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A fuzzy inference system with application to player selection and team formation in multi-player sports

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ABSTRACT

The success or failure of any team lies in the skills and abilities of the players that comprise the team. The process of player selection and team formation in multi-player sports is a complex multi-criteria problem where the ultimate success is determined by how the collection of individual players forms an effective team. In general, the selection of soccer players and formation of a team are judgments made by the coaches on the basis of the best available information. Very few structured and analytical models have been developed to support coaches in this effort. We propose a two-phase framework for player selection and team formation in soccer. The first phase evaluates the alternative players with a fuzzy ranking method and selects the top performers for inclusion in the team. The second phase evaluates the alternative combinations of the selected players with a Fuzzy Inference System (FIS) and selects the best combinations for team formation. A case study is used to illustrate the performance of the proposed approach.

1. Introduction

The process of player selection and team formation in multi-player sports is a complex multi-criteria problem with conflicting objectives. Selection of players in a team is always a difficult decision making task with many dimensions. Coaches are required to consider a large number of qualitative and quantitative attributes in the player selection process. These attributes may include the player's individual skills and performance statistics, combination of players, physical fitness, psychological factors, and injuries among others (Arnason et al., 2004). Some coaches may also use importance weights to determine the impact of each attribute. Importance weights are useful to coaches since they indicate how the impact of a particular attribute relates to the probability of a successful outcome.

Soccer (more commonly known as football in many regions) is a team sport that is popular in almost every country in the world. The player selection process for professional soccer teams is crucial in the quest for winning. So much so that a wrong selection can cost a soccer team the championship and even millions of dollars if the player turns out not living up to the team's expectations. Traditionally, professional soccer teams use a variety of sports psychology assessments for evaluating players. There is no doubt that these assessments are of great benefit and are extremely useful when trying to form a winning soccer team. However, this is just one part of the big puzzle when trying to assess a player's suitability for a team. The ability

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to select suitable players and arrange an effective team formation is indispensable for reaching the top for team sports (Boon & Sierksma, 2003).

Katzenbach and Smith (1993) defined a team as a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable. The main goal of team building is teamwork, which is the vehicle for integrating information, technology, competence and resources based on human interactions (Kinlaw, 1991). A variety of approaches for the selection of team members have been proposed in the literature. Most of these studies have focused on the use of teams in business and industry. The business and industry's adoption of a teamwork methodology in the pursuit of cost effectiveness and greater innovation has spawned significant research (Chen, Cheng, & Chuang, 2008; English, Griffith, & Steelman, 2004; Kirkman, Rosen, Tesluk, & Gibson, 2004; Mannix & Neale, 2005).

The conceptual work of several scholars has highlighted five key elements for team-building: clear goals with measurable outcomes, clinical and administrative systems, division of labor, training, and communication (Baldwin, 1994; Cohen & Bailey, 1997; Fried, Topping, & Rundall, 2000).

Askin and Sodhi (1994) have presented a novel method for organizing teams in concurrent engineering. They developed five different criteria for team formation and discussed team training, leadership, and computer support issues. Zakarian and Kusiak (1999) proposed an analytical model for the selection of multi-functional teams. They used the analytic hierarchy process and the quality function deployment method to prioritize "team membership" based on customer requirements and product specifications. Braha (2002) has proposed a team-building approach based on task partitioning by specifying task dependencies and partitioning the tasks among a number of teams. Chen and Lin (2004) proposed a team member model for the formation of a multi-functional team in concurrent engineering. They used the analytic hierarchy process and Myers–Briggs type indicators to model team member characteristics. In the software development field, Gronau, Fröming, Schmid, and Rüssbüldt (2006) developed an algorithm to propose a team composition for a specific task by analyzing the knowledge and skills of the employees. In the project management field, Durmusoglu and Kulak (2008) proposed a team building process using axiomatic design principles. They proposed to establish teams by identifying the needed skills and preparing a skill development procedure to ensure maximum utilization of team members' talents. Feng, Jiang, Fan, and Fu (2010) proposed a member selection method in cross functional teams where both the individual performance of the candidates and the collaborative performance between candidates were considered.

Fuzzy set theory has also been used in the team member selection and team formation research. Liang and Wang (1992) proposed integrating fuzzy logic into weighted complete bipartite graphs and developing a polynomial time algorithm for solving personnel placement. Yaakob and Kawata (1999) used triangular fuzzy numbers to evaluate the workers' skills and measure their suitability in work teams. DeKorvin, Shipley, and Kleyle (2002) developed a model for the selection of personnel in multiple phase projects, which took into account the match between the skills possessed by each individual, the skills needed for each phase, and flexible budget considerations. They used the fuzzy construct of compatibility to measure the fit of a person's skill set to the goal set for each project phase in fuzzy environment. Dereli, Baykasoglu, and Das (2007) used simulated annealing and proposed a fuzzy mathematical programming model for the formation of quality audit teams. Shipley and Johnson (2009) proposed a fuzzy set-based model for selecting project membership to achieve cognitive style goals.

The above studies demonstrate the importance of team member selection in a wide variety of applications. In spite of the importance of member selection and team formation research in business and industry, this subject has not been widely researched in the sport science literature. The current literature on player selection and team formation in multi-player sports is very limited and scattered. Boon and Sierksma (2003) formulated a linear optimization model to headhunt or scout a new team in soccer and volleyball by combining the qualities of the candidates and players with the functional requirements. Merigó and Gil-Lafuente (2011) analyzed the use of the ordered weighted averaging (OWA) operator in the selection of human resources in sport management. They used the Hamming distance, the adequacy coefficient and the index of maximum and minimum level to parameterize these decision-making techniques and select of a football player for a team. Ahmed, Deb, and Jindal (2011) considered the overall batting and bowling strength of a cricket team and proposed a constrained multi-objective optimization model for selection of the players on the team.

Fuzzy sets and fuzzy logic are powerful mathematical tools for modeling uncertain industrial, human and natural systems. They are facilitators in decision making by means of approximate reasoning and linguistic terms. Their role is significant when applied to complex phenomena not easily described by traditional mathematics. Moreover, users often feel more comfortable using linguistic terms instead of precisely specified numerical values. Sport management often involves decision making in the absence of precise and complete information. Fuzzy sets and logic can be effectively used in sport management applications such as sport operations, sport economics, sport marketing, sport human resources, and sport facility management.

In this paper, we propose a Fuzzy Inference System (FIS) for player selection and team formation in soccer. Fuzzy sets are used to transform the linguistic variables used for assessing the players' performance on multiple attributes into triangular numbers. The linguistic variables are used to deal with the difficulty in expressing players' skill levels and performance ratings with discrete values. Fuzzy numbers are very useful in promoting the representation and information processing under fuzzy environment (Dubois, 1978). The linguistic variables are also used to assess the performance of each candidate player in different positions.

A FIS is a non-linear system that employs fuzzy IF–THEN rules to model the qualitative aspects of human knowledge without employing precise quantitative analyses. The most popular fuzzy logic modeling techniques can be classified into

three types: the linguistic models (Mamdani-type) (Mamdani & Assilian, 1975), the relational equation models, and the Takagi–Sugeno–Kang models (Sugeno, 1985). In linguistic models, both the antecedent and the consequence are fuzzy sets while in the Takagi–Sugeno–Kang models the antecedent consists of fuzzy sets but the consequence is comprised of linear equations. Fuzzy relational equation models aim at building the fuzzy relation matrices according to the input–output process data. The FIS proposed in this study is intended to evaluate alternative player arrangements.

The remainder of this paper is organized as follows. In Section 2, we provide an overview of fuzzy set theory. In Section 3, we present the details of the proposed approach. In Section 4, we present a case study to illustrate the effectiveness and applicability of the proposed approach. Finally, in Section 5, we present our conclusions and future research directions.

2. Fuzzy set theory

Many real-world applications cannot be described and handled by classical set theory. Fuzzy set theory, proposed by Zadeh (1965) is a powerful technique for dealing with the sources of imprecision and uncertainty that are non-classical in nature. In the absence of complete and precise information, fuzzy sets and logic are widely used to model uncertain systems (Saghafian & Hejazi, 2006; Soltani & Haji, 2007; Zadeh, 1965).

2.1. Fuzzy logic and fuzzy operations

A fuzzy set $\tilde{A}$ in a universe of discourse X is characterized by a membership $\mu_{\tilde{A}}(x)$ which associates with each element x in X a real number in the interval [0,1]. The function value is termed the grade of membership of x in $\tilde{A}$ (defined by Zadeh, 1965). A fuzzy set $\tilde{A}$ in X is a set of ordered pairs:

$$\tilde{A} = \{[x, \mu_{\tilde{A}}(x) | x \in X]\} \tag{1}$$

where the membership value $\mu_{\tilde{A}}(x)$ can take values between [0,1]. Complete non-membership is represented by 0, and complete membership as 1. The values between 0 and 1 represent intermediate degrees of membership. Fuzzy numbers are the special classes of fuzzy quantities. A fuzzy number is a fuzzy quantity $\tilde{A}$ that represents a generalization of a real number. There are different classes of fuzzy numbers, but triangular and trapezoidal fuzzy numbers are the most commonly used classes of fuzzy numbers in real-world problems. A triangular fuzzy number is defined by three real numbers, namely, the triplet (a, b, c), where $a < b < c$. The possibility degree is measured by the membership function $\mu(x)$, where the x argument refers to events. In the triangular fuzzy number, we have $\mu(a) = \mu(c) = 0$ while $\mu(b) = 1$ (Eq. (2) and Fig. 1). The membership function has the following form:

$$\mu_{\tilde{A}}(x) = \begin{cases} 1 - \dfrac{(a-x)}{\alpha} & a - \alpha \le x \le a \\ 1 - \dfrac{(a-x)}{\beta} & a \le x \le a + \beta \\ 0 \quad \text{otherwise} \end{cases} \tag{2}$$

A linguistic variable is a variable whose values are expressed in linguistic terms (Zhang, 1986) and differs from a numerical variable in that its values are not numbers, but words or sentences in natural or artificial language (Zadeh, 1975). The concept of a linguistic variable is very useful in describing situations that are too complex or not well-defined in conventional quantitative expressions.

The algebraic operations on fuzzy numbers can be defined by using the extension principle. In this paper, some algebraic operations developed by Dubois (1978) were used. Assume that there are two linguistic variables expressed as fuzzy numbers $\tilde{A}_1$ and $\tilde{A}_2$, where $x_1 = (a_1, b_1, c_1)$ and $x_2 = (a_2, b_2, c_2)$. According to x_1 and x_2, the most widely used basic fuzzy operations are defined in Table 1.

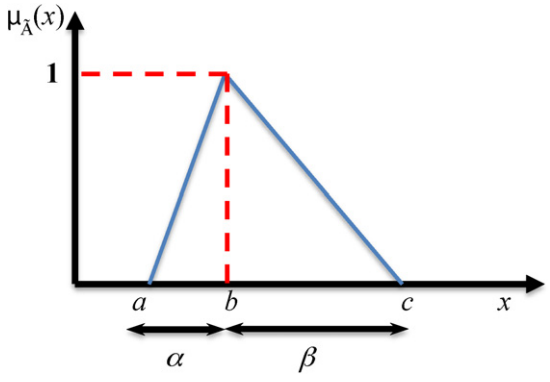

Fig. 1. The triangular fuzzy number.

Table 1
The basic fuzzy operations.

Opposite	$-(a_1, b_1, c_1) = (-a_1, -b_1, -c_1)$
Reverse	$(a_1, b_1, c_1)^{-1} = \left(\frac{1}{c_1}, \frac{1}{b_1}, \frac{1}{a_1}\right)$
Addition	$(a_1, b_1, c_1) \oplus (a_2, b_2, c_2) = (a_1 + a_2, b_1 + b_2, c_1 + c_2)$
Subtraction	$(a_1, b_1, c_1) - (a_2, b_2, c_2) = (a_1 - a_2, b_1 - b_2, c_1 - c_2)$
Multiplication by scalar	$k \otimes (a_1, b_1, c_1) = (ka_1, kb_1, kc_1)$
Multiplication by fuzzy	
For $x_1 > 0, x_2 > 0$	$(a_1, b_1, c_1) \otimes (a_2, b_2, c_2) = (a_1a_2, b_1b_2, c_1c_2)$
For $x_1 < 0, x_2 > 0$	$(a_1, b_1, c_1) \otimes (a_2, b_2, c_2) = (c_1a_2, b_1b_2, a_1c_2)$
For $x_1 < 0, x_2 < 0$	$(a_1, b_1, c_1) \otimes (a_2, b_2, c_2) = (c_1c_2, b_1b_2, a_1a_2)$
Division by fuzzy	
For $x_1 > 0, x_2 > 0$	$(a_1, b_1, c_1)/(a_2, b_2, c_2) = \left(\frac{a_1}{a_2}, \frac{b_1}{b_2}, \frac{c_1}{c_2}\right)$
For $x_1 < 0, x_2 > 0$	$(a_1, b_1, c_1)/(a_2, b_2, c_2) = \left(\frac{c_1}{c_2}, \frac{b_1}{b_2}, \frac{a_1}{a_2}\right)$
For $x_1 < 0, x_2 < 0$	$(a_1, b_1, c_1)/(a_2, b_2, c_2) = \left(\frac{c_1}{a_2}, \frac{b_1}{b_2}, \frac{a_1}{c_2}\right)$

2.2. Fuzzy IF–THEN rules and FIS

The fuzzy IF–THEN rules or fuzzy conditional statements are expressions in the form of IF *A* THEN *B*, where *A* and *B* are labels of fuzzy sets (Zadeh, 1965) characterized by appropriate membership functions. Due to their concise form, fuzzy IF–THEN rules are often employed to capture the imprecise modes of reasoning that play an essential role in the human ability to make decisions in uncertain and imprecise environments. If a given fuzzy rule has multiple antecedents, the fuzzy operator (AND or OR) is used to obtain a single number that represents the result of the antecedent evaluation (Eqs. (3) and (4)). This number (the truth value) is then applied to the consequent membership function. To evaluate the disjunction of the rule antecedents, an OR fuzzy operation is used. Typically, using the fuzzy operation union:

$$\mu_{A\cup B}(X) = \max[\mu_A(X), \mu_B(X)] \tag{3}$$

Similarly, in order to evaluate the conjunction of the rule antecedents, an AND fuzzy operation is applied to the intersection:

$$\mu_{A\cap B}(X) = \min[\mu_A(X), \mu_B(X)] \tag{4}$$

Fuzzy IF–THEN rules form a core part of the FIS. Fuzzy inference employing fuzzy IF–THEN rules can easily model the qualitative aspects of linguistic human knowledge and reasoning processes without precise quantitative analyses (Ho, Zhang, & Xu, 2001).

The FIS provides a computational framework for manipulating and reasoning the imprecise expressions in an environment. The main goal of an FIS is to model human decision-making within the conceptual framework of fuzzy logic and approximate reasoning (Horikawa, Furuhashi, & Uchikawa, 1992). The FISs have been successfully applied in several fields such as automatic control, data classification, decision analysis, expert systems, and computer vision. Fuzzy inference is the real process of mapping from a given set of input variables to an output relied upon a set of fuzzy rules. In general, a FIS consists of four modules as shown in Fig. 2 (Huang & Chiu, 2009).

The fuzzification module transforms the system inputs, which are crisp numbers, into fuzzy sets by applying a fuzzification function. The inference engine simulates the human reasoning process by making fuzzy inferences on the inputs through a set of rules. These rules are expressed with an IF–THEN format (If *x* is *A*, Then *y* is *B*). The membership degrees for each confirmed rule in the rule evaluation process (rule firing) are simplified to one membership degree using fuzzy implication. There are different ways to define an implication (Mamdani, 1977; Mizumoto & Zimmermann, 1982; Zadeh, 1971). The outputs of the rule evaluation are unified using an aggregation process that combines the membership functions into a single membership function. The defuzzification module transforms the fuzzy set obtained by the inference engine into a crisp value. Many different defuzzification methods have been proposed (Ross, 1995), such as centroid of area, bisector of area, mean of maxima, maximum criterion (Lee, 1990).

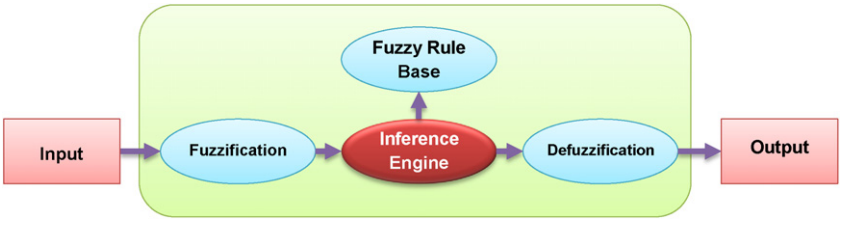

Fig. 2. The fuzzy inference system.

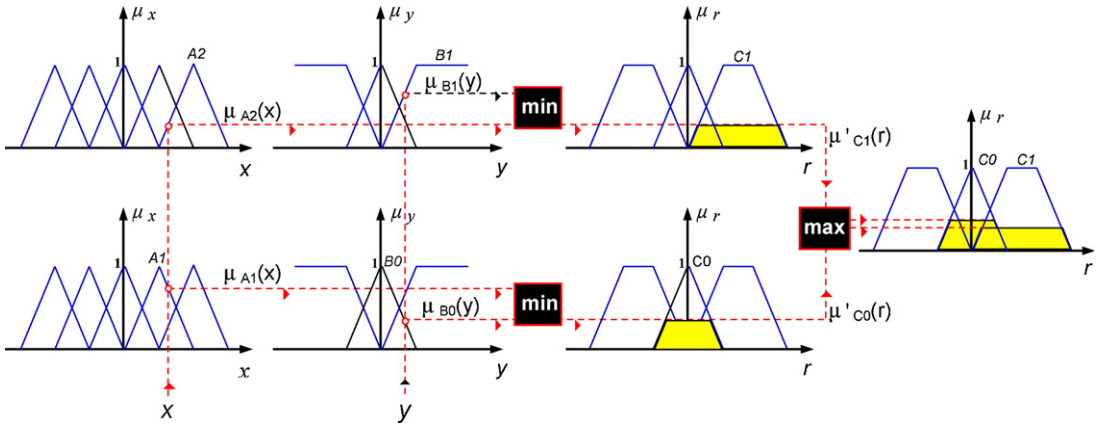

Fig. 3. The Mamdani's fuzzy inference method.

There are two types of FISs that can be implemented in the Fuzzy Logic Toolbox: Mamdani-type (Mamdani & Assilian, 1975) and Sugeno-type (Takagi & Sugeno, 1985). These two FISs vary in the way outputs are determined. The first type is used in this paper. The Mamdani's method is used most commonly in the real-world applications due to its simplicity in structuring the 'min–max' operations. In summary, Fig. 3 shows a two input Mamdani FIS with two rules. It fuzzifies the two inputs by finding the intersection of the crisp input value with the input membership function. It uses the minimum operator to compute the fuzzy "and" for combining the two fuzzified inputs to obtain a rule strength. It clips the output membership function at the rule strength. Finally, it uses the maximum operator to compute the fuzzy "or" for combining the outputs of the two rules.

3. The proposed approach

As in all team sports, soccer players must specialize at various positions and understand how to interact with their teammates in other positions in order to effectively compete in the game. This is especially true for soccer where players need the structure a system of play known as formation to be able to properly perform. The general terms used for different positions in soccer are: goalkeeper, defenders, midfielders, and forwards. In general, each team has 20 players (without considering the three goalkeepers) and 10 are chosen by the coaches as the starting lineup to participate in the event when the game begins. The number of players in each of the three positions is based on the team formation selected for the game.

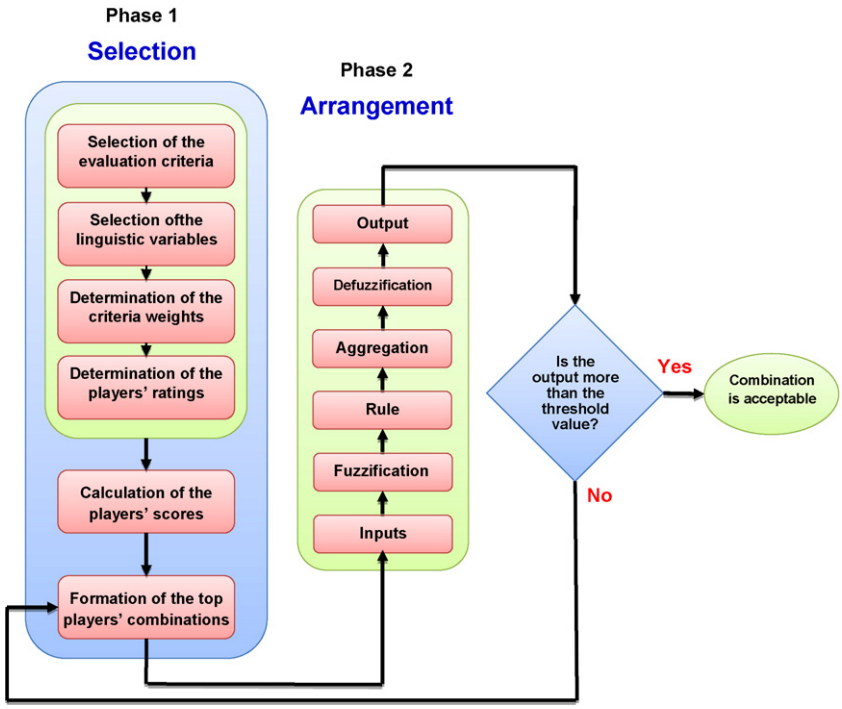

Fig. 4. A graphical representation of the proposed framework.

We present a two-phase approach depicted in Fig. 4 for team selection and arrangement. In the selection phase, we use a fuzzy ranking method to evaluate the alternative players. The fuzzy ranking method proposed by Yaakob and Kawata (1999) is employed in this phase to choose the team members. In the arrangement phase, the FIS is used to evaluate various combinations among the team members in each position.

3.1. Phase 1: Selection

Evaluating soccer players is a challenging process, particularly when the criteria used for evaluation are based on skill, vision, and tactical insight. In this phase, we identify a set of evaluation criteria such as ability to control the ball, dribbling skills, ability to recover the ball, ability to create space to receive a pass, score goals. Coaches generally evaluate each player based on their preferred evaluation criteria. We use linguistic variables for the weight of the evaluation criteria and the player ratings for each position. After compiling and synthesizing these weights and ratings, Eq. (5) is used to calculate a total score for each player in different positions:

$$E_{eval}(PO, i) = \frac{1}{k}\sum_{t=1}^{k} e(i, PO, C_t) \otimes W(PO, C_t) \tag{5}$$

where $E_{eval}(PO, i)$ is the total score for each player for a given position, $e(i, PO, C_t)$ is the performance rating of a player on an evaluation criterion for a position, and $W(PO,C_t)$ is the importance weight of an evaluation criterion for a position. The center value of these triangular membership functions presents the maximal grade of the membership and the most possible value for a player's suitability (Yaakob & Kawata, 1999).

In the final step, the top three combinations for the defenders, midfielders and forwards are identified. The reason for selecting three combinations for each position is to provide the coaches with the ability to discard unacceptable combinations.

3.2. Phase 2: Arrangement

In this phase we use FIS to arrange the selected players for each position. The inputs to the FIS model are provided by the coaches based on the arrangement factors (e.g. the number of times players have played together, the number of times players passed the ball to each other in a game, etc.). The output of the FIS is the percentage of arrangement (POA) for the top player combination in each position. In order to convert the inputs into outputs, FIS requires a fuzzification of the inputs, an evaluation of the associated rules, an aggregation of the associated rules, and a posterior defuzzificaton of the aggregation result. If the POA is more than the threshold value, the proposed combination is considered acceptable; otherwise, the combination with the next highest score should be substituted and the POA should be recalculated.

4. Illustrative case study

The proposed approach is illustrated with the real data obtained from the Parsan[1] Soccer Club (PSC), a professional soccer team based in Tehran, Iran. Parsan was founded in 1968 and has been in the first division of Iranian soccer since 1974. Without considering three goalkeepers, the team is comprised of 20 players including seven defenders, eight midfielders, and five forwards. Three coaches including the head coach, the offensive coach, and the defensive coach agreed to use the method proposed in this study to form a team for the league championship game. The coaches had selected a 4–4–2 formation for the upcoming game. This is the most popular and balanced formation in soccer today. The formation consists of 4 defenders, 4 midfielders and two forwards as shown in Fig. 5.

The team formation process was divided into two phases: the selection phase and the arrangement phase.

4.1. Phase 1: Selection

In this phase, the three coaches considered 18 evaluation criteria presented in Table 2. These criteria had been routinely used by the coaches for team formation at the PSC in the past.

The players' assessment of the 18 evaluation criteria were expressed with the following linguistic variables proposed by Karsak (2000): "Poor (P)", "Fair (F)", "Good (G)" and "Very Good (VG)". Fig. 6 presents the membership function of the linguistic variables used for performance assessment. The importance weight of the criteria were also expressed with linguistic variables with the following values: "Not important (NI)", "Not so important (NS)", "Normal (N)", "Important (I)" and "Very important (VI)". Fig. 7 shows the membership function of the linguistic variables used for weight assessment.

In the next step, the three coaches collectively assigned the importance weights given in Table 3 for each of the 18 criteria for the three different positions. They also assigned the performance ratings in the form of linguistic variables given in Table 4 for the 20 players based on their previous performance prior to the playoff season.

[1] The name changed to protect the anonymity of the football team which participated in this study.

Fig. 5. A graphical display of the 4–4–2 formation.

Table 2
The evaluation criteria.

Criterion number	Criteria description
C1	Heading, jumping
C2	Shoot
C3	Short passing
C4	Crossing
C5	Ball control
C6	Dribbling
C7	Finishing (composure)
C8	Speed
C9	Creativity
C10	Create goal scoring position
C11	Tackling
C12	Both feet
C13	Great stamina
C14	Height
C15	Providing through (long) pass
C16	Technical ability
C17	Create attacking opportunities
C18	Read the game

Data collected in Tables 3 and 4 provided the basis for calculating and overall score of the players for three different positions given in Table 5. For example, the score for player 1 is calculated as follows:

$$\begin{aligned} G \times VI + F \times NS + G \times VI + \cdots + G \times NS + F \times I + G \times I &= (0.6, 0.8, 0.9) \times (2.5, 3, 3.5) + (0.3, 0.5, 0.7) \times (1, 1.5, 2) \\ &\quad + (0.6, 0.8, 0.9) \times (2.5, 3, 3.5) + \cdots + (0.6, 0.8, 0.9) \times (1, 1.5, 2) \\ &\quad + (0.3, 0.5, 0.7) \times (2, 2.5, 3) + (0.6, 0.8, 0.9) \times (2, 2.5, 3) \\ &= (12.6, 25.45, 37.55) \end{aligned}$$

Table 6 shows the overall score and ranking of each player for each position based on the middle value of the triangular numbers presented in Table 5.

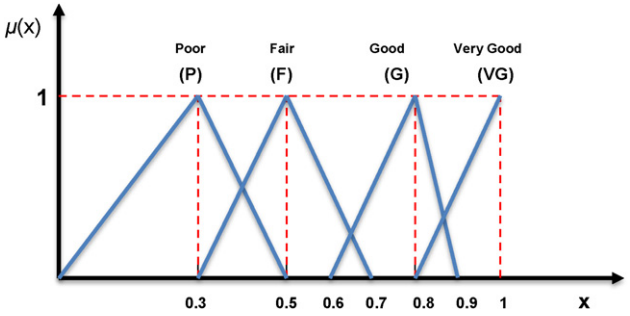

Fig. 6. The membership function used for the performance scores.

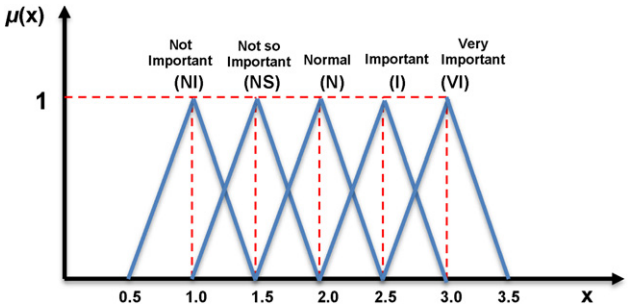

Fig. 7. The membership function used for the importance weights.

In the final step, the three top quadruple combinations of the defenders and midfielders and the three top binary combinations of the forwards were formed and then ranked by their average score. For example, the average score for combination (5, 2, 7, 1), which was formed by four top players for defender position, was obtained as follows:

$$\frac{27.75 + 26.8 + 25.9 + 25.45}{4} = 26.47$$

Table 7 shows the overall ranking of the top three 4–4–2 combinations. According to this table, combinations (5, 2, 7, 1), (5, 2, 7, 6), and (5, 2, 7, 4) were the top three combinations for the defenders position; combinations (12, 14, 13, 8), (12, 14, 13, 9), and (12, 14, 13, 15) were the top three combinations for the midfielders position; and combinations (18, 20), (18, 17), and (18, 19) were the top three combinations for the forwards position.

Table 3
The criteria weights.

Criterion number	Defender	Midfielder	Forward
C1	VI	N	VI
C2	NS	I	VI
C3	VI	VI	I
C4	NS	I	I
C5	I	VI	VI
C6	NS	VI	I
C7	NS	N	VI
C8	N	I	VI
C9	NS	VI	I
C10	NS	I	VI
C11	VI	I	NS
C12	NS	NS	I
C13	N	VI	I
C14	I	NS	VI
C15	NS	VI	I
C16	NS	I	VI
C17	I	VI	I
C18	I	VI	I

Table 4
The performance rating of each player with respect to different criteria.

Criterion number	Defender							Midfielder								Forward				
	Player number																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C1	G	G	VG	F	G	F	VG	G	G	F	G	F	P	VG	VG	G	G	VG	G	VG
C2	F	VG	G	P	F	G	G	F	G	G	VG	F	G	VG	G	VG	VG	G	G	G
C3	G	G	VG	G	G	F	G	G	VG	VG	G	VG	G	F	G	G	VG	G	G	G
C4	G	G	F	P	G	VG	F	G	G	G	F	G	VG	P	G	F	G	VG	G	G
C5	G	F	F	G	G	VG	G	G	VG	G	VG	G	F	G	VG	G	VG	G	VG	VG
C6	F	G	F	G	G	F	P	G	G	F	VG	G	G	VG	G	VG	F	VG	G	G
C7	F	F	G	P	F	G	G	G	F	G	VG	G	G	F	VG	G	G	VG	VG	G
C8	G	F	P	VG	G	G	G	VG	G	G	F	G	VG	G	VG	G	VG	G	G	VG
C9	F	G	F	F	G	P	G	G	VG	G	G	VG	G	VG	F	G	VG	G	G	VG
C10	F	G	P	F	P	F	F	G	G	G	F	G	VG	VG	G	VG	G	G	G	VG
C11	G	G	VG	VG	G	VG	G	G	G	F	F	G	VG	G	F	G	F	G	G	G
C12	P	G	P	F	G	F	P	F	F	F	G	G	F	G	F	P	F	VG	G	P
C13	G	G	F	G	VG	VG	G	G	G	VG	G	G	F	G	F	G	VG	VG	G	G
C14	G	G	F	VG	G	VG	G	G	F	F	G	G	G	G	VG	G	G	VG	F	VG
C15	G	G	G	F	G	G	F	F	G	F	VG	G	VG	G	G	VG	VG	G	G	G
C16	G	P	F	P	G	F	G	G	F	G	VG	G	VG	G	VG	G	G	VG	G	G
C17	F	G	F	P	G	F	F	G	VG	G	F	G	G	VG	VG	G	VG	G	G	G
C18	G	G	F	G	G	F	G	VG	F	G	F	G	VG	G	F	G	G	F	G	G

Table 5
The overall score of each player in three positions.

Position	Player number	Overall score
Defenders	1	(12.6, 25.45, 37.55)
	2	(13.85, 26.8, 38.85)
	3	(11.55, 22.2, 34.9)
	4	(10.75, 23, 35.15)
	5	(14.2, 27.75, 39.6)
	6	(12.4, 24.5, 37.35)
	7	(13.1, 25.9, 37.9)
Midfielders	8	(20.25, 35.25, 48.45)
	9	(20.9, 34.85, 48.3)
	10	(19.15, 33.35, 46.9)
	11	(19.5, 33.6, 47.6)
	12	(21.25, 36.05, 49.1)
	13	(21.9, 35.4, 48.9)
	14	(21.3, 35.65, 49)
	15	(20.05, 34.55, 48.4)
Forwards	16	(23.4, 37.5, 50.8)
	17	(25.4, 38.6, 52.25)
	18	(26.4, 39.85, 53.3)
	19	(23.65, 38.1, 51.3)
	20	(25.1, 38.9, 52.15)

4.2. Phase 2: Arrangement

This phase is intended to determine the best arrangement for the 4–4–2 formation. Let us consider the three defenders' combinations as an example to illustrate the procedure for identifying the best defenders combination. Based on the result from the previous phase, the top defensive combination was (5, 2, 7, 1) whose arrangement was calculated using the FIS. The coaches identified (x, y) as the two input factors influencing team arrangement:

- Factor x was the number of players' teammate relations (NOTR) in one (or both) of the two last games. The simultaneous presence of two players in one team was one teammate relation. Maximum value of NOTR is shown in Eq. (6).

$$\frac{n(n-1)}{2} \tag{6}$$

where n is the number of players in a specific position. In this case, the number of defenders was 4. Therefore, the maximum NOTR value was 6 for the proposed team. A schematic view of the NOTR ($x = 4$) is represented in Fig. 8. The line between points 2 and 7 in this figure shows that these players played in one (or both) of the last two games together.

Table 6
The overall score and ranking of each player.

Position	Player number	Overall score	Ranking
Defenders	5	27.75	1
	2	26.8	2
	7	25.9	3
	1	25.45	4
	6	24.5	5
	4	23	6
	3	22.2	7
Midfielders	12	36.05	1
	14	35.65	2
	13	35.4	3
	8	35.25	4
	9	34.85	5
	15	34.55	6
	11	33.6	7
	10	33.35	8
Forwards	18	39.85	1
	20	38.9	2
	17	38.6	3
	19	38.1	4
	16	37.5	5

Table 7
The overall ranking of the top three 4–4–2 combinations.

Position	Player combinations	Average rating	Ranking
Defenders	(5, 2, 7, 1)	26.47	1
	(5, 2, 7, 6)	26.23	2
	(5, 2, 7, 4)	25.86	3
Midfielders	(12, 14, 13, 8)	35.58	1
	(12, 14, 13, 9)	35.48	2
	(12, 14, 13, 15)	35.41	3
Forwards	(18, 20)	39.37	1
	(18, 17)	39.22	2
	(18, 19)	38.97	3

- Factor y is the average number of players (ANOP) who played together in the last 10 games. Table 8 shows the number of defenders out of four who played together in each of the last 10 games. The ANOP was calculated as follows:

$$y = \frac{(2+2+4+\cdots+3)}{10} = 2.9$$

Next, we converted the two inputs into the POAs for the top combinations for each position. A series of fuzzification, rule evaluation, aggregation and defuzzification procedures were used to accomplish these tasks. These procedures depicted in Fig. 9 are described next.

(i) *Fuzzification*: In this procedure, the crisp values were transformed into fuzzy values according to their respective membership functions. The membership function for the inputs x and y are shown in Fig. 9a and b, respectively. The membership degree for input ($x = 4$) was 0.5 in the M and H areas and the membership degree for input ($y = 2.9$) was 0.6 in the M and 0.4 in the H areas.

(ii) *Rule evaluation*: The results from the previous procedure showed that inputs x (ANOP) and y (NOTR) are positioned in the M and H areas. The combination of these four areas consisted of four rules shown in Fig. 9c. The membership degrees of

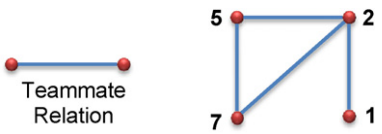

Fig. 8. The schematic view of the NOTR.

Table 8
The number of defenders who played simultaneously.

Match number	Number of defenders played together
1	2
2	2
3	4
4	3
5	2
6	3
7	3
8	4
9	3
10	3

the output function (Z) in the mentioned areas of the rule-based table were calculated according to Eqs. (7)–(10):

$$\mu_{MO}(Z) = \mu_M(4) \wedge \mu_M(2.9) = \min(0.6, 0.5) = 0.5 \tag{7}$$

$$\mu_H(Z) = \mu_M(4) \wedge \mu_H(2.9) = \min(0.5, 0.4) = 0.5 \tag{8}$$

$$\mu_H(Z) = \mu_H(4) \wedge \mu_M(2.9) = \min(0.5, 0.6) = 0.5 \tag{9}$$

$$\mu_E(Z) = \mu_H(4) \wedge \mu_H(2.9) = \min(0.5, 0.4) = 0.4 \tag{10}$$

(iii) *Aggregation*: The membership degrees from the rule evaluation procedure were graphically represented by a line in each area of the output function where more than one membership degree was obtained. The maximum value for these degrees was selected according to Eq. (11) and the output function areas were aggregated accordingly. The results of the aggregation procedure represent an area which contains the fuzzy solution to the problem. This area is represented with heavy red lines in Fig. 9d.

$$\mu_{agg} = \max\{\min(0.5, MO), \min(0.5, H), \min(0.4, E)\} \tag{11}$$

(iv) *Defuzzification*: In this procedure, the Mamdani's inference system method (Mamdani & Assilian, 1975) was used to convert the fuzzy outputs into crisp output values through a defuzzification process. We used the Centroid method, one of the most popular defuzzification techniques, to transform the fuzzy values into crisp values as suggested in the Mamdani's inference system method (Ross, 1995). The crisp values of the outputs were obtained according to Eq. (12) in Fig. 9, where $\int$ denotes an algebraic integration.

Next, Delphi method was used to select a threshold value for the POAs in each position. The Delphi method was developed at the RAND Corporation to obtain the most reliable consensus of opinion from a group of knowledgeable individuals about an issue not subject to objective solution (Dalkey & Helmer, 1963). It is a structured group interaction that proceeds through multiple rounds of opinion collection and anonymous feedback. Although Delphi dates back to early 1950s, the most recognized description of the method was offered by Linstone and Turoff (1975). Fischer (1978), Schmidt (1997), Okoli and Pawloski (2004), and Keeney, Hasson, and McKenna (2006) also provide excellent reviews.

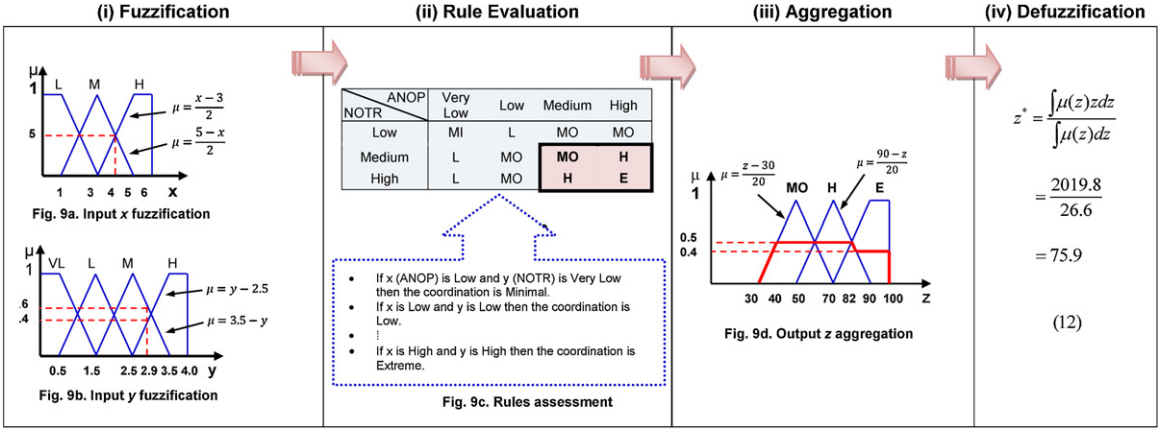

Fig. 9. The fuzzy rule-based calculation. (For interpretation of the references to color in the text, the reader is referred to the web version of the article.)

Table 9
The final 4–4–2 team formation.

Position	Player combinations
Defenders	(5, 2, 7, 1)
Midfielders	(12, 14, 13, 8)
Forwards	(18, 20)

Fig. 10. The final 4–4–2 team formation.

Each round in Delphi involves a written survey of the participants followed by statistical feedback to them for each survey question. After seeing the results from the previous round, the participants are asked to reconsider their opinions. Generally, there is a convergence of opinions after three or four rounds, and a stabilized group opinion emerges. This group opinion may reflect agreement, disagreement or some of each. The optimum number of participants depends on the number needed to have a representative pooling of views (Ndour, Force, & McLaughlin, 1992).

The coaches had selected 60% as a threshold value for the POAs in each position. This value was agreed upon after two rounds of Delphi where the coaches had shared their preferences and threshold values with each other anonymously. The similarities and differences among the threshold values suggested by different coaches were discussed and they were able to reach a consensus on the selected threshold value. The POA of the four chosen defenders in combination (5, 2, 7, 1) was more than 60% ($z = 75.9\%$) and therefore this arrangement was considered acceptable. After arranging the defenders, the above procedures were employed for the midfielders and the forwards. Eventually, the final arrangement presented in Table 9 was developed. A schematic representation of the final 4–4–2 team formation is also shown in Fig. 10. According to the method proposed in this study, the 4–4–2 formation with four defenders (5, 2, 7, 1), four midfielders (12, 14, 13, 81), and two forwards (18, 20) was proposed to the coaches as the best team formation for the upcoming league championship game.

5. Conclusions and future research directions

Contemporary sports impose greater requirement on player selection and team formation strategies (Trninic, Papic, Trninic, & Vukicevic, 2008). The process of player selection and team formation in multi-player sports is a complex multi-criteria decision-making problem with conflicting objectives. Coaches are required to consider a large number of qualitative and quantitative attributes in the player selection process. In spite of the importance of using structured and analytical methods for player selection and team formation, very little research has been conducted on the subject in sports science. We

proposed a two-phase framework for player selection and team formation in soccer. The players were selected in the first phase and the best combinations of the selected players were evaluated with a FIS for team formation. We presented a case study to demonstrate the applicability of the proposed framework and exhibit the efficacy of the procedures and algorithms. The contribution of the proposed method is threefold: (1) it addresses the gaps in the sport science literature on the effective and efficient player selection and team formation; (2) it considers imprecise or vague judgments which lead to ambiguity in the decision process; and (3) it uses a meaningful and robust multi-criteria model to aggregate both qualitative judgments and quantitative data.

The proposed framework does not imply a higher-level of 'accuracy' in player selection and team formation. While our approach enables the coaches to assimilate the precise data and imprecise or ambiguous judgments into a formal systematic approach, it should be used with care and in conjunction with the game objectives. Our approach helps the coaches to think systematically about complex multi-criteria decision making problems and improves the quality of their decisions. The coaches' judgment is an integral component of player evaluation; therefore, the effectiveness of the model relies heavily on the cognitive capabilities of the coaches.

Although the case study in this paper considered two factors as inputs in the FIS, the approach permits a large degree of flexibility to integrate additional factors in the evaluation process. The methodology discussed in this paper is not only suitable for multi-player sports, it is also appropriate for modeling workgroups and project teams in business and industry. In conclusion, we stress that our contribution addresses yet a small part of the issues that are involved with arranging players in multi-player sports. It is safe to say that quantitative and analytical player selection and team formation as a discipline is at its infancy. Therefore, we hope that the study presented here can inspire others to pursue further research in this area.

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Analytical Study of Challenges and Barriers of Creation of Value through Information Systems in Management and Construction Processes of Projects by Contracting Firms in Tehran

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ABSTRACT

Now, information system of project management is an essential part of any project, which consists of tools and techniques that are used to collect, synthesize, integrate and distribute outputs of the project management process. Project management whether inside the country or across the world in dealing with the increasing volume of information, and following it, the complexity of the decision-making, has found that manual non-integrated systems, and even in some cases non-specialist, based on the importance of information and information systems are not capable to create value. In other words, these systems often cause that most of managers are drowned in an eddy of information in sensitive conditions and cannot take the appropriate decisions and cause the organization is driven toward the loss of opportunities to create new values. Study the problems related to the use of information systems, exploitation and the correct use in order to create value is important for the organization or firm; because in this way the creation of value will be easier for these firms and at the lower levels of projects. The present study investigates the analytical challenges and barriers of creation of value through information systems in management and construction processes of projects by contracting firms in Tehran based on a descriptive-survey method using questionnaire, one-sample test, chi-square and AHP model by SPSS software version 21. The results show the significance of tests, and the problems and constraints are classified based on their significance that the institutional, human and environmental factors are the most important barriers respectively.

KEYWORDS: challenges and barriers, creation of value, information system, management and construction, contracting firms of Tehran.

INTRODUCTION

Successful managers are those who can better manage and use the information to make on-time, effective and problem-solving decisions. In fact, the fate of works is tied up with decision-makings and if decisions are not taken based on the accurate principles, the system becomes unstable. In decision-maker's components and conditions, including the deduction of adequate and accurate information and utilizing the experiences and advice of knowledgeable experts, enough attention must be paid (Aliakbari and Mahdipoor, 2010). Today, most organizations are looking for selecting and implementing appropriate model or approach to improve the quality of their products and services, and ultimately to create value for all stakeholders, but in spite of expanding enormous costs, due to the lack of integrated business processes that covers all levels of the organization, have not been successful (Talaei and Jabalameli, 2007).

Information system is a set of elements that are related with each other that collect data and information, manipulate and distribute them, and provide feedback to achieve a goal (Banaeyan, 2008: 147). Organizational information system is an information system to study the information which relates to that organization. Organizational information systems are used in three fields which include performing operations, controlling operations and decision making in organizations. Organizational information systems can be performed manually or by computer, or synthetically by computer and manually (Omidvar, 2006: 2).

Creation of value can be used by relying on teamwork, collection wisdom and flexibility of its work program, alongside many other project management processes to improve their results; therefore, it is particularly concerned. In this tool, it is tried much attention be paid to issues of cost, time and the need, and reach them to an optimum level. The more the needs are important and worthy, the more effective the use of creation of value will be. But more precisely, the fields which enjoy the following criteria have more talent to benefit from the value:

- High cost;
- The high number of components;
- The existence of complex parts and systems;

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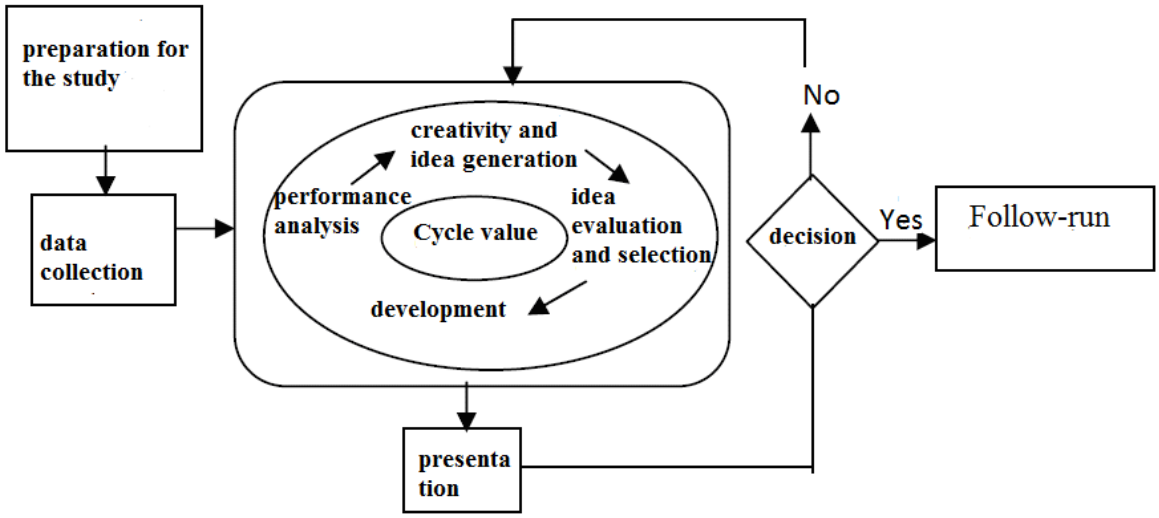
- Long period of time from initial design;
- Mass production (repetition of operation frequency);
- Variable environment;
- The importance of customer satisfaction;
- Exclusive items;



Value cycle

The barriers of the creation of value in information systems

The integration approach in information systems often means taking a strategic approach towards reform, because the integration of the objectives of the reforms, information and technology need a continuous and integrated activity in areas of organizations and at level of high rank managers. Integration is an approach with the greatest likelihood of creating potential benefits to reform the information age; however, this approach enjoys the minimum generality. Some of the reasons for the lack of fortune by public sector organizations towards the integration approach include the following:

Factors that hinder the development of the "denial" approach include insufficient knowledge and skills, lack of financial resources, lack of accountability by public officials, suspicion towards the success of IT, and the weakness of infrastructures

Factors that encourage continuing the worship approach including the notion of IT as a decisive solution for the reforms in the public sector, pressures from the external organizations, rapid changes and continuous innovations in the field of IT and managers' imitational attitudes.

Other limiting factors of the integration approach include technical barriers, barriers related to knowledge and skills, barriers related to the quantity and quality of data and structural and cultural barriers (Hicks, 2000).

The main problem in this research is that the creation of value through information systems in management and construction of projects in contracting firms in Tehran is faced with which type of difficulties and obstacles? And, what are the roles of organizational, human and environmental factors in lack of value creation through information systems in management and construction of projects in contracting firms in Tehran?

The main question of the research

What are the barriers and problems of the creation of value through information systems in management and construction of projects in contracting firms in Tehran?

Sub-questions

1. What are the role of environmental factors in hindering the creation of value through information systems in management and construction of projects in contracting firms in Tehran?
2. What are the role of human factors in hindering the creation of value through information systems in management and construction of projects in contracting firms in Tehran?
3. What are the role of organizational factors in hindering the creation of value through information systems in management and construction of projects in contracting firms in Tehran?

Background of the research

Hassanzadeh (2005), in a research entitled "the study and comparison of the performance of Bhutan firm before and after the implementation of project-based information systems", investigated the performance of Bhutan firm before and after the implementation of the plan and found that there is a positive relationship between the two variables of information systems of the firm and performance of the firm, and automation has caused the performance of the firm to be improved.

Tavakolizadeh Davoodi (1996) studied the effect of training how to use computer databases on the accuracy coefficient of information retrieval at the search time and found that training users how to use computer databases has a relative association with reducing the search time.

Ghazizadeh Fard (1996), in his doctoral dissertation entitled "designing and explaining the model of studying and analysis of the human barriers in establishment and use of management information system", identified the barriers in the form of four sections that are manpower, lack of connection among information systems, systems without content, and systems without management.

Kazemi et al (2008), in a research entitled "the study of barriers in establishment of e-government in Iranian governmental organizations" investigated the six categories of barriers including administrative barriers, organizational barriers, technical barriers, human barriers, financial barriers and environmental barriers. The results of this study showed that, except for financial and technical factors, the other factors act as barriers to the deployment of e-government in Iranian governmental organizations.

Kia (2007) in a research studied the barriers and strategies of establishment of electronic city in the view of experts in the field of information and communication technology and classified them in five categories that the results showed that the administrative, educational, economic, technical, political and cultural barriers are placed in ranks one to five respectively.

Farhangi et al (2010), in a study entitled "the study of barriers of the effective use of information and communications technology in order to improve accountability to stakeholders in Iranian firms of mining industry" investigated the social barriers, infrastructural barriers, digital interval, law barriers, information security barriers and change management as the main barriers to the effective use of information and communication technology. The results showed that the components of the social barriers, infrastructural barriers, digital interval and legal barriers create the maximum deterrence respectively and information security and change management create minimum deterrence respectively.

Badragheh (2010), in his doctoral dissertation entitled "the implications and challenges of implementing a management information system", studied the factors affecting the use of management information system and ranked them from one to six as managerial factors, cultural-organizational factors, learning-teaching factors, technical factors, human factors and economic factors respectively.

Khosrovpoor (1999), in a study investigated the factors influencing the success of the organizations' information systems, that the results indicated that the knowledge of managers and users is an important factor in this field.

Batangar (1991) in a study found that the lack of skillful human resources in information system, and also lack of professional managerial experts are considers as the critical challenges in management information systems in developing countries.

McLain and Dillon (1992), in a study, suggest that the criteria for assessing the quality of information systems are classified into six main categories including system quality, information quality, system applications, user satisfaction, impact on individuals and impact on the organization.

Igbaria and Ivari (1997), in a research, investigated the occupational diversity as an important factor in the success of information systems. According to these researchers, the more the occupational diversity, the more it is necessary to change the basic properties of the system because of occurring unexpected events, that this issue requires user's participation.

RESEARCH METHOD

In this study, in order to achieve a clear idea on analysis of the challenges and barriers to the creation of value through information systems and research principles, the descriptive-library method has been used. The purpose of the research is to study the challenges and obstacles in creating value analytically through information systems in processes of management and construction in contracting firms in Tehran. The present research is an applied one in terms of objective and a descriptive-survey one in terms of nature and methodology. The field and survey data were collected through researcher-made questionnaire. The population consists of professionals, academic experts, general managers, project managers and quality managers and the experienced experts in a number of contracting firms in Tehran, which include 93 individuals, and based on Cochran formula, the sample size was selected as 73 individuals. The validity of the questionnaire was confirmed by experts, and its reliability was obtained equal to 0.91

according to Cronbach formula. To study hypotheses, one-sample test and Chi-square using SPSS software and AHP model using EXPERT CHOICE 11 software were used.

$$N = \frac{\frac{t^2 pq}{d^2}}{1 + \frac{1}{n}\left(\frac{t^2 pq}{d^2} - 1\right)}$$

$$N = \frac{\frac{(1.96)^2 (0.95)(0.05)}{(0.05)^2}}{1 + \frac{1}{90}\left(\frac{(1.96)^2 (0.95)(0.05)}{(0.05)^2} - 1\right)} = 73$$

It should be noted that the data collected in this study are as follows: first, the related literature was collected through internet and reviewed, and then the population was selected and the questionnaires was distributed. Finally, the samples were examined as a field study that the results are discussed as following.

Findings

The first hypothesis testing

Environmental factors act as a barrier in the creation of value through information systems in management and construction of projects in contracting firms in Tehran.

According to the scores obtained from the sample and performing one-sample t-test, the results are summarized in following tables. As it can be seen, p-value, i.e, the significance is equal to 0.000, that is less than the value of α (α= 0.05); so the null hypothesis which states that the mean of the variable of environmental factors equals to 3 is not approved. From one hand, the two numbers shown in the column related to 95 percent confidence interval of mean difference does not include zero. Therefore, this shows that the null hypothesis is rejected. Positivity of upper and lower limits of this interval also indicates that the mean of environmental factors according to the mean of community which is 3.23, equals to 3. The overall result will be explained in this way that the condition of environmental factors, according to the mean of the studied population which is 3.23, is relatively high. The two other hypotheses are tested in this way.

Table 1

Variables	**No.**	**Mean**	**Standard deviation**	**Standard deviation from the mean**
	73	3.23	0.514	0.060
The rate of prevention of creating value by environmental factors	t-value	Degree of freedom	Significance level	Difference from mean
	3.847	72	0.000	0.23

Therefore, the results show that the mean of significance of items (0.000) is less than 0.05 which suggests that the hypothesis is confirmed.

The second hypothesis

Human factors act as a barrier in creation of value through information systems in management and construction of projects in contracting firms in Tehran.

Table 2

Variables	**No.**	**Mean**	**Standard deviation**	**Standard deviation from the mean**
	73	3.32	0.371	0.043
The rate of prevention of creating value by human factors	t-value	Degree of freedom	Significance level	Difference from mean
	7.356	72	0.000	0.32

Therefore, the results show that the mean of significance of items (0.000) is less than 0.05 which suggests that the hypothesis is confirmed.

The third hypothesis

Organizational factors act as a barrier in creation of value through information systems in management and construction of projects in contracting firms in Tehran.

Table 3

Variables	No.	Mean	Standard deviation	Standard deviation from the mean
	73	3.19	0.362	0.042
The rate of prevention of creating value by organizational factors	t-value	Degree of freedom	Significance level	Difference from mean
	4.449	72	0.000	0.19

According to the significance level given in the table above which is equal to 0.000 and its comparison with allowable error rate of 0.05 with 95% confidence, we can conclude that, in the view of respondents, the organizational factors with mean of 3.19 moderate in creating value through information systems at more than intermediate level in construction management of projects in contracting firms in Tehran.

Based on the results obtained from the analysis of the significance of each of the environmental, organizational and human factors, human and organizational factors are more significant than environmental factors, and organizational factors, in comparison with other indicators, enjoy higher significance, and therefore in this classification, the organizational factor is placed at the first priority and the environmental factor is placed at the last priority.

Prioritization of barriers to the creation of value

To prioritize the components preventing the creation of value through information systems in management and construction of project in contracting firms, i.e., the three main environmental, human and organizational components, Friedman test was used. The results of this test are summarized in the following table:

Table 4. Test Statistics [a]

N	**73**
Chi-Square	53.510
df	3
Asymp. Sig	0.000

[a] Friedman Test

Since the significance value is less than 5%, the ranking of the independent variables is different.

Table 5

Factors	Mean of ranks	Chi-square value	df	Sig
Environmental factors	1.86			
Human factors	1.99			
Organizational factors	2.15	53.510	3	0.000

1. Organizational
2. Human
3. Environmental

The analytic hierarchy process for paired comparison

One of the factors of decision making method by AHP parameters is the multiple analytic hierarchy process AHP, which the use of this method requires the following four steps:

Step one. Modeling: in this step, the problem and purpose of decision-making are formed as a hierarchy of elements of decision that are associated with each other. The decision elements include decision making index and the options of decision.

Step two. The preferential judgment or paired comparisons: comparisons between different options of decision making are done based on each index and the importance of each index is determined by doing paired comparisons.

Step three. Calculation of relative weights, weight and the importance of the elements are determined in comparison with each other by a set of numerical calculations.

Step four. Integration of relative weights and calculation of final weight: this step is done in order to rank the alternatives. In the method of AHP, there is as a subject under the title of "system adaptation". The rate of adaptation is a mechanism that determines the rate of adaptation of comparisons. This mechanism indicates that how

much we can trust the priorities in tables. Experience has shown that, if the adaptation rate is less than 0.1, adaptation of comparisons can be accepted; otherwise, the comparisons must be done again (Mehrgan, 2004).

Prioritization and ranking (AHP)

AHP method is a technique which is used for solving multi-criterion decision-making problems with a hierarchical structure. To do AHP method, it is required that we specify our criteria and alternatives a structural hierarchy, i.e, we must specify what criteria and sub-criteria we have considered to rank the alternatives. Then the paired questionnaire for comparison including all scales, sub-scales and items must be designed. In the questionnaire for the paired combining binary comparison, all scales (criteria) and options (alternatives) should be considered (of course, according to the hierarchical structure of the problem!). So, if the number of criteria and alternatives is much, it causes the number of paired comparisons increases that this leads to long questionnaire and respondents may be mistaken in comparisons or due to impatience, comparisons are not done with high accuracy, and inconsistency rate increases. For this purpose in order to achieve better results and more specific assessment in the present study, a limited number of indicators criteria were used. Therefore, the number of parameters and options must be to the extent that the number of paired comparisons in the questionnaire seems reasonable. The next point is that the AHP method is a method which is based on experts' opinion, that is, the paired comparative questionnaire should be administered to the experts and specialists who are dominant on all aspects and criteria of the problem. In some cases it is likely, there are not more than 3 or 5 experts in the sample, however, there is not any problem in this respect, and the obtained results are completely significant and scientific, because the questionnaire have been completed by experts, and there is no need to have a high volume of samples. The remarkable point is that, the reason for using AHP method in this study is the rate of accuracy of the results, because the obtained results are based on opinions of academic experts and scholars in this field, and its advantage than other analytical models, such as TOPSIS and taxonomy, is its high precision because of the accurate weighting and the expert-based results.

Since, the number of barriers avoiding creation of value, that have been surveyed and approved in the table above, is much, by utilizing the experts' consultation and opinions and based on obtained data from the above tables including the mean of each proposition, the following criteria were considered as the main criteria for prioritization and ranking of the factors.

Environmental factors

- Non-existence or being less active the forums
- Lack of measurement standard for the quality of information systems
- Lack of holding appropriate training courses for post-graduates
- Non-appropriate use of media
- Non-evaluation of environmental aspects

Human factors

- Lack of necessary precision in collecting information
- Non-satisfaction of individuals' welfare state
- Lack of experience of managers and absence of appropriate technocracy
- Non-participation of managers and staff
- Non-awareness of managers and users precisely from what they want

Organizational

- Technology and structural problems in consulting firms
- Inappropriate and incorrect implementation of system in constructional projects
- Lack of human resources with two professional areas of computer and management
- The absence or lack of appropriate controls on the employees working in this field
- Unfavorable condition of teaching and training the experts

To analyze the data collected from the AHP questionnaire of the survey that was developed by a set of seven experts who had sufficient information and experience in the field, the following results were obtained. In addition, to analyze data collected, the Geopel 26.07.2014 software was used.

Table 6. Environmental components

Rank	Environmental variable	Weight
1	Non-existence or being less active the forums	42.3%
2	Lack of measurement standard for the quality of information systems	21.4%
3	Lack of holding appropriate training courses for post-graduates	14.9%
5	Non-appropriate use of media	9.1%
4	Non-evaluation of environmental aspects	12.3%

Based on the results of AHP data analysis, as it can be seen in the table above, experts and specialists of the field allocated the maximum weight to the component of "non-existence or being less active the forums" and the minimum weight to the component of "non-appropriate use of media" and the components of "lack of measurement

standard for the quality of information systems" and "non-holding appropriate training courses for post-graduates" and "non-evaluation of environmental aspects" are placed at following priorities respectively.

Table 7. Human factors

Rank	Human variable	Weight
1	Lack of necessary precision in collecting information	29%
2	Non-satisfaction of individuals' welfare state	21.4%
3	Lack of experience of managers and absence of appropriate technocracy	19.8%
5	Non-participation of managers and staff	14.2%
4	Non-awareness of managers and users precisely from what they want	15.5%

Based on the results of AHP data analysis, as it can be seen in the table above, experts and specialists of the field allocated the maximum weight to the component of "lack of necessary precision in collecting information" and the minimum weight to the component of "non-participation of managers and staff" and the components of "non-satisfaction of individuals' welfare state", "lack of experience of managers and absence of appropriate technocracy" and "non-awareness of managers and users precisely from what they want" are placed at following priorities respectively.

Table 8. Organizational components

Rank	Organizational variable	Weight
1	Technology and structural problems in consulting firms	24.9%
3	Inappropriate and incorrect implementation of system in constructional projects	18.1%
2	Lack of human resources with two professional areas of computer and management	23.7%
5	the absence or lack of appropriate controls on the employees working in this field	17.8%
4	Unfavorable condition of teaching and training the experts	15.6%

Based on the results of AHP data analysis, as it can be seen in the table above, experts and specialists of the field allocated the maximum weight to the component of "technology and structural problems in consulting firms" and the minimum weight to the component of "unfavorable condition of teaching and training the experts" and the components of "lack of human resources with two professional areas of computer and management", "Inappropriate and incorrect implementation of system in constructional projects" and "lack of proper control on the activities of staff" are placed at following priorities respectively.

Overall, the results indicate the superiority of the organizational factor with allocated weight of 20.20 from the mean of weights compared to the human factor (19.8%), and environmental factor (20%). So in this field, organizational factors are the most important barrier in creating value through information systems, and environmental factors and human factors are at next ranks respectively.

Conclusion

IT is considered as a tool to empower the most important factor in increasing the efficiency and effectiveness of the organization, and the different industries have taken important steps for the use of these technologies to maintain their survival in today's competitive environment and to enhance their consequences of using them.

Several factors affect the creation of value in information systems in contracting firms, which in this research, the environmental, human and organizational factors have studied that the results in two phases of prioritization based on AHP model and the level of significance and effectiveness in the lack of efficacy in creating value through information systems indicate that in the phase of significance and based on the mean of significance for each of the items of the questionnaire, the organizational factor is more significant and is placed at the first place; the human factor is at second place and the third place is allocated to environmental factor.

Furthermore, based on the AHP ranking model, the superiority of the organizational factor with weight of 20.20 is evident in comparison with human factor with weight of 19.8%, and environmental factor with weight of 20. Therefore, in this part, the organizational factors are the most important factors in preventing the creation of value through information systems, and the environmental and human factors are at following places.

In general, all human, environmental and organizational factors prevent the creation of value through information systems in management and construction of projects in contracting firms in Tehran, and basic precautions should be taken in this area to be able to achieve the positive and effective role of these factors in creation of value.

Suggestions

- Efforts must be done to create value and to achieve the expected results for shareholders, stakeholders and customers through the development and greater efficiency.
- Considering important the views and expectations of the client to create value.
- Internal processes for production and giving customer the service purposefully must be studied and analyzed.
- The potential competences in culture, technology and staff must be considered for creation of added value, and according to it, various plans must be designed and these capacities should be considered on the environmental, organizational and humane advantages.
- Targeting on the strength of systems, with continuous promotion of complete information related to all vital information systems and capturing the market and customer needs, in order to retain existing customers, along with attracting new customers and markets.
- Creating balance in the goals of information systems and information technology with business and organizational needs.

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Influence of professional ethics on project managers to achieve the aims of development company projects

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Abstract

Professional ethics is one of the most important issues in the world. Today most of the countries in industrial world believe that being indifference of ethics and being irresponsible to social obligations causes damage to development company projects. For this reason, lots of successful companies believe that it is needed to and should have ethical strategies in an organization. The aim of this paper is influence of professional ethics on project managers to achieve the aims of development company projects. The research method used in this research is description of correlation coefficient. For the data collection purpose, a questionnaire is distributed. The sample population consists of 200 people from development project managers that were randomly selected. Constancy of this questionnaire was tested by SPSS statistical software using Pierson correlation coefficient and regression analyses. The findings show that professional ethics and properties like justice, honesty, sympathy, responsibility among project managers can significantly influence the success of development companies.

1. Introduction

Today industrial world and technological complicacy, increasing population and their need to more production for a better life, have presented time to human being. When the characteristics of people change, the society will be vulnerable. A society or a culture will be constant when it has simple ethical values such as respecting to other people.

Observance of law, respecting to other people's life and possession, loving family, defense, help to poor people and paying tax depend on bravery, loyalty, honesty, forgiveness, charity, sympathy, politeness and responsibility. Professional ethic consists of all the features of human life. Development of human societies and more complicated relationships new needs are being made. Appearance of different professions is the result of response to these needs and formed along the time and changing conditions and developed step by step. These professions firm every day because of necessity of division of labor and specialization and play their role for a better life.

Continuation of professions and employment of the members depend on the type and the service qualification that is presented and also reliability which is the result of these services. This reliability is the main capital of professions and should be maintained. The main duty and aim of all professions is presenting service to society and personal benefits should be followed only in the frame of presenting them.**2. Problems statement**

Complexity of new era organization and development in technological policy of economic and other environmental factors force organizations and companies to enable themselves for continuing their life. Using management tools and techniques in this regard enables managers to have a basic role in survival of organizations using suitable methods.

Today professional ethics is an important issue in the world. But it is not considered in societies many countries in industrial world believe that indifference to ethics and being irresponsible to social obligations cause to annihilation of companies and organizations. For this reason lots of successful companies have concluded that there should be culture based on ethics in organizations and performing projects. Therefore, considering ethics is an important issue(Giver Gian 1382).

Project performance consists of two words: project and performance. The combination of them as a main structural issue plays a very important role. One the evolution that is the result of different economic, social and cultural revolutions was scientific management movement that after using it there was increasing in production and efficiency. According to "system project management organization" we can define project management like this: project management is the technique of conduction and matching human resources and interests in the longevity of a project using modern methods of management so that to achieve to the aims about frame work, time cost, qualification and contribution. A manager of a project apply necessary conduction regarding to regulated policies by company's head managers for performing an activity having aim, budget, duration, specified qualification as technical properties that should be performed. The manager of a project for performing a regulated contract design a suitable structure and organization and determine the employers' relationship among superiors, inferiors and peers (Naqi Amiri et al, 1390).

Development project management requires new management knowledge and perception of manufacturing and design process. Development projects are collections of determined aims and limitations because they have completing timetable. Managing such projects has common items with managing projects in other specialized or technological areas such as: space, pharmacology and developing energy although technique and organizational orders and related work process are different.

In brief, this research is trying to find out whether professional ethics on project managers have any impact to achieve the aims of development company projects.

Professional ethics

Construction project management requires being aware of new management techniques as well as having understanding for design and construction process. Construction projects are a set of specified objectives and limitations such as time framework necessary for accomplishing it.

Managing such projects have many common ground with project management in specialty and technological fields such as space, pharmaceutics and energy development, Furthermore the organizational procedures are different for each one of them.

1.1 Professional ethics

In the past, the professional ethics has been referred to as work and job morals. Today some authors of professional ethics use its meaning for defining this concept. Various definitions are presented for professional ethics.

a) Professional ethics is the individual or group commitment of mental and physical energy to a collective idea for summoning up the strength and inner talents of group and individual to develop in the best manner.

b) The professional ethics is one of the new branch of ethics attempting to address various professional ethic issues and consider specific principles for it.

c) Professional ethics deals with ethical issues and morale principles and values of a professional system and addresses ethics in a professional environment.

d) Professional ethics is a set of rules that one should observe voluntarily and based on the voice of conscience, without any external compulsion or fear from punishment in case of breaching rules.

e) Individual ethics is individual responsibility toward its own behavior. As a human individual the professional ethics is merely the responsibly of the individual toward its own professional behavior, as a professional or organizational position.

f) This morale encompasses a set of value instruction, obligations, behaviors, bearings and orders to do.

In Cambridge philosophical dictionary (Date/?), the professional ethics includes one or more of following items:

1. An acceptable ethical value that should manage the work of employees.

2. Ethical value that in fact directs a group of employees.

3. Examining the professional ethics in the past concepts, including examining the norms in the field of desirable values for employees or descriptive study (scientifically) of behaviors and actual beliefs of a group of employees. The professional values such as legal, obligatory and requirement principles such as ethical virtues and ideals (Frederichson).

Work division in social life and specialization of issues is the basis of developing professions. Over time, the ever-increasing growth of knowledge and technology and complexity of social relations entailed professional development. The quality of presenting services and the expanded credit by professionals resulted in endurance and survival of professions and occupation of its members over history. Professional ethics is a knowledge presenting the limit and boundary of responsibilities in a

methodical manner and determines the proper and fitting behavior in any profession and set forth practical guidance. Many known profession have composed some practical rules and standards for their professional ethics that encompasses ethical responsibilities to society, others and environment. In fact, in social behaviors determining what to do and not to do is undertaken by the ethics. Thus the same set of to-do and not to do form the main core of professional ethics (Naqi Amiri et al, 2011).

Professional ethics features

Today in professional ethics, the notion of "you have the right and I have to it" is the basis of any kind of ethics in the business. This basis of individual relation behavior can be considered as a main principle for organizational relationship. the features of professional ethics within modern concept includes: having scientific nature, having practical role, presenting a professional, native and culture-related attribute, dependency to an ethical system, presenting human knowledge with motivational literature, presenting interdisciplinary attitudes (Sears, 2015).

As for individual features of professional ethics Cadozir states following attributes:

1. Responsibility

In this regard, one is in charge of its decisions and its consequences. One is an example for all. It is sensitive and of high morale. Uprightness and fame characterize its work. He attempts to fulfill all of its responsibility and complete the undertaken task with all its zeal and purity of intention.

2. Honesty

One opposes the hypocrisy and two-faced character. It listens to the voice of its conscience. It pays attention to nobility in any situation. It is brave and courageous.

3. Justice and fairness

It supports the truth. It has no prejudice once judging. It does not discriminate people in terms of culture, socioeconomic status, race and nationality.

4. Empathy with others

It is sympathetic and compassionate. It takes part in calamities of others and supports them. It pays attention to other people's feelings. It identifies others' problems as its own.

The concept of project management

Project management is a set of knowledge, skills and tools and technics that by adopting and integrating the project management process including initiative, planning, implementation, control and termination processes manages the projects activities for achieving to project objectives and addressing its needs. Managing a project without attention the technic and knowledge of project management is exactly like doing a football game without having play tactics. A football coach should encourage players to collaborating with each other and constantly asks himself "what should

we do in this match to find a higher score than the rivals". Addressing these issues is a key point that each one of team member should take into account. Addressing the question that which factor affects the achievement of a team is a crucial issue in performing a project. Having specified tactics for achieving to the goal and coordinating and integrating chosen tactics as well as process of bringing about improvements in those tactics and so on are among cases that can take place by adopting project management technics and knowledge. Many project teams adopt a method like a football team for accomplishing various projects so that they undertake the task of accomplishing the objective of project. One of the most important problems threatening the project team work is lack team work that often stems from lack of their familiarity with team work skills. a project team after accomplishing the project and its completion dissolves, while team member should evaluate their experiences before the team dissolution. Because having attention to past experiences and using them in the future projects results in the decrease of schedule as well as consuming less sources for the planning (Gack * Clements, 2014).

Majority of project managers often stress on three factors of cost, time and project realm as the factors affecting project management process. Meanwhile attention the quality, whether the quality of accomplishing the project management process or the quality of final product quality are among factors that can be affected by other three factors. So that a project with high quality in accomplishing the project management process is one that delivers a product with determined specifications within planned frameworks of cost, time and domain. Having such attitude to the quality is in fact choosing a systematic attitude in project management. Organizing project activities, project executive team and etc.

Also attention to uncertainties that may occur during the project lifecycle is among important factors in the field of project management (Hueman, 2015).

Realization of professional ethics in projects

Having proper ethics within projects is not easy, Project managers should take some actions to take decisions and assume ethical behavior appropriate for common and normal state, not an abnormal and special state. Five actions actualize this goal.

Firstly, consider the ethical constitution regardless of professional organization, many of them covers the same topics within different arenas.

Secondly, put the morale as a part of all important decisions and activities either individually or collectively. Many decisions and actions entails intense or slight ethical consequences.

Thirdly, the ethics should be placed within everyday issues of all people, the idea that ethics is related only to other people is a dangerous.

Fourthly, being of high ethics calls for being assertive, thinking right and doing right is a demanding task, once the work situation is overwhelming, some pressure is applied from superiors, team members, coworkers and other parties for putting into action normal policies.

Fifthly, remember that it is possible to successfully accomplish projects and to do and think ethically. People can be morale and at the same time the project be accomplished on time and with pre-allocated budget and the objectives be actualized (Takey, 2015).

Construction project cycles

Construction project cycles are divided into 15 following steps:

Step 1: declaring need to developing the projects and presenting work plan and proposing to management and planning organization by the exploiter.

Step 2. Examining the proposal and anticipating the preliminary costs for accomplishing the project and future planning by the management and planning organization with participation of exploiter unit.

Step 3: proposing the funding of the project accomplishment in the bill of budget and proposal of accomplishment unit by management and planning organization.

Step 4: issuing the project accomplishment to accomplishment institution and concluding the plan agreement

Step 5: providing the project through choosing consultant engineer or by the accomplishment institution itself (step 1 and 2) while conducting necessary technical test in the site of the plan.

Step 6: determining the project accomplisher and related power delegating

Step 7: adjusting bid documents and providing list of qualified contractors and issuing the letter of invitation by project accomplisher.

Step 8: holding bid commission and determining the winner and contract dealing.

Step 9: land delivery and introducing the supervision unit to contractor and providing the schedule for accomplishing the project.

Step 10: site equipment and starting the accomplishment tasks by contractors, declaring the required materials by order and issuing the draft by employer.

Step 11: periodical inspections, site sessions and problem settlement

Step 12: controlling foreign and currency funds and project costs and arranging plans amendments.

Step 13: performing temporary delivery and addressing the definite state of contractor and consultant engineer of the project (if there is any).

Step 14: maintenance period and then fulfilling the definite delivery.

STEP 15: handling possible claims associated with project and the overall evaluation of the project

5-1 specifications of managers in construction projects

The ability to achieve the maximum quality and quantity of progress with the minimum cost is the main characteristic of a good executive in the workshop. In fact being aware of the value of time, manpower, material and machinery provision are the primary requirements of a research manager and he should always be trying to find appropriate and principled methods for better doing of activities to improve the works.

Todays, an adequate planning and organization, awareness of promotion of actions by project manager, diagnosis of suitable tools, personnel, manner and compressive programming, all should be considered in management and handling the project, due to existence of specialist human resources and specialized machinery and technology.

Handling a project has become a profession and science, especially in the condition of complexity of large projects and relation of managers with labor organizations according to labor rules and construction machinery and the increased labor costs and business communications among manpower, etc. Hence, Peij(Date) suggests the basic principle as follows, through the conducted studies to set up and manage a construction project by the experts of this field:

1- Management
2- Raw materials
3- Manpower
4- Machinery
5- Financial costs

That is known as the WORKSHOP OF FIVE (M) OF MANAGEMENT that the project manager should take into account these five effective factors in essential planning of his workshop. All 5 factors are explained in next sections.

The position of a manager will remain stable if he can coordinate with other responsibilities of management line in order to takes advantage of them in project promotion.

Because of the complexity and extension of current projects, supervision of a workshop with linear organization that is also called military system is not feasible. Because in these organizations there are one manager and a number of labors and the manager is closely associate with workers. Therefore, a supervisor should assign responsibilities to administrators and monitor their performance. Direct relation, timely reports to the Board of Directors and consultation with them, checking the personnel, friendly cooperation of experts, sufficient awareness of finance and accounting systems, study of proper ways to generate revenue, and finally making needed changes, are essential in the progress of the project. Generally, before the performance of project, supervisor should review the project area from all aspects and make a comprehensive report of those studies.

1-6 the impact of professional ethics in the success of projects in construction firms

The professional ethics are the main challenge of the behavior of managers. Because they reflect the accordance of economic performance with social performance, that is expressed as commitments of

organization or firm to others. This morality has a kind of impact on the company operation. Ethic application process in the behavior of people and groups and its application in the success of construction firm have has following steps:

1- Success stems from professional ethics
2- Professional ethics comes from trust creation
3- Trust creation originates from behavior prediction
4- Behavior prediction emanate from continuity and legal behavior
5- Continuity and legal behavior rooted in responsibility
6- Responsibility stems from law and personal belief

Success of construction projects or organizations is due to the application of professional ethics. The organization ethics begins from trust creation. The more trust to organization, plans and managers the more commitment to organization and more responsibilities. Trust creation results in increasing of organizational capability in responding to environmental needs. Since, it will cause the creation of synergies in organizational capability.

In this way, when there is professional ethics between the managers, organizational goals will continue to pursue the profitability but not only within the scope of law information and sensitivity to it and responsibility to ethical standards. Ethics programs help organization to maintain their ethical performance in turbulent condition. Nowadays, ethical management is considered as one of the scientific fields of management that has operational approach and several scientific tools (Forsberg, 2012).

1-6-1 the advantages of professional ethics of managers in construction companies

Many advantages are reported as the result of employing manager with professional ethics as follows:

1- Pay attention to business ethics results in the fundamental improvement of conditions
2- Ethics programs causes the organization to keep its performance in turbulent condition
3- Professional Ethics programs coordinated the behavior of workers with the priority moral values that directors wished for. Continuous consideration and discussion about values will result in growth of the sprite of teamwork, honesty and openness in the workplace. Employees feel that there is harmony among their values and values of organization so are motivated and have better performance.
4- These programs lead to growth and development of workers
5- Ethics make us sure that the policy of organization is legal
6- Ethics programs are to prevent a criminal act. They are trying to discover immoral cases and breaking the law to report them. When organization is aware of breaking the law and doesn't report it to top officials, it has committed "negligence" crime and specific penalties are considered for that by the law. Therefore, organization attempts to decrease penalties through ethical behavior.
7- Ethical programs are useful in management of values expressed in quality management, strategic planning and diversity management

8- Ethics programs contribute to creation of positive image of organization in the eyes of the people

9- then the consequences of ethical failure :When an ethical problem occurs, managers should address directly, otherwise it will have severe consequences

Marred reputation is one of its consequences. If ethical violations are not considered, some stakeholders may not consider the managers, and other above project or organizational position. So that, managers can hardly receive support to complete the project since individuals lose their confidence to receive what it had been promised. Marred credit is among other consequences. Credit is so much important and it is not only the credibility of the manager of project but also team members should also maintain their validity in stakeholders' sight, because they are their agents. The Management of a project without reliability or with limited credit results in weaker results of the project.

Professional ethics especially with regard to projects is a serious issue. When it is used in projects, individuals can focus on their responsibilities instead of focusing on their behavior and decisions in the way that may lead to endangering the reputation of project, project members and organization. In the other words, people can focus on the doing what is proper and completion of the project. Negative aspects are that individuals spend so much time for taking decisions and activities instead of focusing on responsibilities in the way that causes the success of that project.

3- The research significance

Professional ethics is one of the most important issues of project management field. Indeed, achieving the project goals without considering ethical solutions will have little human value. For this reason, different standards or ethical cods has been developed in project management as well as other professions such as medicine, marketing, management and so. Project Management Association of America, as the largest reference of project management throughout the world, has developed an ethical standard for project managers. In order to join the Forum you should confirm adherence to these standards (Kiniz, 2015).

The best way to understand the importance of professional ethics of managers is to compare projects with ethics and without it. If project managers and other beneficiaries behave ethically, temporary deliveries such as programs charters will act as safe outputs which can help in the production of final product. Everybody knows that provisional product, is the output of honest and trustful people that can be used high confidence. Now, look at the issue from different angle: if project managers and other stakeholders have been recognized not to be moral based how much people can trust the temporary product and final product. You're right: they will have limited credit in the eyes of others (Taki, 2015).

4-1 the main objectives

1- Investigate the effectiveness of **professional ethics** of project managers in the success of construction firms.

2-4 Sub goals

1- Investigate the effectiveness of **responsibility** in professional ethics of project managers in the success of construction projects
2- Study of effectiveness of **justice** in professional ethic s of project managers in the success of construction projects
3- Review of effectiveness of **honesty** in professional ethic s of project managers in the success of construction projects
4- Study of effectiveness of **sympathy with others** in professional ethic s of project managers in the success of construction projects

5- Research questions

5-1 main questions

1- Whether the professional ethics of managers can cause the success construction firms projects?

2- Whether the responsibility in the professional ethics of managers can cause the success construction firms projects?
3- Whether the justice in the professional ethics of managers can cause the success construction firms projects?
4- Whether the honesty in the professional ethics of managers can cause the success construction firms projects?
5- Whether the sympathy with others in the professional ethics of managers can cause the success construction firms projects?

6- Research hypothesis

6-1 The main hypothesis
1- Professional ethics of managers causes the success of construction firm s projects

6-2 – sub-hypothesis
1- Responsibility in Professional ethics of managers can causes the success of construction firm s projects

2- Justice in professional ethics of managers can cause the success of construction firm s projects

3- honesty in professional ethics of managers can cause the success of construction firm s projects

4- sympathy with others in professional ethics of managers can cause the success of construction firm s projects

7- Literature Review

Amiri et al. (1390) whoe defined professional ethics as "a necessity for organization" believed that the creation of adequate platform for employees in all professions is one of the main concerns of efficient managers in different levels in order that employees do their profession with a sense of complete responsibility to their society and its issues and observe moral principles. In fact, their aim is to study the professional ethics concept, its importance, its various aspects and the need of current societies to moral. They also refer to the specialists of people with professional ethics including responsibility, superiority, racing and respect to others' values and social norms (Amiri, et al. 2011).

Shakeri and qorbani (2005), in a research studied the "project management and recognition of mail reasons of contractors' claims in construction projects". They argued that one of the economical features of economic development of each country is its construction schemes. In evaluation the success of construction projects what is more objective is technical design and engineering of them. While, other factors that seem invisible may have prominent role, engineering of project from legal perspective is one of the factors that the foundation credit of project is based on it. Based on the Treaty definition, contractor is committed to do all cases under the Treaty with clear quality over the specific duration and based on special price. Therefore, with the review of this definition it can be deducted that if each main factor of treaty changes can cause the claim of contractor. The main reason of created claims can be summarized in two factors of change and delay. Project management to meet its main objectives requires the control of effective factors in emergence of changes and delays in order to provide measures by taking into account the needed predictions (Shakeri&qorbani, 2005).

Wang & Buckeridge, in "ethics for construction and the Global Market managers" they claim that ethical decision making has central role in management and construction engineering. This is not very evident in the 21st century, when the construction industry should act in very wide organizational fields. While the construction corporations follow the projects in the international markets, many of the investors are purchasing or forming the common dealings with the internal corporations. Recently, new and various professional views employ the managers of developing countries increasingly in order to perform the commercial and engineering projects under construction. The building industry has somewhat immoral behavior or corruption in developing countries because of difference in the culture and management systems in different countries and this variety becomes manifested in different approaches of morality and professional action.

Importantly, the active professionals of the building engineering should be aware of these differences. However, teaching the available moral principles to professional engineers is generally without global components. In this section, it is emphasized on professional records including required awareness of these differences as a necessity for citizens' behaviors. The discussion of the nature of building industry and global patterns emphasizes on this matter that why professional training and moral principles should be merged with building and civil management and engineering. Then it can be expected an appropriate training base for professional record about the international engineering (Wang and Pouchrich, 2015).

In an investigation, Carden & Campell proceeded to survey on "project management and legal requirements of merger: a model for moral considerations". They believe that the organizations have considered this matter that the behaviors which are both moral and legal are the main areas for increase in competition, stability and marketing images.

Therefore, it is important to perceive the moral problems which a half of the project management faces it and to present methods and models which reduces the opportunity for immoral and illegal and irresponsible behaviors. They investigated the project management and legal consideration of the executive projects using a model and they discussed about this model in the case of compilation processes and its consideration (Carden, Campbell, 2014).

In an investigation, Amoylan and W. Walker proceeded to survey "the moral principles in project-research management about value-based leadership in project-oriented areas". They addressed the value-based leadership skills and the good-natured professionals' values and concepts in project management and also, they considered the applicability of this structure of leadership for the processes of major project management in different industries and applications. According to the investigations they carried out, they considered appropriateness of the value-based leadership approach for the project leadership teams concentrating on improving the partnership in project-oriented industries. In their paper, the project-oriented industries includes: a) structure and design of facilities, b) information technology (in both system development and telecommunication), c) new programs related to product development, and d) areas related to production (Amoylan and W.Walker, 2012).

8. Methodology

The method applied in this paper is a description of the type of correlation. The managers of civil corporation projects constitute the statistical society of this paper in which 200 people are selected stochastically.

8.1. Assessment tools

In this paper, our assessment tool is researcher-made questionnaire. This questionnaire of professional morality includes 8 dimension and 16 questions which is following the survey on the rate of professional moral in managers, employers and etc. Its reliability and stability is emphasized by Bordbar (2012).

8.2. Data analysis method

The method applied in this paper is surveying in which the data were analyzed using the SPSS statistical software and Pierson correlation coefficient test and regression analysis of step-by-step type. It is assumed in this investigation that the professional morality of project managers which causes success in civil engineering corporation projects is predicted and the step-by-step regression analysis test gives the possibility for us to test such assumption.

9. Findings

- Correlation coefficients between the aspects of professional ethics with success in project are presented in table.1.

Table.1. correlation coefficients between the professional ethics with success in project

Variable	Pierson's value of statistic	P-value	Sum
Responsibility	0.583	0.003	200
Justice	0.478	0.000	200
Loyalty	0.421	0.000	200
Empathizing with the others	0.349	0.001	200

As it is shown in the Table 1, the relation between different aspects of professional ethics and success in the project is evaluated. As it is considered, according to a meaningful level less than 0.05, there is a meaningful statistical relation between the aspects of professional morality with success in the project. Therefore, the correlation coefficients between the responsibility, justice, loyalty and empathizing with the others with success in project equal to 0.583, 0.478, 0.421 and 0.349 respectively in order to positive correlation. Among the above coefficients, correlation, responsibility in professional ethics with success in project are in the highest level (r=0.583) and the correlation coefficient of empathizing with the others with success in the project (r=0.349) are at the lowest level.

- The findings related to the step-by-step regression analysis of professional ethics aspects with success in project are presented and given in the below tables.

According to the overall assumption, "there is a relation between the aspects of professional morality of the project managers and success in the projects of civil corporations." The results of step-by-step regression analysis are investigated in order to survey on the effect of professional ethics dimensions on the project success in civil engineering corporations.

Table.2. Correlation coefficients of model

Model	Simple correlation coefficient	Explanation coefficient	Adjusted explanation coefficient
Responsibility	0.583	0.340	0.337
Responsibility - justice	0.471	0.387	0.381
Responsibility -justice- loyalty	0.412	0.416	0.407
Responsibility -justice- loyalty- empathizing with the others	0.312	0.304	0.301

As it is illustrated in the Table 2, in the step-by-step regression analysis, totally, during three steps, three aspects of professional morality (responsibility, justice and loyalty) have had multiple correlations with success in project. Based on the order of importance of predictor variables in step-by-step regression analysis, the responsibility in the professional morality with success in project has had a multiple correlation coefficient equaling to 0.583. In the second step, the multiple-correlation coefficient has reached to 0.471 with adding the justice to the professional morality. In the third step, the multiple-correlation coefficient has reached to 0.412 with adding the value of loyalty in professional morality. Finally, in the fourth step, with adding the variable of empathizing with the others to the professional morality, the multiple-correlation coefficient has reached to 0.312. Totally, these four variables have been able to explain 30.4% of variance of success in the project.

Table.4. Standard and non-standard step-by-step regression coefficients of the aspects of professional morality with success in the project

steps	Input variables	Non-standard coefficient		Standardized coefficient	Value of "t" statistic	Level of meaningfulness (Sig.)
		B	Std. Error	Beta		
1	Constant value	0.878	0.271	0.583	3.236	0.001
	Responsibility	0.688	0.068		10.099	0.000
2	Constant value	0.478	0.281		1.700	0.091

	Responsibility	0.541	0.076	0.459	7.143	0.000
	Justice	0.274	0.070	0.251	3.907	0.000
3	Constant value	0.254	0.284		0.893	0.373
	Responsibility	0.447	0.080	0.379	5.577	0.000
	Justice	0.285	0.069	0.261	4.150	0.000
	Loyalty	0.171	0.055	0.186	3.109	0.002
4	Constant value	0.235	0.213		0.954	0.373
	Responsibility	0.412	0.061	0.349	5.451	0.000

	Justice	0.236	0.054	0.253	4.451	0.000
	Loyalty	0.123	0.046	0.164	3.261	0.002
	Empathizing with the others	0.216	0.012	0.095	1.951	0.001

As it is shown in the above table, the step-by-step regression analysis of professional morality aspects with success in project was carried out through entering the responsibility in the professional morality in the first step and the variable of justice in the professional morality in the second step and loyalty in the professional morality in the third step. In step-by-step regression analysis in the first step, the variable of responsibility with a beta coefficient of 0.583 has strength for a meaningful prediction to succeed in the project. In the second step, the variables of responsibility and justice having beta coefficients of 0.459 and 0.251 respectively are able to predict meaningfully to succeed in the project. In the third step, the variables of responsibility, justice and loyalty having beta coefficients of 0.379, 0.261 and 0.186 have the strength for meaningful prediction to succeed in the project and finally, in the fourth step, the variables of responsibility, justice, loyalty and empathizing with the others having beta coefficients of 0.349, 0.253, 0.164 and 0.095 respectively have the strength for meaningful prediction to succeed in the project.

10. Discussion and results

According to the main assumption of the investigation which proceeds to research the influences of professional morality of the project managers on the success of civil engineering corporation projects, it can be stated that the professional ethics of project managers is very influential on the success of the projects of civil engineering projects. Indeed, whatever the professional morality is higher among the employees of civil engineering corporations, the project has a higher success and it is not affected by instability. This assumption has concordance to Helgadottir's theory on 2007 in a paper entitled as “the moral aspect of managing the moral thought project of the project managers and practice of moralities in the proposed project”.

According to the first assumption of the secondary assumptions which proceeds to investigate on the influence of responsibility on the success of civil engineering corporation projects in the professional morality of the project managers, it indicates that the responsibility of project managers is influential on the success of civil engineering corporation projects. Indeed, when the managers and employees have more responsibility to conduct their projects, the success is higher in that project. This assumption has conformity to the theory of Dickson et al (2001) which have proceeded in a research to investigate on responsibility in the organizational space affected by the moralities which is the output of leadership and thematic values.

According to the second assumption which proceeds to survey the effect of justice on the professional morality of the project managers in the success of civil engineering projects, it indicates that the justice of the project managers is influential on the success of the civil engineering projects, because the managers and the employers can increase the success in that project through observing justice and equity in setting the civil engineering projects and establishing the justice in a way.

According to the third assumption which proceeds to investigate on the influence of loyalty in the professional morality of the project managers on the success of the civil engineering projects, it indicates that loyalty of project managers is influential on the success in the civil engineering projects. Indeed, the managers and employers can cause promotion and development of the civil engineering projects in a way through observing their politeness and truthfulness in the work environment and during the project implementation.

According to the fourth assumption which proceeds to investigate on the influence of empathizing with the others on the success of civil engineering projects in the professional morality of the project managers, it indicates that sympathy of managers with the others is influential on the success of civil engineering projects. When a disorder or problem occurs for the employers or mangers of that corporation during a project implementation, other employers or managers can also prevent manifesting those problems through their cooperation and help and provide the causes for advancing the project. This assumption is concordant to the theory of Soen (2007) who has investigated the management of moral behaviors in civil engineering corporations, because he has explained the role of empathizing and management of the managers in his studies.

11. Conclusion

Today in the world, the professional ethics are counted as one of the important issues. But in the societies, this issue is not that much considered. Many of the countries have reached this belief in the industrial world that inattention to the moral problems and escaping from the social responsibilities and commitments causes annihilation of corporations and organizations. It is why many of the successful corporations achieved this result that a morality-based culture should be formed in the organization and project implementations. Therefore, attention to the professional morality has a special position. The position of a good project manager would be steady and firm if he/she can perform the required coordination with the other different responsibilities of the

management line and use them to promote the project at the maximum level. Considering the complexity and wideness of modern projects, we cannot administrate a workshop through the method of linear establishments which in such establishments, the existence of a manager or a supervisor having some simple workers is required in which the relation between the workers is exactly proposed . Hence, a project manager should assign the responsibilities to the administrators through a correct planning and he/she should request correct administration of the given responsibilities for performing the tasks through having a complete supervision of them. Success in the project of civil engineering corporations or the organization is due to use of professional ethics. The ethics of any organization is started from trust creation. Whatever confidence to the organization, plans and managers (superior, moderate and basic managers) is higher than the level of commitment to the organization and its tasks would be higher. Trust creation would result in increasing the organizational power to respond to the environmental demands, because trust creation would create synergism in the strength of the organization.

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Prioritizing Factors Affecting Customer Satisfaction in the Internet Banking System Based on Cause and Effect Relationships

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Abstract

The significance of adopting online service and using in the banking industry has attracted researchers' attention in the past decade. In such condition that banks use online services to provide easiness and safety in the internet banking transactions for their customers, it is natural that studying on the factors affecting customer satisfaction in internet banking system has utmost importance in banking industry, today. Hereupon, this research attempts to study the key factors affecting customer satisfaction in internet banking system to prioritizing based on cause and effect relationships. For this purpose, according to the literature, seven main factors were identified as most important factors affecting customer satisfaction in internet banking which totally include 27 measurement items. Then, to evaluate the cause and effect relationships of factors an online questionnaire link distributed to professors and students as a group of potential expert users of internet banking and finally 20 completed questionnaires collected. To analyze interactions between the factors using Grey-based DEMATEL method, first experts' opinions of grey numbers are converted to crisp numbers and all opinions are unified into a single view. Then the crisp numbers normalized in DEMATEL and total matrix of each factor is calculated. At the end, the values of R, D, R+D and R-D are calculated, which based on these criteria the cause and effect relationships of factors analyzed and factors affecting customer satisfaction in internet banking system prioritized.

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Keywords: Internet banking; Grey-based DEMATEL; Customer saticfaction; Cause and effect relationship

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1. Introduction

Over the past decades, the extension of new information and communication technologies within the financial industry has impacted on customer services of the banks. The speed of growing in technology has more influence on changing in the banking industry than any other (Kirakosyan and Dănăiaţă, 2014). Consumer views toward the advantage of and tendency to use internet banking were determined and measured (Liao and Cheung, 2002). Internet banking is one of the most important businesses in electronic business around the world (Ariff et al, 2012). Internet (or online) banking is "a new type of information system which uses emerging techniques like the internet and the World Wide Web, and has changed how customers perform various financial activities in virtual space" (Shih and Fang, 2006). The definition of internet banking is the user needs to neither buy any software, nor save any information and any back up on the computer (Wu et al, 2008).

Since the internet banking is becoming increasingly popular, it is necessary to survey factors affect their customer views, in a systematic way (Wu and Chang, 2012). Thus, the factors affecting customer satisfaction in the internet banking system need to be investigated in further studies. On the other hand, cause and effect relationships of these factors can impact on knowing internet banking customers' point of view and improve internet banking quality services.

There are lots of research endeavors aiming at knowing the explanation of customer's behavioral intentions consisted of customer's intention to preserve their service provider and positive recourse to their environment (Yoon, 2010; Beheshti Zavareh et al, 2012; Santouridis and Kyritsi, 2014; Apostolos et al, 2014). But prioritizing the factors affecting customer satisfaction in the internet banking system based on cause and effect relationships has not been investigated.

In this paper, factors affecting customer satisfaction in the internet banking will be investigated in literature and prior research to determine the final factors. Finally, the distribution of one-to-one comparison questionnaire, will ask the influence of each factor, then using a grey-based DEMATEL approach, interactions between these factors will be examined to measure and prioritize.

1. Literature review

1.1. Internet banking

There are four electronic banking channels: ATMs, touch-dial telephone banking, internet banking, and mobile banking. Internet banking is a banking channel that allows consumers to do a wide range of financial and non-financial services through a bank's website (Hoehle et al, 2012). The first online banking services which used internet were established in 1994 by Stanford Federal Credit Union (SFCU), it spreads quickly in the world (Yoon, 2010). A number of the studies about online banking have been done around the world (Yoon, 2010). As its first introduction in the '90s, internet banking is increasingly selected by bank customers around the world (Santouridis and Kyritsi, 2014). This relatively new banking transactions channel provides its users "round the clock" access to bank services, decreased time, direct access around the world, lower costs and removing the anxiety due to cash carrying (Santouridis and Kyritsi, 2014). Banking via internet has speared as a strategic reference to obtain higher efficiency, control of operations and cost reduction by substituting paper based and labor intensive methods with automated processes has resulted to higher productivity and profitability (Malhotra and Singh, 2009). Recent empirical researches suggest that internet banking is not having an independent influence on banking profitability, although these results may alter as the use of the internet becomes more extended (Malhotra and Singh, 2009). Banking via internet has appeared as a strategic reference to obtain higher efficiency, control of operations and cost reduction by substituting paper based and labor intensive methods with automated processes has resulted to higher productivity and profitability.

1.2. Customer Satisfaction in Internet Banking

These days online banking has huge number of users around the world, so it is important to focus about customer satisfaction. Customer satisfaction is the feeling of customers after using a service (Yoon, 2010). The searching on the service quality dimension of internet banking customers assess online services also test the relationships between service quality dimension customer satisfaction, customer trust and customer loyalty (Wu et al, 2008). Customer service is involving its positive effects on customers (Yoon, 2010). Internet banking prepares customers a more flexible option that saves their time, effort and enables personal financial management (Takieddine and Sun, 2014).

Yoon (2010) showed that highly satisfied online bankers were about 39% likely to buy extra products and services from their bank. For this reason, knowing the factor affecting customer satisfaction with online banking is very important (Yoon, 2010). According to the prior research, some factors affecting customer satisfaction like speed, ease of use, security, design, information content, and customer support service, are provided, and the impacts of experience on the relevance between these and customer satisfaction are analyzed (Yoon, 2010).

For transactions leaded among an open network that may conclude huge money values, security mainly with regard to appropriate permission and secretly would tend to be that face of trust that matter the maximum (Liao and Cheung, 2002). Because internet-based electronic banking includes the transfer of money, people will be especially careful in account and implementation (Liao and Cheung, 2002). Operational exactness is a main quality attention in products and services including computer technology, therefore because internet-based electronic banking includes the transfer of money, people will be especially careful in account and implementation (Liao and Cheung, 2002).

Reliability is an important factor among in dominant dimension of traditional service quality in internet banking. Reliability is basic of the product or service quality (Liao and Cheung, 2002). The definition of reliability is the ability to do the promised service dependably and accurately. Some researchers found that reliability ranking was the most powerful predictor of customer satisfaction (Zeithaml et al, 1999).

Internet-based transactions might seem complicated and threatening for many customers so it is appropriate to look for the ease of use of web sites to be a necessary determinant of perceived electronic banking (Zeithaml et al, 1999). It is a measurement of system quality and a determination of information technology adoption (Yoon, 2010).

Navigability is another factor that has effect on customer satisfaction. It is important so the company must design your website to offer functionality and ease of use, because poor design may stop user of revisiting the site (Hernández et al, 2009). The navigability reveals the clear website card, chance to find important place and enough working links on each page (Vladimirov, 2012).

The site aesthetic of the online banking web site may affect to customer satisfaction (Yoon, 2010). Researchers have studied the impact of aesthetics on customer perception of online internet banking. Site aesthetic involves features such as color, size, printing, animation and so on (Zeithaml et al, 1999).

Therefore, according to the literature the most important factors affecting customer satisfaction in the internet banking identified, include: efficient and reliable service, fulfillment, security / trust, site aesthetic, online responsiveness / contact, ease of use and website navigability, which each of them has some measurement items demonstrated in table 1. Therefore, this study using measurement items in table 1, aims to prioritizing factors affecting customer satisfaction in the internet banking system based on cause and effect relationships.

Table 1. Factors affecting customer satisfaction in internet banking and their measurement items

Main Factors	Measurement Items
Efficient and reliable services	Browser Efficiency: The service delivered through the Internet banking pages is quick.
	Web Site Availability: The Internet banking part of website is always available for business.
	Website Interactivity: When the Internet banking section promises to do something by a certain time, it does so.
	Website Proper Work: Complete quickly a transaction through the bank's website.
Fulfilment	User-friendly interface: Organization and structure of Internet banking pages easy to follow.
	Website Accuracy: Accurate promises about the services being delivered.
	On Time Reaction: The Internet banking part of website launches and runs right away.
	Banking Accuracy: Internet banking transactions are always accurate.

Security/trust	Customer authentication: No misuse of customers personal Information.
	Safety/Security: Feel safe in internet banking transactions.
	Confidence: Confidence in the internet banking service.
Site aesthetic	Website Attractively: The Internet banking webpage is attractive.
	Website appearance: The Internet banking webpage is visually pleasing.
Online Responsiveness/contact	Direct and Fast Contact: Prompt response to customer request.
	Quick Help: Quickly resolves online transaction problems.
	Direct Link: The Internet banking customer services are easily accessible by telephone/other means.
	Number of channels for communications: channels like phone number, emails, address, etc. of each functions in the bank website.
	Easiness of asking questions online: tools and channels which customers supposed to asking their questions should be simple and easy.
	Well function system of FAQs: the proper design of frequently asked questions (FAQs).
	Feedbacks and consumer opinions: forum for discussion, complaints, etc.
Ease of use	Website Info: Easily find what customers need on the website
	Website map: Graphic representation of banks' websites help customers to use internet banking services
	Convenient Transaction: Able to use the Internet banking utilities of website without a lot of effort
	Website Intelligibility: Graphics used in website adds meaning to website content.
Website navigability	Easiness and speed of navigation: Links need to be descriptive and allow the people to know exactly where they are going.
	Efficient search engine: Clients easily find what they search for, with a simple keyword.
	Sufficient number of working links on each page: The website links are valid and active, expired links should be removed.

1.3. Research Background

Several studies have been conducted in the field of internet banking. Yoon (2010) showed that, speed, design, information content, security, and customer support service had a significant effect on customer satisfaction in the low-experience group or the high-experience group,, but ease of use did not have a significant effect on customer satisfaction in either of the groups. Hu and Liao (2011) by studying five domestic banks related to financial holding companies in Taiwan, found most important factors of evaluating e-service quality of internet banking with a fuzzy multiple-criteria decision-making approach. Zavareh et al. (2012) research showed that efficient and reliable services, performance, security/trust, site aesthetics, responsiveness/contact, and ease of use constitute electronic service quality for internet banking services in Iran. Hanafizade et al. (2013) presented a systematic review of 165 research articles published on the adoption of internet banking (1999-2012). Their findings indicated a significant increase in interest in the topic of internet banking adoption during this period that leaves a fertile area for academic research in the coming decade. Santouridis and Kyritsi (2013) have done a research on investigating the determinant of internet banking adoption in Greece, which showed that customer conception about usefulness, credibility and easiness of use of internet banking have main effect on intentions towards using internet banking. Kirakosyan and Danita (2014) focused on the relationship between the customer satisfaction and loyalty/retention and communication management in banking system that concluded that banks required making a paradigm shift in management procedures through continuous innovation in the service of customers. Apostolos et al. (2014) provided and tested a model to investigate the background of customer loyalty of fixed broadband service providers in Greece, which their findings emphasized that perceived service quality dimensions, emotional satisfaction and image were critical factors of customer loyalty. Takieddine and Sun (2015) showed that national culture is an important moderator as it created differences in internet banking diffusion as well as internet access in different country groups.

According to the literature, there are lots of research endeavors aiming at discover factors affecting customer satisfaction in the internet banking, but prioritizing factors affecting customer satisfaction in the internet banking system has not been investigated base on cause and effect relationships. Therefore, this study will be investigate these relationships using a Grey-based DEMATEL approach.

2. Research Methodology

2.1. Grey System Theory

Grey systems theory is looking for through the coverage of the data and series production for the real patterns modeling based on poor information (negligible) (Liu and Lin 2006). The grey value can be described as the number of uncertain data (Dong et al, 2006).

Assume that X is a universal set, then the G Grey set of universal set X with $\overline{\mu_G}(x)$ and $\underline{\mu_G}(x)$ is defined as the top and bottom limit of the G membership function as in equation (1):

$$\underline{\mu_G}(x) : X \to [0,1] \quad , \quad \overline{\mu_G}(x) : X \to [0,1] \tag{1}$$

Equation $\overline{\mu_G}(x) \geq \underline{\mu_G}(x)$ is entirely comprehensible and the equation of the grey set will become to fuzzy set which it indicates that the grey theory is conclude fuzzy and flexibility cases in the contact of hard phase (Nezhad et al, 2009). In this study, the number of grey $\otimes X_{ij}^{p}$ for P decision that will evaluate the effect of i criteria on j, is considered:

$$\otimes . X_{ij}^{p} = \left[\underline{\otimes} X_{ij}^{p}, \overline{\otimes} X_{ij}^{p} \right] \tag{2}$$

Converting grey data to crisp number for the criteria follows three steps:

1. Normalization:

$$\Delta_{Min}^{Max} = Max_j \overline{\otimes} X_{ij}^{p} - Min_j \underline{\otimes} X_{ij}^{p} \tag{3}$$

$$\underline{\otimes} \tilde{X}_{ij}^{p} = \left(\underline{\otimes} X_{ij}^{p} - Min_j \underline{\otimes} X_{ij}^{p} \right) / \Delta_{Min}^{Max} \tag{4}$$

$$\overline{\otimes} \tilde{X}_{ij}^{p} = \left(\overline{\otimes} X_{ij}^{p} - Min_j \underline{\otimes} X_{ij}^{p} \right) / \Delta_{Min}^{Max} \tag{5}$$

2. Calculate total normalized crisp value:

$$Y_{ij}^{p} = \frac{(\underline{\otimes} X_{ij}^{p} (1 - \underline{\otimes} X_{ij}^{p}) + (\overline{\otimes} X_{ij}^{p} \times \overline{\otimes} X_{ij}^{p})}{1 - \underline{\otimes} X_{ij}^{p} + \overline{\otimes} X_{ij}^{p}} \tag{6}$$

3. Calculate the crisp value:

$$Z_{ij}^{p} = Min_j \underline{\otimes} X_{ij}^{p} + Y_{ij}^{p} \Delta_{Min}^{Max} \tag{7}$$

From equation (8) is used to turn ideas into a unit view

$$Z_{ij}^{p} = \frac{1}{p}(Z_{ij}^{1} + Z_{ij}^{2} + ... + Z_{ij}^{p}) \tag{8}$$

2.2. DEMATEL

DEMATEL method based on assumptions of a system that includes a set of criteria and paired comparisons and the relationship between these criteria is made with mathematical models (Büyüközkan and Çifçi, 2012).

In this method, firstly, a direct relation matrix organized by according to specialist ideas and the critical factors. The resulting T-matrix is an $n \times n$ matrix that represents interactions criteria, as T_{ij} refers to the degree of effect of *i* criterion on *j* criterion, $T = \lfloor T_{ij} \rfloor_{n \times n}$.

Then we make the normalized matrix of direct relation (S), $S = \lfloor S_{ij} \rfloor_{n \times n}$, where $0 \le S \le 1$. Instructions of making the matrix S are with respect to equations (9) and (10) as follows:

$$K = \frac{1}{MAX_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} \tag{9}$$

$$S = K \times T \tag{10}$$

Then the total relation matrix (T) built using equation (11), where *I* represents an $n \times n$ identity matrix.

$$M = S(I - S)^{-1} \tag{11}$$

R and D are the sum of rows and columns calculated form the equations (12), (13) and (14) as follows:

$$M = m_{ij} \qquad i, j=1, 2\ldots, n \tag{12}$$

$$R = \lfloor \sum_{j=1}^{n} m_{ij} \rfloor_{n \times 1} \tag{13}$$

$$D = \lfloor \sum_{j=1}^{n} m_{ij} \rfloor_{1 \times n} \tag{14}$$

To determine the cause and effect relationships, (R) indicates effectiveness of a factor on other factors (effectiveness of variables), (D) for each factor reflects the impact of other factors on it (influence of variables), the "Influence" horizontal axis vector (R+D) shows how much importance the criterion has, and the "Relation" vertical axis (R-D) categorizes criteria into a cause group and an effect group. When (R-D) is positive, the criterion will be assigned to the cause group, and when negative, the effect group (Hung, 2011).

3. Research Findings

In this paper, according to the literature, seven main factors were identified as most important factors affecting customer satisfaction in the internet banking which totally include 27 measurement items (Table 1).Then, to evaluating the cause and effect relationships of all main factors and their measurement items, designed an online questionnaire

with one-by-one questions, which asked from respondents to how each factor affect to other factors and how other factors affect that factor using linguistic variables (no affect, very low affect, low affect, high affect, very high affect). So, the online questionnaire link distributed to professors and students as a group of potential expert user of internet banking and finally 20 completed questionnaires collected to analyze interactions between the factors using Grey-based DEMATEL method. The demographic statistics of respondents are shown in table 2.

Table 2. Demographic statistics of respondents

Sex		Age				Education			IB Experience	
Male	Female	Under 30 years	30-40 years	40-50 years	over 50 years	Bachelor (BA)	Master (MA)	PhD	Yes	No
11	9	9	6	2	3	3	9	8	20	-

At this stage after receiving the questionnaires, first according to Fu et al. (2012) the responses from linguistic variable turned into grey value range, which the instructions shown in table 3. Second according to equations (3) to (7) experts' opinions of grey numbers are converted to crisp numbers and by equation (8) all opinions are unified into a single view.

Table 3. Linguistic scales for the importance weight of factors

Linguistic variable	Grey values
Very low	[0,0.3]
Low	[0.3,0.5]
Medium	[0.4,0.7]
High	[0.5,0.9]
Very high	[0.7,1.0]

Then the crisp numbers using the equations (9) and (10) normalized in DEMATEL and using equation (11) total matrix of each of the main factors and their measurement items are calculated separately. At the end, the values of R, D, R+D and R-D are calculated. The results are shown in table 4.

Table 4. Results of Grey-based DEMATEL analysis for all main factors and their measurement items.

Factors		R	Rank	D	Rank	R+D	Rank	R-D
Efficient and reliable services		6.95168537	4	7.77754563	1	14.729231	4	-0.82586025
Fulfilment		7.22714181	3	7.60711535	2	14.8342572	3	-0.37997354
Security/trust		6.78090191	6	7.09983856	4	13.8807405	6	-0.31893665
Site aesthetic		5.75580119	7	5.29978402	7	11.0555852	7	0.45601717
Online Responsiveness/contact		6.8266369	5	7.08110504	5	13.9077419	5	-0.25446814
Ease of use		7.98162415	1	7.60593719	3	15.5875613	1	0.37568696
Website navigability		7.9070029	2	6.95946845	6	14.8664714	2	0.94753445
Efficient and reliable services	Browser Efficiency	15.2966947	3	14.8936723	3	30.1903671	3	0.40302242
	Website Availability	14.5625952	4	14.6622811	4	29.2248763	4	-0.09968596
	Website Interactivity	16.3387973	2	17.5765408	1	33.9153381	1	-1.2377435
	Website Proper Work	16.3953637	1	15.4609567	2	31.8563204	2	0.93440704
Fulfilment	User-friendly interface	19.5870969	2	18.1639888	4	37.7510857	4	1.42310817
	Website Accuracy	20.0022758	1	18.9680534	3	38.9703292	2	1.0342224
	On Time Reaction	18.6405138	4	19.550536	2	38.1910498	3	-0.9100222
	Banking Accuracy	18.7116019	3	20.2589103	1	38.9705121	1	-1.54730837

Security/trust	Customer authentication	11.4996957	3	12.443108	3	23.9428037	3	-0.94341223
	Safety/Security	13.449475	1	12.6957568	2	26.1452318	2	0.75371811
	Confidence	13.3811975	2	13.1915034	1	26.572701	1	0.18969412
Site aesthetic	Website Attractively	10.4131535	1	10.4131535	1	20.8263069	1	0
	Website appearance	9.41315346	2	9.41315346	2	18.8263069	2	0
Online Responsiveness/contact	Direct and Fast Contact	4.5673798	7	5.53648661	4	10.1038664	5	-0.96910681
	Quick Help	4.94064323	6	5.67613258	3	10.6167758	4	-0.73548935
	Direct Link	5.19582377	4	4.70966875	6	9.90549252	6	0.48615501
	Number of channels for communications	5.16604812	5	4.38353665	7	9.54958477	7	0.78251147
	Easiness of asking questions online	5.82559951	2	5.67766364	2	11.5032632	2	0.14793587
	Well-functioning system of FAQs	5.55854475	3	5.31231001	5	10.8708548	3	0.24623474
	Feedbacks and consumer opinions	6.19646417	1	6.15470511	1	12.3511693	1	0.04175907
Ease of use	Website Info	11.3132883	3	11.3566073	2	22.6698956	3	-0.04331904
	Website map	9.78572669	4	10.6494407	4	20.4351674	4	-0.86371402
	Convenient Transaction	11.9722977	1	11.6634927	1	23.6357903	1	0.30880499
	Website Intelligibility	11.6571721	2	11.0589441	3	22.7161162	2	0.59822807
Website navigability	Easiness and speed of navigation	19.0280736	2	20.9722824	1	40.000356	1	-1.94420886
	Efficient search engine	19.4961083	1	17.9595429	2	37.4556512	2	1.53656534
	Sufficient number of working links on each page	18.0918681	3	17.6842245	3	35.7760926	3	0.40764352

4. Discussion

As mentioned before, (R) indicates effectiveness of a factor on other factors (effectiveness variables), (D) for each factor reflects the impact of other factors on it (influence of variables), The “Influence” horizontal axis vector (R+D) shows how much importance the criterion has, and the “Relation” vertical axis (R-D) categorizes criteria into a cause group and an effect group. When (R-D) is positive, the criterion will be assigned to the cause group, and when negative, the effect group (Hung, 2011). The ranking of factors with respect to these criteria are shown in table 4.

As first result, with regard to R criterion for seven main groups of factors, the “Ease of use” has the highest impact on other groups. According to D criterion, “Efficient and reliable services” group, most affected from other groups. According to R+D, the group of “Ease of use” factor has the most interaction with the other groups which it demonstrates great importance of this factor group. Also according to the R-D criterion, the groups “Site aesthetic”, “Ease of use” and “Website navigability” are causal factors (positive), and the groups “Efficient and reliable services”, “Fulfilment”, “Security/trust”, “Site aesthetic”, and “Online responsiveness/contact” are effect factors (negative).

In the first main group “Efficient and reliable services”, according to R criterion “Website Interactivity” factor has the greatest influence on other factors. According to D criterion “Website Proper Work” factor, most affected from other factors. According to R+D, the factor of “Website Interactivity” has the most interaction with the other factors which it demonstrates great importance of the factor in this group. Also according to the R-D criterion, the factors “Browser Efficiency” and “Website Proper Work” are causal factors (positive), and the factors “Website Availability” and “Website Interactivity” are effect factors (negative).

In the second main group "Fulfilment", according to R criterion "Banking Accuracy" factor has the greatest influence on other factors. According to D criterion "Website Accuracy" factor, most affected from other factors. According to R+D, the both factors "Website Accuracy" and "Banking Accuracy" have the most interaction with the other factors which it demonstrates great importance of these factors in this group. Also according to the R-D criterion, the factors "User-friendly interface" and "Website Accuracy" are causal factors (positive), and the factors "On Time Reaction" and "Banking Accuracy" are effect factors (negative).

In the third main group "Security/trust", according to R criterion "Confidence" factor has the greatest influence on other factors. According to D criterion "Safety/Security" factor, most affected from other factors. According to R+D, the factor of "Confidence" has the most interaction with the other factors which it demonstrates great importance of the factor in this group. Also according to the R-D criterion, the factors "Confidence" and "Safety/Security" are causal factors (positive), and "Customer authentication" is effect factor (negative).

In the fourth main group "Site aesthetic", the factor "Website Attractively" according to R criterion, has the greatest influence on other factors; according to D criterion most affected from other factors; and according to R+D, has the most interaction with the other factors, which these demonstrate great importance of this factor in this group. Also according to the R-D criterion, the value of factors "Website Attractively" and "Website appearance" is "zero" which is mean they are on the intersection of the axes, they are both causal and effect.

In the fifth main group "Online responsiveness/contact", the factor "Feedbacks and consumer opinions" according to R criterion, has the greatest influence on other factors; according to D criterion most affected from other factors; and according to R+D, has the most interaction with the other factors, which these demonstrate great importance of this factor in this group. Also according to the R-D criterion, the factors "Direct Link", "Number of channels for communications", "Easiness of asking questions online", "Well functioning system of FAQs", and "Feedbacks and consumer opinions" are causal factors (positive), and "Direct and Fast Contact" and "Quick Help" are effect factors (negative).

In the sixth main group "Ease of use", the factor "Convenient Transaction" according to R criterion, has the greatest influence on other factors; according to D criterion most affected from other factors; and according to R+D, has the most interaction with the other factors, which these demonstrate great importance of this factor in this group. Also according to the R-D criterion, the factors "Convenient Transaction" and "Website Intelligibility" are causal factors (positive), and "Website Info" and "Website Map" are effect factors (negative).

In the seventh main group "Website navigability", the factor "Easiness and speed of navigation" according to R criterion, has the greatest influence on other factors; and according to R+D, has the most interaction with the other factors, which these demonstrate great importance of this factor in this group. But according to D criterion, the factor "Efficient search engine" is the most affected from other factors. Also according to the R-D criterion, the factors "Efficient search engine" and "Sufficient number of working links on each page" are causal factors (positive), and "Easiness and speed of navigation" is effect factor (negative).

5. Conclusions

The Grey-based DEMATEL analysis applied in this research, besides prioritizing the factors and determining cause and effect factors, getting the entrance data in the range of uncertain numbers is the special characteristic of this method, which considers the uncertainty of decision system structure and inputs of decision system. The most important result that can be derived from this cause and effect relationship analysis would be the planning to advance the goals and division of duties and obligations in internet banking system to boost the customer satisfaction; so that the degree of influence of a factor can be attracted the attentions and be considered in planning and designing of the internet banking websites to get most satisfactions of their customers. As well as, causal or effect factors may also be useful to provide banking services through the internet toward increasing customer satisfaction, because in the internet banking system, notifying to the "causal factors" determined in this research, and considering them in to planning and designing, can be change and improve their influences on "effect factors" in order to make customer satisfaction better.

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Modeling Flexibility Capabilities of IT-based Supply Chain, Using a Grey-based DEMATEL Method

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Abstract

New technologies, universal competition, and increased customer demands are imposing organizations to revise how they can benefit from Information Technology (IT) capabilities to do better supply chains management. One of the key essentials to keep organizations in the present economic competition is effective management of their supply chains under uncertainty. The concept of supply chain flexibility intends to specify the ability of a supply chain to perform in satisfaction under uncertainty. However, there is lack of cause and effect modelling in this area. Accordingly, this paper attempts to study the flexibility capabilities of IT-based supply chain, using a Grey-based DEMATEL Method. To this end, according to the literature, four main factors were identified as most important flexibility capabilities of IT-based supply chain which totally include 25 measurement items. Next, to evaluate the cause and effect relationships of factors an online questionnaire link distributed to professors and experts in this subject which finally 20 completed questionnaires collected. To analyze factors interactions using Grey-based DEMATEL method, firstly, experts' opinions of grey numbers are turned into crisp numbers and all opinions are unified into a single viewpoint. Then the crisp numbers normalized in DEMATEL and total matrix of each factor is calculated. At the end, the values of R, D, R+D and R-D are calculated, which based on these criteria the cause and effect relationships of factors analyzed and flexibility capabilities of IT-based supply chain prioritized.

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Keywords: Supply chain flexibility; Grey-based DEMATEL; IT-based supply chain; Cause and effect relationship

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1. Introduction

Information Technology (IT) based supply chain incurs firms to develop flexibility and reach real-time operations via information sharing and dynamic collaboration among partners. IT-based supply chain activities consist of planning, sourcing, making, delivering, and returning. IT joins the separated supply chain operations into a unified, coordinated system that is responsive, fast, efficient and flexible (Zhang, 2007). As well as, IT may be considered as an essential lever helping to develop sharing and collaborative decision-making among partners in supply chain (Singh and Teng, 2016). In today's internationalized world, competition has gone beyond the single firms boundaries and spread all over of the supply chain (Moon et al., 2012). Furthermore, firms in many industries are encountering increasing unstable demand and must adapt their production volume within very short time ranges without imposing considerable cost. Thereupon, such firms must adjust to changing conditions quickly and easily. The whole supply chains are competing with one another now, therefore, supply chains must be more responsive in fulfilling changing requirements effectively and in presenting high added value (Seebacher and Winkler, 2015). Hence, it is essential that supply chain members adapt and modify themselves to achieve a parity between their organizations' responsiveness and marketplace' changes by improving their flexibility in all operational activities (Moon et al., 2012). In addition, in a supply chain environment, the breadth and depth of IT integration among partners, meets computer mediated communications, processes, monitoring, sharing, coordination and joint decision-making (Singh and Teng, 2016). Furthermore, processes and supply chains perform in an uncertain environment, and in order to stay competitive, must have a requisite level of robustness to changing situations (Wang et al., 2015). Flexibility is the key features that reflect the capacity to diminish uncertainty (Stevenson & Spring, 2007).

Albeit research on flexibility is remarkable and its significance has been recognized for some time, much of the research has focused on intra organizational flexibility and has concentrate largely on manufacturing systems (e.g.,; Upton, 1994; Gupta and Somers, 1996; Koste and Malhotra, 1999; Vokurka and O'Leary- Kelly, 2000). Flexibility studies from the IT-based supply chain perspective, however, have thus far been bounded. Barros et al. (2015) in their research, concluded that from the aspect of citations and analyses of recent scientific papers, there is an opportunity for IT advances in the field of supply chain, especially with respect to manufacturing and products/services development. In this vein, while manufacturing flexibility has been the subject of much research, supply chain flexibility is taken into consideration in few research papers. Specially, modelling flexibility measurement items of IT-based supply chain has not worked through researchers in this area. Therefore, in this paper, flexibility capabilities of IT-based supply chain will be identified and prioritized using a grey-based DEMATEL method. For this purpose factors indicating flexibility of the IT-based supply chain, and their measurement items will be investigated in literature and prior research to specify the final factors. Then, the distribution of one-to-one comparison questionnaire, will ask the influence of each factor, then interactions among these factors will be examined to measure and prioritize, using a Grey-based DEMATEL approach. Finally, the results will be aid to modelling flexibility capabilities of IT-based supply chain.

2. Literature review

2.1. IT-based Supply Chain

The increasing application and utilization of information technology (IT) in supply chain can be related to value creation and performance improvements in organizations. Because of globalization, firms have begun to concern themselves with IT and the supply chain to gain planned cost decrements. Now IT supports the firms' operations, unifies distant links of the supply chain and growing interlinks firms with its customers (Barros et al., 2015). As well as, IT reduces coordination costs and the risk of transactions; it can create a less risky relationship among the parties by advancing information exchange, and replacing the assets' investment with a high degree of particularity with an investment in IT. With explicit systems, IT can reduce imperfect information and uncertainty, and act as a safekeeping by decreasing information asymmetries and improving group norms among the partners (Singh and Teng, 2016). IT plays remarkable role in supply chain management by integrating firm networks and synchronizing material flow, information and financial (Acar and Uzunlar, 2014). IT techniques and practices are used to enable information sharing all over supply chain partners, by incorporate both internal and external business functions. Moreover, the adjustment

of IT objectives with strategic supply chain management can improve efficiency, profitability, and productivity (Marinagi et al., 2014). Therefore, IT-based supply chain integrates and coordinates material flow, information, and finances from supplier to the end consumer. At this point, IT serves as an important enabler of value chain coordination through capturing, organizing, and sharing critical information with respect to key business functions, both inside and outside a firm's borders and contributes to firm benefits by developing quality and cycle times and reducing transaction risks and coordination costs (Dehning et al, 2007). As, a meta-analysis by Leuschner et al. (2013) identified numerous research articles that indicate a positive and significant correlation between integration and firm performance, IT integration results in improved supply chain performance via elevated levels of process and information integration (Prajogo and Olhager, 2012). Supply chain management aims to support the organization providing the tools to link technology and people and trying to adjust the technology with the capabilities of the organization and its business partners (Shaik and Abdul-Kader, 2013).

2.2. Supply Chain Flexibility (SCF)

With global competition quickly intensifying and moving to the supply chain level, supply chain flexibility (SCF) has become more and more important (Chuu, 2011). Although there is no generally accepted definition of flexibility, existing definitions can cover some limited aspects of it (Beach et al., 2000). Mascarenhas (1981) defines flexibility as the capability of a manufacturing system to adapt to environmental changes. Cox (1989) considers flexibility as the ability of the firm to respond quickly to changes in market conditions. Nagarur (1992) defines flexibility at the level of internal production as the capability of the manufacturing system to adapt to variations such as product, load, process, and machine breakdown. A more general definition might be the ability of the firm to respond to changes more rapidly, with reduced costs, and less effect on system effectiveness (Upton, 1994). Flexibility is increasingly important in adapting uncertainty in the business environment (Narasimhan et al., 2004). Roa and Wadhwa (2002) stated that supply chain flexibility is appearing as a crucial competitive priority for the future. Importance of supply chain flexibility is identified by Lummus et al. (2003) in several reasons. First, new trends, like mass customization, require supply chain to meet individual customer requirements without adding considerable costs. Second, certain industries, especially high-tech industries, need upside and downside flexibility, which generally indicates to the ability to quickly increase or decrease production to a new unplanned level and then strengthen that level. Third, in several innovative product categories, like electronic devices and fashion apparel, demand uncertainty is a fact of life, and creating a responsive supply chain is one way of avoiding uncertainty. Finally, the unstable environment in which firms find themselves requires quick new product introduction, rapid response to customer requirements across the world, and rapid turn-around on customer orders. Lummus et al. (2005) also suggested that supply chain flexibility is important in the current global marketplace, with firms both having global networks and competing globally.

Of the factors of supply chains competition, flexibility can be properly regarded as a critical one. Flexibility means having the capability to present products/services that meet the customers' individual demands (Gunasekaran et al., 2004). Some flexibility measures could consist of product development cycle time, economies of scope, machine/toolset up time, and number of inventory turns (Christopher, 1992). Vickery et al. (1999) outline five components of supply chain flexibility from an "integrative, customer-oriented" aspect, which include volume flexibility, product flexibility, distribution flexibility, access flexibility, and new product introduction flexibility. Garavelli (2003) and Sánchez and Pérez (2005) investigated two main aspects of supply chain flexibility: process flexibility and logistics flexibility. Process flexibility regards the number of product types that can be produced at each production site, irrespective of their location. Logistics flexibility indicates the different logistics strategies that can be token to purchase a component from a supplier or to release a product into a marketplace. In the same way, Swafford et al. (2006) suggested a three-dimensional supply chain flexibility that consists of sourcing/procurement flexibility, manufacturing flexibility, and logistics/distribution flexibility. Moon et al. (2012) proposed that supply chain flexibility can be used as a second-order factor model containing four dimensions include flexibility of sourcing, operating system, distribution, and information system. Also, Swafford et al (2008) used four measurement items to achieve supply chain agility through IT integration and flexibility, namely, IT integration, supply chain flexibility, supply chain agility, and competitive business performance.

Therefore, according to the literature the most important factors identified as flexibility capabilities of IT-based supply chain, include sourcing flexibility (SF), operating system flexibility (OSF), distribution flexibility (DF), and

information technology integration (ITI), which each one has some measurement items demonstrated in Table 1. Accordingly, this study using these measurement items to aim at prioritizing flexibility capabilities of IT-based supply chain based on cause and effect relationships, using a Grey-based DEMATEL approach.

Table 1. Factors identified as flexibility capabilities of IT-based supply chain and their measurement items

Main labels	Measurement items	References
Sourcing Flexibility (SF)	SF1: Number of available suppliers	Swafford et al. (2006)
	SF2: Range of products and services provided by major suppliers	
	SF3: Range of suppliers that provide Major materials / components / products	Lummus et al. (2003) and Swafford et al. (2006)
	SF4: Ability to add and remove suppliers	
	SF5: Ability to change suppliers to satisfy changing requirements	
	SF6: Ability to change quantity of supplier's order	Swafford et al. (2008)
	SF7: Ability to change delivery times of supplier's order	
Operating System Flexibility (OSF)	OSF1: Output volumes the firm can produce	Koste et al. (2004), Pagell and Krause (1999) and Sawhney (2006)
	OSF2: Range of new products or services the firm can develop every year	Koste et al. (2004), and Sethi and Sethi (1990)
	OSF3:Ability to change output volumes	Koste et al. (2004), and Sethi and Sethi (1990)
	OSF4:Ability to change products and services mix	
	OSF5:Ability to adjust manufacturing facilities and processes	Gupta and Somers (1996) and Koste et al. (2004)
	OSF6:Ability to change production volume capacity	Swafford et al. (2008)
	OSF7:Ability to accommodate changes in production mix	
Distribution Flexibility (DF)	DF1: Number of warehouses, loading capacity, and other distribution facilities	Swafford et al. (2006)
	DF2: Ability to add or remove carriers or other distributors	
	DF3: Ability to change warehouse space, loading capacity, and other distribution facilities	
	DF4: Ability to change delivery modes	
	DF5: Ability to transfer delivery schedules	
	DF6: Ability to alter deliver schedules to meet customer requirement	Swafford et al. (2008)
Information Technology Integration (ITI)	ITI1: Use of IT to coordinate/integrate activities in design and development	Swafford et al. (2008)
	ITI2: Use of IT to coordinate/integrate activities in procurement	
	ITI3: Use of IT to coordinate/integrate activities in manufacturing	
	ITI4: Use of IT to coordinate/integrate activities in logistics and distribution	
	ITI5: Use of enterprise resource planning or supply chain planning software for managing/coordinating global supply chain activities	

The first aspect of SCF is sourcing flexibility (SF), which determined by the ability of the procuring function to handle available suppliers and to influence these suppliers' performance in presenting quality materials and services (Moon et al., 2012). In other words, SF indicates the availability of qualified materials and services and the capability to effectively purchase them in response to variable requirements (Lummus et al., 2003). Generally, sourcing contains the pre-activities of a firm's core business which provide critical links between supplier firms and buyer firms and lead to the purchase of materials, products/ services to meet the buyer firm's daily business (Lummus et al., 2003; Swafford et al., 2006; Tachizawa and Giménez, 2009). In connection with this, we believe that a firm who has more diversity of supply sources, has broader range of materials available from the main suppliers, and has the capability

to add/ remove suppliers as wish; it might be more proper to secure a flexible supply flow to meet their daily operations (Lummus et al., 2003; Swafford et al., 2006).

The second aspect of SCF is operating system flexibility (OSF), which is used to examine the supply chain operational processes, particularly in manufacturing (Moon et al., 2012). OSF indicates the ability to exploit usage of acquired resources to effectively produce a range of products and services to meet varied market demands. In other words, OSF is the ability to provide qualified products with a wide spectrum of features, mixes, and volumes according to varied customer specifications (Sethi and Sethi, 1990; Koste et al., 2004). Furthermore, OSF makes firms capable of producing required products timely via setup time reduction, preventive maintenance, cellular manufacturing layouts, and/or quality improvement endeavors. At the plant level, OSF can be implicated in machining, materials and labor arrangement, and process routing flexibilities (Moon et al., 2012).

The third aspect of SCF is distribution flexibility (DF), which indicates firm's capability to control the movement and storage of materials, end products/ services under continuously evolving marketplace conditions (Swafford et al., 2006). The major determinant of DF is the firm's ability to manage effectively and efficiently its distributors, loading capacity, warehouses, and other distribution facilities (Moon et al., 2012). We predict that if a firm wants to increase its flexibility in delivery, it should have more available loading capacity, warehouses, and other distribution/logistics facilities, have the capability of changing these facilities' functional structure, schedules, and delivery modes, and have less constraints to add/ remove logistics providers and/or distributors (Swafford et al., 2006).

Information technology integration (ITI), the fourth aspect of SCF, which makes SCF on the basis of IT, includes three elements: physical flow integration, information flow integration, and financial flow integration (Rai et al., 2006). IT provides the mechanism for firms to effectively collect, store, reach, share, and analyze data. (Swafford et al., 2008). Information sharing also makes the opportunities for enhanced supply chain agility (Mondragon et al., 2004). Furthermore, higher levels of IT integration and the information sharing ability in a real-time way helps a firm acquire higher levels of supply chain flexibility (Swafford et al., 2008). The first four measurement items (listed in Table 1) are about utilization of IT for integration and coordination within product development, procurement, manufacturing, and logistic proceedings. The fifth measurement item relates to the utilization of enterprise resource planning (ERP) software for integration and coordination all over the supply chain activities. On the other hand, IT integration can involve sharing information in a firm's internal supply chain activities and with its supply chain partners. In order to focus more on internal, our first four measurement items related to utilization of IT for integration in a firm's functional areas while the fifth measurement item related to utilization of IT for internal integration in the firm and for external integration with supply chain partners.

2.3. Research Background

Several studies have been conducted in the field of IT-based supply chain and supply chain flexibility in the literature. Gong (2008) presented an economic assessment model of supply chain flexibility with developing containing flexibility of labor, machine, routing, and IT, with total system flexibility which measured by an economic index. Swafford et al (2008) focused on supply chain flexibility and supply chain agility functions and its use of IT for integration.

Moon et al. (2012) presented an instrument for measuring supply chain flexibility for the clothing and textile companies. Their findings indicate that supply chain flexibility can be used as a second-order factor model containing four dimensions include flexibility of sourcing, operating system, distribution, and information system. Torabizadeh et al. (2012), researched on effect of information system strategies on supply chain strategies and supply chain performance, in which considered aligning information systems with supply chain management strategies, and showed their effect on supply chain and firm performance. Also, Marinagi et al. (2014) studied about the impact of IT on supply chain competitive advantage development. They have conducted a field research in 2013, in a cross-sectional sample of Central Greece firms, which their findings confirmed the critical role of IT techniques and practices on the setup of a sustainable competitive advantage on the basis of supply chain management. Acar and Uzunlar (2014) assessed direct and the cumulative positive impacts of the IT and process development activities on the performance of time-based supply chain, in furniture industry in Kayseri region of Turkey. Wang et al. (2015) worked on flexibility analysis of process supply chain networks, which utilized a flexibility analysis framework to characterize supply chain flexibility. Also, they presented two illustrative case studies to demonstrate the application of this framework. Their

study offered a decision-making framework for optimal supply chain design using a quantitative measure of flexibility. Barros et al. (2015) analysed the available scientific literature of business processes using the application of IT in supply chain management from 2009 to 2014. Their research indicated an opportunity for IT advances in the field of supply chain related to products or services production and development. Singh and Teng (2016) enhanced the supply chain outcomes through IT and trust. They collected data from 167 purchasing and supply chain managers, which their findings aid to develop a more complete and clear understanding of the related mechanisms with which the partnership resources, apply their beneficial impacts on supply chain outcomes.

IT-based supply chain and supply chain flexibility may have been among the leading concerns of researchers in recent years, but the studies that focus on SCF remain inadequate (Garavelli, 2003; Gong, 2008). A major limitation of the previous studies is their lack of insight into the application by organizations of information technology (IT) to adapt to changing circumstances. Because of the important role of information systems in a supply chain, the inclusion of IT in the study of SCM is inevitable. Therefore, this study will be investigate the cause and effect relationships among flexibility capabilities of IT-based supply chain using a Grey-based DEMATEL approach.

3. Research Methodology

3.1. Grey System Theory

Deng (1982) introduced the concepts of grey theory from a grey set. Grey systems theory is looking for through the coverage of the data and series production for the real patterns modeling based on poor information (negligible) (Liu and Lin 2006). Grey systems methodology can handle many of the ambiguities generated from imprecise human decisions (Fu et al., 2001; Li et al., 2007). The grey value can be described as the number of uncertain data (Dong et al, 2006).

Let X as a universal set, G as Grey set of universal set X with $\overline{\mu_G}(x)$ and $\underline{\mu_G}(x)$ will be defined as the top and bottom limit of the G membership function as in equation (1):

$$\underline{\mu_G}(x): X \to [0,1] \quad , \quad \overline{\mu_G}(x): X \to [0,1] \tag{1}$$

Equation $\overline{\mu_G}(x) \geq \underline{\mu_G}(x)$ is obvious and the equation of the grey set will become to fuzzy set which it indicates that the grey theory is conclude fuzzy and flexibility cases in the contact of hard phase (Nezhad et al, 2009). In this study, the number of grey $\otimes X_{ij}^{p}$ for P decision that will evaluate the effect of i criteria on j, is considered:

$$\otimes . X_{ij}^{p} = \left[\underline{\otimes} X_{ij}^{p}, \overline{\otimes} X_{ij}^{p}\right] \tag{2}$$

Converting grey data to crisp number for the criteria follows three steps:

1. Normalization:

$$\Delta_{Min}^{Max} = Max_j \overline{\otimes} X_{ij}^{p} - Min_j \underline{\otimes} X_{ij}^{p} \tag{3}$$

$$\underline{\otimes} \tilde{X}_{ij}^{p} = \left(\underline{\otimes} X_{ij}^{p} - Min_j \underline{\otimes} X_{ij}^{p}\right) / \Delta_{Min}^{Max} \tag{4}$$

$$\bar{\otimes}\tilde{X}_{ij}^{p} = \left(\bar{\otimes}X_{ij}^{p} - Min_j \underline{\otimes}X_{ij}^{p}\right) / \Delta_{Min}^{Max} \tag{5}$$

2. Calculate total normalized crisp value:

$$Y_{ij}^{p} = \frac{(\underline{\otimes}X_{ij}^{p}(1-\underline{\otimes}X_{ij}^{p}) + (\bar{\otimes}X_{ij}^{p} \times \bar{\otimes}X_{ij}^{p})}{1-\underline{\otimes}X_{ij}^{p} + \bar{\otimes}X_{ij}^{p}} \tag{6}$$

3. Calculate the crisp value:

$$Z_{ij}^{p} = Min_j \underline{\otimes}X_{ij}^{p} + Y_{ij}^{p}\Delta_{Min}^{Max} \tag{7}$$

From equation (8) is used to turn ideas into a unit view

$$Z_{ij}^{p} = \frac{1}{p}(Z_{ij}^{1} + Z_{ij}^{2} + \ldots + Z_{ij}^{p}) \tag{8}$$

3.2. DEMATEL

Decision-making trial and evaluation laboratory (DEMATEL) method could structure and handle complex causal relationship among the variables utilizing a combination of matrices or graphs (Jeng and Tzeng, 2012; Hsu et al., 2013). DEMATEL method based on assumptions of a system that includes a set of criteria and paired comparisons and the relationship between these criteria is made with mathematical models (Büyüközkan and Çifçi, 2012). In comparison with other multi-attribute decision-making approaches like Analytical Hierarchical Process (AHP), in which factors are assumed independent; DEMATEL is a structural modeling method that tries to figure out interdependence amongst the elements of a system via a causal diagram (Kim, 2006; Tseng, 2009; Wu et al., 2010).

In this approach, firstly, a direct relation matrix organized by according to specialist ideas and the critical factors. The resulting T-matrix is an $n \times n$ matrix that represents interactions criteria, as T_{ij} refers to the degree of effect of i criterion on j criterion

$$T = \lfloor T_{ij} \rfloor_{n \times n}.$$

Then we make the normalized matrix of direct relation (S), $S = \lfloor S_{ij} \rfloor_{n \times n}$, where $0 \le S \le 1$. Instructions of making the matrix S are with respect to equations (9) and (10) as follows:

$$K = \frac{1}{MAX_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} \tag{9}$$

$$S = K \times T \tag{10}$$

Then the total relation matrix (T) built using equation (11), where I represents an $n \times n$ identity matrix.

$$M = S\left(I - S\right)^{-1} \tag{11}$$

R and D are the sum of rows and columns calculated form the equations (12), (13) and (14) as follows:

$$M = m_{ij} \qquad i, j=1, 2\ldots, n \tag{12}$$

$$R = \left[\sum_{j=1}^{n} m_{ij}\right]_{n\times 1} \tag{13}$$

$$D = \left[\sum_{j=1}^{n} m_{ij}\right]_{1\times n} \tag{14}$$

To determine the cause and effect relationships, (R) indicates effectiveness of a factor on other factors (effectiveness of variables), (D) for each factor reflects the impact of other factors on it (influence of variables), the "Influence" horizontal axis vector (R+D) shows how much importance the criterion has, and the "Relation" vertical axis (R-D) categorizes criteria into a cause group and an effect group. When (R-D) is positive, the criterion will be assigned to the cause group, and when negative, the effect group (Hung, 2011).

4. Research Findings

In this paper, according to the literature, four main factors were identified as most important flexibility capabilities of IT-based supply chain, which totally include 25 measurement items (Table 1). Then, to evaluate the cause and effect relationships of factors an online questionnaire was designed with one-by-one questions, which asked from respondents to how each factor affect to other factors using linguistic variables (no affect, very low affect, low affect, high affect, very high affect). So, the online questionnaire link distributed to professors and experts in this subject which finally 20 completed questionnaires collected to analyze interactions among the factors using Grey-based DEMATEL method. The demographic statistics of respondents are shown in Table 2.

Table 2. Demographic statistics of respondents

Sex		Age				Education		
Male	Female	Under 30 years	30-40 years	40-50 years	over 50 years	Bachelor (BA)	Master (MA)	PhD
11	9	3	5	5	7	1	5	14

At this step after receiving the questionnaires, first, according to Fu et al. (2012) the responses from linguistic variable turned into grey value range (Table 3). Second, according to equations (3) to (7), experts' opinions of grey numbers are converted to crisp numbers and by equation (8) all opinions are unified into a single view.

Table 3. Linguistic scales for the importance weight of factors

Linguistic variable	Grey values
Very low	[0,0.3]
Low	[0.3,0.5]
Medium	[0.4,0.7]
High	[0.5,0.9]
Very high	[0.7,1.0]

Then, the crisp numbers using the equations (9) and (10) normalized in DEMATEL and using equation (11) total matrix of each of the main factors and their measurement items are calculated separately. At the end, the values of R, D, R+D and R-D are calculated. The results are shown in Table 4.

Table 4. Results of Grey-based DEMATEL analysis for all main factors and their measurement items.

Factors		R	Rank	D	Rank	R+D	Rank	R-D
Sourcing Flexibility (SF)		4.311075834	1	4.229771873	1	8.540847707	1	0.081303962
Operating System Flexibility (OSF)		3.089216218	3	3.967870944	2	7.057087162	2	-0.878654726
Distribution Flexibility (DF)		3.015380098	4	3.881759525	3	6.897139623	3	-0.866379427
Information Technology Integration (ITI)		3.870202924	2	2.206472733	4	6.076675657	4	1.663730191
Sourcing Flexibility (SF)	SF1	1.058543871	6	1.050836339	6	2.10938021	7	0.007707532
	SF2	0.963600337	7	1.311997885	5	2.275598222	6	-0.348397548
	SF3	1.499508242	3	1.342435588	4	2.84194383	5	0.157072654
	SF4	2.098662946	2	1.034085535	7	3.132748482	3	1.064577411
	SF5	1.492902277	4	1.722122269	3	3.215024546	2	-0.229219992
	SF6	1.168349329	5	1.895477902	2	3.063827231	4	-0.727128573
	SF7	2.385398502	1	2.310009986	1	4.695408488	1	0.075388516
Operating System Flexibility (OSF)	OSF1	1.606534123	6	3.117540006	1	4.724074128	3	-1.511005883
	OSF2	1.87322541	5	1.807212247	6	3.680437658	5	0.066013163
	OSF3	3.005231884	1	2.047011109	5	5.052242993	1	0.958220775
	OSF4	2.308705622	3	2.148506822	3	4.457212444	4	0.160198799
	OSF5	1.918801098	4	1.257747377	7	3.176548474	7	0.661053721
	OSF6	2.85452278	2	2.054496215	4	4.909018994	2	0.800026565
	OSF7	1.180048719	7	2.31455586	2	3.494604579	6	-1.13450714
Distribution Flexibility (DF)	DF1	0.820924898	6	0.740393724	6	1.561318622	6	0.080531174
	DF2	0.901995434	5	0.907053679	5	1.809049113	5	-0.005058246
	DF3	1.255374654	4	1.063045151	4	2.318419805	4	0.192329502
	DF4	1.385662079	3	1.392571811	3	2.77823389	3	-0.006909731
	DF5	2.295793138	1	2.170242045	2	4.466035183	1	0.125551093
	DF6	2.032537333	2	2.418981125	1	4.451518457	2	-0.386443792
Information Technology Integration (ITI)	ITI1	3.718884165	2	2.283048379	5	6.001932544	2	1.435835786
	ITI2	2.29792602	4	3.442835211	2	5.740761231	3	-1.144909191

ITI3	3.081073948	3	2.488158474	4	5.569232422	4	0.592915473
ITI4	2.263609902	5	3.228789178	3	5.492399079	5	-0.965179276
ITI5	3.849054644	1	3.767717435	1	7.61677208	1	0.081337209

5. Discussion

As mentioned before, (R) indicates effectiveness of a factor on other factors (effectiveness variables), (D) for each factor reflects the impact of other factors on it (influence of variables), The "Influence" horizontal axis vector (R+D) shows how much importance the criterion has, and the "Relation" vertical axis (R-D) categorizes criteria into a cause group and an effect group. When (R-D) is positive, the criterion will be assigned to the cause group, and when it is negative, will be in the effect group (Hung, 2011). The ranking of factors with respect to these criteria are shown in Table 4.

As the first result, with regard to R criterion for four main groups of factors, the factor "Sourcing Flexibility" according to R criterion, has the greatest influence on other factors; according to D criterion most affected from other factors; and according to R+D, has the most interaction with the other factors, which these demonstrate great importance of this factor in this group. Also according to the R-D criterion, the groups "Sourcing Flexibility", and "Information Technology Integration" are causal factors (positive), and the groups "Operating System Flexibility" and "Distribution Flexibility" are effect factors (negative).

In the first main group "Sourcing Flexibility", the factor "SF7" (ability to change delivery times of supplier's order) according to R criterion, has the greatest influence on other factors; according to D criterion most affected from other factors; and according to R+D, has the most interaction with the other factors, which these demonstrate great importance of this factor in this group. Also according to the R-D criterion, the factors "SF1", "SF3", "SF4" and "SF7" are causal factors (positive), and the factors "SF2", "SF5" and "SF6" are effect factors (negative).

In the second main group "Operating System Flexibility", the factor "OSF3" (ability to change output volumes) according to R criterion has the greatest influence on other factors and according to R+D, has the most interaction with the other factors which it demonstrates great importance of these factors in this group. But, according to D criterion "OSF1" (output volumes the firm can produce) factor, most affected from other factors. Also according to the R-D criterion, the factors "OSF2", "OSF3", "OSF4", "OSF5" and "OSF6" are causal factors (positive), and the factors "OSF1" and "OSF7" are effect factors (negative).

In the third main group "Distribution Flexibility", the factor "DF5" (ability to transfer delivery schedules) according to R criterion has the greatest influence on other factors and according to R+D, has the most interaction with the other factors which it demonstrates great importance of these factors in this group. But, according to D criterion "DF6" (ability to alter deliver schedules to meet customer requirement) factor, most affected from other factors. Also according to the R-D criterion, the factors "DF1", "DF3" and "DF5" are causal factors (positive), and the factors "DF2", "DF4" and "DF6" are effect factors (negative).

In the fourth main group "Information Technology Integration", the factor "ITI5" (use of ERP or supply chain planning software for managing/coordinating global supply chain activities) according to R criterion, has the greatest influence on other factors; according to D criterion most affected from other factors; and according to R+D, has the most interaction with the other factors, which these demonstrate great importance of this factor in this group. Also according to the R-D criterion, the factors "ITI1", "ITI3" and "ITI5" are causal factors (positive), and the factors "ITI2" and "ITI4" are effect factors (negative).

6. Conclusions

In this research, applied the Grey-based DEMATEL analysis, besides prioritizing the factors and determining cause and effect factors, getting the entrance data in the range of uncertain numbers is the special characteristic of this method, which considers the uncertainty of decision system structure and inputs of decision system. The most important result that can be derived from this cause and effect relationship analysis would be the planning to improve and develop the flexibility in IT-based supply chain; so that the degree of influence of a factor can be attracted the

attentions and be considered in planning and designing of supply chain to get most flexibility under adoption of information technology. As well as, causal or effect factors may also be useful to provide more flexibility through using information technology, because in IT-based supply chain, notifying to the "causal factors" determined in this research, and considering them in to planning and designing, can change and improve their influences on "effect factors" in order to make more flexibility.

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Comparative – Superlative Comparison of Contractor`s Sufficiency in Various Types of International Contracts

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ABSTRACT

Nowadays, development of construction projects is among the vital and important plans in urban areas. The perspective of a city highly depends on its construction projects, and the way they have been managed**.** There are many construction projects that face with severe failures as the result of improper selection of their contractors. This study overviews a comparative-superlative comparison of contractors' efficiency in various types of international contracts. Choosing a competent contractor can significantly decrease the possibility of construction projects failures. The contractor selection includes three steps: contractor prequalification, tendering and selection. The data for this research was gathered using survey method. This paper investigates the current conditions of evaluating the contractors and comparing various methods of prequalification as well as comparing the contractor selection methods in three different countries of Hong Kong, USA and Australia. The questionnaires were circulated among a wide range of experts in this field of study, aiming to examine the most suitable technique for contactor selection and then, the obtained results were analyzed using inferential and descriptive statistics through the SPSS software. Based on the findings, the significance of this study lies in the point that the decision support systems are considered in assigning the contractors to fulfill the projects with respect to solving the problem of single and multiple criteria methods.
KEY WORDS: contractors' sufficiency, international contracts, decision support

1 INTRODUCTION

In the governmental sections, the project owners usually assign the construction and installation projects to the contractors. Therefore, the contractors play an important role in the projects and their selection process is a critical decision for the employers. The selection process should be designed in such a way that the selected contractors complete the project on time, with a reasonable cost and having proper quality. The purpose of the preliminary and final evaluations of the contractors is to select the qualified contractors out of all the voluntary contractors based on the criteria such as the financial and technical capacities, the organizational and management capability, their registered experiences, the health and work security, the environmental consideration, and their treatment to the loss claims (Hatush and Skitmore, 1997). Since the selection process accompanies with many risks for the employers, they always try to decrease the existing risk level (Hatuzh and Skimore, 1997). During the recent years, there have been various problems to implement the projects led to high capital losses. Considering the statistics, about 10% of these problems relates to the contractors inefficiency. Due to the existing problems, the employers have not ever considered a trend which can solve such problems. The employers need a filter to prevent the unqualified contractors to participate in the tenders in order to solve the problems (Rajaii and Hazrati, 2008). The construction projects have four main contexts including preliminary studies, design, implementation, and exploitation/ maintenance (Acar, et al. 2005). The main problem lies in the fact that inappropriate selection of contractors leads to lose huge capitals, but it is needless to say that disregarding the first and third stages are the prevailing reasons to end a construction project with high losses. The present study focuses on the problems in the project due to the inappropriate selection of the contractors. Late 1980s and early 1990s were the time of emergence of the main views and approaches regarding the contractors prequalification. Various types of determined models and methods were based on a series of simple decisions investigating the prequalification issue relying on the definition of some rules and parameters. Studies by Russel (1990), named as prequalification 1 and prequalification 2, consisted of definition of a series of criteria in different levels and some conditions for the criteria. The criteria and conditions created the algorithms which were a base to design a computer program for the prequalification. By reviewing the mathematical decision making models over the time, the researchers used the multi-criteria decision making models instead of the conventional ones. Therefore, the mathematical models such as SAW, AHP and TOPSIS have been greatly applied in the modern methods of prequalification.

On this matter, Lai et al. (2004) made use of SAW mathematic model for prequalification in which every criterion has a value and the contractors` criteria have specific scores determined by SAW method in this trend. However, Al-Subhiet, et al., (2001) applied AHP model to determine the contractors' sufficiency. To this purpose, the contractors capabilities were

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compared using AHP model based on the paired comparisons with respect to the prequalification criteria and the qualified persons were determined. Furthermore, Thomas and Skitmore (2001) introduced over 50 criteria for prequalification presented in 8-part questions. Also, Sing (2005) presented a fuzzy framework to select the contractors and suggested a fuzzy method for prequalification in 2007.

The present study is an applied study aiming to achieve a sufficient technique for determination of most proper contractors for the projects. This study aims to achieve the objectives through the following steps:

- Comparative – superlative comparison of contractors sufficiency in various international contracts
- Comparison of the contractors preliminary evaluation method in three different countries
- Comparison of various methods of prequalification
- Introduction of the most suitable method in assigning the projects to the contractors

2 LITERATURE REVIEW

The major amounts paid for projects are usually for the construction ones. The project failures cause irreparable human and financial losses for the country (like the recent failures in Pakistan). In most cases, technical and economic feasibility studies are needed to begin the projects. It also requires large scale of supervision. The project cannot be defined by the little preliminary information and time and cost is not definite (Parchami, 2009). The industrial projects are different from the construction ones. In industrial projects the major contract budget is paid for equipment; such as construction projects, failure of the project irreparable. The employer`s general objectives is only needed to begin the project. It requires macro scale supervision. The project can be defined as estimated by very little information (Parchami, 2009). Today, various methods such as free tendering, limited tendering, preliminary evaluation, negotiation or a composition of different methods are applied to select the most suitable contractors. When the project needs high technology or a specific skill, the employer uses the limited tendering and only the contractors can participate in the tendering process that can satisfy the project needs. The preliminary evaluation system is used when the projects cannot be assigned to a contractor with the sufficiency lower than the minimum capacities considered by the employer. Once the contractor is very complex with unique technical and financial characteristics, the negotiation method is used. In many countries, the project is given to the contractor suggested the lowest cost. However, there are some terms for this criterion in some countries. For example, in Denmark, two highest and two lowest suggestions are eliminated and the suggested price closer to the average of the rest prices will be selected. The similar trend is in Italy, Portugal, Peru, and Southern Korea with the difference that only one of the highest and lowest suggestions is eliminated. In Canada and America, the lowest suggested price but with 10% of the project price is selected. In France, the abnormal low price is deleted. As evident, the suggested price is the only criterion to select the contractor in many countries. Considering the price as the only selection criterion is very risky and it will not be economic in long term since the contractor may have a poor performance during the project implementation (Mirfarhadi, 2005).

2.1 The contractor selection process in three different countries

Housing authority in the Hong Kong keeps a list of registered contractors. The qualified contractors of the list should participate in the annual interview. Ministry of Urban Road and Development (MURD) also has a holistic performance assessment scoring system. Hence, it studies the functional levels of the contractors in progressing projects. The system includes the input and output evolutional components computing the scores of the output and input of each component and the composite score which is a base for the comparative score. The standard of the project is divided into three categories with two leveling lines which are the composite target quality score (CTQS) and the composite lower score threshold (CLST). The most opportunities are given to the contractors whose scores are more than the highest composite quality and the contractors whose scores are less than the lowest composite quality are not allowed to participate in the next stage of the tender (Misra, S. C. & Mondal, A. 2010). The government of Queensland in Australia has a system to evaluate the contractors called the Pre-Qualification Criteria (PQC). The name of all the volunteer contractors should be registered in the system to be able to participate in the tender related to the government construction projects with the contract value of 1,000,000 Australian Dollars. The contractors are evaluated based on the criteria such as technical capacities, management approach and personnel engagement in the pre-determined continuous organizational improvement. PQC systems have been designed in order to ensure the congruence between the size and complexity of the project with the contractor capability. The contractors have the validity up to 2 years in the system and are placed in one of the four following levels (Recker, J. 2012):

- Level one: with an effective functional performance
- Level two: with the commitment for the continuous improvement
- Level three: with the best performance in industry
- Level four: with the best performance in the world

The enterprise usually uses the selective or open method for the tenders of the construction projects (dependent on the project needs). The contractors are invited to cooperate through the public advertisements in the open tenders while the tender documents are available for the contractors who are qualified based on the system criteria. In the selective method, the contractors are invited to cooperate only based on the conformity between their capabilities and efficiency, and the project needs (the maximum of the project rate which can be given to the contractors is 33% of the annual turnover (Recker, J. 2012).

2.2 The conceptual model of preliminary evaluation system

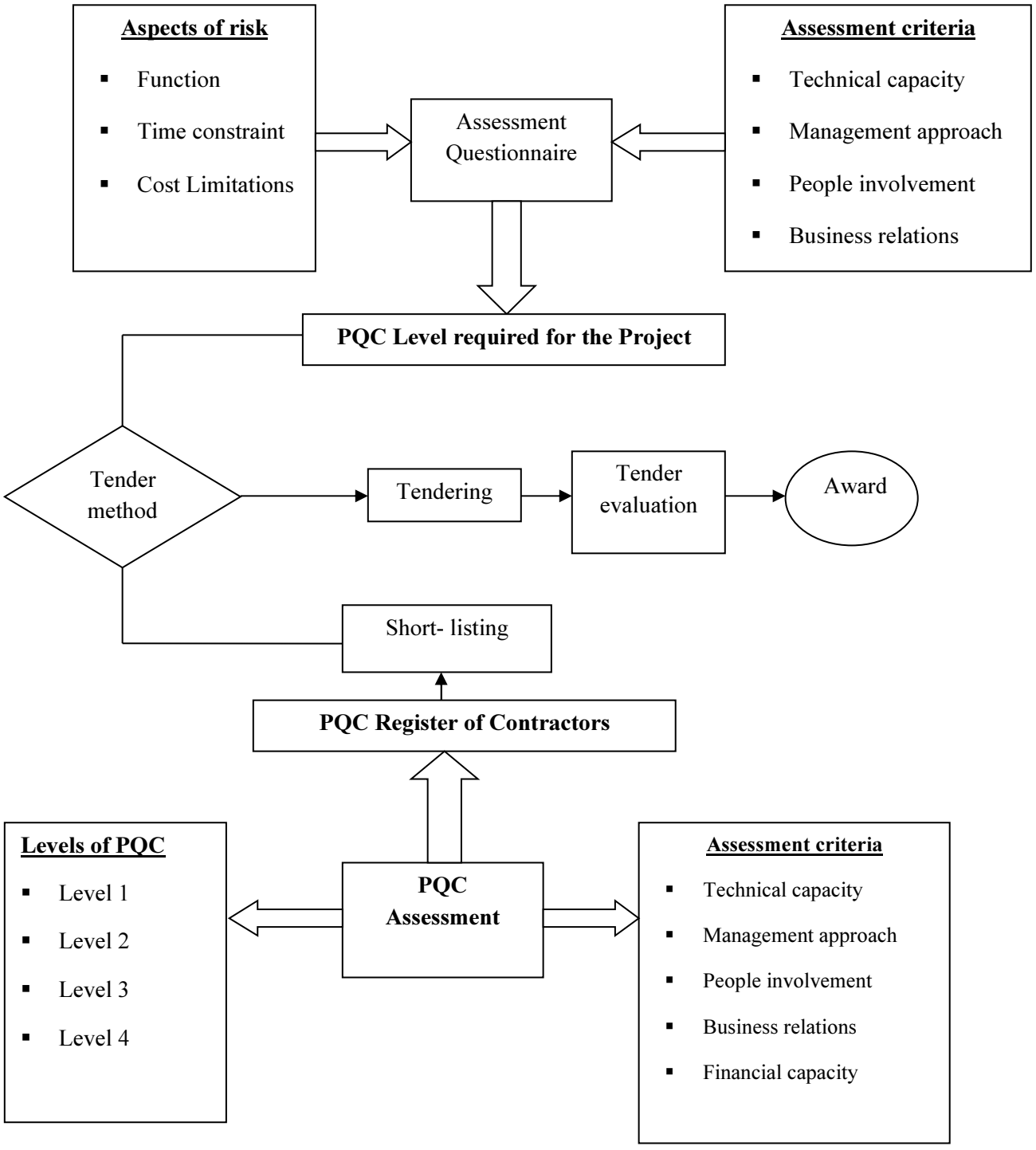


Figure 1- the conceptual model of preliminary evaluation system – Australia (Recker, J. 2012)

Many studies were conducted to improve and organize the contractors' evaluation in America (Rebecca and Brown, 2009, Schierholes, 2012). Many American governmental employers apply different evaluation rates. These rates are applied to define the parameters. For example, the maximum work value a contractor can suggest for a certain project, these rates, define

a base to create a dynamic and structures approach as well as more borders to select the qualified contractors, and the contractors are not limited to static and certain sets.

2.3 Types of prequalification methods

The conventional prequalification methods can be divided into filtering and ranking methods. The underlying parameters of decision making about the contractors are listed in the filtering method. The parameters may have some sub-parameters defined in different levels. There are some principles for each of these parameters or sub parameters usually stated as an algorithm. Thus, the contractors' characteristics with each parameter and principle are compared with the algorithm with respect to the available information. If the contractor could satisfy the first parameter with respect to the stated principles, the next parameter would be stated, otherwise the contractor would be disqualified and the trend would be ended. The contractors can satisfy all the indices which will be qualified and will be registered in the short list before holding the tender (Abbasnia et, al., 2005).

Also, a series of the parameters may have a series of parameters in the second method. Each of these parameters is given a score with respect to the contractors` characteristics. A final score is given to the contractor considering the weights and their importance level relative to each other. The transient tender put a cut-score to accept with respect to these parameters. A contractor gains a score lower than the cut-score will be disqualified.

The proposed model of Palanceeswaran et al. (2001), is a filtering model presented in some institutions of Hong Kong, Australia and America after a series of prequalification models evaluation. Three filters are proposed in the model including personnel services building (PSB), radiation recorder controller (RRC) and workload. If the contractor is disqualified in any of these filters the trend will be ended. The contractors pass all three filters successfully will be registered in the short list of before holding the tender (Palanceeswaranet, al., 2001).

RRC filter introducing responsibility and sufficiency is the first and main filter and defines the general capabilities of the contractor regardless of a certain project. However, the contractor`s confirmation or rejection depends on the implores objectives. RRC filter includes responsibility, sufficiency and accountability.

PSB filter introduces the specific project characteristics. Therefore, the contractor must satisfy the specific needs of the project if he/she is totally qualified. For instance, PSB filter involves the specific equipment, specific administrative methods, following specific standards, etc.

Workload filter controls the co-occurrence works of the contractor. In other words, the aim is that the contractors with a lot of mistakes due to their heavy volume of their workload are deleted ((Palanceeswaranet, al., 2001).

An instance of prequalification score models is the governing trend in the Mass Transient Railway Corporation (MTRC) of Hong Kong in such a way that the decision maker board specifically focus on the agreement with the contractor over the general needs. If the board, based on the questionnaires completed by the contractor conclude that the contractor have accepted all the general conditions, they will enter the next stage of prequalification. In this stage, there is a series of criteria or sub criteria defined by the union. The evaluation board allocates a score to each criterion with respect to the available information of each contractor and the contractor`s final score is determined based on each criterion weights. The criteria weights are also determined by the evaluation board in each project. Finally, the contractors with the highest score are qualified. The prequalification parameters applied by the union are presented in figure 2 (Kumaraswamy, M., 1996).

2.4 MTRC prequalification criteria

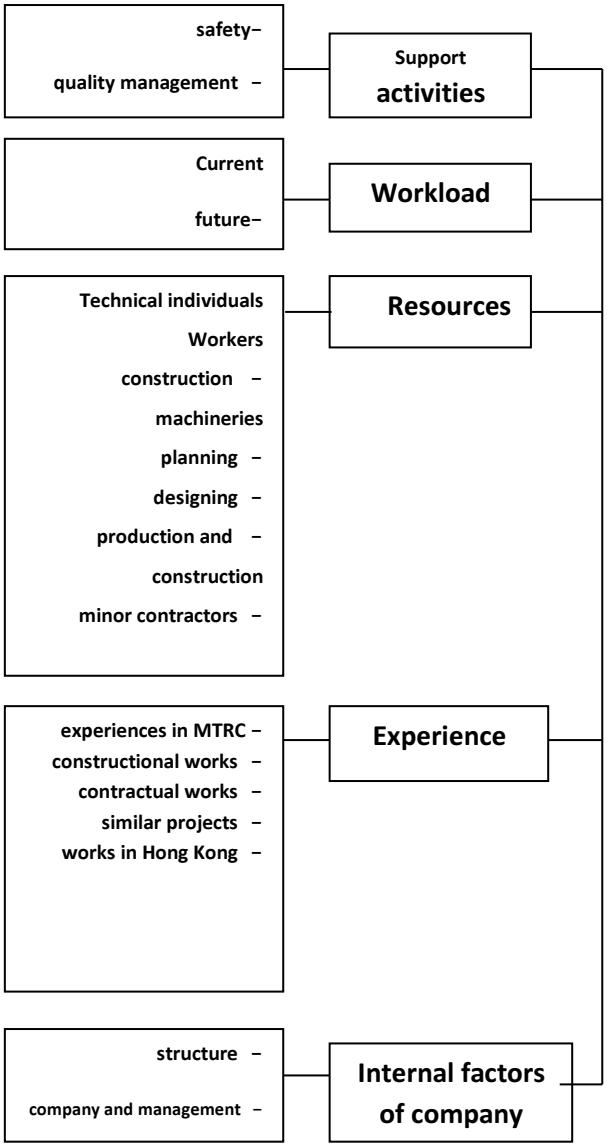


Figure 2- MTRC prequalification criteria (Vom Brocke, 2012)

The prequalification parameters applied by the union are presented in figure 2, that include support activities, workload, resources, experience and internal factors of company, which the first is composed of safety and quality management, second is composed of current and future, third is composed of technical individuals, workers, construction machineries, planning, designing, production and construction, , fourth is composed of experiences in Mass Transient Railway Corporation(MTRC), constructional works, contractual works, similar projects, works in Hong Kong, and the fifth composed of structure, company and management, relation.

2.5 Types of contractor selection systems

There are several systems and methods for selecting the contractors of construction project. In this section, we present some systems for the selection process which include:

1- Selection by minimum price method
2- Selection by first method of modifying cost method
3- Selection by second method of modifying cost method

2.5.1 The single criterion contractor selection system

- **The contractor selection by the minimum price method**
  The conventional method is mostly used in Iran, and given this method, the contractor who suggests the lowest price is usually the first preference. Disregarding the parameters such as time, cost, and security are of disadvantages of this method. Further, contractors might agree to give the project to a certain contractor (Bidi, 2007, p.2).
- **Modifying cost method – the first method**
  The modifying methods were innovated to modify the method of the minimum price and solve its problem in the single criteria systems. In one of these methods, the prices out of the determined range are deleted in such a way that if the estimation price of the consultant is A Rial, the prices out of the range of A + B and A – B will be deleted and the minimum price will be selected as the tender winner. The confidence range is determined by the consultant engineer with respect to the work type and price. Very low and very high prices are eliminated from the tender.
- **Modifying cost method – the second method**
  The countries such as Italy and Portugal have invented a system to select the contractors using the cost criterion method which have solved the problems of the minimum price to some extent. In this method, the mean of the prices are determined first and are recorded as average price. All the prices higher and lower than 10% of the average price are eliminated and the average range of the rest prices are computed again. The first price which is lower than the computed average price is selected as the tender winner. Also, very low and very high prices are eliminated and the collusion possibility among the contractors is disappeared (Bidi, 2007).

2.6 The multi-parameters contractor selection system

The multi-parameter systems have been designed based on the effective factors other than the price in the contractor selection. The parameters include time, cost, quality, security, durability, and maintenance. The number of the parameters and their weight effect are selected based on the employer objectives and the project type. Unifying the units and changing the qualitative parameters into the measurable qualitative parameters are the most important points in the multi-parameter systems. In this method, the parameters usually are changed into the cost and are summed to the suggested price of the contractor. Finally, the obtained price is the sum of the changed prices (Lingard, Hughes and Chinyio, 1997).

2.7 The decision support systems for contractor selection

Decision support systems are a kind of development in the multi-parameter contractor selection. These systems have two inputs and one output:

A. **Decision making criteria (input)** includes the defined criteria of the employer which are effective in the strategy and formula of the contractor selection.
B. **The contractor information (input)** enters the contractor`s characteristics to make decisions.
C. **Decision making (output)** the final decision to invite the contractor.

An overview of the decision support systems for contractor selection as a kind of development in the multi-parameter contractor selection has both inputs and output. Considering the fact that decision making criteria, and the contractor information and the last decision making including the ultimate decision to invite the contractor are all effective for the next stage, all of aforementioned items mentioned in this study.

2.8 Effective parameters in the contractor selection

- **The employer type:** being a private or governmental employer influences the contractor selection. The private employers are more inflexible compared to the governmental employers. In other words, the governmental employers are exposed under the governmental and legal conditions. Therefore, decision making will be different in this system.
- **The employer objectives:** every employer has some specific objectives affecting the contractor selection. The employer objectives are fallen into the general objectives, the project objectives and the contractor selection objectives. The general objective of the private employers is to maximize the profit while for the governmental employers is to provide the general facilities. The contractor selection objective of the governmental employers is to select the contractor with the minimum responsibility for the employer while private employers' objective is to select the qualified contractor.
- **The required resources:** the required resources include human, financial, equipment, resource as well as material. For example, the equipment criterion will be the most important if the project needs the machineries.
- **The contract strategy:** the contract strategies are the available policies to implement the project. The policies include the completion time of the project, the specific contractor selection and so forth. For instance, the contractors' ability to complete the previous projects is of importance to complete the works rapidly.
- **The implementation limitations:** the factors such as the governmental principles, the geographical place of the project and the accessibility of the resources are of the implementation limitations. As such, the contractor selection criterion to support the project in the place will be considered as the main criteria of decision making if the geographical place of the project is the mountain.

- **The work type:** the work type affects the criteria selection in terms of the needed amount of the credit, the implementation complexity and the work dimensions. For example, high financial ability of the contractor is the main criteria of decision making in the projects with high costs. (Langford and Male, 2008)

3 METHODOLOGY

This study is a descriptive survey study in terms of research aiming at make categorization. The data was gathered through both field and library review methods. In addition, 30 questionnaires were circulated among different experts of the aforementioned three countries to determine the contractors' sufficiency.

In a construction project, most of the budget is spent in the preliminary stage of the project and any mistake in this stage leads to high losses. Therefore, selecting the qualified contractor is very important in the construction projects in order to ensure that the risk of the resource loss in terms of the cost and time is minimized and the projects have the highest implementation quality and security beforehand and afterwards. Two solutions have been provided to this problem: changing the tenders holding trend and the contractors prequalification before holding the tender (Abbasnia et, al., 2005).

Considering that, this study investigates the current conditions of contractors' evaluation methods and compares various techniques of prequalification. Also, the preliminary evaluation methods are compared in three different countries of Hong Kong, America and Australia.

Population of a study is a collection of units which are sharing some points and the researcher tends to study their various features. The sample size of this study includes 30 experts (calculated form Morgan table) that have been selected out of the research population as the sample. The samples were selected through random selection process.

The first step in multi-criteria method of research is using a questionnaire. The respondents (which are the mentioned experts in this field) give different scores to the established criteria and sub-criteria.

4 Findings

The gathered data was analyzed using the descriptive and inferential statistics. The purpose of the descriptive statistics is to compute the population parameters using the census of all the elements of the population. Meanwhile, the inferential statistics intends to infer on the population through analyzing the information which is called the non-deterministic evaluation. The researcher computes the sample statistics and generalizes the findings to the population using the estimation or testing the statistical hypothesis. The data analysis and measurement of the significance level were done using SPSS software.

4.1 Frequency distribution (using single criterion method)

Table 1- frequency distribution based on the contractor selection using single criterion method

Variables	Frequency	Frequency percentage	Valid percentage	Median
Very weak	6	20%	20%	2
Weak	12	40%	40%	
Average	12	40%	40%	
Strong	0	0%	0%	
Very strong	0	0%	0%	
Total	30	100%	100%	

According to table 1, 20% of the sample evaluates the contractor selection by the single criterion method as very weak, 40% of the sample evaluates it as average and 40% of the sample evaluates it as average. Also, the median (equals with 2) indicates that the average of the sample opinion is weak regarding the contractor selection using the single criterion method.

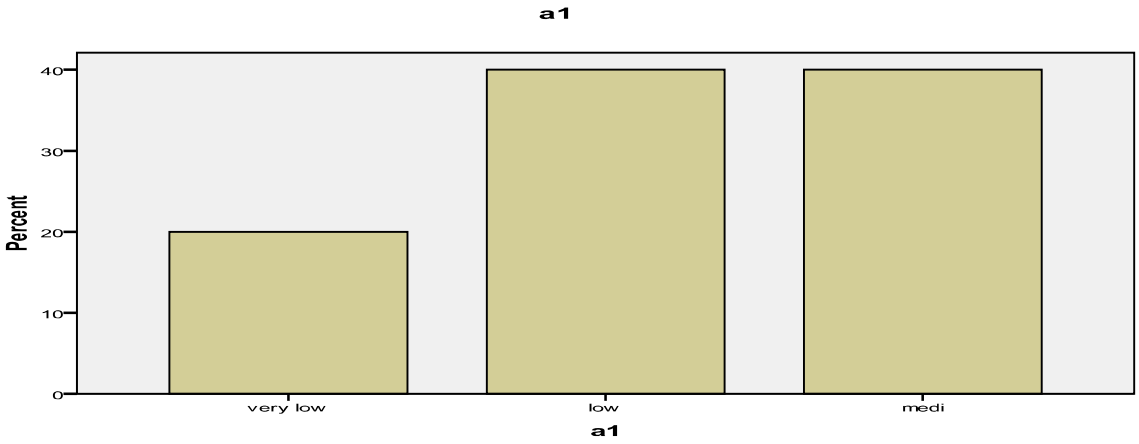


Figure 1- frequency distribution based on the contractor selection using single criterion method

4.2 Frequency distribution (using multi criterion method)

Table 2- frequency distribution based on the contractor selection using multi-criteria method

Variables	Frequency	Frequency percentage	Valid percentage	Median
Very weak	2	6.7%	6.7%	3
Weak	5	16.7%	16.7%	
Average	18	60%	60%	
Strong	5	16.7%	16.7%	
Very strong	0	0%	0%	
Total	30	100%	100%	

According to table 2, 6.7% of the sample evaluates the contractor selection with the multi-criteria method as very weak, 16.7% of the sample evaluates it as average and 60% of the sample evaluates it as average, and 16.7% evaluate it as a strong method. Also, the median (equals with 3) indicates that the average of the sample opinion is average regarding the contractor selection using the multi-criteria method.

Frequency distribution based on the contractor selection

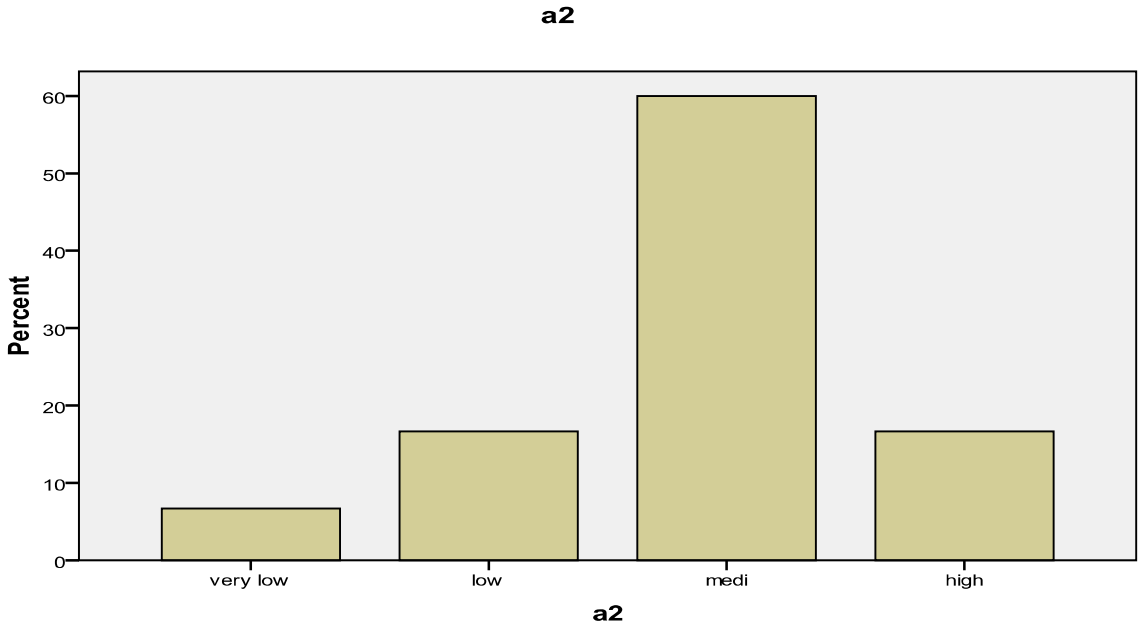


Figure 2- frequency distribution based on the contractor selection using multi-criteria method

4.3 Frequency distribution (using the decision support method)

Table 3- frequency distribution based on the contractor selection using the decision support method

Variables	Frequency	Frequency percentage	Valid percentage	Median
Very weak	0	0%	0%	3
Weak	0	0%	0%	
Average	17	56%	56%	
Strong	12	40%	40%	
Very strong	1	3.3%	3.3%	
Total	30	100%	100%	

According to table 3, 56% of the sample evaluates the contractor selection with decision support method as average, 40% of the sample evaluates it as strong and 3.3% of the sample evaluates it as very strong method. Also, the median (equals with 3) indicates that the average of the sample opinion is average regarding the contractor selection using the decision support method.

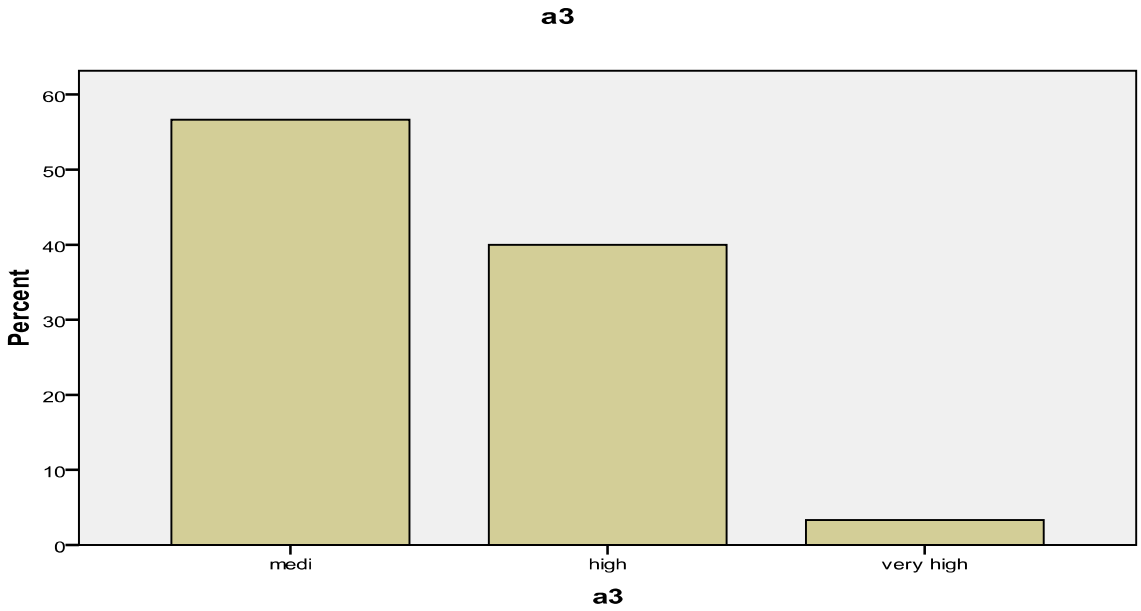


Figure 3- frequency distribution based on the contractor selection using the decision support method

According to table 4, the experts have evaluated the single criterion method with the mean of 2/20as a weak method. Also, the mean of the multi-criterion method has been estimated equal with 2/87, indicating that it is a low average method. The mean of the decision support is 3/57 indicating that it is a high average method, close to strong method.

Table 4- estimation of the contractor selection methods mean

Variable	Mean	Standard deviation
Single criterion	2.20	0.761
Multi-criteria	2.87	0.776
Decision support	3.57	0.571

Therefore, it can be extracted that the decision support method with the highest mean has been welcomed by the experts more than the other methods. Multi-variable regression test has been used to evaluate the multiple effects of the contractor selection methods with the best selection criterion as well as determining the best method of the contractor selection.

Table 5- the entered and remover variables

Model	Entered variables	Removed variables	Regression method
First	Above independent variables	-	ENTER

According to table 5, all the variables under investigation have been entered into the model without any specific order.

Table 6- estimation of the regression model summary

Row	Model	Multiple correlation coefficients	Determination coefficient	Balanced determination coefficient
1	Above variables	0.824	0.680	0.643

Table 6 indicates the relationship between the independent variables (different contractor selection methods) with the variable (the contractor selection methods criteria). According to the table, the multiple correlation coefficients of the independent variables with the variable of the contractor selection methods` criteria equals with 0/824. The determination coefficient (effect and predication) of the independent variables equals with 0/680 and the balanced determination coefficient based on the degree of freedom of the variables equals with 0/643. In other words, the amount of the variable of the contractor selection methods criteria based on the above variables effects equals with 0/68which is 0/64 with precise computation of degree of freedom (this value is the average coefficient indicating the relative efficiency of the model). Therefore, 64% of the variations of the best criterion of selection is predicted and determined by the above variables.

Table 7- ANOVA analysis and determining the significance level of the model

Model	Squares sum	Degree of freedom	Mean squares	F statistic	Sig
Determined (regression)	7.320	3	2.440	18.400	0.000
Residual	3.448	26	0.133		
Total	10.768	29			

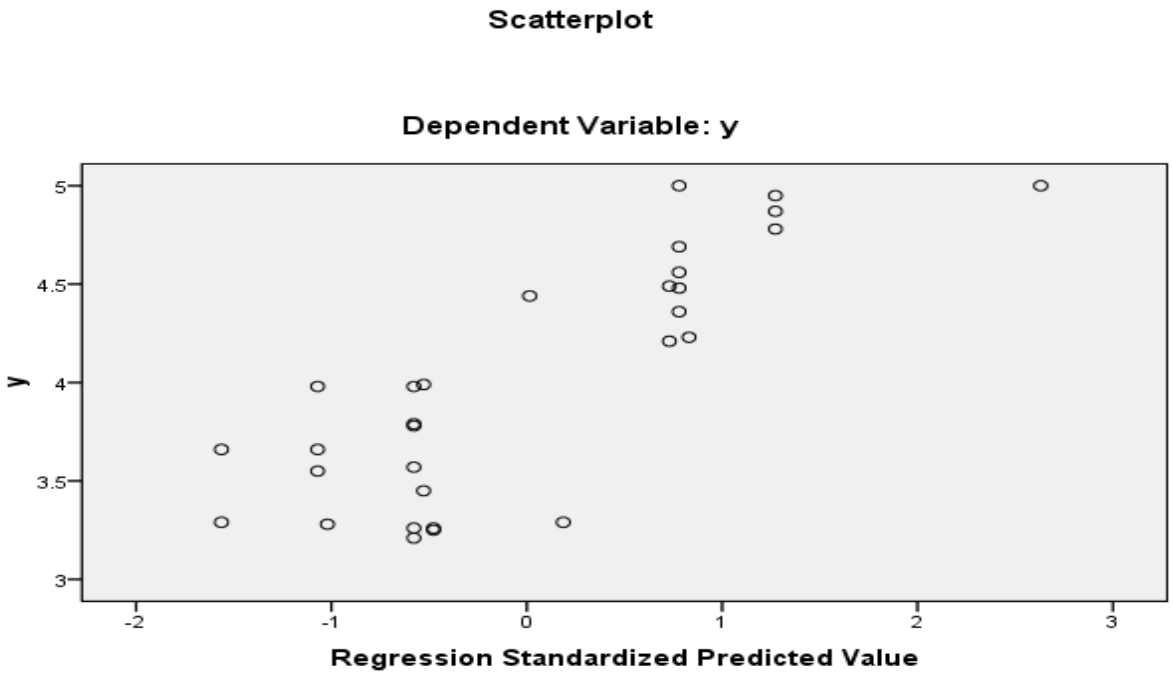
According to table 7 and considering the value of F statistic as well as the observed level of error (P-Value< 0/05), there is a correlation at the confidence level of 99%. In other words, there is a significant relation between the independent variables and the criteria of the contractor selection. Therefore, the null hypothesis is rejected and the alternative hypothesis is confirmed.

Table 8- regression weight coefficients

Model factors	Non-standard B	Standard B	t value	Sig
Constant coefficient	1.006	-	2.315	0.029
Single criterion	0.025	0.032	0.253	0.802
Multiple criterion	0.273	0.347	2.516	0.018
Decision support	0.657	0.616	4.936	0.000

According to table 8, the value of the weight coefficients of each variable on the standardized and non-standardized independent variable (Beta), t test value and the observed error level of each variable with the dependent variable have been considered. Accordingly, the value of the standardized weight effects of the single criterion method is 0/032, the multi-criteria method is 0/347 and the decision support is 0/616. However, it can be understood that the decision support is the best method of the contractor selection. Also, considering these coefficients, the regression equation of the contractor selection criterion can be stated firstly and the amount of the effect of each independent variable can be predicted for each variation unit in the dependent variable. Additionally, the value of F statistic and the level of significance indicate the net and significant effect of the decision support method at the confidence level of 99% and indicate the net and significant effect of the multi-criterion method at the confidence level of 95%.

Furthermore, the scatter plot of the dependent variable based on the standardized value of the predictive variables will be as follow:



5 DISCUSSION AND RESULTS

Holding tenders is based on the law issued on the year2003 by the national parliament of Iran. Using the decision support systems to select the contractors has been predicated. According to the act, the employers can qualitatively evaluate the contractors and invite them to cooperation in case of obtaining the necessary score. Based on this act, the contractor

offered the most appropriate price will be the tender winner. Moreover, the tenders in which the contractors must present technical offers in addition to the commercial offers it is allowed to balance the offered prices based on the obtained score (Bidi, 2007). There are several methods of tenders:

5.1 Open tendering

Open tendering allows anyone to submit a tender to supply the goods or services that are required. Generally an advert will be placed giving notice that the contract is being tendered, and offering an equal opportunity to any organization to submit a tender.

On larger projects, there may then be a pre-qualification process that produces a short-list of suitable suppliers who will be invited to prepare tenders. This sort of pre-qualification process is not the same as selective tendering (see below).

Open tendering has been criticized for attracting tenders / expressions of interest from large numbers of suppliers, some of whom may be entirely unsuitable for the contract and as a result it can waste a great deal of time, effort and money. However, open tendering offers the greatest competition and has the advantage of allowing new or emerging suppliers to try to secure work.

5.2 Selective tendering

Selective tendering only allows suppliers to submit tenders by invitation. A pre-selected list of possible suppliers is prepared that are known by their track record to be suitable for a contract of the size, nature and complexity required. Consultants or experienced clients may maintain 'approved' lists of prospective suppliers and then regularly review performance to assess whether suppliers should remain on the list.

Selective tendering can give clients greater confidence that their requirements will be satisfied and should reduce the wasted effort that can be involved in open tendering. It may be particularly appropriate for specialist or complex contracts, or contracts where there are only a few suitable firms. However, it can exclude smaller suppliers or those trying to establish themselves in a new market.

5.3 Negotiated tendering

Negotiating with a single supplier may be appropriate for highly specialist contracts, or for extending the scope of an existing contract. It can reduce the costs of tendering and allow early contractor involvement, but the competitive element is reduced, and unless the structure of the negotiation is clearly set out there is the potential for an adversarial atmosphere to develop, even before the contract has been awarded.

5.4 Serial tendering

Serial tendering involves the preparation of tenders based on a typical or notional bill of quantities or schedule of works. The rates submitted can then be used to value works over a series of similar projects, often for a fixed period of time following which the tendering procedure may be repeated.

Serial tendering can reduce tender costs, and may encourage suppliers to submit low rates to secure an ongoing program of work.

6 Conclusion

Considering the effect of the qualified contractor selection in the cost and quality of the project implementation, various methods of the contractor selection is of particular importance. Today, the decision support systems are highly considered in assigning the projects to the contractors with respect to solving disadvantages of the single criterion and multi-criteria so that the tender holding law takes them into consideration in Iran. But lack of proper knowledge about the systems in executive organizations and among the consultant engineers as well as the existing defects in tenders holding have caused the decision support systems not to apply appropriately. Based on the findings, the significance of this study lies in the point that the decision support systems are considered in assigning the contractors to fulfill the projects with respect to solving the problem of single and multiple criteria methods.

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A Proposed Framework for Evaluating Student's Performance and Selecting the Top Students in E-Learning System, Using Fuzzy AHP Method

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Abstract
With passing time, e-learning is finding more favors with academic people, since it provides learning opportunity anytime and anywhere. Assessment as one of the most important tools to improve the quality of high educational systems has been revolutionized with the appearances of new methods in education and development of new technologies in field of e-learnings. A good system for evaluating the learning achievement of students is the key to appreciating the aim of education. Recently, fuzzy set theory applied to many methods for the educational grading systems. In this study, a special framework, which considers several points of view of many experts by weighting fuzzy opinions, is proposed for the evaluation of students' performance in e-learning systems. The findings suggest a framework contained 6 main criteria and 24 sub-criteria that each one has a score considering their weight which determined during this study using fuzzy AHP method. This framework can be used for selecting the best students, specifically in higher education online learning systems.

Keywords: Assessment, Student Evaluation, E-learning, Fuzzy AHP, evaluation framework.

1. Introduction

Taking notice of academic performance, effective and organized measurement of the development of knowledge and skill especially in fields of individual activity that involve complex and challenging problems is highly notable (Hsieh et al, 2012). The new technological world has changed from earlier ages. Obstacles of global learning are falling down because of Information Technology (IT) and the internet advancement that leads to the world has become a very big warehouse of information, and learning is no longer limited by distance, location, or physical existence and people who like to learn can now become "invisible" students (Tham et al, 2005). E-learning systems have a great growth in recent years, because of the notable advantages of that, like flexibility, convenience, portability, and worldwide learning community. Therefore, e-learning is becoming critical for many real-world tasks, as such economic pressure on educational institutions to learn more flexible and to save costs (Abdellatief, 2011).

Evaluation of students ' learning achievement is the process of determining the performance levels of individual students related to educational goals and will be ensure that all students receive fair grading so as not to limit present and future opportunities of students. Thus, the system should be reviewed and improved regularly, to ensure that it is accurate, fair, and worthwhile to all students (Saleh, 2009). Thus, student performance evaluation is one of the important requirements of most educational institutions and universities. According to this result and the growing extension use of e-learning method,the need to do research in the field and provide a framework for evaluating performance of students in e-learning system delineates the necessity of conducting this research.

Certainly, some factors are more effective than others for evaluating students' performance, and should be more considered in evaluations, the previous common methods gave equal weights to each indicator and that is a weakness of the old evaluation methods. Another weakness is that sometimes the data or the responses of respondents do not have certainty, and should be considered a range of responses for questions. The fuzzy set theory introduced by Zadeh (1965), has been widely used in solving problems in several fields, and also recently it used in educational grading systems (Hsieh et al, 2012; Abdellatief, 2011; Saleh and Kim, (2009); Tham et al, 2005). Fuzzy AHP covers the flaws and weaknesses of the old methods mentioned above. In this paper, we used fuzzy AHP method for evaluating students' performance in e-learning systems, and finally presented a new framework for evaluating students' performance that can be used for selecting the best students, specifically in higher education online learning systems.

2. Literature Review

2.1. Online Learning System

Nowadays, revolution of the Internet has become a bridge for delivery online education. Therefore, online learning (used interchangeably with "e-learning") has received significant attention as a tool of supplying substitutes for traditional "face to face", instructor-led education (Douglas, 2004). It provides various opportunities to widen the learning setting for varied student's communities (Keengwe, 2010). Govindasamy (2002) argues that e-learning contains instruction delivered via all electronic media like the Internet, extranets, intranets, and hypertext/hypermedia documents. Pituch and Lee (2006) state that students will get various educational aid and communication approach from e-learning because of an existing wide-ranging technology employ to e-learning containing virtual classroom, computer-based learning, web-based learning, and digital collaborations (Urdan et al., 2000) Moreover, e-learning provided participation of students' independent of time and place, and regardless of geographic location (Richardson et al, 2003). Furthermore, E-learning systems can be present the following benefits (Rosenberg, 2001; Harun, 2002; Ismail, 2002; Gordon, 2003, Liaw et al., 2007):

- It lowers costs such as low recurring costs, and customer support costs;
- It makes more regulatory compliance;
- Its content is more timely and dependable;

- It is a just in time learning approach;
- It builds universal communities;
- It fulfills business needs;
- It retrains staff members;
- It offers an increasingly precious learner service.

Govindasamy (2002) stated that e-learning is a tool to solve problems of authentic learning and performance (Sandars et al, 2005) reported that the most generally stated advantages of e-learning were the availability of up-to-date information, the speed and accessibility to a wide-ranging resource, and the opportunity for the learner to work at their own terms and conditions.

Cantoni (2004) argued that delivery of e-learning is cheaper, it is self-paced (e-learning courses can be taken just in necessary time), it is faster (learners can skip what they already know), it offers consistent content (in contrast with traditional learning that different teachers may present different material about the same topic), it works from anywhere and anytime, it can be updated easily and quickly because the updated materials are simply uploaded to a server, it can make an increased retention and a better control on the subject (because of many elements such as audio, video, interaction, quizzes) and can be handled easy for large community of students.

Yang and Lin (2010) asserted that perception of learners about the internet might be different when they experience e-learning. Therefore, this raises an issue of learner perspective to use e-learning. The advancement of distribution technologies has encouraged many institutions to set about presenting online education (Kay, 2009). Development of new technologies such as simulations and interactive media lead to evolving distance education programs (Myers, 2007). Achievement in the institution's attempts to prepare good quality, suitable, and effective distance education is not a given, even if the courseware that is now being presented online was all right received in its classroom-based format (Smith, 2009). The last concern relates to the learning in the traditional brick and mortar classes being on balance with the online learning (Perantoni, 2010). Khan (2001) offers an e-learning framework with eight elements, such as technological, institutional, ethical, management, resource support, interface design, pedagogical, and evaluation components.

2.2. Assessment

Assessments are linked to learning and grading as a major component in a classroom, which are used to demonstrate a student's educational attainment.

"Assessments have become far more than merely one-time events attached to the end of the teaching; they have become part of the learning process by keeping students posted on their progress and confident enough to continue striving" (Stiggins, 2006).

Traditionally, assessments have been used in a summative method as assessments of learning, but recently, learning assessments are being used in a formative method (Collins, 2012). Summative assessments perform at the end of the learning process. Therefore, they are evaluative in nature, make judgments about achievement of a student, and are incorporated into grade of a student because of communicate their level of the standard educational attainment (Chappuis, 2009). According to (Chappuis, 2009), a definition of summative assessment is as "assessments that provide evidence of student achievement for the purpose of making a judgment about student competence or program effectiveness". Some common examples of summative assessments are major quizzes, end of unit tests; end of course tests (such as final exams), papers or projects (Collins, 2012).

Assessments should measure student performance and outcome in feedback to students about their performance. McConnell (1999) states that assessment may be one of the last remaining bastions of academic life, in a formal course it is usually the one element where the learner has no, or very little, opinion or control. Usually the instructor performs the assessment unilaterally with the final decision about learner performance being their personal view. The evaluation process scours to confirm whether the learning aims and outcomes have been performed and achieved efficiently (Rae, 1999).

Using test scores alone does not adequately measure the intricacies of learning, and should not be equated with the quality of student performance or learning (Tham et al, 2005).

3. Methodology

3.1. Conceptual Bases

3.1.1. Analytic Hierarchy Process (AHP)

The AHP method established to solve multiple criteria decision problems by setting their priorities (Karahalios, 2011) and to settle the conflict between practical demand and scientific decision-making, and to find a way to combine process qualitative analysis and quantitative analysis. AHP applied to making decisions in two sequential steps: design a hierarchy, which includes breaking down the decision problem into a hierarchy of interrelated decision elements (i.e., goal, and evaluation criteria); and hierarchy evaluation, which includes extracting weights of the criteria and incorporating these weights and preferences to specify alternative priorities (Sanjay and Ramachandran, 2006). AHP method is one of the widely used MCDM methods (Vaidya et al, 2006). One of the main advantages of the AHP method is the simple structure. The AHP is designed to represents human mind and nature. Thus, AHP can make a chance to search and evaluate the cause and effect relationship between goal, criteria, sub-criteria and alternatives using decomposing the structure of the problem (Milosevic, 2003). Furthermore, the application of AHP does not include burdensome mathematics; it understood easily and handled both qualitative and quantitative data in effect (Cengiz et al, 2003).

3.1.2. Fuzzy theory

Fuzzy set theory was specifically created to represent uncertainty and vagueness mathematically and provide formalized tools for dealing with the imprecision inherent to many problems. It resembles human reasoning in its use of approximate information and uncertainty to make decisions (Cengiz, et al, 2003). It also makes classes and grouping of data with boundaries that are not sharply defined (i.e., fuzzy) and it is easier to understand (Felix and Niraj, 2007).

The values of a linguistic variable are not numbers but words or sentences in a natural or artificial language (Zadeh, 1975). Fuzzy numbers express linguistic variables. A fuzzy number is a fuzzy set on the real line that satisfies the conditions of normality and convexity (Hadi, 2008). It is a quantity whose value is imprecise, rather than exact as is the case with "ordinary" (single-valued) numbers.

Usually A triangular or trapezoidal fuzzy number is applied to express the decision group's perception of alternative's performances with respect to each criterion (Debashree and Debjani, 2011). Indeed, a triangular fuzzy number (*TFN*) is a special case of a trapezoidal fuzzy number. When the two most promising values are the same number, the trapezoidal fuzzy number becomes a triangular fuzzy number (Debashree and Debjani, 2011). We use triangular fuzzy number for our research method, fuzzy AHP.

3.1.2.1. Establishing fuzzy number

Fuzzy set elements have degrees of membership. In classical set theory, the membership of elements in a set is assessed in binary terms according to a bivalent condition, an element either belongs or does not belong to the set (Liou et al, 2007) (Wu et al, 2007). The mathematics concept borrowed from (Liou et al, 2007) and (Hsieh et al, 2004).

A fuzzy number Aon$R$, to be a *TFN* if its membership function $\mu_A(x): R \longrightarrow [0,1]$ is equal to following Eq. (1):

$$\mu_A(x) = \begin{cases} \frac{x-l}{m-l}(l \le x \le m) \\ \frac{u-x}{u-m}(m \le x \le u) \\ 0, otherwise \end{cases} \quad (1)$$

From Eq. (1), *l* and *u* mean the lower and upper bounds of the fuzzy number $\tilde{A}$, and *m* is the modal value for $\tilde{A}$. The *TFN* can be denoted by $\tilde{A} = (l, m, u)$. The operational laws of *TFN* $\tilde{A}_1 = (l_1, m_1, u_1)$ and $\tilde{A}_2 = (l_2, m_2, u_2)$ are displayed as following Eqs. (2)– (6).

Addition of the fuzzy number $\oplus$

$$\tilde{A} \oplus \tilde{B} = (l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (2)$$

Multiplication of the fuzzy number $\otimes$

$$\tilde{A} \otimes \tilde{B} = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) = (l_1 l_2, m_1 m_2, u_1 u_2) \quad (3)$$

Subtraction of the fuzzy number $\ominus$

$$\tilde{A} \ominus \tilde{B} = (l_1, m_1, u_1) \ominus (l_2, m_2, u_2) = (l_1 - u_2, m_1 - m_2, u_1 - l_2) \quad (4)$$

Division of a fuzzy number $\oslash$

$$\tilde{A} (\oslash) \tilde{B} = (l_1, m_1, u_1) \oslash (l_2, m_2, u_2) = \left(\frac{l_1}{u_2}, \frac{m_1}{m_2}, \frac{u_1}{l_2}\right) \quad (5)$$

Reciprocal of the fuzzy number

$$(\tilde{A})^{-1} = (l_1, m_1, u_1)^{-1} = \left(\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}\right) \quad (6)$$

3.1.3. Fuzzy AHP

Since fuzziness and vagueness are common specifications in many decision-making problems, a good decision-making model needs to tolerate vagueness or ambiguity (Yu, 2002). Based on the concept of fuzzy set theory, fuzzy AHP was originally introduced by Van Laarhoven and Pedrycz (1983). Linguistic values, whose membership functions are usually characterized by *TFNs*, are recommended to assess preference ratings rather than conventional numerical equivalence method, because the fuzzy linguistic method can take the optimism/pessimism rating attitude of decision makers into account (Liang et al ,1994). Through AHP, the importance of several attributes is obtained from a process of paired comparison, in which the relevance of the attributes or categories of drivers of intangible assets are matched two-on-two in a hierarchic structure (Sun, 2010).

Therefore, the fuzzy-AHP method should be more suitable and effective than conventional AHP in real practice where an uncertain pairwise comparison environment exists (Lee et al, 2008).

There are many fuzzy-AHP methods proposed by various authors (Van Laarhoven et al, 1983; Chang, 1996; Cheng, 1997; Deng, 1999; Leung and Cao, 2000; Mikhailov, 2004).

These methods are systematic approaches to the alternative selection and justification problem by using hierarchical structure analysis and the concepts of fuzzy set theory. Decision-makers usually find that it is more confident to give interval judgments than fixed value judgments. This is because usually he/she is unable to explicit about his/her preferences due to the fuzzy nature of the comparison process.

Then, we will briefly introduce that how to accomplish the fuzzy AHP in the following steps (Sun, 2010).

Step 1: Construct pairwise comparison matrices among all the elements/criteria in the dimensions of the hierarchy system. Assign linguistic terms to the pairwise comparisons by asking which is the more important of each two dimensions, as following matrix $\tilde{A}$

$$\tilde{A} = \begin{bmatrix} 1 & \alpha_{12} & \cdots & \alpha_{1n} \\ \alpha_{21} & 1 & \cdots & \alpha_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_{n1} & \alpha_{n2} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \alpha_{12} & \cdots & \alpha_{1n} \\ 1/\alpha_{12} & 1 & \cdots & \alpha_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\alpha_{1n} & 1/\alpha_{2n} & \cdots & 1 \end{bmatrix} \quad)$$

Where

$$\alpha_{ij} = \begin{cases} 9^{-1}, 8^{-1}, 7^{-1}, 6^{-1}, 5^{-1}, 4^{-1}, 3^{-1}, 2^{-1}, 1^{-1}, 1, 2, 3, 4, 5, 6, 7, 8, 9, 1, i \neq j \\ 1 i = j \end{cases}$$

Step 2: To use geometric mean technique to define the fuzzy geometric mean and fuzzy weights of each criterion by (Hsieh et al, 2004)

$$r_i = \left(\alpha_{i1} \otimes \ldots \otimes \alpha_{ij} \otimes \ldots \otimes \alpha \right)^{1/n} \quad (8)$$
$$w_i = r_i \otimes^{-1}$$

where α_{ij} is fuzzy comparison value of dimension *i* to criterion *j*, thus, r_i is a geometric mean of fuzzy comparison value of criterion *i* to each criterion, w_i is the fuzzy weight of the *i*th criterion, can be indicated by a *TFN*, $w_i = (lw_i, mw_i, uw_i)$. The lw_i, mw_i and uw_i stand for the lower, middle, and upper values of the fuzzy weight of the i^{th} dimension.

3.1.4. Establish the decision group

A decision group composed of academic experts such as professors who had experiences in e-learning systems is firstly formed. In order to obtain representative views, knowledge coverage and different academic viewpoint of the decision makers should be considered, the ratio of them should be reasonably considered. If the decision group is established as above, fair and reliable evaluation results can be obtained.

3.2. Research Methodology

3.2.1. Establish the evaluation framework and indexes

The first step in this paper was included investigating literature review and interviews with executives and evaluation units of academic e-learning systems, that evaluation criteria and indicators have been identified. During the second step, a questionnaire was distributed among instructors and teaching assistants in e-learning systems, which criteria extracted from the literature and interviews, have been sieved to eliminate inappropriate and inconsequential criteria. According to collected answers, from criteria derived from the literature and interviews, 13 criteria were excluded. After removing the least important criteria, the remaining criteria were grouped into six main criteria that included totally 24 sub criteria. The final elected criteria are shown in Table 1.

Table 1. The final criteria and sub criteria for evaluating the performance of students in e-learning system

Sub-criteria	Main criteria	Row
Total grade point average (GPA)	Scientific-Educational	1
Each semester's GPA		
Having scientific research , academic promotion, national and international conferences and scientific meetings	Scientific-Research	2
Activities and collaboration in research projects		
Book or book chapter compilation		
Participation in the preparation of university publications		
Translating and compiling books		
Being creative and stylish content formats including student exercises, quizzes , projects and academic papers	Creativity, invention and innovation	3
Patented inventions		
Plans and ideas in science and technology exhibitions inside and outside the country		
Active interaction with professors, teaching assistants and the dept. chief	E-activities	4
Send assignments timely in Portal		
Participate in teamwork trainings		
Portal continuous activities in courses		
Active participation in online classes		
Participating in university and faculty surveys		
ICDL and Internet skills		
Experiences to being Teachers Assistant	Sharing and spreading knowledge	5
Teaching theoretical-practical Courses		
Teaching workshops and training courses		
Attending educational and research workshops	Personal development activities	6
Participate in Scientific Forum Activities		
Presence in professional meetings, forums, media, academic circles or webinar as an expert		

Top ranked in student's academic-research authentic competitions		

3.2.2. Determining the linguistic variables

Linguistic variables take on values defined in its term set. Linguistic terms are subjective categories for the linguistic variable. A linguistic variable is a variable whose values are words or sentences in a natural or artificial language. Here, we use this kind of expression to compare main-criteria for students performance evaluation together and also compare their sub-criteria together by nine basic linguistic terms, as “Perfect”, “Absolute”, “Very good”, “Fairly good”, “Good”, “Preferable”, “Not Bad,” “Weak advantage” and “Equal” with respect to a fuzzy nine level scale. In this paper, the computational technique is based on the following fuzzy numbers defined by Gumus (2009) in Table 2. Here, each membership function (scale of fuzzy number) is defined by three parameters of the symmetric triangular fuzzy number, the left point, middle point, and right point of the range over which the function is defined.

Table 2: Linguistic scale of relative importance used in the pair-wise fuzzy comparison measures.

Fuzzy number	Linguistic terms	Triangular fuzzy numbers
1	Equal	(1, 1, 1)
2	Weak advantage	(1, 2, 3)
3	Not bad	(2, 3, 4)
4	Preferable	(3, 4, 5)
5	Good	(4, 5, 6)
6	Fairly good	(5, 6, 7)
7	Very good	(6, 7, 8)
8	Absolute	(7, 8, 9)
9	Perfect	(8, 9,10)

These linguistic variables used for pair-wise comparisons questionnaire that distributed to experts.

Before calculating the weights of the index, the consistency of the comparison matrix should be checked. As a rule, only if consistency were less than 0.10, it considered as acceptable, otherwise the pair-wise comparisons should be revised. In this research after inserting the details of all questionnaires into Expert Choice software, all consistencies were less than 0.02 that shows answers are consistence.

3.2.3. Weighting the criteria

For calculate overall weight of criteria, we use Expert Choice software for analyzing pair-wise comparisons according to fuzzy AHP method, that shows weights for each respond. First, we have multiplied each sub-criterion to its main criteria, for all responds. Then in order to averaging all responds (weights), we used geometric mean for criteria and sub-criteria (column “Overall weight” in table 3). Then, the percentage of the total weight was calculated. For this purpose, the geometric mean of each criterion divided to sum of them (column “Percentage” in table 3). This percentage shows weight of each criteria/sub-criteria relative to all criteria/sub-criteria. These weighted criteria and their sub-criteria and the rank of each of them displayed in table 3.

Table 3: Final weighted criteria and sub-criteria using fuzzy AHP

Main Criteria	Overall weight	Percentage	Sub-Criteria	Overall weight	Percentage
Personal development activities	0.237893558	26.11%	Top ranked in student's academic-research authentic competitions	0.080718637	10.41%
			Presence in professional meetings, forums, media, academic circles or webinar as an expert	0.072736485	9.38%
			Participate in Scientific Forum Activities	0.038048095	4.90%
			Attending educational and research workshops	0.019677011	2.54%
Scientific-Research	0.183812048	20.18%	Activities and collaboration in research projects	0.040035719	5.16%
			Having scientific research , academic promotion, national and international conferences and scientific meetings	0.038360416	4.95%
			Book or book chapter compilation	0.031345668	4.04%
			Participation in the preparation of university publications	0.025296112	3.26%
			Translating and compiling books	0.022661144	2.92%
Sharing and spreading knowledge	0.15924516	17.48%	Teaching workshops and training courses	0.053620923	6.91%
			Teaching theoretical-practical Courses	0.039882327	5.14%
			Experiences to being Teachers Assistant	0.035161155	4.53%
Creativity, invention and innovation	0.132905226	14.59%	Being creative and stylish content formats including student exercises, quizzes , projects and academic papers	0.045883003	5.92%
			Plans and ideas in science and technology exhibitions inside and outside the country	0.04585439	5.91%
			Patented inventions	0.019049835	2.46%
E-activities	0.113478507	12.46%	Participate in teamwork trainings	0.027301808	3.52%
			Portal continuous activities in courses	0.023457231	3.02%
			Active participation in online classes	0.015645358	2.02%
			Active interaction with professors, teaching assistants and the dept. chief	0.014582819	1.88%
			Participating in university and faculty surveys	0.006280225	0.81%
			Send assignments timely in Portal	0.006209796	0.80%
			ICDL and Internet skills	0.005937092	0.77%
Scientific-Educational	0.083662099	9.18%	Each semester's GPA	0.048601153	6.27%
			Total GPA	0.019358161	2.50%
Total		100%			100%

3.3. Final Framework

At the end, we should get final scores to each main criterion and their sub-criteria. For this purpose, the percentages acquired at last step (table 3) for each sub-criterion rounded (up or down) to be non-decimal scores. Total sum of these scores in each group will be the score of their main criteria. In this

way, we scored all sub-criteria with respect to their weights and importance of their main criteria in scale "100" that are shown in table 4.

Table 4: Final framework for evaluating students' performance in e-learning systems

Main Criteria	Score	Sub-Criteria	Score
Personal development activities	27	Top ranked in student's academic-research authentic competitions	10
		Presence in professional meetings, forums, media, academic circles or webinar as an expert	9
		Participate in Scientific Forum Activities	5
		Attending educational and research workshops	3
Scientific-Research	20	Activities and collaboration in research projects	5
		Having scientific research , academic promotion, national and international conferences and scientific meetings	5
		Book or book chapter compilation	4
		Participation in the preparation of university publications	3
		Translating and compiling books	3
Sharing and spreading knowledge	17	Teaching workshops and training courses	7
		Experiences to being Teachers Assistant	5
		Teaching theoretical-practical Courses	5
Creativity, invention and innovation	14	Being creative and stylish content formats including student exercises, quizzes , projects and academic papers	6
		Plans and ideas in science and technology exhibitions inside and outside the country	6
		Patented inventions	2
E-activities	14	Participate in teamwork trainings	4
		Portal continuous activities in courses	3
		Active interaction with professors, teaching assistants and the dept. chief	2
		Active participation in online classes	2
		Send assignments timely in Portal	1
		ICDL and Internet skills	1
		Participating in university and faculty surveys	1
Scientific-Educational	8	Each semester's GPA	6
		Total GPA	2
Total	100		100

4. Results and discussion

According to table 4, the results of weighting demonstrate that among all main criteria, "Personal development activities" and "Scientific-Research" with score "27" and "20" out of "100", respectively, are more important than the other criteria. Ranking of the main-criteria affecting on students' performance evaluation in e-leaning system, in this research is as following:

1. Personal development activities;
2. Scientific-Research;
3. Sharing and spreading knowledge;
4. Creativity, invention and innovation;
5. E-activities;
6. Scientific-Educational.

As well as, the ranking of all sub-criteria shows in table 4. Briefly, we can say the most important sub-criteria are as follows:

1. Top ranked in student's academic-research authentic competitions (10);
2. Presence in professional meetings, forums, media, academic circles or webinar as an expert (9);
3. Teaching workshops and training courses (7);

4. Being creative and stylish content formats including student exercises, quizzes, projects and academic papers (6);
5. Plans and ideas in science and technology exhibitions inside and outside the country (6);
6. Each semester's GPA (6);
7. Experiences to being teachers assistant (5);
8. Teaching theoretical-practical Courses (5);
9. Participate in Scientific Forum Activities (5);
10. Activities and collaboration in research projects (5);
11. Having scientific research, academic promotion, national and international conferences and scientific meetings (5).

12. Conclusions

Students today are exposed to different learning environments to gain the maximum value in learning. Every institution is unique and has its own strengths in conducting online courses. Therefore, evaluating progress of students especially in online learning systems, and understand their performance is very important.

In this paper, the problem is the students' performance evaluation in e-learning systems that need some critical factors which will be weighted and scored to present a framework for this evaluation.

Compared with the existing students' performance evaluation methods, fuzzy AHP is a more systematic and efficient method than the other methods. Compared with the other MCDM methods and student's performance evaluation methods, the use of fuzzy AHP methodology offers a number of benefits. For example, the other MCDM method experiences difficulty in capturing uncertain and imprecise judgment of experts (Prasun, 2011). Fuzzy AHP can overcome such inability by handling linguistic variables. Thus, fuzzy AHP is an efficient tool for handling the fuzziness of the data involved in deciding the preferences or judgments of different decision variables (Sezhian, 2011). So we used of a fuzzy AHP method in the students' performance evaluation in higher education e-learning systems. For this purpose, first, 40 initial factors extracted from literature and interview with experts, that through a distributed questionnaire to expert, 13 factors excluded which included totally 24 sub-criteria. Secondly, via considering these criteria, the weights of six main criteria and their sub-criteria are calculated by using fuzzy-AHP. Then all sub-criteria scored with respect to their weights and importance of their main criteria, shown in table 3. Finally, the final framework based on non-decimal scores in scale "100" proposed in table 04. This framework shows the importance of each criterion for evaluating performance of students in e-learning system at higher education.

Most of universities assess their students annually, and select the best students regard to their achievement and performance in one last year or each semester passed. The results of this study can be used by these universities with online learning methods in higher education systems for evaluating their students annually.

We propose that this framework of assessment is effective for two purposes. First, we can evaluate student progress relative to multi dimensions, not only rely on their final exams. Second, although grades, as a measure of student learning, reflect student and instructor factors (Tomcho, 2008), we can use student performance data to demonstrate teaching efficacy and overall academic performance of university or institution. These two purposes are linked if, through this method of analysis, faculty and department of chief discover a low level of student's performance on a measure of student learning and, therefore, adjust their methods of teaching and policies to produce a better result. This intentional and iterative process of identifying student learning outcomes, linking the outcomes to course assessments, and examining the overall levels of student learning can inform teaching.

This assessment framework also offers one tool to inform students, and faculty can use assessments to provide evidence of student learning. A by-product of this framework of assessment is that it provides clear direction to students about the objectives that are important for the progress and it offers faculty a mechanism for evaluating progress toward those objectives. For example, students inform that such actions as presence in professional meetings, forums, media, academic circles or webinars as an expert; participate in scientific forum activities; or attending educational and research workshops that recognized at this framework as most important factors, helps clarify student proficiencies that

should be evident at the end of the course. So students in an e-learning system can realize that for being most successful and advancing their capability, what measurement needs to do. So performance of the students will be more targeted.

The integrated evaluation system is designed to provide practitioners with a fuzzy point of view to traditional performance evaluation model for dealing with imprecision. The proposed method enables decision analysts to better understand the complete evaluation process. Furthermore, this approach provides a more accurate, effective, and systematic decision support tool. Furthermore, the further research can explore that how to improve the gaps in each criteria based on Network Relationship Map (NRM) and capture the complex relationships among these evaluation criteria. The NRM is not only to find out the most important criterion for the performance but also to measure the relationships among these evaluation criteria.

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