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New perspective to ERP Critical Success Factors: Priorities and Causal Relations under fuzzy environment

Mohsen Sadegh Amalnick[1], Ayyub Ansarinejad[2,*], Sina-Miri Nargesi[3], Shakib Taheri[4]

Department of Industrial Engineering, College of Engineering, University of Tehran, Iran, Email: amalnick@ut.ac.ir.
Department of Industrial Engineering, College of Engineering, University of Tehran, Iran, Email: ansarinejad@ut.ac.ir.
Faculty of Industrial and Mechanical Engineering, Qazvin Islamic Azad University, Qazvin, Iran,Email:mirinargesy@gmail.com.
Department of Industrial Engineering, College of Engineering, University of Tehran, Iran, Email, shakibtaheri@gmail.com

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Abstract

Enterprise Resource Planning (ERP), systems are high technical cross-functional information systems that designed to improve organizational performance and competitiveness by streamlining business processes and eliminating duplication of works and data. Regarding the fact that ERP systems have a tremendous advantage for organizations but the implementation of an ERP is not straightforward and it involves significant risks. Several studies have conducted to identify the critical success factors (CSFs) in the ERP implementation process. However, most of those studies are lacking in systematic efforts to classify and evaluating CSFs. This study is motivated by a lack of theoretically research in the classification and evaluating CSFs by considering the causal relationship among CSFs that are affected the successful implementation of ERP systems. To achieve this aim Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytical Network Process (ANP) is applied. The proposed methodology implemented in the biggest refrigerator production company in Iran.

Keywords: ERP Critical Success Factors, Fuzzy DEMATEL, Fuzzy ANP, CFCS Defuzzification Method.

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[1]Assistant Professor, Department of Industrial Engineering, College of Engineering, University of Tehran, Iran.
[2,*]Corresponding author: M.S. Student, Department of Industrial Engineering, College of Engineering, University of Tehran, Iran, Tel: +98(21)82084162, Fax: +98(21) 88013102.

1. Introduction

Enterprise Resource Planning (ERP), systems are high technical cross-functional information systems that designed to improve organizational performance and competitiveness by streamlining business processes and eliminating duplication of works and data [1]. ERP provides three major advantages consist of: automation and integration of business processes; availability of common data and business practices throughout the organization and generation of information in real time [2]. In another classification four categories on the ERPs benefits are considered: (1) improvement of information flow between sub-units through standardization and integration of activities; (2) centralization of administrative activities, such as accounts payable and payroll; (3) reduction of IS maintenance costs and increased ability to deploy new IS functionality; (4) enablement of transformation from inefficient business processes to accepted best-of-practice processes [3]. Many businesses adopted ERP as a tool to achieve strategic competitive advantages [4]. Despite of tremendous advantage of ERP systems, the implementation of an ERP is not straightforward and it involves significant risks [5]. ERP implementation projects need to be controlled, and the implementation of an ERP system is significantly different than a traditional system implementation [6]. The ERP implementation is complex and requires significant investment in consulting and software, which is usually affordable only by very large corporations [7]. The implementation of ERP also requires a wide range of skills that many companies have faced several impediments during different phases of implementation[8]. Cost or time overruns is reported as a cause of many cases of the failure in ERP implementation [9].

The motivation of this study is that although several critical success factor analyses in the field of information system implementation appear in the literature, most of them do not have any technical background [10]. In addition lack of theoretically empirical research in the classification factors by considering causal relationship among factors, that are affected the successful implementation of ERP systems is existed. Therefore in this study Analytical Network Process is used to fill the gap in lack of technical background and the fuzzy DEMATEL procedures, is used to classify CSFs into the cause and effect groups for helping decision-makers focus on those factors that provide great influence [11]. The proposed methodology implemented in an actual case in the biggest refrigerator production company in Iran.

The remaining parts of this paper are structured as follows: In Section 2, Fuzzy set theory, CFCS Defuzzification method, Fuzzy ANP, and Fuzzy DEMATEL are described in section 3, the proposed methodology is applied to evaluate ERP critical success factors on an actual case; finally, Section 4 presents a conclusion of our study.

2. Evaluation Methods

In this section, CFCS Defuzzification method, Fuzzy ANP, and Fuzzy DEMATEL are described as follows.

2.1. CFCS Defuzzification method

Various methods of defuzzification exist, and the method used in this study is CFCS defuzzification method [12].

$A_{ij}^{k} = (l_{ij}^{k}, m_{ij}^{k}, r_{ij}^{k})$ indicates the fuzzy assessments between the criterion *i* and the criterion *j* of the *k* th evaluator. The steps of CSCF method are described as follows:

Step 1: Normalization

$$xl_{ij}^{k} = (l_{ij}^{k} - \min l_{ij}^{k}) \big/ \Delta_{\min}^{\max} \qquad (1) \qquad\qquad xm_{ij}^{k} = (m_{ij}^{k} - \min l_{ij}^{k}) \big/ \Delta_{\min}^{\max} \qquad (2)$$

$$xr_{ij}^{k} = (r_{ij}^{k} - \min l_{ij}^{k}) \big/ \Delta_{\min}^{\max} \qquad (3) \qquad\qquad \text{Where } \Delta_{min}^{max} = \max r_{ij}^{k} - \min l_{ij}^{k} \qquad (4)$$

Step 2: Computing lower (ls) and upper (us) normalized value:

$$xls_{ij}^{k} = xm_{ij}^{k} \big/ (1 + xm_{ij}^{k} - xl_{ij}^{k}) \qquad (5) \qquad\qquad xrs_{ij}^{k} = xr_{ij}^{k} \big/ (1 + xr_{ij}^{k} - xm_{ij}^{k}) \qquad (6)$$

Step 3: Computing total normalized crisp value:

$$x_{ij}^{k} = [xls_{ij}^{k}(1 - xls_{ij}^{k}) + xrs_{ij}^{k}] \big/ [1 - xls_{ij}^{k} + xrs_{ij}^{k}] \qquad (7)$$

Step 4: Computing crisp value:

$$z_{ij}^{k} = \min l_{ij}^{k} + x_{ij}^{k} \Delta_{\min}^{\max} \qquad (8)$$

These steps should be followed separately for *k* evaluators.

2.2. Fuzzy ANP

Saaty [13] suggested the use of ANP to solve the problem when dependency among alternatives or criteria exists. The result of computations or weights in ANP approach forms a supermatrix. After the computation of all weights in the supermatrix, it is possible to derive the weights of priorities.

A supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two groups of nodes (clusters) in a network [14].

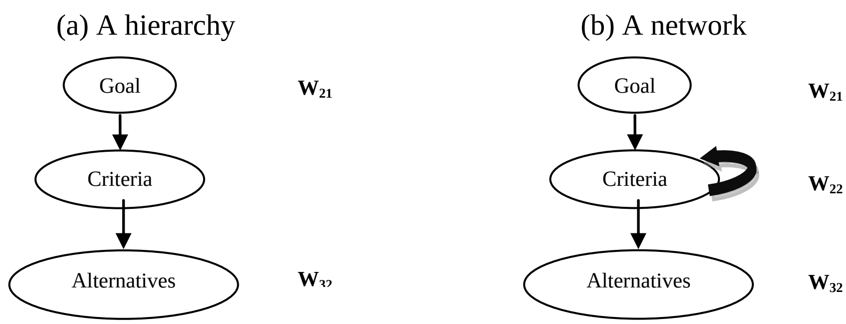

Figure 1: (a) Hierarchy and (b) Network

In Figure 1, W_{21} is a vector that represents the impact of the ‘‘Goal” on the “Criteria”; and W_{32} is a matrix that represents the impact ‘‘Criteria” on each item of the ‘‘Alternatives”. W_{22} represents interdependency, and the supermatrix of the elements in a component or between two components [13]. W_{21} and w_{32} are obtained from pair-wise comparisons but W_{22}, or inner dependences, are calculated by Fuzzy DEMATEL method. Since there is inner dependency among clusters in a network, the sum of columns in the supermatrix is usually more than one and called unweighted supermatrix. The columns of unweighted supermatrix must be normalized first to make it stochastic, it means, each column of the matrix sums should be equal to 1. The result of this normalization is the weighted supermatrix. To achieve a convergence on the obtained weights, the weighted supermatrix is raised to the power of *2p +1*; where *p* is an arbitrarily large number, and this new matrix is called the limited supermatrix. The property of the limited supermatrix is that nonzero columns of this matrix have the equal value correspondingly. Eventually, having the limited supermatrix, the final priorities of all the elements (alternatives, criteria, and sub criteria) can be obtained. Because the real world is actually full of ambiguities or in one word is fuzzy, several researches have combined fuzzy theory with ANP. Definitions and descriptions in associated with linguistic variables which are used in this research are Saaty scales [15].

The CFCS method is applied to deffuzify fuzzy numbers in pair-wise comparisons. In the state that we have several decision makers, like what we face in maintenance strategy selection, after all steps of CFCS method are done for each evaluator pair-wise comparisons, to aggregate different opinion of decision makers Equation (9) should be calculated.

$$z_{ij} = \sqrt[k]{(z_{ij}^1 \times z_{ij}^2 \times \cdots \times z_{ij}^k)} \tag{9}$$

In this Equation, z_{ij}^k is a crisp value of evaluation between the criteria or alternative *i* and *j* of the *k* th evaluator that should be calculated through CFCS method. Also, z_{ij} is the aggregated crisp value of evaluations between the criteria or alternative *i* and *j*.

Using Equation (9) different crisp evaluation of several decision makers will be converted into one aggregated crisp value. After calculating the aggregated crisp value of all evaluators, the final weight of each criterion or alternative can be calculated through geometric mean method in AHP which is introduced by Saaty [15].

2.3. Fuzzy DEMATEL

The DEMATEL was originally developed to deal with complexity in local and worldwide problems effectively [16]. The main application of DEMATEL is the identification of relations between causes and effects of complex problems. In order to apply the DEMATEL in the crisp environment for one evaluator, the following steps are needed.

Step 1: Finding the direct-relation matrix

This matrix shows the degree of effect that each criterion has on other criteria. In this step, an expert fills such a matrix i.e. a matrix which shows the degree of effect criterion i on criterion j. these amounts of effect can be expressed by words such as 0 (no influence), 1 (low influence), 2 (high influence), and 3 (very high influence). This matrix is called the direct-relation matrix that is a $n \times n$ matrix *Z.* Also, z_{ij} in matrix Z indicates the degree of effect criteria *i* on criteria *j*.

Step 2: Normalizing the direct-relation matrix

The normalized direct-relation matrix *X* can be calculated through Equation (10) and (11), in which all main diagonal elements in the matrix *X* are equal to zero. In the matrix *X*, each criterion does not affect itself.

$$X = k \times Z \tag{10}$$

$$k = Min\left(\frac{1}{\underset{1\le i\le n}{Max} \sum_{i=1}^{n} z_{ij}}, \frac{1}{\underset{1\le j\le n}{Max} \sum_{j=1}^{n} z_{ij}}\right) \tag{11}$$

$$i, j \in \{1, 2, 3, \ldots, n\}$$

Step 3: calculating the total-relation matrix

After calculating *X* in step 2, the total-relation matrix *S* can be derived by using Equation (12) as follows:

$$S = X + X^2 + X^3 + \cdots = \sum_{i=1}^{\infty} X^i \qquad \text{when i} \to \infty \Rightarrow S = X(I - X)^{-1} \tag{12}$$

Where, *I* is the $n \times n$ identity matrix.

Step 4: calculating two indexes *D+R* and *D-R* for each criterion and drawing causal diagram.

In this step, first we should calculate the sum of a row (*D*) and the sum of a column (*R*) for each criterion separately. Clearly, *D* and *R* are two vectors. Vector *D* and *R* can be calculated as Equation (13) and (14). Finally, the causal diagram can be obtained by drawing (*D + R*, *D - R*) points for each criterion.

$$S = [s_{i,j}]_{n \times n} \quad i, j \in \{1, 2, 3, \ldots, n\}$$

$$D = \sum_{j=1}^{n} s_{i,j} \quad \forall\ i = 1, 2, \ldots, n \tag{13}$$

$$R = \sum_{i=1}^{n} s_{i,j} \quad \forall\ j = 1, 2, \ldots, n \tag{14}$$

Several researchers have combined fuzzy theory with DEMATEL. Definitions and descriptions associated with linguistic variables that are used in Fuzzy DEMATEL are shown in Table 2.

Table 1: Fuzzy comparison scale of DEMATEL method

Linguistic term	Linguistic values
Very high influence (VH)	(0.75,1.0,1.0)
High influence (H)	(0.5,0.75,1.0)
Low influence (L)	(0.25,0.5,0.75)
Very low influence (VL)	(0,0.25,0.5)
No influence (NO)	(0,0,0.25)

So far, we have described the crisp DEMATEL for one evaluator. Now, for fuzzy group decision making in DEMATEL by using Linguistic terms in the Table 2, direct-relation matrix for all the evaluators can be obtained. Then, to calculate the defuzzification values of each direct-relation matrix, CFCS method is applied to each evaluator by using Equations (1) – (8). In Group Fuzzy DEMATEL Approach to aggregate all the direct relation matrixes of *k* evaluators, the Equation (15) should be used:

$$z_{ij} = \frac{1}{k}(z_{ij}^1 + z_{ij}^2 + \cdots + z_{ij}^k) \tag{15}$$

After aggregating the direct relation matrices total relation matrix *S* can be calculated through Equation (10) and (11).

2.4. Combination of Fuzzy DEMATEL and Fuzzy ANP

As above mentioned W_{22} in ANP supermatrix represents the inner dependency and can be obtained from Fuzzy DEMATEL method. After calculating the total relation matrix *S* in Fuzzy DEMATEL and before inserting into unweighted supermatrix, the total relation matrix *S* should be normalized [17]. Finally, final weight can be obtained by calculating weighted and limited supermatrix.

3. Experimental Results

In this section, we implement the proposed methodology on an actual case a refrigerator producer company in Iran. The ratings of main factors and fuzzy decision matrices for sub factors are attained from a verbal questionnaire filled by eleven different experts in a company and then converted to fuzzy numbers based on proper scales in literature for Fuzzy ANP and scales of Table 2 for Fuzzy DEMATEL. The steps of the proposed methodology to evaluate ERP CSFs are described in following with all the specifics.

Step 1: Identify the Decision Criteria and Maintenance Strategies

We should first specify the factors and sub factors which are addressed in literature as critical success factors in ERP implementation. Totally, 14 factor and 33 sub factors which are shown in Table 2 are considered in this study.

Table 2: ERP Critical success factors classification

ID	Critical Success Factor
	C1-Business Process and Software Customization
1.1	Business Process Reengineering
1.2	Minimum Customization
	C2-ERP Vendor selection
2.1	Fitness
2.2	Flexibility
2.3	Cost
2.4	User Friendly
	C3- Project Team
3.1	Best composition of people from different parts of organization
3.2	Acceptable business and technical knowledge
3.3	Full-time team members
3.4	Lack of ERP expertise
3.5	Financially, support of implementation project team and creating incentives
	C4- Project management / Business plan / Business model
4.1	Effective project management
4.2	Clear business plan and vision
4.3	Business model
	C5- Project Scope
	Maintain the initial Scope of project
	C6- Implementation Method
6.1	Big bang
6.2	Phased
6.3	Parallel
	C7-Management
7.1	Top management Support
7.2	Top management commitment assign resources
7.3	Set policies to establish new organizational structure
	C8- Consultants
8.1	Capability of consultants
8.2	Use consultants in all steps of implementation
8.3	Manageability of consultant
	C9- Organizational/Communication
9.1	Clear and regular communications among employees and implementation team

9.2	User involvement
9.3	Change management
	C10-Readiness to Change
	Management and employees readiness to change
	C11-Training
11.1	Training and Education
11.2	Training and re-skilling of IT department employees
11.3	Department for training and supporting users after implementation
	C12-Software Development
	Software and user interface development
	C13-Budgeting
	Maintain planned budget
	C14- Test and Migration to new system
14.1	Necessity of performing detailed and adequate tests

Step 2: Build the Network Scheme

Based on the obtained result from step 1, the Network scheme in this step will be constructed. We assume that there is the inner dependency among factors. This assumption is beginning with study of Akkermansand van Helden [18]. Figure 2 shows the network scheme designed in Superdecision software.

Step 3: Obtain the rating of main factors and construct Pair-Wise comparison matrices for sub factors

To obtain the rating of main factors each expert gives one scales to each main factor, and then average of linguistic values is calculated. The summarized value of this calculation for "*C1: Business process and customization* "is shown in Table 3. After calculation of each criterion weight by dividing each criterion weight to sum of weights, the normal weights are calculated.

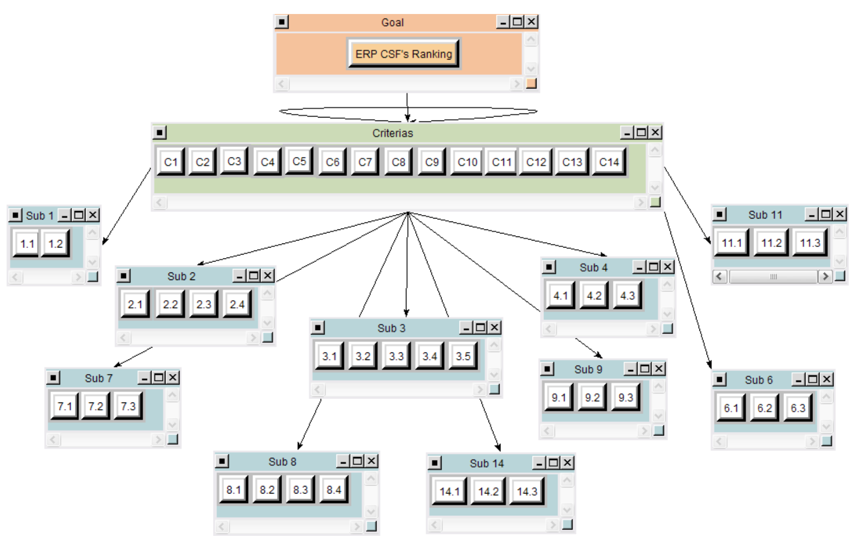

Figure 2: the network scheme to ranking of ERP CSFs in Superdecision software

These weights are inserted in ANP Super matrix.

Table 3: Weights and Normal Weights of Main Factors

Factor	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14

Weight	0.773	0.649	0.589	0.380	0.380	0.699	0.946	0.649	0.975	0.965	0.859	0.589	0.480	0.859
Normal Weight	0.079	0.066	0.060	0.039	0.039	0.071	0.097	0.066	0.100	0.098	0.088	0.060	0.049	0.088

After the ratings of main factors are obtained the pair-wise comparison matrices for sub factors are gathered from a verbal questionnaire filled by eleven experts in Company. Then these verbal pair-wise comparison matrices are replaced with correspondent triangular fuzzy numbers.

For example, the fuzzy comparison matrix for one evaluator of five sub factors of *C3: Project team*, with respect to the C3 is shown in Table 4.

Table 4: The fuzzy pair wise comparisons with respect to C3

C3	3.1	3.2	3.3	3.4	3.5
3.1	(1,1,1)	(2,3,4)	(5,6,7)	(2,3,4)	(4,5,6)
3.2	(0.25,0.333,0.5)	(1,1,1)	(3,4,5)	(1,2,3)	(2,3,4)
3.3	(0.143,0.1667,0.2)	(0.2,0.25,0.333)	(1,1,1)	(0.25,0.333,0.5)	(0.333,0.5,1)
3.4	(0.25,0.333,0.5)	(0.333,0.5,1)	(2,3,4)	(1,1,1)	(3,4,5)
3.5	(0.1667,0.2,0.25)	(0.25,0.333,0.5)	(1,2,3)	(0.2,0.25,0.333)	(1,1,1)

Table 4 is a consistent matrix and to deffuzify the triangular fuzzy numbers of Table 4 using CFCS method (Equation s (1) – (8)) Table 5 is obtained.

Table 5: The final crisp value of one evaluator for sub factors of C3

C3	3.1	3.2	3.3	3.4	3.5
3.1	1	3.016	5.930	3.016	4.959
3.2	0.339	1	3.988	2.045	3.016
3.3	0.167	0.251	1	0.339	0.541
3.4	0.339	0.541	3.016	1	3.988
3.5	0.200	0.339	2.045	0.251	1

To aggregate different opinions of decision makers, Equation (12) should be used. Finally, final weights will be calculated using geometric mean method introduced by Saaty [15]. Final weights and crisp integrated values of the fuzzy pair wise comparisons for eleven evaluators for five sub factors of C3 are shown in Table 6.

Table 6: Final weights and Crisp integrated values for sub factors of C3

C3	3.1	3.2	3.3	3.4	3.5	Geometric mean	Weights
3.1	1	4.542	5.118	2.894	5.012	3.203	0.451
3.2	0.423	1	4.0245	2.221	2.994	1.625	0.229
3.3	0.216	0.318	1	0.289	0.567	0.408	0.057
3.4	0.376	0.597	3.349	1	4.159	1.256	0.177
3.5	0.316	0.396	1.876	0.346	1	0.605	0.085

Similarly, the Final weights for all sub factors with respect to main factors by using eleven experts opinion are calculated.

Step 5: Create the Pair-wise inner dependencies' matrix and calculate total relation matrix using Fuzzy DEMATEL

In this step, to measure the amount of dependencies and for calculating numerical quantities of these dependencies, among main CSFs, pair wise inner dependencies' matrix based on eleven experts' judgments is established. Equation (1) – (8) are applied on the mentioned matrices for each expert and then by Equation 15, different opinions are aggregated and using Equation (10), (11) and (12), total relation matrix is obtained.

Step 6: Combine Fuzzy DEMATEL and Fuzzy ANP to find maintenance strategy Priority

This step is the final step of proposed method. To evaluate CSFs and finding priorities, first we must construct ANP supermatrix.

Table 7: The limited supermatrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	Goal
C1	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	0.0420	**0.0420**
C2	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	0.0585	**0.0585**
C3	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	0.0694	**0.0694**
C4	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	0.0565	**0.0565**
C5	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	0.0246	**0.0246**
C6	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	0.0404	**0.0404**
C7	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	**0.0625**
C8	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	0.0369	**0.0369**
C9	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	**0.0478**
C10	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	0.0493	**0.0493**
C11	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	0.0419	**0.0419**
C12	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	0.0179	**0.0179**
C13	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	0.0499	**0.0499**
C14	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	0.0177	**0.0177**
1.1	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279	**0.0279**
1.2	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063	**0.0063**
2.1	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	0.0248	**0.0248**
2.2	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	**0.0143**
2.3	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059	**0.0059**
2.4	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	**0.0026**
3.1	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	0.0255	**0.0255**
3.2	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	**0.0129**
3.3	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032	**0.0032**
3.4	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	**0.0100**
3.5	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	**0.0048**
4.1	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	0.0139	**0.0139**
4.2	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	0.0243	**0.0243**
4.3	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	0.0077	**0.0077**
6.1	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	**0.0030**
6.2	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	**0.0088**
6.3	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	**0.0211**
7.1	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	0.0287	**0.0287**
7.2	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	0.0088	**0.0088**
7.3	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	0.0132	**0.0132**
8.1	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	**0.0165**
8.2	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	**0.0024**
8.3	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	0.0037	**0.0037**
8.4	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	0.0075	**0.0075**
9.1	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	0.0137	**0.0137**
9.2	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	**0.0027**
9.3	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	0.0225	**0.0225**
11.1	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	0.0211	**0.0211**
11.2	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	0.0048	**0.0048**
11.3	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	0.0082	**0.0082**
14.1	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	0.0069	**0.0069**
14.2	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	**0.0030**
14.3	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045	**0.0045**

The construction of ANP unweighted supermatrix is started by inserting the weights of main factors under the goal node in supermatrix. In the next step, the normalized values of matrix S in DEMATEL, will be inserted to unweighted supermatrix. In the final step of constructing unweighted supermatrix the weights of the pair wise comparisons are inserted. For example, the weights of sub factor *C3* are inserted under the main factor of C3 in unweighted supermatrix. To achieve weighted supermatrix at first the columns of unweighted supermatrix must be normalized, it means, the sum of each column of the unweighted matrix should be equal to 1. To obtain the limited supermatrix, weighted matrix is raised to the power of $2p+1$; where p is an arbitrarily number until it reaches the convergence. The results are provided in Table 7 and named the limited supermatrix. Finally, having the limited supermatrix, the global priorities of all the elements (critical success factors and sub factors) can be obtained. As a result and based on Table 7, the final weights of all fourteen CSFs and Sub factors is obtained from limited supermatrix. The calculation of limited supermatrix is done by use of Superdecision software. According to results, *C3:"Project Team"* with calculated weight of 0.1128, among other main CSFs is the most important CSF in ERP implementation of the company. After that, *C7: "Management"* with calculated weights of 0.1015 is in the second place. The third place is belonged to *C2: "ERP Vendor selection"*. The next important CSF is *C4: "Project / business plan and business model"* and *C13: "Budgeting"* is the fifth place.

4. Conclusion

ERP implementation is not straightforward, and it involves significant risks that may lead to failure. In order to reduce the failure rate of ERP implementation and also better understanding of the implementation process, several studies have conducted. However, most of those studies as mentioned simply list factors and are lacking in the systematic efforts and technical background to classify and evaluating factors. To evaluate the priority of CSFs MCDM method could be useful. AHP method as a MCDM technique in that problem could be applied but AHP is suffering from inability to consider the interaction among factors. To overcome such a problem ANP is a good choice. In other hand to precisely estimate the interrelation among CSFs which is assumed in this article, DEMATEL is a very suitable technique. Application of DEMATEL has two advantages, firstly, it reduces the volume of computation in ANP, and secondly it provides us a valuable information about the causal relationship among CSFs. Applying these two methods under fuzzy environment by giving the experts opinions could lead us to realistic decision making process. The results of this study show s that ***C3:"Project Team"***, ***C7: "Management"***, ***C2: "ERP Vendor selection", C4: "Project / business plan and business model"*** and ***C13: "Budgeting"*** is the top five CSFs. These results could be very useful in other similar cases. As an extension of this study, using data mining techniques such as fuzzy clustering in causal relation results of DEMATEL could give us better understanding of same CSFs.

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