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Strategic Decision Making in Selecting Internal/External ERP Software by Entropy &TOPSIS

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ABSTRACT

Business atmosphere has changed, due to increasing competitors and competition among markets, and companies need to increase their competitive capabilities. Therefore, in these dynamic markets, companies need to engage developed information systems such as Enterprise Resource Planning (ERP). Nevertheless, companies face many defeats and problems in ERP systems implementation process which causes immense expenses and disadvantages. Usually, these problems come from an incorrect software selection; therefore can prevent of all losses and gain profit from all ERP systems benefits and advantages by selecting an appropriate one. In this research, at first, by experts, effective modules in selecting an ERP system software was determined, secondly, by using Shannon's Entropy technique, they were weighted and finally, most suitable choice of ERP software systems for using in Iranian companies and organizations was chosen by using TOPSIS technique.
KEYWORDS: Enterprise resource planning; ERP software selection; External/Internal software; Entropy; TOPSIS

1. INTRODUCTION

Nowadays, business environment is changed due to intensive competition among competitors and companies need to improve their competitive capabilities. Therefore, they focus on improving their agility and competitive capabilities with decreasing total costs and delay times, increasing ROI, responding to customers' needs, improving services, increasing quality of products and efficiency of production. That is why in these dynamic markets, companies need to employ developed information systems such as Enterprise Resource Planning (ERP) [5, 12].Investing on these systems is a significant strategy which aids businesses gaining competitive advantages and giving optimal level of services [13].

In most international companies, ERP systems are in the heart of information systems strategy. Indeed, due to globalization, there is a high pressure on information systems departments of companies for designing and setting global ERP software that is able to control and managing all company's branches activities in all over the world[1]. Besides, ERP systems are designed and produced based on culture, language, economic and political indexes and other western countries properties which play a significant role in ERP market; therefore, they are most differ from eastern countries features and these diversities cause many conflicts in ERP systems implementation and in some cases give rise to defeats and bankruptcies for them because of ERP systems' expenses [7]. Using ERP systems which are produced by local experts and companies who are familiar with local conditions and some limitations on implementing information systems especially systems in their area that lead to producing flexible ones with high correspondence, can prevent some ERP implementation failures. Nevertheless, based on some Iranian ERP experts opinions, ERP systems which are designed and produced in Iran, have some specific problems and limitations that cause companies are in doubt for choosing between Iranian or foreign (western) ones.

This article wants to:

A. Recognize indexes which play a significant role in choosing ERP software in Iran;
B. Choosing the most appropriate ERP software system between Iranian and foreign one.

2. Research background:

Since 1980 ERP has been elevated by the American Production and Inventory Control Society (APIC) by developing MRP IIoperation system to other systems of the company such as finance, marketing and human resources [14]. The eleventh edition of the APIC dictionary in page 38 defines ERP as a "framework for organizing, defining, and standardizing the business processes necessary to plan effectively and control an organization so the organization can use its internal knowledge to seek external advantage" [15].Selecting and carrying out ERP system is so time consuming and costly [16],furthermore, based on surveys, does not meet managers' anticipations so that, 85% of companies spot it as an investment for more than five years, 70%

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anticipate no more than 25% of return on investment and 50% do not estimate the ROI [17]. Although ERP systems have a high failure rate and huge investment for Purchasing and carrying out them are needed, however, companies continue to pursue these systems [18]. According to a survey was done based on predictions by AMR in 2007, revenues of ERP software systemswill raise from 28.8 billion dollars in 2006 to 47.7 billion dollars in 2011; additionally, AMR predicted revenues from these systems in Asia-Pacific region will raise intensively among five years from 3050 to 5723 million dollars, which explain the growing importance of ERP systems in the world [19].

Nikookar et al. (2011) [20] mentioned these steps before choosing a trustworthy ERP system vendor: 1) develop business requirements and future business processes that are unique to their business and adapted with their strategic objectives; 2) be guided through the IT/ERP vendor selection process by using a tried and tested selection approach, nevertheless, based on their unique business requirements; 3) create business case, justification, and ROI scenarios to determine the most feasible approach. Tsai et al. (2011) [3] expressed that increasing satisfaction level of supporting and servicing system's providers quality can help to implement ERP systems. Kwahk and Ahn (2010) [4] identified reasons of failure in the enterprise resource planning systems from the users' perspective, additionally, proposed social and technical factors that affecting on these systems application. Karsak and Ozogul (2009) [2] provided a decision framework for ERP software selection based on QFD, fuzzy linear regression and zero-one goal programming. Ge and Vob (2009) [21] studied on ERP research and its development and implementation in China and described the current market, challenges and future trends for ERP software; also, according to their surveys, cultural and linguistic aspects play a momentous role in successful ERP implementation in that country. Yazgan et al. (2009) [16] proposed a model that merges Analytic Network Process (ANP) with Artificial Neural Network (ANN). At first, the ERP system selection problem was modeled by ANP, therefore weighted valuesof factors and priority values of ERP software were determined; then, an ANN model was designed and all the valuesfrom the previous ANP model were going to be used in training stage; the resulting model comprises the best ERP software for a new organization. Yang et al. (2007) [22] studied on the selection of system suppliers and contract negotiation during the ERP implementation of a local construction company in Taiwan; therefore, they listed seven factors: coding system, working process reengineering, priority of ERP functionality implementation, customization, participant roles, consultant role and performance level of subcontractor which play significant role in successful implementing of ERP. Avison and Malaurent (2007) [1] mentioned cultural differences have significant impact on ERP implementation in Asia; also, Africa, America and Europe are after that respectively. Wei et al. (2005) [5] presented a seven steps comprehensive framework for selecting a suitable ERP system that it can systematically form the objectives of ERP selection to support the business aims and strategies of an enterprise, identify the appropriate attributes, and set up a consistent evaluation standard for facilitating a group decision process. Wei and Wang (2004) [6] proposed an eleven steps framework and hierarchical attribute structure for selecting an ERP project, using two dimensional analysis and fuzzy set theory.Xue et al. (2005) [7]they compared ERP systems between China and western countries and surveyed five defeats which vendors faced in China; hence, identified eight factors that play fundamental role in failures and categorized them in three categories: 1. Cultural diseases 2. Environmental differences 3. Technical issues.Sheu et al. (2004) [8] identified six nationaldifferences in ERP implementation: culture and language,government/corporate politics, management style, government regulations, time zone, and labor skills, and surveyed how they affect it.

3. Entropy and TOPSIS methodology

3.1. Shannon Entropy technique

Entropy was originally defined in1865 by Rudolf Clausius, however, Claude Shannon introduce dmodern entropy in 1948. The concept of Entropy is particularly notable as it is applied across physics, information theory, mathematics, and many other branches of science and engineering. Entropy is a measure of the uncertainty associated with a random variable [23-25].

It is assumed that we have a DM matrix:

$$\begin{array}{c|cccc} & X_1 & X_2 & \cdots & X_n \\ \hline A_1 & r_{11} & r_{12} & \cdots & r_{1n} \\ A_2 & r_{21} & r_{11} & \dots & r_{2n} \\ \vdots & \vdots & \vdots & & \\ A_m & r_{m1} & r_{m2} & \cdots & r_{mn} \end{array} \quad (1)$$

Step 1. Normalization: $p_{ij} = \dfrac{r_{ij}}{\sum_{i=1}^{m} r_{ij}}; \forall i, j$ (2)

Step 2. Compute Entropy: $E_j = -k\sum_{i=1}^{m}\left[p_{ij} \cdot \ln p_{ij} \right]; \forall j$, where k is equal to: $k = \frac{1}{\ln m}$ (3)

Step 3. Set $d_j = 1 - E_j; \forall j$ as the degree of diversification (4)

Step 4. Set $W_j = \frac{d_j}{\sum_{j=1}^{n} d_j}; \forall j$ as the importance of model[23, 24]. (5)

3.2. TOPSIS technique

TOPSIS is a technique that choose best alternative by similarity to ideal solution [26]; in the other words, selected alternative should have a minimum distance from ideal solution [23].

Krohling and Campanharo (2011) [26] explain TOPSIS as follows:

Firstly, normalization: $N = \left[n_{ij} \right]_{m\times n}, i = 1,...,m,\ j = 1,...,n;$ (6)

where $n_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{m} r_{ij}^2}}, i = 1,...,m,\ j = 1,...,n.$

Secondly, form normalized weighted DM matrix:

$$P = \left[p_{ij} \right]_{m\times n},\ i = 1,...,m,\ j = 1,...,n \quad (7)$$

where $p_{ij} = w_i \times n_{ij},\ i = 1,...,m,\ j = 1,...,n.$

The TOPSIS steps:

Step 1. Identifying positive (A^+) and negative (A^-) ideal solutions as:

$$A^+ = (p_1^+, p_2^+, ..., p_m^+)$$

$$A^- = (p_1^-, p_2^-, ..., p_m^-) \quad (8)$$

where

$$p_j^+ = (\max_i p_{ij}, j \in J_1; \min_i p_{ij}, j \in J_2)$$

$$p_j^- = (\min_i p_{ij}, j \in J_1; \max_i p_{ij}, j \in J_2)$$

where J_1 and J_2 represent the criteria A^+ and A^- respectively.

Step 2. Calculate the Euclidean distances from A^+ and A^- for each alternative A_i respectively as:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (d_{ij}^+)^2}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (d_{ij}^-)^2} \quad (9)$$

where

$$d_{ij}^+ = p_j^+ - p_{ij}, i = 1,...,m$$

$$d_{ij}^- = p_j^- - p_{ij}, i = 1,...,m$$

Step 3. Calculate the relative closeness ξ_i for each alternative A_i with respect to ideal positive solution as: $\xi_i = \frac{d_i^-}{d_i^+ + d_i^-}$ (10)

Step 4. Rank the alternatives according to the relative closeness. The best alternatives are those that have higher value ξ_i and therefore should be chosen because they are closer to the positive ideal solution [26].

4. RESULTS AND DISCUSSION

In this study, experts opinions were used for modifying modules and obtain optimal ones that are significant in an ERP system selection. Expert's team is composed of managers who have ERP implementation responsibility, experts from consulting companies, universities and Iranian software companies which produce ERP systems. At first, 22 modules were obtained from scientific papers [1-11] and a questionnaire was formed based on them, then a team was composed with 24 experts and were asked using questionnaire for modifying parameters; however, just 20 responded. Table 1 shows experts' opinions.

Table 1
Modules were obtained by experts' opinions

1)	**Customization**	**2)**	**Total cost**
3)	**Vendor's capabilities**	**4)**	**Vendor's reputation**
5)	**Cultural factors**	**6)**	**Implementation time**
7)	**Standardization**	**8)**	**Changing in organization's processes**
9)	**Support & services quality**	**10)**	**System quality**
11)	**Information quality**	**12)**	**User friendliness**
13)	**Goal and vision fit**	**14)**	**Risks**
15)	**System's reliability**	**16)**	**Quality of relationship with vendor**
17)	**System's impact on organization**		

In second step, ten experts were asked to weight modules. They modified 17 parameters to 14 (table 2) and then weighted them (table 3); table 4 represent E_j quantities.

Table 2
Modified modules

Variable	Module	Variable	Module
X_1	Customization	X_8	Information quality
X_2	Cultural factors	X_9	User friendliness
X_3	Implementation time	X_{10}	Goal and vision fit
X_4	Standardization	X_{11}	Risks
X_5	Changing in organization's processes	X_{12}	System's reliability
X_6	Support & services quality	X_{13}	Access to software's source
X_7	System quality	X_{14}	Total cost

Table 3
Weights of modules

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
A_1	8.8	8.9	20	2.6	2.4	7.6	3.4	3.1	8.3	8.2	2.4	3.8	8.1	0.5
A_2	2.1	1.4	60	7.3	8.3	2.2	6.6	7.5	2	2.2	8.6	6.1	1.6	4

Table 4
E_j quantities

	Module	E_j		Module	E_j
1	X_1	0.707	8	X_8	0.872
2	X_2	0.573	9	X_9	0.711
3	X_3	0.811	10	X_{10}	0.744
4	X_4	0.831	11	X_{11}	0.756
5	X_5	0.768	12	X_{12}	0.96
6	X_6	0.768	13	X_{13}	0.646
7	X_7	0.925	14	X_{14}	0.503

Then, modules were ranked with Shannon's entropy technique (table 5):

Table 5
Ranking of modules

Rank	Module	Weight	Rank	Module	Weight
1	X_{14}	0.145	8	X_5	0.067
2	X_2	0.124	9	X_6	0.067
3	X_{13}	0.103	10	X_3	0.055
4	X_1	0.085	11	X_4	0.049
5	X_9	0.084	12	X_8	0.037
6	X_{10}	0.074	13	X_7	0.021
7	X_{11}	0.071	14	X_{12}	0.011

In this step, TOPSIS technique was used; then, positive and negative ideal solutionswere defined (table 6) and the Euclidean distances were calculated (table 7):

Table 6

Positive ideal solutions and negative ideal solutions

Module	A^+	A^-	Module	A^+	A^-
X_{14}	0.018	0.144	X_6	0.018	0.064
X_2	0.122	0.019	X_3	0.064	0.018
X_{13}	0.101	0.02	X_4	0.017	0.052
X_1	0.082	0.019	X_8	0.046	0.016
X_9	0.081	0.019	X_7	0.034	0.014
X_{10}	0.071	0.019	X_{12}	0.018	0.009
X_5	0.019	0.068	X_{11}	0.009	0.005

Table 7

Euclidean distances

d_1^+ **= 0.0373**	d_1^- **= 0.226**
d_2^+ **= 0.226**	d_2^- = 0.0373

Ultimately, these results were obtained from TOPSIS: Cl_1=0.858, Cl_2=0.141.

5. Conclusion

Although Iranian ERP systems success rate is low, nevertheless, few surveys have been done for identifying its reasons and roots. Hence, for aiding Iranian software companies to improve their ERP systems and organizations who need these systems, more researches are needed. The researches on ERP systems in Iran are faced obstacles for many reasons and this study, not an exception; some of these barriers are: 1. Lack of ERP experts in Iran,2. Low number of companies which implemented ERP, 3. No or ultra low number of successful ERP implementation in Iranian companies, 4. Lack of real ERP software producers in Iran.

According to results which were obtained from this research, Iranian ERP software system with 85.8% of similarity to ideal solution is predominating on foreign one with 14.1%, because it has:

1.Less total costs, 2. Iranian companies access to its source, 3. Because of cultural factors, it is more friendliness with Iranian users, 4. Few risks, 5. Customization capability, 6. More services and support.

In this paper, were tried to help Iranian organizations and companies in selecting appropriate ERP system software process between Iranian software and foreign one. According to this survey, Iranian ERP software is a best choice for Iranian organizations. Finally, the following suggestions are offered: Firstly, According to high failure rate of ERP implementation in Iran, a comprehensive study on the reasons is recommended; Secondly, More studies on ERP customisation are suggested.

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