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E-readiness Measurement Through Fuzzy Analytical Hierarchy Process (FAHP) Case Study: Tehran Stock Exchange

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Abstract: Nowadays one of the most important negotiable and basic challenges of E-government development in less developed countries is lack of E-readiness for developing it. According to different researchers, in Iran also one of the reasons of less developing of E-government in governmental and none-governmental organizations is lack of E-readiness. According to the key role of Information Technology and its use in organizations, countries have tried to extend their social and economical situation in the world. In order to reach this aim, countries and organizations must increase their ability to taking part in networked world. In recent years, some researches have been done in e-readiness assessment field. Because governmental organizations play an important role in running e-government innovation then e-readiness of these organizations is progressive factors of e-government. Therefore this research tries to explain a new model for e-readiness assessment of governmental organization of Iran. This research with the review of the most important country and organization-based e-readiness assessment models and combining P3I3 and KPMG models, is paid to defining and calculating a comprehensive e-readiness assessment model by a fuzzy AHP approach. The advantage of FAHP in prioritizing qualitative criteria is used to Calculating e-readiness indicators. This model meets the Iranian IT industry conditions. finally, the weight of criteria has gained with FAHP method.

Key words: E-readiness Assessment (ERA), E-Government, Information Communication & Technology (ICT), Fuzzy Analytical Hierarchy Process (FAHP).

INTRODUCTION

Nowadays we see revival of old concepts and putting words as prefix letters e are these words; terms such as e-government e-business, e-learning and many of the other words. What apart from playing with the words is considered a challenge that shows how we can through electronic communication services to individuals in the age of global information society will (Rezayeie, 2005).Communications and information technology as a tool that enables companies to compete in the electronic environment makes electronic preparation and evaluation tool by means of which the emissions coefficient is measured and information communications technology (Fathian *et al,* 2008:580). E-commerce success is achieved only when the principles according to arrangements to provide e-readiness. Since different tools for e-readiness assessment by consulting firms and universities has been applied (Ruikar *et al*, 2005:100). E-readiness assessment is a new topic in IT industry that is used in two scopes: organizational and national. During recent years many tools have been developed for assessing E-readiness by many institutions and countries. Regardless to being new the ITC conception in the world in comparison with other Industries, there is a big gap in research and practical projects in Iran. E-readiness assessment model for Iranian governmental organizations was presented in 2005 and the comprehensive model for developing ITC was introduced in 2006 by Ali Ahmadi.Then, Bagheri by using that comprehensive modelassessed E-readiness of Tehran Stock Exchange (TSE) by applying AHP in 2007. This article assessed E-readiness of Tehran Stock Exchange by applying Fuzzy AHP (Hanafizadeh *et al*, 2008:106).

The Concept and Goal of E-Governance:

There are many definitions of E-Governance and every definition focuses on special aspects (Madon,2004). According to one of them, the E-Governance means using information technology for free information movement in order to omit traditional and physical systems(sachdeva, 2005:6).

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One of the most important steps for E-Governance implication is E-readiness assessment(Danish,2006:6) and one of the most applications of E-readiness assessment is defining a criteria for clarifying digital gap(Matthias,2006).

Definition of E-readiness Assessment:

The concept of e-readiness is important because its level can be a strong predictor of how well a country can perform in the new economy. An e-readiness assessment would provide policy makers with a detailed scorecard of their economy's competitiveness relative to its international counterparts (tung *et al,* 2003).There are many definition of E-readiness assessment (Ruikar, 2005:101). The Center of International Development (CID) in Harvard university in corporation with IBM company presents a new definition for E-readiness: "The degree to which a community's relative advancement in the areas that are most critical for ICT adoption and the most important applications of ICTs" (Danish, 2006).

E-readiness Assessment Tools:

E-readiness assessment has risen as a method and a tool for assessing readiness status of countries in terms of infrastructure necessary to participate in community planning and to fill the digital gap in this field between developed and developing countries. During recent years, many E-readiness assessment tools have been developed. These tools, generally focus on two level: organizational and national(Fathian *et al,* 2008:580).

***E-readiness Assessment Tools in Organizational Level*:**

There are four models for E-readiness assessment tools in organizational level. These models include: E-Business Maturity Model (EMM), Perceived e-Readiness Model (PERM), Klynveld-Peat-Marwick-Goerdeler and P3I3.

E-readiness Assessment Tools in National Level:

The Bridge institute has divided E-readiness assessment tools in 4 categories: The most important E-readiness assessment tools in organizational level include: The Asian Pacific Economic Cooperation model(APEC), Center for International Development model(CID), Center for International Development & Conflict Management model (CIDCM), Edward M. Crenshaw & Kristopher, K. Robinson model, Heeks model, McConnell International model, MOSAIC model, Computer Systems Policy Project model (CSPP), The World Information Technology and Services Alliance model (WITSA), The Massachusetts Institute of Technology model (MIT), World Economic Forum model, The Economist Intelligence unit model (EIU) (Fathian *et al,* 2008).

E-readiness Assessment Tools in Organizational Level:

There are four models of e-readiness assessment at the organizational level which state the readiness of the organization for e-commerce and reaching the e-government (Shoul,2005).These four models include: 1- E-Business Maturity Model (EMM), 2- Perceived e-Readiness Model (PERM), 3- Klynveld-Peat-Marwick-Goerdeler (KPMG) and, 4- P_3L_3.

Analytic Hierarchy Process (AHP):

The classic AHP model is an applied method in solving the Multiple Criteria Decision Making (MCDM) models. It was first introduced by Saaty in 1971 (Azar & faraji,2007). AHP decreases the infirmity of classic AHP technique in which the absolute numbers are used for qualitative evaluations. The Fuzzy Numbers Theory was first introduced by Professor Lotfizadeh in 1965 (Amy *et al*, 2007:99).Fuzzy numbers are the distributed form of absolute numbers. The fuzzy set called N, of the real numbers set of R is a real fuzzy number if it owns three characteristics of convexity, normality and single exponential and cohesion (momeni,2006). One of the most useful fuzzy numbers is Triangular Fuzzy Number (TFN). Each TFN has three factors and is shown as M= (l,m,u) (Shavandi,2007). (Figure 1).

Generally, two fuzzy numbers are de-fuzzed and are converted to absolute numbers to get compared. The most important methods of de-fuzzication are: Average method, Mean Center method and Rift method (momeni,2006). In mean center method, the following equation is used for converting the fuzzy numbers to absolute numbers:

$$\forall i, j \quad A_{ij} \ \frac{(UE_{ij} - L_{ij}) + (M_{ij} - LE_{ij})}{3} + a_{ij} \tag{1}$$

Conceptual Model of E-readiness Evaluation of Organization:

The conceptual model of e-readiness evaluation includes six main dimensions:Managerial Commitment, Information Technology (IT) Infrastructures, IT Policies and Strategies, Managerial Specialized Dimensions, Human Resource Development and IT-based Processes.

The introduced models of e-readiness evaluation have different dimensions. The conceptual model of this paper has been obtained by integrating two models of KPMG and P3I3. This model covers the important criteria and sub-criteria of other existing models of e-readiness evaluation (Shavandi, 2007).

Research Methodology:

This research is an applied research and the tool for data collection is questionnaire. The population contains 2 PhD experts, 20 masters and 9 bachelors who are quite well aware of IT and stock exchange facts. Finally, by using the model in stock exchange organization, 40 questionnaires were distributed among the managers and experts, of which 35 questionnaires were answered and 31 were instrumental.

Validation of the Model:

To evaluate the validity of the model, six main questions have been used. According to the number of respondents sideway T-test has been applied and the error level is 5% ($\alpha = 0.05$). As it is presented in table (1), all of the hypotheses have been confirmed. In all of these hypotheses, the null hypothesis has been more than average of Likret.

Reliability Evaluation:

For evaluating the reliability of the questionnaire which contains 30 questions of Likret, Chronbach' Alpha Coefficient has been used. The questions belong to six areas of main criteria of e-readiness evaluation. The population includes 31 experts of the organization and the reliability has been measured by Chronbach' Alpha which is $\alpha = 0.94$. As this α is close to 1, the reliability of the questionnaire was confirmed. In table (2) the results of this measurement which have been done by SPSS 14 software, are presented.

As it is shown in table (2), two coefficients of Alpha have been calculated:

- Alpha coefficient
- Alpha coefficient of standardized values

The standardized alpha coefficient is used when the considered values for obtaining the average and standard deviation have been converted to Z standard, so the calculated Chronbach' alpha which is 0.94, confirms the reliability of the measurement scale in this research.

Data Analysis and Findings of the Research:

In this phase, the analysis of collected data has been done through FAHP method. First, six main criteria have been evaluated in one matrix and then the criteria of any of the six criteria of e-readiness evaluation model have been evaluated in separated matrixes. The questionnaire has been used for data collection in which the numbers are TFN and the used spectrum is also fuzzy (Table 3).

Following equation:

$$ERM = \sum_{i=1}^{6} a_i * b_i \quad (2)$$

a_i = the primary mark of i-th index;

b_i= the weight of i-th index.

To calculate the primary mark of the indicators, a questionnaire has been used containing 31 questions regarding the criteria and sub-criteria of e-readiness evaluation. As the answers of each question own the values of 1 to 5, the score of each question will be among 1 to 5. Hence, a numerical average is considered for each question and the primary mark of each index is obtained. The weight of each index is also equal to the row average of normalized matrix of duad comparisons. By calculating the weights of duad comparisons, the mark of each main criterion was evaluated and of the sum, the total mark of e-readiness in stock exchange was measured. A summary of the results of evaluation is presented in table (7).

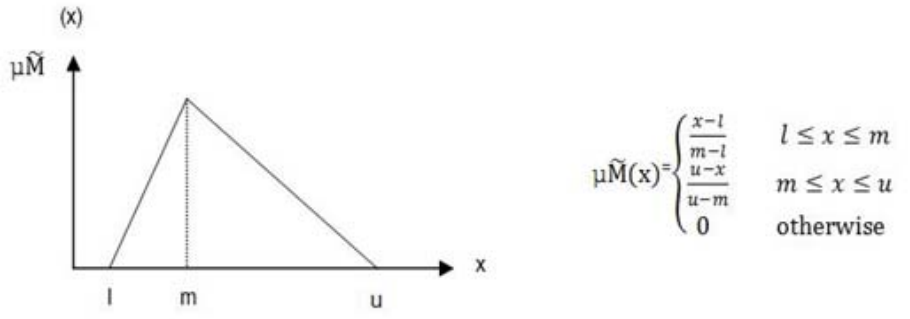

Fig. 1: TFN and its membership function (Shavandi, 2007).

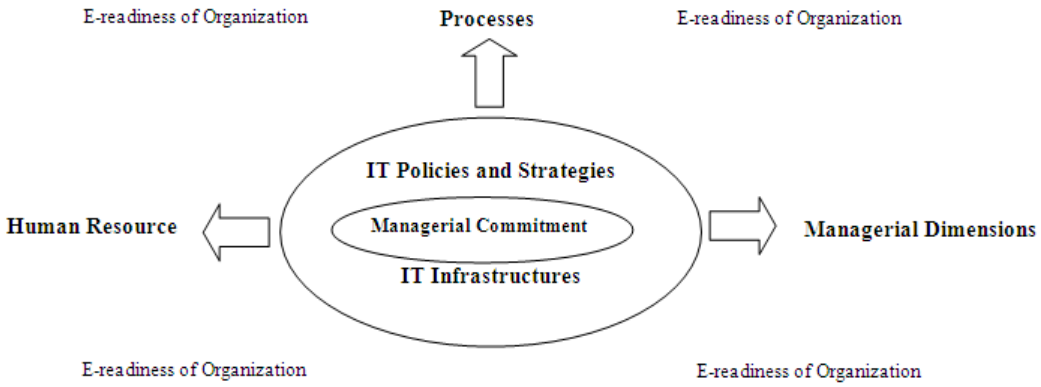

Fig. 2: The Conceptual Model of E-readiness Evaluation of Iran Organizations (Baqerinejad and saaty, 2006:16).

Table 1: The results of Validation Test of the Model.

No.	The hypothesis of Validation	T	P-value	Result
1	The criteria and sub-criteria of the model are logical and more than average	1.90	0.035	Null hypothesis confirmed
2	The presented model, more than average, is easily useful.	0.32	0.377	Null hypothesis confirmed
3	The model, more than average, can be used for different organizations.	1.48	0.075	Null hypothesis confirmed
4	The model, more than average, is complete for the considered objective.	1.04	0.165	Null hypothesis confirmed
5	The main criteria of the model, more than average, are sufficient for evaluation.	2.20	0.0192	Null hypothesis confirmed
6	The sub-criteria cover the main criterion more than average.	0.28	0.391	Null hypothesis confirmed

Table 2: the results of reliability evaluation.

N of Items	Cronbach's Alpha Based on Standardized Items	Cronbach's Alpha
30	0.948	0.947

Table 3: Applied fuzzy spectrum

Definitions	Priority of the row to column			Priority of the column to row		
	Fuzzy numbers			Fuzzy numbers		
Equal importance	1	1	1	1	1	1
Rather more important	2.33	3	3.67	0.27	0.33	0.43
Much importance	4.33	5	5.67	0.18	0.20	0.23
Very much importance	6.33	7	7.67	0.13	0.14	0.16
Absolutely more important	8.33	9	9.67	0.10	0.11	0.12

Table 4: The integrated matrix of sextet criteria

Main criteria matrix	Managerial commitment			IT policies and strategies			Managerial specialized dimensions in organization		
Managerial commitment	1	1	1	3.70	2.59	2.90	2.25	1.87	1.52
IT policies and strategies	0.48	0.39	0.27	1	1	1	1.89	1.50	1.16
Managerial specialized dimensions in organization	0.66	0.53	0.44	0.86	0.67	0.53	1	1	1
IT human resource development	1	1	1	0.97	0.80	0.66	0.74	0.62	0.53
IT infrastructure	1.50	1.25	1.03	1	1	1	1.08	0.62	0.52
IT-based processes	1.87	1.60	1.34	1.91	1.60	0.92	1	1	1

Then, the obtained fuzzy numbers have been de-fuzzed through the area center method.

Table 5: de-fuzzed matrix of sextet criteria

Main criteria matrix	Managerial commitment	IT policies and strategies	Managerial specialized dimensions in organization	IT human resource development	IT infrastructure	IT-based processes
Managerial commitment	1.00	3.87	2.37	3.79	3.63	2.94
IT policies and strategies	0.52	1.00	2.00	4.36	4.36	1.10
Managerial specialized dimensions in organization	0.69	0.91	1.00	3.45	2.05	1.79
IT human resource development	0.40	0.35	0.46	1.00	1.02	0.77
IT infrastructure	0.43	0.35	0.77	1.57	1.00	1.11
IT-based processes	0.58	1.42	0.94	1.96	2.14	1.00
Sum of column	3.62	7.90	7.54	16.33	14.20	8.71

In the next phase, the weight of each criterion has been calculated (Table 6).

Table 6: Normalized matrix of dual comparisons of sextet criteria.

Main criteria matrix	Managerial commitment	IT policies and strategies	Managerial specialized dimensions in organization	IT human resource development	IT infrastructure	IT-based processes	Row average
Managerial commitment	0.28	0.49	0.31	0.24	0.26	0.34	0.32
IT policies and strategies	0.14	0.13	0.27	0.27	0.31	0.13	0.21
Managerial specialized dimensions in organization	0.19	0.11	0.13	0.21	0.14	0.21	0.17
IT human resource development	0.11	0.04	0.06	0.08	0.07	0.09	0.07
IT infrastructure	0.12	0.04	0.10	0.10	0.07	0.13	0.09
IT-based processes	0.16	0.18	0.12	0.12	0.15	0.11	0.14

Table 7: total mark of e-readiness in Tehran' stock exchange.

No.	Main Criterion	Primary Mark	Weight	Total Mark
1	Managerial commitment and emphasis on using IT	3.75	0.32	1.20
2	IT policies and strategies in organization	2.31	0.21	0.48
3	Managerial specialized dimensions in organization	1.78	0.17	0.30
4	IT human resource development	1.98	0.07	0.15
5	IT infrastructure	3.70	0.09	0.28
6	IT-based processes and the benefits of its application	2.55	0.14	0.36
	Total mark of e-readiness in stock exchange			2.78

Results and Recommendations:

This paper presents a method of an organization e-readiness evaluation through Fuzzy AHP method. FAHP provides much precise results than AHP. In this paper, the mark of e-readiness and ranking of the criteria of e-readiness evaluation of stock exchange organization have been obtained through this method. Therefore, the most important results of this research are as following:

1- This research showed the method of evaluating the e-readiness in stock exchange organization while describing its definitions. The model of systematic e-readiness evaluation has been presented as a tool for the managers to evaluate the e-readiness and providing improving strategies based on fuzzy sets theory and AHP approach.

2- Final mark of e-readiness evaluation of stock exchange organization is 2.78 and according to the maximum mark which is 5, it suggests that the organization must create the required strategies to reach a higher e-readiness mark. Also, ranking of six main criteria of e-readiness are as following:

- Managerial commitment: 0.32
- IT policies and strategies: 0.21
- Managerial specialized dimensions in organization: 0.17

- IT-based processes: 0.14
- IT infrastructure: 0.09
- IT human resource development: 0.07

Stock exchange brokerages and other financial institutes also can apply this model for their periodic e-readiness evaluations.

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