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Identifying and Ranking Technology-Telecommunications Context of Information Security Management System in E-Government Using Fuzzy AHP Approach

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Abstract. In recent years, many security threats have entered into the organizations' information and changed the organizational performance resulting in their exorbitant costs. This question is of particular importance about government agencies that use information and Internet systems. This issue enabled the top managers of organizations to implement a security system and minimize these costs. Using Information Security management system is considered as a tool to promote information security and information systems. According to research conducted, four contexts of legal, technical communication, organizational-managerial, and cultural and social have been detected in the effective establishment of information security management system in electronic government. The aim of the present study is to identify and rank the sub-criteria of technical- communications for the effective establishment of information security management system in electronic government. For this purpose, by reviewing the literature, a list of important criteria was developed and the sub-criteria of technical-communications for the effective establishment of information security management system were

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identified and classified into six general areas by conducting interviews with experts and completing a questionnaire. Then a census and paired comparison questionnaire of experts were carried out and the criteria were weighted and ranked with the analysis of data through fuzzy AHP approach.

Keywords: E-government; information security management system; technical-telecommunications context; fuzzy AHP.

1. Introduction

In the present era, information is of particular importance as a strategic resource and a key competence. Thus the issue of information security has been high on the agenda of governments for the correct use of this resource. With the tremendous advances in the tools and technologies used to transfer this information and due to the widespread use of electronic information technologies in the public sector, most commercial transactions, transactions, organizational processes and services have been distorted from traditional to electronic form and has created a concept called e-government. Successful adoption of new technology helps the government to provide public services efficiently [10]. E-government has been used as the use of ICT, especially the Internet, to increase the level of access citizens, government agencies, employees of public sector and online private sector companies [8]. Risk analysis, concentrating on assets, threats and vulnerabilities, used to play a major role in helping to identify the most effective set of security controls to protect information technology resources. To successfully protect information, the security controls must not only protect the infrastructure, but also instill and enforce certain security properties in the information resources [12]. Using these new ways of interaction in the government, new aspects of security threats have also emerged and the need for information security management system implementation in e-government is inevitable. In e-government that the communications have been established between people and the government together special attention should be paid to security issues. On the other hand the most important mission of computer networks is hardware and software resources sharing and quick and easy access to information. Control of access and

usage of resources that are shared are considered as the priorities of a network security system. In this regard, it is necessary for any organization to follow a specific strategy to protect valuable to run the security system. In our country, due to the importance of implementing an information security management system and the greatest impact on technical-communications, we rank the sub-criteria of this context and implement it in the e-government based on the priorities.

2. Literature Review

Security is one of the most important issues in E-governance. Nowadays, in information era, providing information assets security has become one of the major challenges in organizations. Some researchers have likened the information to blood in the organization's vessels which is considered as a life-giving factor [9], and if the blood circulation is restricted or endangered, the organization will be faced with death [3]. Given that modern economics and businesses completely depend on IT to survive; the need to protect information has already increased [7]. The ISMS is framework which has presented three views which are confidentiality, integrity, and availability to protect information [11]. Security management confronts the risk of violent and rapidly changing scenarios and addresses the vulnerability of humanitarian agencies in the midst of such a risk: It therefore must be a dynamic and "ever green" system, a framework to guide and provide consistency for future decisions made incrementally [6]. Norris and Moon (2005), Ebrahim and Irani (2005) and Wimmer and Bredow (2001) have all published articles concerning security and privacy issues in e-government. It is noted that, in fact, e-government itself has become a major contributor to these issues due to its basic concepts of openness and availability. Many developing countries have yet to consider adopting adequate legislation related to information security management, laws that criminalize cyber-attacks and enable police to adequately investigate and prosecute such activities [12]. In addition, many do not have privacy or network security laws or regulations which could be used to take action against the misuse of ICT resources [1,2]. Security is traditionally concerned with information

properties of confidentiality, integrity and availability these properties underpin services such as user authentication, authorization, accountability and reliability [5].

3. Methodology

Analytical Hierarchy Process (AHP) is one of the ways that is used for decision making and choosing an option from among several options, due to the factors determined by the decision-maker. This approach was developed by Tomas Saaty in 1980. Analytic hierarchy process reflects the normal behavior and human thought. This technique examines the complex issues based on their interactional effects and resolve them simply to make deals. Applying this method involves four major steps:

Step 1. The first level represents the main objectives of the decision making process. Second level represents the basic indicators and third level provides decision options.

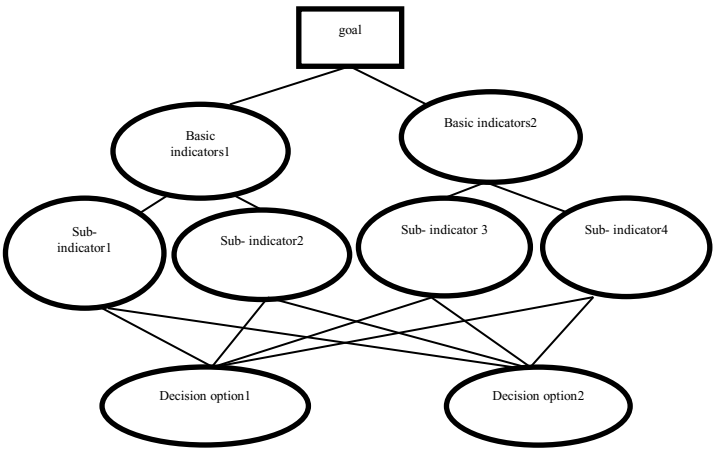

Figure1. Hierarchical modeling

Step 2. Preferred judgment: Comparisons between the various options of option are done based on each indicator. This is done by comparing

the pairs of elements (paired comparison) by assigning numerical scores indicating the superiority of either of the two elements. The computed weight is called relative weights. For this, usually the criteria of the following table are used for comparing the options or i th indicators with respect to the j th options or indicators.

Table 1. Comparing the options or i th indicators with respect to the j th options or indicators

Values	(Preferences)
5	Extremely Preferred
4	Very Strongly Preferred
3	Strongly Preferred
2	Moderately Preferred
1	Equally Preferred

This matrix will be completed according to the following assumptions:

If the element of i th row is preferred than the element of j th column then the j th element is preferred as than the i th element.

Step 3. Relative weight calculations: Weight and significance of "decision elements" are determined through a series of numerical calculations.

These operations are summarized as follows:

1. Calculate the total number of paired comparisons matrix for each column, then divide column element on the total of numbers in that column. the new matrix that is obtained in this way, is called the normalized comparison matrix.

2. Find the average numbers in each row of the normalized comparison matrix. The average relative weight shows the corresponding rows of the matrix elements.

To determine the best option, matrix priority (weight) vector indices in the index is multiplied.

Step 4. Integration with relative weights: This step is done in order to determine the ranking of options.

Steps to calculate the consistency ratio

1. Calculate the vector sum of the weighted matrix of paired comparisons of the relative weight of the column vector multiply. That way you get a new vector, the vector sum of the weights (weighted sum vector = WSV).

2. Calculate the adjustment vector: Vector elements of the vector are the weighted sum of the relative priority share. The resulting vector, vector adaptation (consistency vector=CV).

3. Obtaining λMax: Average compatibility λMax gain vector elements.

4. Obtain λMax: mean vector elements to achieve consistency index λMax consistency: consistency index=CI is defined as follows (n is the number of options on issue).

$$CI = \frac{\lambda Max - N}{N - 1} \tag{1}$$

5. Calculate the consistency ratio: the ratio of consistency index and consistency index divided randomly (random index=RI) is obtained.

$$CR = \frac{CI}{RI} \tag{2}$$

Chang in 1992, a very simple way to extend the analytic hierarchy process, fuzzy space provided. This method is based on the arithmetic mean of expert supervision and the normalized time using triangular fuzzy numbers has been developed, researchers were welcomed.

Triangular fuzzy number to be greater degree of probability $\mu 2 = (l2, m2, u2)$ than the triangular fuzzy number $\mu 1 = (l1, m1, u1)$ mathe-

matically it is defined as follows:

$$(M2 > M1) = Sup(y \geqslant x)[min)\mu M1(x)\mu M2(y)] \tag{3}$$

This relationship can also be expressed as follows:

$$(M2 > M1) = hgt(M2 \cap M1) = \mu Mz(d) \tag{4}$$

d: Coordinates of the intersection point of two membership functions $\mu M1, \mu M2$

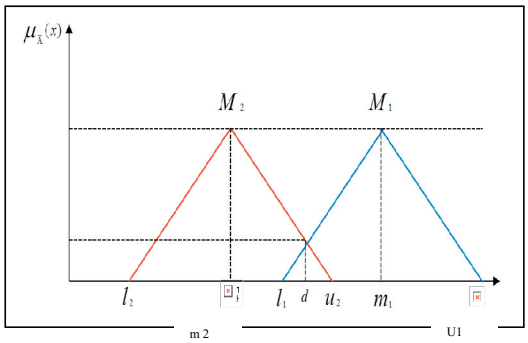

Figure 2. Triangular fuzzy number to be greater degree of probability

Verbal expressions Chang method can be expressed as follows:

Table 2. Verbal expressions Chang method

Reverse fuzzy number	Triangular fuzzy number	Verbal Phrase
(1‹1‹1)	(1‹1‹1)	Equally important
(1/5,1/3,1)	(1,3,5)	Slightly important
(1/7,1/5,1/3)	(3,5,7)	More important
(1/9,1/7,1/5)	(5,7,9)	Very important
(1/9,1/9,1/7)	(7,9,9)	Totally important

4. Stages of Chang Method

Step 1: Drawing a hierarchical tree: In this phase, the hierarchical structure using standard target levels and the option to draw.

Step 2: Paired judgment matrix agreed upon experts in the form of a decision tree and uses a fuzzy triangular numbers following matrix can form.

Step 3: Arithmetic Average Reviews: Calculate the arithmetic mean opinion makers to the following matrix are obtained:

$$\begin{bmatrix} (1,1,1) & \left\{\begin{matrix}\tilde{a}_{121}\\ \tilde{a}_{122}\\ \vdots\\ \tilde{a}_{12p_{12}}\end{matrix}\right\} & \cdots & \cdots & \left\{\begin{matrix}\tilde{a}_{1n1}\\ \tilde{a}_{1n2}\\ \vdots\\ \tilde{a}_{1np_{1n}}\end{matrix}\right\} \\ \left\{\begin{matrix}\tilde{a}_{211}\\ \tilde{a}_{212}\\ \vdots\\ \tilde{a}_{21p_{21}}\end{matrix}\right\} & (1,1,1) & \cdots & \cdots & \left\{\begin{matrix}\tilde{a}_{2n1}\\ \tilde{a}_{2n2}\\ \vdots\\ \tilde{a}_{2np_{2n}}\end{matrix}\right\} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \left\{\begin{matrix}\tilde{a}_{n11}\\ \tilde{a}_{n12}\\ \vdots\\ \tilde{a}_{n1p_{n1}}\end{matrix}\right\} & \left\{\begin{matrix}\tilde{a}_{n21}\\ \tilde{a}_{n22}\\ \vdots\\ \tilde{a}_{n2p_{n2}}\end{matrix}\right\} & \cdots & \cdots & (1,1,1) \end{bmatrix} \xrightarrow{\tilde{a}_{ij}=\frac{\sum_{k=1}^{p_{ij}} a_{ijk}}{p_{ij}}}$$

$$\begin{bmatrix} (1,1,1) & \tilde{a}_{12} & \cdots & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & (1,1,1) & \cdots & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & \cdots & (1,1,1) \end{bmatrix}$$

Step 4: Calculate the sum of the row elements: Calculate the sum of rows:

$$M_i = \frac{S_i}{SS} = S_i \times [SS]^{-1}$$

Step 5: normalized out of the rows weights normalized by the sum of each row is divided by the sum of total rows.

$$\tilde{S_i} = \sum_{j=1}^{n} \tilde{a_{ij}} \qquad i = 1, 2, ..., n \tag{6}$$

Step 6: Setting up a greater likelihood of being
At this stage, the degree of risk is greater than any of the other M_i M_i is weighed. To the original non-normalized weights to obtain the desired matrix
M-convex fuzzy number to be greater degree of risk than other K-convex fuzzy number $(i = 1, 2, 3, ..., k; M_i)$ is expressed as follows:

$$V(M \geqslant M1, M2, ..., M3) = V[(M \geqslant M1), (M \geqslant M2), ..., (M \geqslant M3)] =$$

$$minV(M \geqslant M_i) \qquad i = 1, 2, ..., k \tag{7}$$

The formula for calculating the degree of probability is greater $M2(d) = V(M2 > M1)$

$$= \begin{cases} 1 & \text{if: } m_2 \geq m_1 \\ 0 & \text{if: } l_2 \geq u_1 \\ (l_1\text{-}u_2) \,/\, ((m_2\text{-}u_2)\text{-}(m_1\text{-}l_1)) & \end{cases} \tag{8}$$

Step 7: Add the vector of normalized weights
To the vector of normalized weights, the weight of each element it is necessary to divide the weight of the total entries, mathematically we have:

Step 8: Combining weights with the option of combining weights and measures, the option to obtain the final weights:

$$\tilde{U}i = \sum_{j=1}^{n} Wi \;\; rij \tag{10}$$

5. Tools

1: The questionnaire was designed to identify the sub-criteria technical-effective communications context for the effective deployment information security management system was designed for the study. Using questionnaires 1 expert opinion about the addition, deletion or merge criteria and how to classify them, face to face interviews were collected.
Questionnaire 2: aimed at calculating the importance and weight of six main factors are identified, based on n = 5 scale based on fuzzy AHP method is designed. In such a way that the audience will see if the first agent is superior to the second factor (the degree of dominance is presented based on the table 1) the right to choose the numbers and the numbers are otherwise left. For sample number 5 on the right shows the row numbers the right to choose the numbers and the numbers are otherwise left. For sample number 5 on the right shows the row numbers Respondents believed that the first criterion is of greater importance than the benchmark. As mentioned in the table1 select the number 1 by the audience to indicate important criteria are the same. The questionnaires were distributed among experts of various government agencies. Team members include managers and central decision-making. On the other hand, most of the questions in order to better understand the questionnaire asked respondents to provide a description of the researcher has been completed. In some cases, the questionnaire was sent by mail, by telephone, description was provided to them.

The population of this research includes the experts and the experts and university professors-who are also familiar with the general information security management system. Since the population of this research is limited, sampling is unnecessary and surveys among experts that have the desired characteristics will be collected and distributed.

6. Findings

According to the experts in the study organizations, the sub criterion of monitoring the outsourcing software with the relative weight of 0.24 has assigned the highest weight to itself. To determine the best option, matrix priority (weight) vector indices in the index multiplied-is.

Table 3. Prioritization the sub-criteria

The relative weights in fuzzy mode	The main criteria	Row
0.24	Monitoring outsourcing software	1
0.22	Isolation of sensitive systems	2
0.18	Network routing control	3
0.15	Technical vulnerability management and penetration testing	4
0.13	Supply and maintenance	5
0.08	Physical and environmental security	6

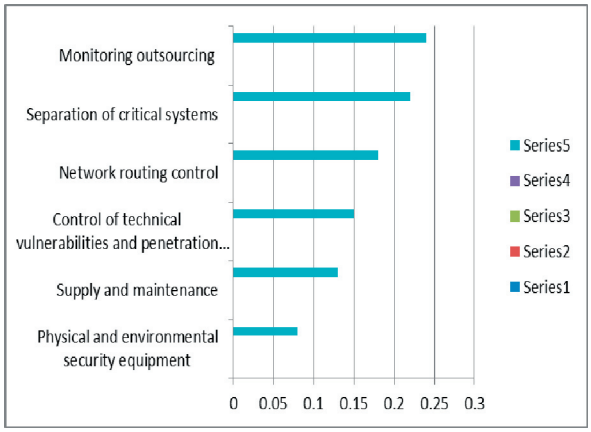

Figure 3. Prioritization the sub-criteria

Figure 2 shows Prioritization the sub-criteria this area. Compare Rates incompatibility of the two fore section the sub-criteria field of technical areas-telecom inventory (2) Research ($CRm = 0.089$) and ($CRg = 0$) are.

Ranking the six-item criteria of technical-communications context for the effective deployment of information security management system, in e-government suggests that the monitoring area is of paramount importance in view of professional managers and decision-makers in government agencies of Zahedan. Unlike the researcher's opinion, from the perspective of decision-makers, managers and professionals, monitoring the outsourcing software is of great importance than the sub-criteria of technical vulnerability and penetration testing. This shows that the overall view governing the organization is not only based on technical controls. It seems that such view in the study organizations increases the level of sub-criteria of vulnerability and penetration testing, network routing and control systems are susceptible to separation.

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