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Research Article

IDENTIFYING THE FACTORS AFFECTING ENTERPRISE RESOURCE PLANNING (ERP) SUCCESS USING FUZZY TOPSIS TECHNIQUE

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ABSTRACT
Enterprise Resource Planning (ERP) System is a management solution that makes an organization enjoys advantages including active presence in competitive market, inventory reduction, and reduction in customer response time through the integration of information and processes. Unfortunately, despites pending a lot of cost and time, a large number of organizations and enterprises implementing ERP system do not succeed for various reasons. In the meantime, awareness of critical factors for the success and failure of organizations are quite significant. In this study, it has been tried to identify and classify critical success factors for ERP system by relying on theoretical backgrounds of the study as well as the opinions of experts in the field. Based on fuzzy TOPSIS technique, 15 critical factors identified in relation to the success of the project implementations were classified that at the end, excellent management support, the suitability of system for the organization and strategic planning revealed the most effects.

Keywords: *Enterprise Resource Planning System (ERP), Fuzzy TOPSIS, Entropy*

INTRODUCTION
Integrated Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Supply Chain Management (SCM) are considered as the most prominent integrated information systems. When they are integrated with business activities, organizational structures based on integrated information systems are formed.ERP system serving many industries and work areas in organizational complexes involves activities such as ACM, warehouse control, manufacturing, financial accounting, human resources and almost any management processes based on other data (O'Leary, 2000).ERP system is a strategy based on Information Technology (IT) which gives the control of all human resources to the managers at different levels by an integrated system with high speed, accuracy and quality so that they will appropriately manage the planning processes of the whole operations of the organization. These systems are tools to transfer and integrate information among software in various business units (Gartner, 2012).The integration of the system and information flow is associated with information aggregation related to all activities of an enterprise such as finance and accounting activities, human resources, production and distribution warehousing and supply and sale chain (Umble *et al*, 2003).
Applying resource planning system has four advantages for a given organization:

- Saving costs in IT
- Efficiency of business processes
- A ground for standardization ofbusiness processes
- A factor for business innovations (Gartner, 2012).

Hence, having resource planning systems is not only superiority for modern organizations but also a necessity whose absence leads to backwardness for those organizations.
In recent years, given the economic pressures and crises and intense competition in the market, most organizations have become sensitive to the information system success and tried to evaluate the rate of their success (Petter *et al.*, 2008). There is much evidence which indicates that most ERP implementation plans have not been finished in due time and within the determined budget (Cotteleer et al, 2003). Research has shown that the most important problems in these systems pertain to lack of meeting two factors of business needs and the poor quality ofthe software applied. In Iran, despite widespread acceptance of these systems on the part of enterprises in recent years, successful samples of theimplementation and utilization of such system are very rare(Amid et al, 2012).Most Iranian

enterprises which have passed the implementation stage by spending costs and time higher than predicted rate face with problems which provide the ground for the reduction of system success at stages after the system implementation. Several contingency factors affect the success and efficiency of ERP system. These factors include: organizational structure, organizational size; organizational culture;top management support and the vision of business(Ifinedo and Nahar, 2009, Ifinedo, 2008).

With regard to the high failure rate of ERP system implementation as well as its devastating role in a business, an investigation into the identification of factors affecting ERP success (Garg and Garg, 2014). The experiences of other scholars and identification of fundamental factors will obviously be crucial (Garg and Garg, 2014). Accordingly, in this study, it is tried to provide a framework for identifying and evaluating factors influencing the implementation success of ERP projects. Specifically, the objectives of the current study are as follows:

- Identifying effective factors in ERP implementation projects
- Evaluating and ranking effective factors in ERP success

The overall structure of the present study consists of the following sections: First, the related literature is discussed. Next, using the related literature and the opinion of the experts on the issue, factors affecting the ERP success are provided. In order to rank the identified factors, Fuzzy TOPSIS method is applied. Finally, the obtained results are fully discussed.

Review of the Related Literature

The identification of success factors is very useful to identify the important elements required for the success of business operations (Hossain, 2001). Important success factors are a limited number of important parameters, elements or steps in a project that should be accurately considered to achieve the management objectives in implementing information system. These are important factors in the enterprise which are accentuated on to realize the business objectives. There are areas in which work should be correctly done so that information system will have useful function and achieve specific objectives (Boon *et al.*, 2003).

In Holland and Light model (Holland and Light, 1999)critical success factors were classified into strategic group (including available systems, business vision, ERP system strategy, top management support and project planning and schedule) and organizational group (including consulting software sale, personnel, configuration software and reengineering, user acceptance, monitoring and feedback, communication and debug).

Zairi's model (2003) includes the results of the analysis of 94 studies on the effect of factors affecting the success of ERP project implementation including top management support, change management, project management, training, communication, evaluation of available system, plan vision, implementation strategy, implementation of consultants, benchmarking, business process change, software selection, implementation approach, system test and system integration. In Amble, Haft, and umbel model (2003).factors affecting the successful implementation of the system include: clear understanding of strategic objectives, top management support, plan management, clear organizational change management, executive group, data accuracy, extensive training, performance measurement and several local uses of the system.

It is observed that ERP success is a complicated and multidimensional concept which can be addressed from different perspectives. If success is considered in the area of system implementation, it can be defined in the set-up and exploitation phases of the system with a predicted reasonable budget and schedule. However, if the macro level of the enterprise, business, and the phase after its implementation are considered, the system success will indicate the achievement rate of the enterprise to the business objectives from the project implementation (Umble *et al.*, 2003).

Gargand Garg (2014) presented 21factors affecting the success of ERP in the form of 4major strategic, technological, people and project management branches. According to this study, strategic factors revealed the greatest impact on ERP system success.

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Fuzzy Multiple Criteria Decision Making

Fuzzy Concepts and Operations

Fuzzy sets theory is a perfect means for modeling uncertainty and inaccuracy emergedfrom human mind which is neither a random nor a probable phenomenon. In fact, fuzzy logic provides the basis for systematization in dealing with ambiguous or not well-defined situations (Kahraman, 2003).

Fuzzy Entropy Method

Entropy is a very important concept in social sciences, physics and information theory.

In the current study, in order to determine the objective weight of criteria, fuzzy entropy method introduced by Hsu and Lin is used.

The steps of this method are as follows (Hsuand Lin, 2006).

Step One: Formation of Fuzzy Aggregated Decision Matrix

According to the number of criteria and options and evaluating all options for various criteria, the aggregated decision matrix is formed as follows:

(7)

$$\widetilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}$$

If decision-making committee has K members and fuzzy ranking of k-th decision-maker is$\tilde{x}_{ij}^{k} = \left(a_{ij}^{k}\ , b_{ij}^{k}, c_{ij}^{k}\right)$. Fuzzy aggregated ranking of $\tilde{x}_{ij} = \left(a_{ij}\ , b_{ij}\ , c_{ij}\right)$ is obtained according to the following relations:

(8)

$$\tilde{x}_{ij} = \frac{1}{K}\left(\sum_{k=1}^{K} a_{ij}^{k}\ , \sum_{k=1}^{K} b_{ij}^{k}, \sum_{k=1}^{K} c_{ij}^{k}\right) \quad i = 1..m\ , j = 1..n$$

Step Two: Formation of overall fuzzy judgment matrix with α-cut

To form overall fuzzy judgment matrix, α-cut is used. The value of α-cut shows the level of feasibility and degree of uncertainty of information obtained from experts. The overall judgment matrix with α-cut is given in relation (9).

(9)

$$\tilde{A}_{\alpha} = \begin{bmatrix} \left[a_{11}{}_{l}^{\alpha}, a_{11}{}_{u}^{\alpha}\right] & \left[a_{12}{}_{l}^{\alpha}, a_{12}{}_{u}^{\alpha}\right] & \cdots & \left[a_{1n}{}_{l}^{\alpha}\ , a_{1n}{}_{u}^{\alpha}\right] \\ \left[a_{21}{}_{l}^{\alpha}, a_{21}{}_{u}^{\alpha}\right] & \left[a_{22}{}_{l}^{\alpha}, a_{22}{}_{u}^{\alpha}\right] & \cdots & \left[a_{2n}{}_{l}^{\alpha}\ , a_{2n}{}_{u}^{\alpha}\right] \\ \vdots & \vdots & \vdots & \vdots \\ \left[a_{m1}{}_{l}^{\alpha}, a_{m1}{}_{u}^{\alpha}\right] & \left[a_{m2}{}_{l}^{\alpha}\ , a_{m2}{}_{u}^{\alpha}\right] & \cdots & \left[a_{mn}{}_{l}^{\alpha}\ , a_{mn}{}_{u}^{\alpha}\right] \end{bmatrix}$$

The lower and upper bounds of these intervals are calculated as following:

(10)

$$a_{ij}{}_{l}^{\alpha} = \alpha\left(b_{ij} - a_{ij}\right) + a_{ij}$$

(11)

$$a_{ij}{}_{u}^{\alpha} = c_{ij} - \alpha\left(c_{ij} - b_{ij}\right) \quad 0 \le \alpha \le 1 \ \ i = 1..m\ , j = 1..n$$

Step Three: Formation of definitive judgment matrix with α-cut and expert's degree of satisfaction based on their own judgment

To determine each expert's degree of optimism or satisfaction on their own judgment, β index is considered. This index transforms the overall judgment matrix into definite judgment matrix. In this study, in order to calculate various degrees of α-cut, the value of expert's degree of satisfaction on their own judgments is considered constant and equal to β = 0.5.

(12)

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$$A = \begin{bmatrix} a_{11}^{\alpha} & a_{12}^{\alpha} & \dots & a_{1n}^{\alpha} \\ a_{21}^{\alpha} & a_{22}^{\alpha} & \dots & a_{2n}^{\alpha} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1}^{\alpha} & a_{m2}^{\alpha} & \dots & a_{mn}^{\alpha} \end{bmatrix}$$

In this matrix, the crisp value of each a_{ij}^{α} is obtained using the following relation.
(13)

$$a_{ij}^{\alpha} = \beta {a_{ij}}_{l}^{\alpha} + (1-\beta){a_{ij}}_{u}^{\alpha} \quad \forall \beta \in [0,1] \quad , \quad 0 \le \alpha \le 1 i = 1..m \, , j = 1..n$$

StepFour: Calculation of entropy index
Entropy index is obtained according to the following relation:
(14)

$$E(C_j) = -\varphi_k \sum_{i=1}^{m} p_{ij} \ln p_{ij} = -\varphi_k \sum_{i=1}^{m} ((\frac{a_{ij}^{\alpha}}{a_j^{\alpha}}) \ln \frac{a_{ij}^{\alpha}}{a_j^{\alpha}}) \, , \quad j = 1..n$$

where$a_j^{\alpha} = \sum_{i=1}^{m} a_{ij}^{\alpha}$ and $p_{ij} = \frac{a_{ij}^{\alpha}}{a_j^{\alpha}}$

also$\varphi_k = \frac{1}{\ln k} \, , \, k = m$

Step Five: Calculation of the weight of criteria
Finally, in order to calculate the weight of criteria by entropy method, the following relation is used in which D_j and w_j are the amount of uncertainty in j-the criterion and the importance coefficient for j-the criterion, respectively.
(15)

$$w_j = \frac{DD_j}{\sum_{j=1}^{n} Dj} \quad j = 1, \dots, n \quad , \quad D_j = 1 - E(C_j)$$

Fuzzy TOPSIS Technique
In TOPSIS technique, options are ranked based on the shortest distance from the positive ideal solution and the longest distance from the negative ideal solution. Steps for TOPSIS method are as follows (Chen, 2000).

Step One: **Formation of aggregated decision matrix**
If triangular numbers$\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$are used, the aggregated decision matrix is obtained using equation 8.
(16)

$$D^{\sim} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \dots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \dots & \tilde{x}_{2n} \\ . & . & \dots & . \\ . & . & \dots & . \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \dots & \tilde{x}_{mn} \end{bmatrix}$$

Step Two: Determination of the weight of criteria matrix
In this study, the combination of weights from surveying the opinions of the experts and fuzzy entropy isused. In so doing, the method introduced by Liu and Kung (2005) is applied in which in order to determine the relative importance of entropy weights (objective weights) to weights obtained from survey (subjective weights), θ index is considered (0≤ θ≤1).

If the decision-making committee has K members and the importance coefficient of j-th index is$\tilde{w}_j^k = (a_j^k, b_j^k, c_j^k)$in terms of k-th decision-maker, the combined fuzzy weight of j-th index $\tilde{w}_j = (a_j, b_j, c_j)$can be achieved by the following relation:
(17)

$$\tilde{w}_j = (a_j, b_j, c_j) = \frac{1}{k}\left(\sum_{k=1}^{K} a_j^k \, , \sum_{k=1}^{K} b_j^k \, , \sum_{k=1}^{K} c_j^k\right)$$

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If w_j and $\tilde{w}_j = (a_j, b_j, c_j)$ are considered as the crisp weight from entropy fuzzy method and fuzzy weight from the opinions of the experts, respectively, for j-th measure, the combined fuzzy weigh of criteria j-th measure is obtained as follows:
(18)

$$\tilde{w}_j = w_j^{\theta} \times (a_j, b_j, c_j)^{1-\theta} \ , 0 \leq \theta \leq 1 \ , \qquad j = 1, \dots, n$$

Step Three: Making the fuzzy decision matrix scale-free
The following relations are used to normalize the elements of decision matrix.
(19)

$$\tilde{r}_{ij} = \left[\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*} \right] \qquad i = 1,2,\dots,n \ , \ j \in \Omega_B$$

$$c_j^* = \max_i (c_{ij}) \ , \ j \in \Omega_B$$

(20)

$$\tilde{r}_{ij} = \left[\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}} \right] \qquad i = 1,2,\dots,n \ , \ j \in \Omega_C$$

$$a_j^- = \min_i (a_{ij}) \ , \ j \in \Omega_C$$

Ω_C and Ω_B are negative criteria (cost) and the set of positive criteria (profit), respectively. After normalization, the normalized fuzzy decision matrix of $\tilde{R} = [\tilde{r}_{ij}]_{m \times n}$ is obtained. Given that all the criteria of the study are positive, in order to make them scale-free, relation 19 was used:

Step Four: Determination of weighted fuzzy decision matrix
The weighted fuzzy decision matrix is calculated by multiplying the weight matrix of criteria by scale-free fuzzy matrix as follows:
(21)

$$\tilde{V}_{m \times n} = [\tilde{v}_{ij}]_{m \times n} \ , \quad \tilde{v}_{ij} = \tilde{r}_{ij} . \tilde{w}_j \quad i = 1, \dots, m \ , \qquad j = 1, \dots, n$$

$\tilde{w}_j$ Expresses the importance coefficient forcriterionC_j.

Step Five: Finding Fuzzy Positive Ideal Solution (FPIS,A^*) and Fuzzy Negative Ideal Solution (FNIS,A^-)
Fuzzy Positive Ideal Solution (FPIS,A^*) and Fuzzy Negative Ideal Solution (FNIS,A^-) are defined as follows:
(22)

$$A^* = \{\tilde{v}^*_1, \tilde{v}^*_2, \dots, \tilde{v}^*_n\} = \{\max \ v_{ij} \ \ |(i = 1, \dots, m\}$$

(23)

$$A^- = \{\tilde{v}^-_1, \tilde{v}^-_2, \dots, \tilde{v}^-_n\} = \{\min \ v_{ij} \ \ |(i = 1, \dots, m\}$$

where$\tilde{v}^*_j$ and $\tilde{v}^-_j$ are the best and worst values for j-th criteria among all options, respectively.
In this study, triangular positive ideal solution and negative ideal solution introduced by Chen (2000) are used (2000). These values are:
(24)

$$\tilde{v}^*_j = (1,1,1) \ j = 1, \dots, n$$

(25)

$$\tilde{v}^-_j = (0,0,0) \ j = 1, \dots, n$$

Step Six: Calculation of distance from fuzzy positive and negative ideal solutions

The distance of each option from fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS) is calculated using the following relations, respectively:

(26)

$$s_i^* = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}^*{}_j) \quad i = 1..m$$

(27)

$$s_i^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}^-{}_j) \quad i = 1..m$$

Step Seven: Calculation of similarity index

Similarity index is calculated as follows:

(28)

$$\boldsymbol{CC_i = \frac{S_i^-}{S_i^- + S_i^*} \; i = 1, 2, ..m}$$

Step Eight: Ranking the options

At this stage, options are ranked according to the rate of similarity index so that options with more similarity index will be prior.

MATERIALS AND METHODS

Methodology

The Study Method

In terms of the objectives, the methodology of the study is applied and with regard to the method, it is a survey study.2237Surveymethodwas used to achieve information and knowledge management and industry experts to evaluate options (factors) compared to the criteria and to determine the importance coefficient of the criteria.

Method of Data Collection

In this study, data collection method includes library and field methods. Library method is mainly used to review the literature and identify overall factors for the ERP. Field success method is applied for identifying the studied industry and factors affecting ERP success in the studied industry. In so doing, using semi-directive interviews, professionals and experts in industry are asked to assist which will result in high realism and accuracy for the obtained results.

Instruments for Data Collection

To collect data, the classifications of the success factors of ERP system was first determined through library studies, then questionnaire as the main instrument fat data collection was obtained by interviewing industry experts and applying their opinions. Experts in this study consist of six directors and supervisors with the minimum of 10 years of experience and full familiarity with industry environment. In so doing, the opinion of each expert was collected in the form of semi-directive interviews and then, the results obtained by Delphi technique were given to the experts. To add or remove factors from the questionnaire, the consensus of at least four individuals out of six experts was considered as decision-making criteria.

Rankings the Success Factors for ERP System

In this study, TOPSIS method with fuzzy data has been used for uncertainty in evaluations. For the acceptability level of each component, fuzzy linguistic values have been given in Table 1.

Table 1: Linguistic variables and fuzzy values for achieving the knowledge of experts

Linguistic variables to determine the importance degree of	Positive triangular fuzzy numbers	Linguistic variables to evaluate the options compared to	Positive triangular fuzzy numbers

criteria		the criteria	
The least important	(0, 0, 0.2)	Too little	(0,0,2)
Less important	(0.15, 0.3, 0.45)	Little	(1.5,3,4.5)
Average	(0.35, 0.5, 0.6.5)	Average	(3.5,5,6.5)
Important	(0.55, 0.7, .85)	Much	(5.5,7,8.5)
Very important	(0.8, 0.8, 1)	Very much	(8,8,10)

In order to determine the factors influencing the ERP success, after reviewing the study literature, the classification represented by Ram *et al.*, (2013) was selected as the study basis and then, to complete this classification, factors stated in other studies were also added to it. The extracted classification in the form of semi-directive interviews with industry experts and university professors was studied to confirm its validity and integrity. Finally, the modified classification resulted from the study literature and experts' opinions including 15 parameters were obtained that is given in Table 2:

Table 2: Success factors of EPR in this study

The success factors	Resources
1. Top management support	An-ru et al. (2009), Ehie and Madsen (2005), El Sawah et al. (2008), Ifinedo (2008), Kansal (2007), Young and Jordan (2008), Z ˇ abjek et al. (2009), Zhang et al. (2003)
2. Strategic planning	Cheng et al. (2006), Ifinedo (2008), Ji and Min (2005), Shi and Lu (2009)
3. Suitability of the system for the organization	El Sawah et al. (2008), Holsapple et al. (2006), Hong and Kim (2002), Motwani et al. (2008)
4. Relation with the organization's objective	Poon and Wagner (2001)
5. Organizational culture	El Sawah et al. (2008), Zhang et al. (2005)
6. Change management	Ji and Min (2005), Cheng et al. (2006), Zabjek et al.2009
7. Budgeting issues	Ehie and Madsen (2005), Yang et al. (2006)
8. Project management	Ehie and Madsen (2005), El Sawah et al. (2008), Ji and Min (2005), Kansal (2007), Zhang et al. (2003)
9. Multi-skilled team	Almashaqba and Al-jedaiah (2010), Wu and Wang(2007)
10. IT equipment	Ifinedo and Nahar (2009)
11. Technological complexity	Al-Mashari et al. (2003)
12. System quality	Hakkinen and Hilmola (2008), Ifinedo and Nahar (2006), Ifinedo et al. (2010)
13. Users' satisfaction and cooperation	Akkermans and van Helden (2002), Rothenberger et al. (2010), Wickramasinghe and Gunawardena (2010)
14. Training	An-ru et al. (2009), Lin et al. (2006), Sun et al. (2005), Xu and Cybulski (2004), Zhang et al. (2003)
15. Perception of usefulness	Amoako-Gyampah and Salam (2004)

To select the criteria for evaluation, after reviewing of the related literature, three criteria which were suitable for the type of considered factors were selected. These criteria are given in Table 3.

Table 3: Effective criteria in evaluating the factors

Row	Criteria	Resources

1	Achievement of strategic objectives of implementation	Exports' opinions
2	Efficiency of system after implementation	Exports' opinions
3	Completion of project within the specified time and budget	Exports' opinions

After verifying the questionnaire, it was sent to 30 experts and managers in the field of ERP system. The questionnaires were sent in the form of a web-based application which aimed at saving time and costs and facilitation in responding. After two weeks that questionnaires were sent, they were resent to the group of respondents who had not sent any questionnaire. A total of 27 questionnaires were completed by respondents; however, one case was removed due to defects in responsiveness.

Results and Findings from the Implementation of the Technique

Calculation of Entropy Weights

After aggregating the views of respondents to questions, the aggregated fuzzy decision matrix and aggregated fuzzy weights of criteria have been obtained.

For the formation of general matrix by taking the fixed α-cut, the lower and upper bounds of the interval$[a_{ij\ L}^{\alpha}, a_{ij\ U}^{\alpha}]$ are obtained based on relations (10) and (11).To avoid increasing the volume of material, the calculated values for α = 0.5 are indicated according to Table 5.

Table 5: General decision matrix in terms of the cut level of α = 0.5

The success factors	**Completion of project within the determined time and budget**		**Efficiency of system after implementation**		**Achievement of strategic objectives of implementation**	
Users' satisfaction and cooperation	[6.2759	4.7931	[4.1466	5.5776]	[5.0776	6.5776]
Technological complexity	[5.5603	4.0948	[4.3017	5.7672]	[3.8879	5.3534]
Change management	[6.3017	4.8017	[4.2414	5.7241]	[4.5172	6.0000]
Budgeting issues	[5.8707	4.4052	[3.6034	5.0517]	[2.8276	4.2414]
Organizational culture	[5.4741	3.9741	[2.7672	4.1983]	[3.0690	4.5517]
Project management	[5.4224	3.9569	[4.7931	6.2759]	[3.2586	4.7069]
Strategic planning	[6.5862	5.1034	[6.2845	7.7155]	[6.7069	8.0862]
Suitability of the system for the organization	[7.1466	5.6810	[5.8621	7.3448]	[6.8017	8.1638]
Perception of usefulness	[6.6466	5.1466	[5.5948	7.0259]	[4.9914	6.4569]
Relation with the organization's objective	[6.3017	4.8017	[5.1552	6.6034]	[6.0345	7.4483]
Multi-skilled team	[5.9310	4.4483	[4.5862	6.0690]	[3.3448	4.8276]
Training users	[6.2845	4.8190	[5.2931	6.7414]	[3.6897	5.1724]
System quality	[5.5862	4.1034	[5.1724	6.6552]	[3.7672	5.2672]
IT equipment	[4.3448	2.8621	[2.1897	3.5690]	[2.3276	3.7069]
Top management support	[7.3276	5.9483	[6.7328	8.0948]	[6.7586	8.1034]

Given the different values of α-cut for the formation of definite decision matrix form the whole matrix, the degree of satisfaction of each expert with his judgment (degree of optimism) will be considered equal to β = 0.5.The obtained definite matrix based on relation (13) has been shown in Table 6.

Table 6: Definite decision matrix per cut level of α = 0.5 and degree of satisfaction of β = 0.5

The success factors	**Completion of project within the determined time and budget**	**Efficiency of system after implementation**	**Achievement of strategic objectives of implementation**
Users' satisfaction and cooperation	0.0683	0.0548	0.0638
Technological complexity	0.0541	0.0568	0.0557
Change management	0.0616	0.0562	0.0640
Budgeting issues	0.0414	0.0488	0.0593
Organizational culture	0.0446	0.0393	0.0545
Project management	0.0467	0.0624	0.0541
Strategic planning	0.0866	0.0789	0.0674
Suitability of the system for the organization	0.0877	0.0745	0.0740
Perception of usefulness	0.0671	0.0712	0.0680
Relation with the organization's objective	0.0790	0.0663	0.0640
Multi-skilled team	0.0479	0.0601	0.0599
Training users	0.0519	0.0679	0.0640
System quality	0.0529	0.0667	0.0559
IT equipment	0.0353	0.0325	0.0416
Top management support	0.0871	0.0836	0.0766

Then, for various values of α-cut levels and constant degree of satisfaction β = 0.5, the entropy weights proportional to each cut level is calculated and its averages considered as the final weights of entropy. These values are presented in Table 7.

Table 7: Values of the weights obtained from the entropy technique for different levels of α and constant value of β = 0.5

Different values of α-cut	**Completion of project within the determined time and budget**	**Efficiency of system after implementation**	**Achievement of strategic objectives of implementation**
α = 0.0	0.14044	0.33770	0.52187
α = 0.1	0.13988	0.33807	0.52205
α = 0.2	0.13934	0.33844	0.52222
	0.13883	0.33881	0.52236
	0.13833	0.33917	0.52249
	0.13786	0.33953	0.52261
	0.13740	0.33989	0.52271
	0.13696	0.34024	0.52280
	0.13653	0.34059	0.52288
	0.13612	0.34094	0.52294
	0.13572	0.34129	0.52299
Average	0.13795	0.33952	0.52254

Implementation of FTOPSIS Stages

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Using relations (19) to (21), triangular aggregation matrix of the previous stage changed to the weighted normalized matrix in which the weights are the
Integration of experts' opinions and the output of entropy technique. In this study, θ = 0.5 is considered for the integration of the weights. The final value of the combined weights is given in Table 8.

Table 8: The combination of entropy weights and subjective weights of the experts

The obtained weights	**Achievement of strategic objectives of implementation**			**Efficiency of system after implementation**			**Completion of project within the determined time and budget**		
Entropy weights W_j^o	0.5225			0.3395			0.1379		
Integrated weights $\widetilde{W}_j^s$	(0.625	0.85	0.85)	(0.575	0.75	0.85)	(0.45	0.6	0.75)
Combined weights	(0.5715	0.666	0.666)	(0.4418	0.5046	0.5372)	(0.2491	0.2876	0.3216)

Finally, using relation (28), results obtained from ranking by integrated weights can be shown according to Table 9.

Table 9: The rank of the success factors of ERP implementation considering θ =0.5

Factors	S^*	S^-	CC_i	**rank**
Top management support	1.8066	1.2538	0.4097	1
Suitability of the system for the organization	1.8532	1.2103	0.3951	2
Strategic planning	1.8576	1.2056	0.3936	3
Relation with the organization's objectives	1.9757	1.0860	0.3547	4
Perception of usefulness	2.0108	1.0498	0.3430	5
Users' satisfaction and cooperation	2.0945	0.9670	0.3159	6
Change management	2.1284	0.9330	0.3048	7
Training users	2.1308	0.9291	0.3036	8
System quality	2.1553	0.9061	0.2960	9
Technological complexity	2.1957	0.8642	0.2824	10
Multi-skilled team	2.2059	0.8549	0.2793	11
Project management	2.2184	0.8415	0.2750	12
Budgeting issues	2.3016	0.7574	0.2476	13
Organizational culture	2.3454	0.7163	0.2340	14
IT equipment	2.4731	0.5880	0.1921	15

Discussion and Conclusion

In this study, by investigating the literature on the area of ERP system and semi-directive interviews with industry experts, a list of success factors of the implementation of ERP system was identified.Then, using fuzzy TOPSIS method, an approach was presented to rank the priority of these factors. In this approach, a combination of subjective weight of decision makers and scientific weights of entropy technique was used in the entropy technique, considering different degrees of uncertainty in evaluations (different α-cut), the weight of criteria was calculated for different degrees of uncertainty and their average was selected as the final weights which results in more realistic results compared to the calculation of weights by one level of uncertainty.

According to the obtained results, it is observed that some factors such as top management support, suitability of the system for the organization, and strategic frameworks have higher status than other factors.

Among the studied factors, it can be observed that compared to project management and finance issues, organizational factors has a higher rank which indicates further need for organizational frameworks in the implementation of ERP system within and after its implementation. It is suggested that the top management of the organization announce his practical commitment to the implementation of ERP system with cooperation and allocation of valuable resources to the system up to the end of its execution. It is also recommended that the organization forma strategic committee which consists of the top managements in different organizational parts, representatives of the project management and those users who deal with the system daily.

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