, 8,9)
Very strongly important	$\tilde{7}$= (5, 7, 9)
Intermediate value between very strongly and strongly important	$\tilde{6}$= (4, 6, 8)
Strongly important	$\tilde{5}$= (3, 5, 7)
Intermediate value between strongly and moderately important	$\tilde{4}$= (2, 4, 6)
Moderately important	$\tilde{3}$= (1, 3, 5)
Intermediate value between moderately and equally important	$\tilde{2}$= (1, 2, 4)
Equally important	$\tilde{1}$= (1, 1, 3)

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3.3. Fuzzy set and linguistic variables

Zadeh (1965), indicated that traditionally quantifying reasonable expressions in conditions that are too complex or those that are hard to define is very complicated. A linguistic variable view in these cases is essential. Each variable is linguistic when its values are sentences or words in an artificial or natural language. The questionnaire was designed by means of the 9-level evaluation scale that had been introduced by (Saaty, 1999) to gain the outcome of relative significance among a pair of indicators/items in comparison with the experts' pairwise. Therefore, the obtained outcomes have been converted into fuzzy numbers; afterward, the comparative matrices of fuzzy pair were generated by a technique introduced by (G. Huang, Baetz, Patry, & Terluk, 1997). A TFN fuzzy partition was employed in order to show the membership function of the expression values.

3.4. Fuzzy Delphi Method

Fuzzy Theory, introduced by Zadeh (Zadeh, 1965), is employed to show uncertain phenomena in the environment mathematically. This is used because of the vagueness of human emotions and perceptions. Using fuzzy theory, human emotions can be explained with higher accuracy (Zadeh, 1965). During the traditional Delphi process, FDM is possibly combined with fuzzy theory. In the fuzzy Delphi process, vague concepts are recorded, and this method helps to collect opinions to reach a consensus, and it can ensure that the analysis has performed in a careful way.

Step 1: Building the structure of KM practices perspective.

The KM practices perspective can be addressed from four different perspectives: human, environmental, organizational, and technological.

Step 2: Establishing the weights evaluation.

The application of the fuzzy triangular numbers to integrate the opinions of experts reduced the fuzzy human thought problems and their low level of accuracy. Additionally, the decision makers could clarify their thinking patterns. The approaches that were applied to integrate the opinions group were total numbers: average numbers, the minimum, the maximum, and the hybrid technique which is an average of the minimum and the maximum. Saaty (1999), believed that by using a geometric average method commonly employed in practical research, scholars were able to present the experts' opinions in a more accurate way. Since the results of the "geometric average" technique can be employed with the definition of the fuzzy judgment matrix, in this paper, the geometric averages are employed to attain a collective expert opinion. Therefore, a number of the triangular fuzzy numbers were used to establish the function of fuzzy membership of the opinions of the experts, as shown in the chart in Fig 2.

This chart showed and presented the minimum of the consensus of expert's common as the maximum as point u and point 1. Therefore, the degree of satisfaction for 2 extremes is shown as $zero$, although the degree of satisfaction between 1 and 0 are given to the segments between l and u. Thus, in this paper, the fuzzy number of all experts' is included, which is denoted as $\widetilde{w}i = (l_{ij}, m_{ij}, uij)_{L-R}$, where the number of fuzzy weight of the index for KM practices index j through the individual expert i is
$\widetilde{w}i = (l_{ij}, m_{ij}, uij)_{L-R}$.

Consequently, the above approach can prevent the deletion of information or the neglecting of information, except information that is offered in $\bar{l}\bar{u}$ as established. This is shown in Fig 2, and the left chart, which presents the traditional Delphi Method, and the consensus includes opinions of as many experts as possible.

The evaluation of fuzzy weight evaluations based on experts opinions have been extracted from the FDM survey. As a result, the number of fuzzy weight of expert i on practices of KM index j can be demonstrated as below:

$$\widetilde{w}i = (l_{ij}, m_{ij}, uij)_{L-R} \quad (1)$$

$$l_{ij} = Min\left(l_{ij}\right), i = 1, \dots, n; \quad j = 1, \dots m \quad (2)$$

$$m_j = \left(\prod_{i=1,j=1}^{n,m} mij\right)^{1/n}, i = 1, \dots, n; \quad j = 1, \dots, m \quad (3)$$

$$l_{ij} = Max\left(u_{ij}\right), i = 1, \dots, n; \quad j = 1, \dots m$$

where n signifies the number of experts, and m indicates the number of indicators for practices of KM.

Step 3: Selecting the appropriate practices of KM for three organization. The fuzzy weight number $\widetilde{w}ij$ produced in Step 2 cannot be applied for a straight comparison. Therefore, in this paper, the fuzzy spread and mean (W.-Z. Wu & Zhang, 2004) technique were used to transform the results into a crisp number of j.

$$ofj = \frac{(u_j + m_j + m_j)}{3} \quad (4)$$

A threshold was provided by the experts. According to previous studies, the study threshold is set as $r = 0.7$, and this was employed for selecting proper practices of KM.

$If\ of\ j \geq r$, then the practices of KM should be chosen;

$If\ of\ j < r$, then the practices of KM should be chosen.

The result of FDM step is shown in Table 2.

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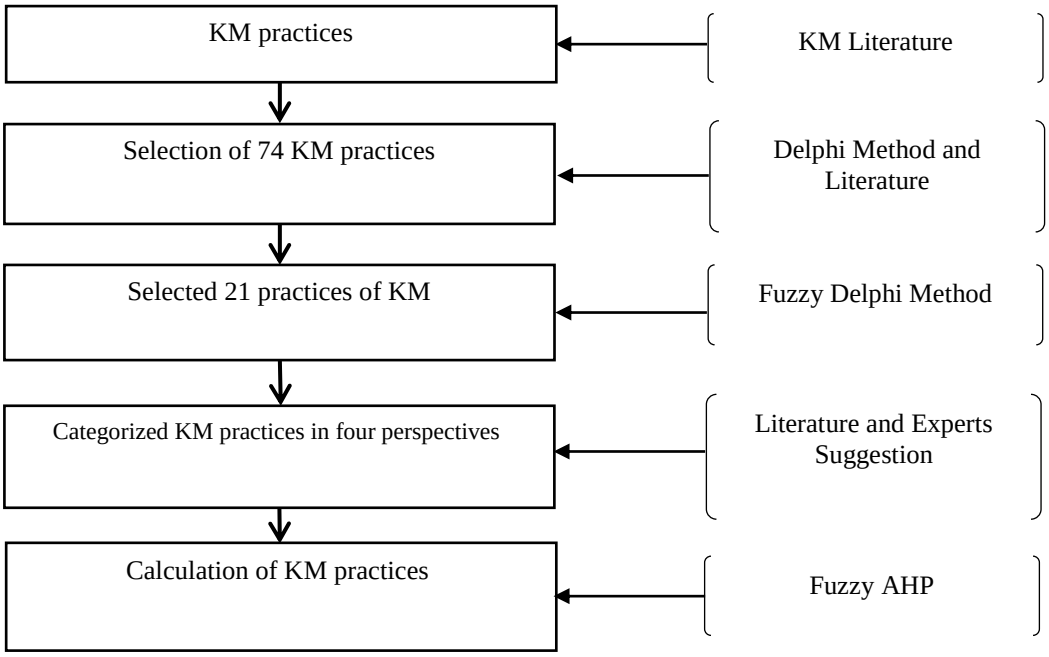

Fig. 1. Process of Knowledge management practices framework development

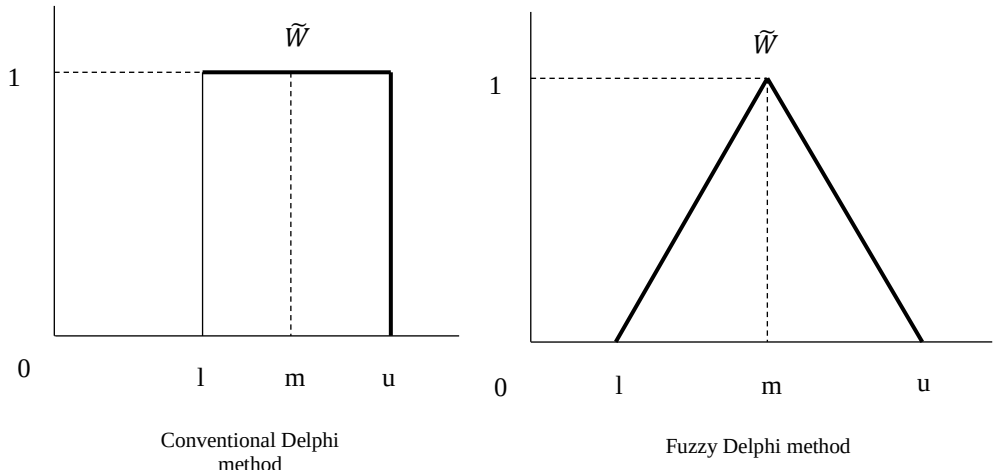

Fig. 2. Comparison of membership functions in the conventional Fuzzy Delphi Method and Delphi Method

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3.5. Fuzzy AHP

Summary of the procedure through which the criteria weights are determined by the fuzzy AHP technique:

Phase 1: Constructing the comparison of pairwise matrices amongst the total features/items in factors of the hierarchical system by means of the experts' questionnaire; then assigning linguistic terms by TFN to the pairwise comparisons by questioning an expert in terms of his/her view features/items as follows;

$$\tilde{A}= \begin{pmatrix} 1 & \tilde{a}_{12} & \dots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \dots & \tilde{a}_{2n} \\ . & . & & . \\ . & . & & . \\ . & . & & . \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \dots & 1 \end{pmatrix} = \begin{pmatrix} 1 & \tilde{a}_{12} & \dots & \tilde{a}_{1n} \\ 1/\tilde{a}_{21} & 1 & \dots & \tilde{a}_{2n} \\ . & . & & . \\ . & . & & . \\ . & . & & . \\ 1/\tilde{a}_{n1} & 1/\tilde{a}_{n2} & & 1 \end{pmatrix}$$

Phase 2: Calculating the weights of fuzzy number and the fuzzy geometric calculation of each measure concluded standardization (Buckley, 1985a) as explained below:

$$\tilde{r} = (\tilde{a}_{j1} \otimes \tilde{a}_{j2} \otimes \dots \otimes \tilde{a}_{jn})^{1/N}, \quad (6)$$

$$\tilde{w}i = \tilde{r}(\tilde{r}_1 \otimes \dots \otimes \tilde{r}_n)^{-1}$$

where $\tilde{a}_{in}$ denotes the fuzzy comparison value of criterion i to criterion n; therefore, $\tilde{r}_i$ indicates the geometric mean of fuzzy comparison value of criterion i to each criterion; $\tilde{w}i$ stands for the fuzzy weight of the ith criterion, which can be denoted by a $TFN, \tilde{w}i = (Lwi, Mwi, Uwi)$. Uwi , $Mwi, and\ Lwi$ signify the upper, lower and middle values of the weights of fuzzy numbers of the ith measure, respectively.

Bellman and Zadeh (1970), suggested the application of decision making problems with fuzzy numbers and commenced fuzzy MCDM. Generally, this investigation technique is employed for the DM problems. The procedures and approaches of the fuzzy MCDM concept are presented in the following sub-sections:

3.6. Measurement of Alternatives

Measurement of linguistic variables is conducted to determine the performance criteria applied by experts to demonstrate their individual assessment and a TFN in the measure range of 0–100 is used for every linguistic variable. Let $\tilde{E}_{ij}^{k}$ denote the performance of fuzzy value of estimator k for choice i under index j and reveal all evaluation criteria. As the perception of each expert is different based on the evaluator's knowledge and experience and definition of the linguistic variables differs, the present research applies the average value concept to the integration of the values of m estimators, which is as follows:

$$\tilde{E}_{ij}^{k}=\left(\frac{1}{m}\right) \otimes (\tilde{E}_{ij}^{1} \oplus \tilde{E}_{ij}^{2} \oplus \dots \tilde{E}_{ij}^{m}) \quad (7)$$

where $\otimes$ signifies the fuzzy multiplication, $\oplus$ represents the fuzzy addition, and $\hat{E}_{ij}$ denotes the fuzzy number average of the decision maker's judgment, which a number of triangular fuzzy has established as $\tilde{E}_{ij}^{k}$ = ($L\tilde{E}_{ij}^{k}$, $M\tilde{E}_{ij}^{k}$, $U\tilde{E}_{ij}^{k}$). Buckley (1985b) proposed a method capable of computing the endpoint values $L\tilde{E}_{ij}$, $M\tilde{E}_{ij}$, and $U\tilde{E}_{ij}$ as follows:

$$L\tilde{E}_{ij} = \frac{\sum L\tilde{E}_{ij}^{k}}{m}, M\tilde{E}_{ij} = \frac{\sum M\tilde{E}_{ij}^{k}}{m}, U\tilde{E}_{ij} = \frac{\sum U\tilde{E}_{ij}^{k}}{m}, \quad (8)$$

3.7. Decision of Fuzzy Synthetic

The fuzzy number calculation is the result of combining weights of a criterion value of fuzzy performance and has been found in the value of fuzzy performance in the basic assessment (Shaverdi, Akbari, & Tafti, 2011). In every criterion, fuzzy AHP, from which the weight $\tilde{w}_j$ can be extracted, the vector of criteria weight $\tilde{w}_j$ = $(\tilde{w}_1, \dots, \tilde{w}_j, \dots, \tilde{w}_n)^t$ can be obtained, whereas the value of fuzzy performance of every choice under n criteria acquired the matrix of fuzzy performance $\tilde{E}$ of every choice, (i.e., $\tilde{E}$ = ($\tilde{E}_{ij}$). The fuzzy matrix $\tilde{E}$ and the vector of $\tilde{w}$ assumed the decision of final fuzzy synthetic, and the achieved outcome was decision of fuzzy synthetic matrix $\tilde{R}$, as follows

$$\tilde{R} = \tilde{E} \odot \tilde{w} \quad (9)$$

where "$\odot$" represents the calculation of the fuzzy numbers, consisting of fuzzy multiplication and fuzzy addition. Due to complexity of the fuzzy multiplication calculation, the outcome is typically denoted and the estimated fuzzy number $\tilde{R}_i$, as $\tilde{R}_i$ = (LR_i, MR_i, UR_i) where LR_i, MR_i and UR_i, respectively, indicate the lower, middle, and upper synthetic performance values of alternative i, that is,

$$LR_i = \sum_{j=1}^{n} LE_{ij} \otimes LW_j,$$

$$MR_i = \sum_{j=1}^{n} Mw_j \otimes ME_{ij}, \quad (10)$$

$$UR_i = \sum_{j=1}^{n} Uw_j \otimes UE_{ij},$$

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3.8. *Fuzzy* Number *Ranking*

A fuzzy number is the fuzzy synthetic decision's outcome that is attained by every choice. The defuzzification is locating the "Best Non-Fuzzy Performance value (BNP)" (T.-Y. Hsieh, Lu, & Tzeng, 2004). Generally, the approaches employed in similar defuzzified fuzzy ranking "consist of center of area (COA)", mean of maximal (MOM), and α −cut. The COA method can be simply and practically applied and there is no need for preferring some evaluators, which is why we use this method. Formula (7) computes the BNP value of fuzzy number $\widetilde{R}_i$:

$$\mathrm{BNP}_i = \left(\frac{[(UR_i - LR_i) + (MR_i - LR_i)]}{3}\right) + LR_i, \forall_i. \quad (11)$$

Based on the value of the BNP extracted for every chioce, the ranking of every chioce and finally criterion can proceed.

4. Results

In the present study, researchers performed a literature survey to collect a total of 74 practices for evaluation of KM practices (Table 2). In the next step, a fuzzy questionnaire was formed by authors using 74 practices and it was sent to experts. The experts were asked to select and categorize the most important KM practices in Iranian Behzisti organizations. Using FDM calculation, 21 practices were selected. According to the literature on KM and suggestions given by the experts, the 21 practices were classified into four perspectives: human, organizational, environmental, and technological.

4.1. *Fuzzy Delphi Method*

The analytic structure of this study is presented in Fig 1. In this paper, fuzzy set theory along with qualitative and quantitative approaches is combined for the evaluation of the KM practices in order to select KM in three Iranian Behzisti organizations. Initially, a survey was done on the literature to find the primary factors for evaluating KM practices. A total of 74 practices were collected from the previously-conducted studies (Table 3). A two-fuzzy questionnaire was provided for this study. In the first phase, the questionnaire was formed using 74 practices of KM gathered from the literature. In the second phase, the questionnaire was distributed among some KM experts to be evaluated by them and their suggestions and opinions were taken into account. The use of expert questionnaires is a useful tool for gathering required data in a Delphi survey when, due to time and distance, interviews cannot be held (Dalkey & Helmer, 1963). The questions were extracted from literature and some of them were suggested by the experts in an open format. Group size affects the efficiency of group decision-making; according to (Anderson, et al., 2001), between 5 and 20 experts should participate in forecasting. Accordingly, the size of decision-making group should not be too large—it should be roughly between 5 and 50 (Gumus, 2009). In the present study, 50 experts were invited to participate, from which we selected 38, including 29 industry experts and 9 academic experts in the field of KM. Finally, 35 experts participated in this research. The procedure of evaluation can be explained as follows. Online survey questionnaires were used to collect the experts' information. In total, 35 questionnaires were returned and validated successfully. Then, weights for the 74 practices and ratings of three organizations were converted into fuzzy sets according to the experts' responses on a 9-level evaluation scale. Along with traditional Delphi process, FDM is possibly combined with the fuzzy theory. The Fuzzy Delphi process takes vague concepts involved, and this helps to gather opinions to reach a consensus with the benefit of ensuring that the analysis have been performed in a careful way. To understand generally the opinions of experts concerning fuzziness, FDM is capable of taking the decisions of the group (Lin, 2013). After the calculation of FDM, 21 practices were selected. According to literature and suggestions of experts, the 21 practices were categorized in four different perspectives (i.e., human, organizational, environmental and technological).

From the above-mentioned steps, a calculated result was achieved as presented in Table 3. Eliminating 53 less important indicators from the total of initial 74 KM practices reduced the total to 21 indicators. According to the literature, discussions held with the experts, and experts' suggestions, 21 practices were categorized into four perspectives, i.e., human, environmental, organizational, and technological. Fig. 3 represents these categories based on the perspective and sub-perspective for Iranian organizations, which can be also used to determine the criteria weights in the FAHP method.

4.2. *Fuzzy AHP*

In the third step, the FAHP approach was used for the calculation of relative weight of the KM practices in three organizations. In the present study, FAHP is used because many researchers (Cebeci & Ruan, 2007; M.-F. Chen, Tzeng, & Tang, 2005; Nieto-Morote & Ruz-Vila, 2011) who have investigated the fuzzy AHP have shown that fuzzy AHP provides scientific data on decision making processes in comparison with the conventional AHP methods in which numerical values of linguistic variables are directly evaluated. The fuzzy numbers are employed for the purpose of evaluation by taking into consideration the deviations of decision takers. The current complex economic conditions have caused most decisions made to minimal in such an environment. Therefore, fuzzy AHP or other similar methods are commonly employed in spite of their complexity in the calculation process (Özdağoğlu & Özdağoğlu, 2007).

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4.3. The fuzzy weight of KM Practices

For ranking, the most significant KM practices in the three Iranian organizations based on the hierarchical framework introduced in the first stage of this research were included in the FAHP questionnaire that was distributed among the experts of KM industries in order to attain their suggestions and opinions. This questionnaire was designed based on the Triangular Fuzzy Numbers (TNF). Table 4 and Table 5 show the fuzzy weight and the fuzzy judgment values of KM practices by FAHP.

4.4. Ranking of the knowledge management

Three Behzisti organizations, including B1, B2 and B3 were selected for the purpose of this study. These organizations were then evaluated in terms of KM success by the panel of experts. Given that the experts had different opinions, various opinions were then combined to achieve a comprehensive and objective evaluation.

Table 2

List of KM practices based on previous studies on KM literature

No.	CSFs	Related studies	Total
1	IT infrastructure	(Ajmal, Helo, & Kekäle, 2010; Akhavan, Jafari, & Fathian, 2006; Alsadhan, Zairi, & Keoy, 2008; Anantatmula & Kanungo, 2010; Basu & Sengupta, 2007; Berawi & Woodhead, 2005; T.-H. Chang & Wang, 2009; Heisig, 2009; L.-S. Huang & Lai, 2012; Hung, Huang, & Lin, 2005; M. E. Jennex & Olfman, 2004; Kazemi & Allahyari, 2010; Lindner & Wald, 2011; Mas-Machuca & Martínez Costa, 2012; McCampbell, Clare, & Gitters, 1999; M.-L. Tseng, 2010; Wong, 2005; Yeh, Lai, & Ho, 2006)	20
2	Organizational structure	(Akhavan, Hosnavi, & Sanjaghi, 2009; Akhavan, et al., 2006; Al-Mabrouk, 2006; T.-H. Chang & Wang, 2009; Cristina, 2009; Delen, Zaim, Kuzey, & Zaim, 2013; Garrido-Moreno & Padilla-Meléndez, 2011; Hassan & Al-Hakim, 2011; M. Jennex & Zakharova, 2005; Kazemi & Allahyari, 2010; Megdadi, Al-Sukkar, & Hammouri, 2012; Migdadi, 2009; Milovanović, 2011; Valmohammadi, 2010; Wang & Chang, 2007b; Wong, 2005; Wong & Aspinwall, 2005; Yang, Fang, & Lin, 2010)	18
3	Organizational culture	(Davenport, 1998; Heisig, 2009; L.-S. Huang & Lai, 2012; Hung, et al., 2005; M. Jennex & Zakharova, 2005; S. Lee, Kim, & Kim, 2012; Liebowitz, 1999; Lindner & Wald, 2011; McDermott & O'Dell, 2001; Migdadi, 2009; Moffett, McAdam, & Parkinson, 2002, 2003; Ramezani, Fathain, & Tajdin, 2013; Siddique, 2012; Skyrme & Amidon, 1997; S.-M. Tseng, 2010; Wong, 2005; Wong & Aspinwall, 2005)	18
4	Leadership	(Akhavan & Jafari, 2006; Akhavan, et al., 2006; Artail, 2006; Chong & Choi, 2005; Garrido-Moreno & Padilla-Meléndez, 2011; Hassan & Al-Hakim, 2011; Heisig, 2009; M. Jennex & Zakharova, 2005; M. E. Jennex, Smolnik, & Croasdell, 2009; Kazemi & Allahyari, 2010; Lindner & Wald, 2011; Valmohammadi, 2010; Wang & Chang, 2007b; Wong, 2005; Wong & Aspinwall, 2005; W.-W. Wu, 2012)	18
5	Knowledge sharing	(Akhavan, et al., 2009; Artail, 2006; Davenport & Prusak, 1998; Heisig, 2009; L.-S. Huang & Lai, 2012; Kazemi & Allahyari, 2010; Kim & Lee, 2006; Moffett, et al., 2002, 2003; Toloie-Eshlaghy & Akbari-Yusefvand, 2011; M.-L. Tseng, 2010; W.-W. Wu, 2012; Yang, et al., 2010; Yu, Kim, & Kim, 2004; Zack, McKeen, & Singh, 2009)	15
6	Information technology	(Akhavan & Jafari, 2006; Al-Mabrouk, 2006; Alavi & Leidner, 2001; Davenport & Prusak, 1998; Hassan & Al-Hakim, 2011; Liebowitz, 1999; Megdadi, et al., 2012; Migdadi, 2009; Siddique, 2012; Skyrme & Amidon, 1997; Wong & Aspinwall, 2005; W.-W. Wu, 2012; Yu, et al., 2004)	14
7	strategy and purpose	(Al-Mabrouk, 2006; L.-S. Huang & Lai, 2012; Kazemi & Allahyari, 2010; Megdadi, et al., 2012; Migdadi, 2009; Milovanović, 2011; Shehzad, Khan, & Naeem, 2013; Siddique, 2012; Wong, 2005; Wong & Aspinwall, 2005; Zack, et al., 2009; Zamani Moghaddam, Mosakhani, & Aalabeiki, 2013)	12
8	HRM	(Akhavan, et al., 2009; Akhavan & Jafari, 2006; T.-H. Chang & Wang, 2009; M.-Y. Chen & Chen, 2011; Ebrahimi, Bushehr, Abbaszadeh, & Fotouhi, 2010; Hassan & Al-Hakim, 2011; Kazemi & Allahyari, 2010; Megdadi, et al., 2012; Migdadi, 2009; Valmohammadi, 2010; Wong & Aspinwall, 2005; Yang, et al., 2010)	12
9	Teamwork	(Choi, 2000; Chong & Choi, 2005; Civi, 2000; Geraint, 1998; Haas, 2002; Hung, et al., 2005; Manning, 2010; Moffett, et al., 2003; Mohrman, Cohen, & Morhman Jr, 1995; Phillips, 1994; Ryan & Prybutok, 2001)	12
10	knowledge structure	(Buckman, 1999; M.-Y. Chen & Chen, 2011; Chong & Choi, 2005; Davenport & Prusak, 1998; Greco, 1999; Hickins, 2000; C.-t. Hsieh, Yang, & Lin, 2002; M. Jennex & Zakharova, 2005; Kazemi & Allahyari, 2010; Moffett, et al., 2003; Tynan, 1999; Yang, et al., 2010)	12
11	Employee involvement	(Bhatt, 2000; Binney, 2001; Choi, 2000; Chong & Choi, 2005; Hall, 2001; Hung, et al., 2005; McCUNE, 1999; Moffett, et al., 2003; O'Brien, 1995; Ryan & Prybutok, 2001; Winslow & Bramer, 1994)	11
12	Benchmarking	(Akhavan, et al., 2009; Akhavan & Jafari, 2006; Chong, 2006; Chong & Choi, 2005; Hung, et al., 2005; Kazemi & Allahyari, 2010; Moffett, et al., 2003; Yang, et al., 2010)	10
13	Employee training	(Akhavan & Jafari, 2006; Chong & Choi, 2005; Cohen & Backer, 1999; Greengard, 1998; Megdadi, et al., 2012; Migdadi, 2009; Moffett, et al., 2003; Siddique, 2012; Wong, 2005; Wong & Aspinwall, 2005)	10
14	Employee motivation	(Akhavan, et al., 2009; Cristina, 2009; Heisig, 2009; M. Jennex & Zakharova, 2005; Moffett, et al., 2002; Slagter, 2007; Toloie-Eshlaghy & Akbari-Yusefvand, 2011; Valmohammadi, 2010; Yang, et al., 2010)	9
15	Knowledge storage	(Akhavan, et al., 2009; Akhavan, et al., 2006; Chin-Loy & Mujtaba, 2007; Fong & Choi, 2009; Kazemi & Allahyari, 2010; Lindner & Wald, 2011; Omerzel, 2010; Toloie-Eshlaghy & Akbari-Yusefvand, 2011)	9
16	Organizational Trust	(Akhavan, et al., 2006; Artail, 2006; Hung, et al., 2005; Kazemi & Allahyari, 2010; S. Lee, et al., 2012; Slagter, 2007; W.-W. Wu, 2012)	8
17	Document management	(Akhavan, et al., 2009; Becerra-Fernandez & Sabherwal, 2001; Ergazakis, Karnezis, Metaxiotis, & Psarras, 2005; Hori, 2000; Luan & Serban, 2002; Yang, et al., 2010)	8

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Table 2

List of KM practices based on previous studies on KM literature (Cont.)

No.	CSFs	Related studies	Total
18	Knowledge acquisition	(L. Chen & Mohamed, 2008; Fong & Choi, 2009; Garrido-Moreno & Padilla-Meléndez, 2011; Gold, Malhotra, & Segars, 2001; S. Lee, et al., 2012; S.-h. Liao & Wu, 2009; Omerzel, 2010; S.-M. Tseng, 2010)	8
19	Organizational learning	(Hassan & Al-Hakim, 2011; Hlupic, Pouloudi, & Rzevski, 2002; Kazemi & Allahyari, 2010; S. Lee, et al., 2012; Slagter, 2007; Yang, et al., 2010; Yu, et al., 2004)	8
20	Motivational aids	(Davenport, 1998; Liebowitz, 1999; Migdadi, 2009; Siddique, 2012; Wong, 2005; Yahya & Goh, 2002)	7
21	Collaboration	(Akhavan, et al., 2009; Kazemi & Allahyari, 2010; S. Lee, et al., 2012; Luan & Serban, 2002; Ramezani, et al., 2013; Yang, et al., 2010)	7
22	resources and budget	(Al-Mabrouk, 2006; Ebrahimi, et al., 2010; Kazemi & Allahyari, 2010; Migdadi, 2009; Milovanović, 2011; Wong & Aspinwall, 2005)	7
23	Environmental initiatives	(Artail, 2006; L. Chen & Mohamed, 2008; Corso, Martini, Pellegrini, & Paolucci, 2003; L.-S. Huang & Lai, 2012; Moffett, et al., 2002; M.-L. Tseng, 2010)	7
24	Interaction with suppliers	(Corso, et al., 2003; Lakshman & Parente, 2008; Mollahosseini & Barkhordar, 2010; Sachin K Patil & Kant, 2014b; M.-L. Tseng, 2010; Tseng, 2014)	6
25	Measurement	(Ahmed, Lim, & Zairi, 1999; APQC, 1999; Davenport, 1998; Holsapple & Joshi, 2001; Wong & Aspinwall, 2005)	6
26	KM architecture	(Akhavan, et al., 2009; Akhavan, et al., 2006; Kazemi & Allahyari, 2010; Ramezani, et al., 2013)	5
27	Society	(Berawi & Woodhead, 2005; Holsapple & Joshi, 2001; Milovanović, 2011; Moffett, et al., 2002)	5
28	Employee empowerment	(Chong, 2006; Chong & Choi, 2005; Kazemi & Allahyari, 2010; Moffett, et al., 2002, 2003)	5
29	Employee traits	(Garrido-Moreno & Padilla-Meléndez, 2011; Heisig, 2009; Sachin Krishnath Patil, 2014; M.-L. Tseng, 2010; Yang, et al., 2010)	5
30	experts assistance	(Akhavan, et al., 2006; T.-H. Chang & Wang, 2009; Kazemi & Allahyari, 2010; Ramezani, et al., 2013; Yang, et al., 2010)	5
31	reward system	(Kazemi & Allahyari, 2010; Slagter, 2007; Toloie-Eshlaghy & Akbari-Yusefvand, 2011; Valmohammadi, 2010; Yang, et al., 2010)	5
32	Communication	(Akhavan, et al., 2009; Artail, 2006; W.-W. Wu, 2012; Yang, et al., 2010; Yu, et al., 2004)	5
33	Knowledge protection	(Gold, et al., 2001; S. Lee, et al., 2012; S.-M. Tseng, 2010)	5
34	Knowledge conversion	(M.-Y. Chen & Chen, 2011; Gold, et al., 2001; S. Lee, et al., 2012; S.-h. Liao & Wu, 2009; S.-M. Tseng, 2010)	5
35	Business process	(Artail, 2006; Heisig, 2009; M. E. Jennex, et al., 2009; Kazemi & Allahyari, 2010)	4
36	Data mining	(Akhavan, et al., 2009; Ergazakis, et al., 2005; Kazemi & Allahyari, 2010; Luan & Serban, 2002)	4
37	Network	(Moffett, et al., 2002; Sachin Krishnath Patil, 2014; Toloie-Eshlaghy & Akbari-Yusefvand, 2011; Yang, et al., 2010)	4
38	Project teams	(Corso, et al., 2003; Hlupic, et al., 2002; Kazemi & Allahyari, 2010; Wang & Chang, 2007a)	4
39	Organization Flexible and dynamic	(Akhavan, et al., 2009; Toloie-Eshlaghy & Akbari-Yusefvand, 2011; Yang, et al., 2010; Yu, et al., 2004)	4
40	Customer interaction	(Corso, et al., 2003; Luan & Serban, 2002; Moffett, et al., 2002; S.-M. Tseng, 2010)	4
41	effective use of software tools	(Akhavan, et al., 2009; Heisig, 2009; L.-S. Huang & Lai, 2012; Kazemi & Allahyari, 2010)	4
42	markets	(M.-Y. Chen & Chen, 2011; Holsapple & Joshi, 2001; Moffett, et al., 2002; S.-M. Tseng, 2010)	4
43	E-learning	(Luan & Serban, 2002; Wild, Griggs, & Downing, 2002; Yang, et al., 2010; Yılmaz, 2012)	4
44	Quality management	(Kazemi & Allahyari, 2010; J.-H. Wu & Wang, 2006; Yang, et al., 2010)	3
45	Organizational climate	(Yang, et al., 2010)	3
46	Government support	(Berawi & Woodhead, 2005)	3
47	Audit & Assessment	(Akhavan, et al., 2006; Moffett, et al., 2002; Wang & Chang, 2007a)	3
48	Project teams	(Sachin Krishnath Patil, 2014; W.-W. Wu, 2012; Yang, et al., 2010)	3
49	Public awareness	(Akhavan & Jafari, 2006; Artail, 2006; S.-M. Tseng, 2010)	3
50	Supplier development	(Corso, et al., 2003; Sachin K Patil & Kant, 2014b; S.-M. Tseng, 2010)	3
51	Industrial competition	(Holsapple & Joshi, 2001; L.-S. Huang & Lai, 2012; S.-M. Tseng, 2010)	3
52	systems storage	(Akhavan, et al., 2009; Akhavan, et al., 2006; Yang, et al., 2010)	3
53	KMS quality	(J.-H. Wu & Wang, 2006; Yang, et al., 2010; Yu, et al., 2004)	3
54	Continuous improvement	(Kazemi & Allahyari, 2010; Moffett, et al., 2002; Yang, et al., 2010)	3
55	Job security	(Akhavan, et al., 2009; Yang, et al., 2010)	2
56	User satisfaction	(Farzin, Kahreh, Hesan, & Khalouei, 2014; J.-H. Wu & Wang, 2006)	2
57	knowledge discovery	(Ergazakis, et al., 2005; Hlupic, et al., 2002)	2
58	employee recruitment and selection	(Kazemi & Allahyari, 2010; S.-M. Tseng, 2010)	2
59	Change management	(Akhavan, et al., 2006; Moffett, et al., 2002)	2
60	Human capital	(Akhavan, et al., 2009; Kazemi & Allahyari, 2010)	2
61	Knowledge repositories	(Akhavan, et al., 2009; Yang, et al., 2010)	2
62	Transparency	(Akhavan, et al., 2009; Akhavan, et al., 2006)	2
63	knowledge controlling	(Heisig, 2009; Lindner & Wald, 2011)	2
64	Knowledge type	(L.-S. Huang & Lai, 2012; Kazemi & Allahyari, 2010)	2
65	Knowledge repositories	(Akhavan, et al., 2009; Yang, et al., 2010)	2
66	Employee turnover rate	(L.-S. Huang & Lai, 2012)	1
67	Employees knowledge	(Heisig, 2009)	1
68	Organizational memory	(Ergazakis, et al., 2005)	1
69	organizational design	(Heisig, 2009)	1
70	Academic research about KM	(Akhavan & Jafari, 2006)	1
71	Employee emancipation	(Moffett, et al., 2002)	1
72	Customer relationship management	(Luan & Serban, 2002)	1
73	Online training systems	(Ergazakis, et al., 2005)	1
74	Technology acceptance	(Holsapple & Joshi, 2001)	1

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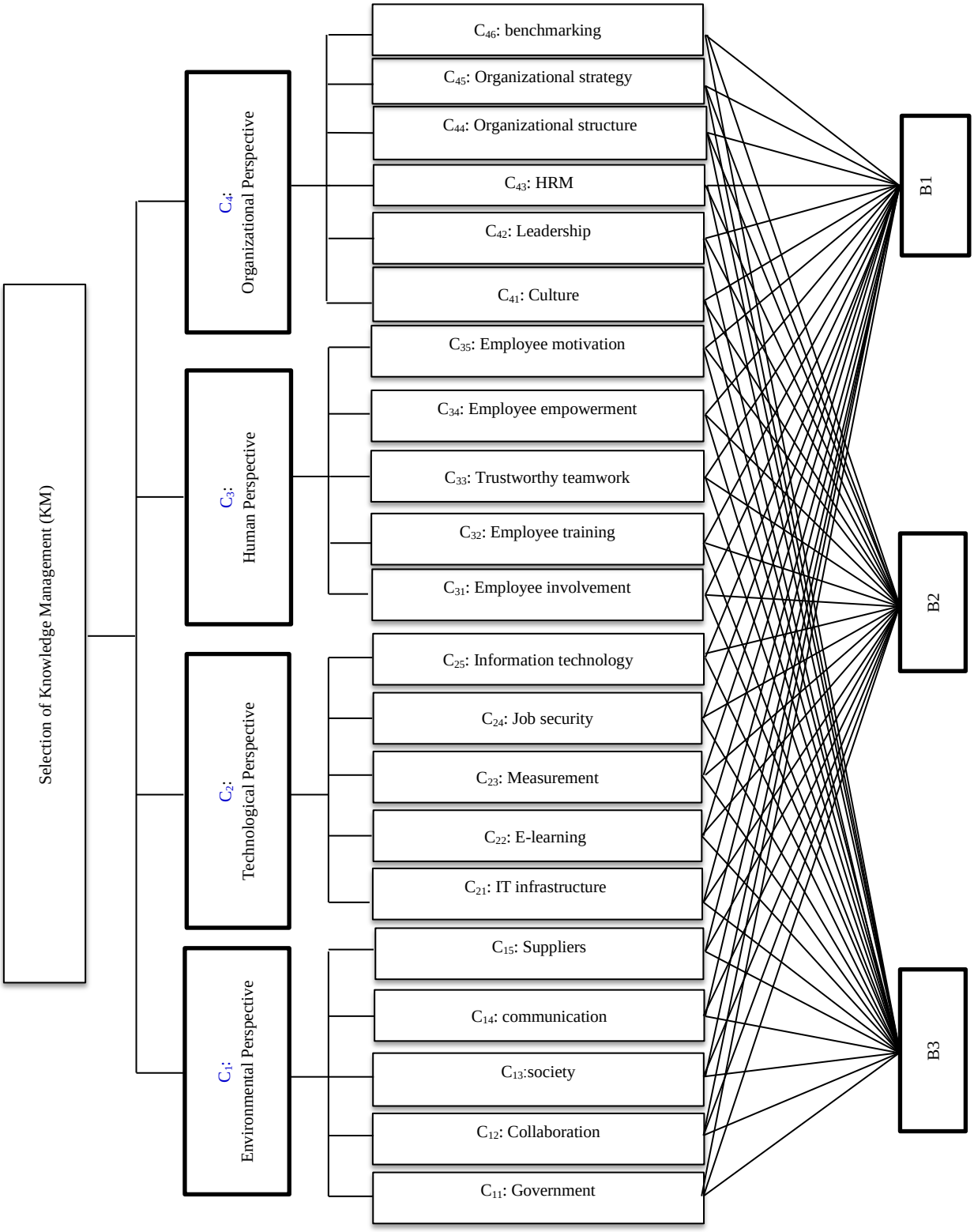

Fig.3. Practices and sub practices for Iranian's three organizations based on FDM

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Table 3

Selection result of KM practices (FDM)

KM practices	Fuzzy calculation		KM practices	Fuzzy calculation	
	Fuzzy numbers (l, m, u)	Defuzzification		Fuzzy numbers (l, m, u)	Defuzzification
Job security	(0.40, 0.73, 1)	0.71	Human capital	(0.20, 0.74, 1)	0.65∗
User satisfaction	(0.20, 0.63, 1)	0.61∗	organizational design	(0.20, 0.57, 1)	0.59∗
Motivational aids	(0.20, 0.63, 1)	0.61∗	Customer interaction	(0.20, 0.63, 1)	0.61∗
Employee turnover rate	(0.20, 0.69, 1)	0.63∗	effective use of software tools	(0.20, 0.61, 1)	0.60∗
Business process	(0.40, 0.67, 1)	0.69∗	Supplier development	(0.20, 0.61, 1)	0.60∗
Employee training	(0.40, 0.69, 1)	0.70	markets	(0.40, 0.68, 1)	0.69∗
Data mining	(0.40, 0.64, 1)	0.68∗	HRM	(0.40, 0.73, 1)	0.71
Collaboration	(0.40, 0.79, 1)	0.73	Public awareness	(0.20, 0.74, 1)	0.65∗
Employees knowledge	(0.40, 0.67, 1)	0.69∗	Academic research about KM	(0.40, 0.67, 1)	0.69∗
Information technology	(0.40, 0.73, 1)	0.71	Knowledge storage	(0.20, 0.69, 1)	0.63∗
Strategic planning	(0.40, 0.67, 1)	0.69∗	Leadership	(0.40, 0.72, 1)	0.71
Benchmarking	(0.40, 0.76, 1)	0.72	Project teams	(0.20, 0.61, 1)	0.60∗
knowledge discovery	(0.20, 0.68, 1)	0.63∗	Organizational learning	(0.40, 0.66, 1)	0.69∗
KM architecture	(0.40, 0.64, 1)	0.68∗	Audit & Assessment	(0.40, 0.64, 1)	0.68∗
IT infrastructure	(0.60, 0.81, 1)	0.80	Knowledge repositories	(0, 0.55, 1)	0.52∗
resources and budget	(0.20, 0.69, 1)	0.63∗	strategy and purpose	(0.40, 0.77, 1)	0.72
Employee involvement	(0.40, 0.73, 1)	0.71	Knowledge acquisition	(0.20, 0.66, 1)	0.62∗
Continuous improvement	(0, 0.63, 1)	0.54∗	Knowledge conversion	(0.20, 0.64, 1)	0.61∗
knowledge structure	(0.20, 0.74, 1)	0.65∗	Transparency	(0.20, 0.70, 1)	0.63∗
systems storage	(0.20, 0.67, 1)	0.62∗	Government support	(0.40, 0.75, 1)	0.72
KMS quality	(0.20, 0.68, 1)	0.63∗	Environmental initiatives	(0.20, 0.63, 1)	0.61∗
Society	(0.40, 0.75, 1)	0.72	Interaction with suppliers	(0.40, 0.72, 1)	0.71
Network	(0.20, 0.57, 1)	0.59∗	Organizational climate	(0.20, 0.67, 1)	0.62∗
Organizational memory	(0.20, 0.68, 1)	0.63∗	Measurement	(0.40, 0.75, 1)	0.72
Project teams	(0.20, 0.61, 1)	0.60∗	Employee emancipation	(0, 0.63, 1)	0.54∗
Industrial competition	(0.20, 0.50, 1)	0.57∗	Customer relationship management	(0.20, 0.64, 1)	0.61∗
Teamwork	(0.40, 0.72, 1)	0.71	Knowledge protection	(0.20, 0.56, 1)	0.59∗
Employee empowerment	(0.40, 0.76, 1)	0.72	Online training systems	(0.20, 0.61, 1)	0.60∗
Employee traits	(0.40, 0.72, 1)	0.71	Document management	(0.20, 0.50, 1)	0.57∗
experts assistance	(0.20, 0.67, 1)	0.62∗	Employee motivation	(0.40, 0.76, 1)	0.72
employee recruitment and selection	(0.20, 0.61, 1)	0.60∗	knowledge controlling	(0.20, 0.64, 1)	0.61∗
reward system	(0.20, 0.56, 1)	0.59∗	E-learning	(0.40, 0.72, 1)	0.71
Organizational structure	(0.40, 0.73, 1)	0.71	Knowledge type	(0.20, 0.66, 1)	0.62∗
Change management	(0.20, 0.62, 1)	0.61∗	Organizational Trust	(0.40, 0.67, 1)	0.69∗
Organization Flexible and dynamic	(0.20, 0.69, 1)	0.63∗	quality management	(0.20, 0.57, 1)	0.59∗
Organizational culture	(0.40, 0.73, 1)	0.71	Communication	(0.40, 0.79, 1)	0.73
Knowledge sharing	(0.40, 0.64, 1)	0.68∗			

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Table 4

Fuzzy weight of KM practices by FAHP

Criteria (dimension and index)	Local weights	Overall weights	$BNP*$	$Standard\ BNP**$	Rank
C_4	(0.137,0.192,0.273)		0.20	0.26	2
C_{41}	(0.211,0.293,0.411)	(0.029,0.056,0.112)	0.31	0.07	7
C_{42}	(0.164,0.222,0.310)	(0.029,0.056,0.112)	0.23	0.04	15
C_{43}	(0.229,0.330,0.475)	(0.038,0.077,0.155)	0.35	0.09	2
C_{44}	(0.235,0.333,0.471)	(0.030,0.063,0.129)	0.35	0.07	4
C_{45}	(0.210,0.308,0.437)	(0.020,0.042,0.083)	0.32	0.05	9
C_{46}	(0.229,0.312,0.424)	(0.030,0.063,0.129)	0.32	0.07	6
C_2	(0.164,0.232,0.327)		0.24	0.32	1
C_{21}	(0.289,0.392,0.537)	(0.048,0.091,0.176)	0.41	0.11	1
C_{22}	(0.202,0.278,0.376)	(0.033,0.065,0.123)	0.29	0.07	5
C_{23}	(0.158,0.230,0.327)	(0.022,0.044,0.089)	0.24	0.05	8
C_{24}	(0.261,0.355,0.483)	(0.034,0.067,0.132)	0.37	0.08	3
C_{25}	(0.191,0.274,0.373)	(0.018,0.038,0.075)	0.28	0.04	11
C_3	(0.010,0.136,0.198)		0.18	0.23	3
C_{31}	(0.200,0.279,0.379)	(0.019,0.039,0.076)	0.29	0.05	10
C_{32}	(0.168,0.246,0.354)	(0.013,0.028,0.056)	0.26	0.03	17
C_{33}	(0.136,0.190,0.267)	(0.013,0.026,0.051)	0.20	0.03	18
C_{34}	(0.150,0.217,0.304)	(0.012,0.024,0.048)	0.22	0.03	19
C_{35}	(0.089,0.126,0.174)	(0.012,0.024,0.047)	0.13	0.03	20
C_1	(0.095,0.139,0.202)		0.15	0.19	4
C_{11}	(0.135,0.198,0.291)	(0.011,0.022,0.046)	0.21	0.03	21
C_{12}	(0.134,0.192,0.274)	(0.018,0.037,0.075)	0.20	0.04	12
C_{13}	(0.166,0.226,0.325)	(0.016,0.031,0.066)	0.24	0.04	13
C_{14}	(0.166,0.226,0.325)	(0.015,0.031,0.060)	0.23	0.04	16
C_{15}	(0.164,0.222,0.310)	(0.016,0.031,0.066)	0.235	0.04	14

Table 5

Indexes weight of three organizations by FAHP

Indexes	B1	B2	B3
C_{41}	0.54	0.57	0.63
C_{42}	0.47	0.66	0.58
C_{43}	0.52	0.65	0.54
C_{44}	0.56	0.42	0.76
C_{45}	0.62	0.52	0.58
C_{46}	0.49	0.75	0.60
C_{21}	0.55	0.56	0.62
C_{22}	0.55	0.60	0.58
C_{23}	0.57	0.63	0.52
C_{24}	0.56	0.53	0.63
C_{25}	0.53	0.50	0.69
C_{31}	0.57	0.52	0.63
C_{32}	0.56	0.57	0.60
C_{33}	0.60	0.57	0.57
C_{34}	0.50	0.63	0.60
C_{35}	0.57	0.60	0.45
C_{11}	0.57	0.54	0.61
C_{12}	0.58	0.48	0.65
C_{13}	0.52	0.58	0.63
C_{14}	0.45	0.66	0.60
C_{15}	0.61	0.53	0.59

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5. Discussion

The findings related to FAHP step that are presented in Tables 4 and 5 show that the technological perspective of the KM practices had the highest weight (0.32) in comparison with the other perspectives that comprised the organizational perspective (0.26), human perspective (0.23), and environmental perspective (0.19). The results obtained in this step are supported by studies previously conducted on KM system. With regard to the computation of FAHP, IT infrastructure from the technological perspective was ranked as the first of the KM practices. This is supported by some researchers, such as Kazemi and Allahyari (2010). According to Kazemi and Allahyari (2010), IT infrastructure is one of the most significant factors in organizations compared to the other factors. HRM was ranked as the second important factor, from the organizational perspective. In a number of previously-conducted studies (e.g. Lopez-Cabrales, Pérez-Luño, and Cabrera (2009) and C.-J. Chen and Huang (2009), the significance of HRM has been confirmed. C.-J. Chen and Huang (2009) indicated that HRM practices, including training, performance appraisal, compensation, participation, and staffing, could contribute to the successful implementation of KM. Lopez-Cabrales, et al. (2009) introduced HRM practices as a factor capable of improving knowledge in organizations; however, few studies have been carried out concerning the use of HRM for knowledge management purposes. Thus, because of the significance of HRM shown in the previous studies, it can be concluded that human resources increasingly is a key issue in competitive advantage of KM.

This study offers the following contributions. First, this study combined fuzzy set theory and qualitative and quantitative approaches for evaluating KM practices for the selection of KM in three organizations. Second, compared to (Kazemi & Allahyari, 2010) this study has provided an inclusive list of KM practices based on the studies previously conducted on the KM system. To this end, 74 KM practices were collected from previous studies to be used in the designed questionnaire. A total of 15 experts were invited to give their opinion regarding the significance of the evaluation criteria and the ratings of alternatives concerning different criteria by means of linguistic variables. Then, linguistic variables were transformed into triangular fuzzy numbers, as shown in Table 1. In the subsequent step, FDM was employed because, although the Delphi method is generally used in several management fields such as KM (Scholl, König, Meyer, & Heisig, 2004), information technology (S.-J. Huang, Wu, & Chen, 2013), enterprise planning resources (Akkermans, Bogerd, Yücesan, & Van Wassenhove, 2003), quality management (Heras Saizarbitoria, 2006), and supply chain management (Melnyk, Lummus, Vokurka, Burns, & Sandor, 2009), suffer from a lack of significant information from the opinions of experts, a low convergence in generating results, and a long interrogation process. Consequently, a great deal of research has been conducted for the improvement of this method in a fuzzy environment. For instance, (Ishikawa, et al., 1993) combining the Delphi method and the fuzzy set theory to propose max-min and fuzzy integration algorithms for the prediction of personal computer diffusion. Murray, Pipino, and van Gigch (1985) also improved the Delphi method within a fuzzy environment. In addition, this method has been applied by researchers to the solution of the fuzziness of a group consensus through combining a linguistic variable and FDM (Kuo & Chen, 2008). Kuo and Chen (2008), reported the benefits of the use of FDMs, including obviously stating the semantic construction of selected the certain options, avoiding the misrepresentation of opinions of experts, and taking into account the fuzzy nature during the survey process. During the FDM step, subsequent to evaluation and calculation of the returned questionnaires, a total of 21 practices were selected for the next step.

After the FDM step, as the second contribution of this paper, the 21 practices were categorized into four perspectives: human, environmental, organizational, and technological. In Fig. 3, these categories are presented according to practices and sub-practices for the Iranian organizations. This categorization is supported by previously conducted research that categorized the KM factors into different groups or perspectives (Heisig, 2009). Thus, as the third contribution of this paper, the authors used FDM for evaluating and identifying the KM practices in the organizations.

As another contribution of this research, FAHP was employed since a number of scholars, such as (Boender, De Graan, & Lootsma, 1989), who had investigated the fuzzy AHP, reported that FAHP provided relatively more adequate descriptions of decision making processes in comparison with the conventional AHP methods. The numerical values of linguistic variables in the classical AHP are used directly for evaluating criteria. For the purpose of evaluation, the fuzzy numbers are employed through taking the deviations of decision takers into consideration in cases where the decision making process is fuzzy within the environment. Because of current complicated economic conditions, most decisions are made within such an environment. As a result, a fuzzy version of AHP or similar methods are generally employed in spite of complexity in their computations (Özdağoğlu & Özdağoğlu, 2007). This part of the present study follows some studies conducted by (Moradi, Aghaie, & Hosseini, 2013) in which FAHP is employed to prioritize and identify the KM implementations.

The significance of other factors has also been supported by previous studies. These factors were government (Akhavan & Jafari, 2006), job security (OuYang, Yeh, & Lee, 2010), E-learning (OuYang, et al., 2010), culture (Jiacheng, Lu, & Francesco, 2010), benchmarking (Akhavan, et al., 2009), information technology (Al-Mabrouk, 2006; Heisig, 2009), society (Berawi & Woodhead, 2005), collaboration (Kazemi & Allahyari, 2010; S. Lee, et al., 2012), suppliers (Lakshman, 2006; Tseng, 2014), communication (Akhavan & Jafari, 2006; Kazemi & Allahyari, 2010), leadership (Wang & Chang,

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2007b; Wong, 2005), trustworthy teamwork (Patil 2014), employee training (Moffett, et al., 2003), employee empowerment (Cristina, 2009), organizational structure (Willem & Buelens, 2009), and employee motivation (Nguyen, Truong, & Buyens, 2010).

5. Conclusion

In recent years, fuzzy theory has attracted a great deal of attention and has been used extensively for problem solving purposes. The present paper proposed an approach that combines fuzzy Delphi method and fuzzy AHP in three Iranian Behzisti organizations. The KM practices framework development process is presented in Fig 1. For future studies, a number of other techniques such as entropy and fuzzy preference relations can be used in order to improve the computation process of the criteria weights employed for evaluating the KM. Employing FDM for experts' opinion can be expressed clearly and integrated in the input variables. Linguistic construction of the input variables can be calculated in the questionnaires and a number of experts can articulate their opinion through the questionnaire. The scope of this study was three Iranian Behzisti organizations, and we believe that conducting studies on various organizations, companies, and SME's may lead to different concerns regarding criteria for the implementation of KM. In addition, in this study, FAHP was used for ranking the most significant KM practices, and we suggest future studies use other techniques such as FANP. Moreover, this study used some MCDM tools in order to rank the KM, and future studies are recommended to use different tools such as weighted product model (WPM), weighted sum model (WSM), PROMETHEE, and so on within the fuzzy environment. The results obtained in the present paper help enterprises or organizations to apply the proposed prioritizing model to the improvement of their decision-making process and implement suitable actions in order to avoid pitfalls prior to starting a KM. Finally, this study provided an all-inclusive list of the KM practices in a Behzisti organizations and it is argued that in future studies, comprehensive lists of KM practices can be provided based of similar fields and homogenous industries.

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