AN AHP FRAMEWORK FOR HOSPITAL INFORMATION SYSTEMS' EVALUATION: THE CASE OF TEHRAN PRIVATE HOSPITALS

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–Abstract–

E-health is defined as the use of electronically–supported applications in the field of healthcare. One of the subsidiaries of e-health is Health Information System (HIS), more specifically Hospital information System (HoIS) which has been recently transformed from paper-based Information System (IS) into electronic one. Although not all healthcare organizations have gone through the transformation process completely, the evaluation of HIS has been the concern of many scholars. In this paper, a hierarchical structure for HoIS evaluation is developed using the available recent literature. Subsequently, Analytic Hierarchy Process (AHP)-based questionnaires were designed and data was collected from HoIS professional users and experts working at Tehran Private Hospitals. The respondents were asked to make pairwise comparisons between each two criteria regarding their importance in the HoIS evaluation process. By employing Group AHP method, weights will be assigned to each criteria presented in the hierarchical structure and the final framework can be used as a guideline for healthcare managers and HoIS software providers.

Keywords: *E-health, Hospital Information Systems, Analytic Hierarchy Process (AHP)*
JEL Classification: I100

1. INTRODUCTION

E-health is defined as "the healthcare practice which is supported by electronic processes and communication" (Rodrigues, 2010: xlvii). E-health encompasses a range of services such as m-health, e-healthgrids, electronic medical records (EMR), consumer health informatics, health knowledge management and healthcare information systems (Rodrigues, 2010: xlvii).

Hospital information system (HoIS) is a classification of health information system (HIS) (Rodrigues, 2010: xl; Yusof et al, 2008: 379). Hospital information system contains subsystems which vary from different points of views. In this paper, HoIS is studied as a system including the following sub systems: admission information system, outpatient information system, hospital ward information system, pharmacy information system, laboratories information system, radiology information system, operating room information system, medical document information system and discharge information system (Deputy of Research and Developement, 2009)

The evaluation of HIS has been concern of many scholars and healthcare organizations' managers. Most healthcare organizations conduct HIS evaluation process minimum once annually and as a result, they require a comprehensive practical guideline. There are some challenges and problems in the evaluation of HIS which were defined in three main problem areas named as follows: the complexity of the evaluation object, the complexity of an evaluation project and the motivation for evaluation (Ammenwerth et al, 2003: 127).

The complexity of evaluation problem implies that evaluation requires understanding of both computer technology and social-behavioral processes; processes affect and are affected by technology (Ammenwerth et al, 2003: 127)

Complexity of the evaluation project is said to originate from the real and complex health care environment with its different professional groups and also its high dependency on external influences (Ammenwerth et al, 2003: 128)

In the third problem area, it is suggested that stakeholders' lack of motivation may have negative impacts on the funding of the evaluation and also the number of participants (Ammenwerth et al, 2003: 130).

Despite all the problems and challenges, the evaluation frameworks and criteria have been suggested for HIS (Yusof et al, 2008: 389) and some related systems including: district health management information systems (Odhiambo-Otieno, 2005: 34), health information infrastructure (Labkoff, Yasnoff, 2007: 104), district health information systems (Hanmer,1999: 165-166) and E-health (Rodrigues, 2010: 15-20). However, the importance of diverse criteria is not determined in most studies.

The central purpose of this paper is to propose an Analytic Hierarchy Process (AHP) framework for the evaluation of HoIS. A hierarchical structure for E-health evaluation is developed based on recent literature (Rodrigues, 2010:18-20). These criteria were selected for two main reasons: Firstly, they are the most compatible criteria with AHP method. Secondly, according to the scholars proposed the criteria, all technical, economic and social dimensions were considered in criteria selection. AHP method techniques are then, used to determine the importance of each criterion presented in the evaluation of Hospital Information Systems.

2. ANALYTIC HIERARCHY PROCESS (AHP)

AHP is a multi-criteria decision making (MCDM) method. It was first suggested by T.Saaty in 1970s (Asgharpour, 2011: 298). This method has been used for evaluation in various areas such as operators evaluation, software evaluation, evaluation of website performance, firms competence evaluation, sustainability evaluation, organizational performance evaluation, technology evaluation and university evaluation (Ishizaka, Labib, 2011: 14336- 14337). AHP allows both qualitative and quantitative approaches to solve complex decision problems (Wong, Li, 2008: 115). In qualitative approach, AHP decomposes the problems into a hierarchy of elements(objectives, criteria, sub-criteria) in different levels (Wong, Li, 2008: 115). In quantitative approach, AHP can prioritize attributes and determine their level of importance by means of pairwise comparisons' judgements." The pair-wise comparison judgments are made with respect to the attributes of one level of hierarchy given the attribute of the next higher level of hierarchy (from the main criteria to the sub-criteria)" (Wong, Li, 2008: 115). The steps of AHP method can be summarized as: developing a hierarchy structure,

making pairwise comparisons, running consistency tests and calculating weights of each element.

3. METHODOLOGY

At first step, a hierarchy with the objective of "evaluation of hospital information systems" is developed (figure1).There were 13 pairwise comparisons' matrices with respect to the hierarchical structure. These matrices were then, distributed among three groups of questionnaires regarding the dimensions they seek information about. Besides, reducing the number of pairwise comparisons in a questionnaire help the decision makers to make decisions with more consistency. The economic matrices were put in the first group, whereas the technical and social matrices were randomly included in the other two groups. HoIS experts and professional users working at 12 Tehran Private Hospitals were asked to complete the questionnaires. The numbers of both completed questionnaires and matrices in each group are represented in table 1.

Table 1: Numbers of both completed questionnaires and matrices in each group

Questionnaire's group	Number of completed questionnaires	Number of matrices
1	7	4
2	30	4
3	27	5

The consistency ratio (CR) values were computed for each matrix and the matrices which their CR values are larger than 0.1, were not considered in the analysis (Asgharpour, 2011: 308). As Aczel and Saaty stated, the best method for integrating judgments in group-decision making is employing geometric mean (Ghodsipour, 2011: 110). The geometric means of each consistent judgment were determined and the weights of elements were calculated using the geometric mean weighting method.

The content validity of questionnaires was confirmed by HoIS experts.

4. Results

In table 2, the assigned weights for each element are represented.

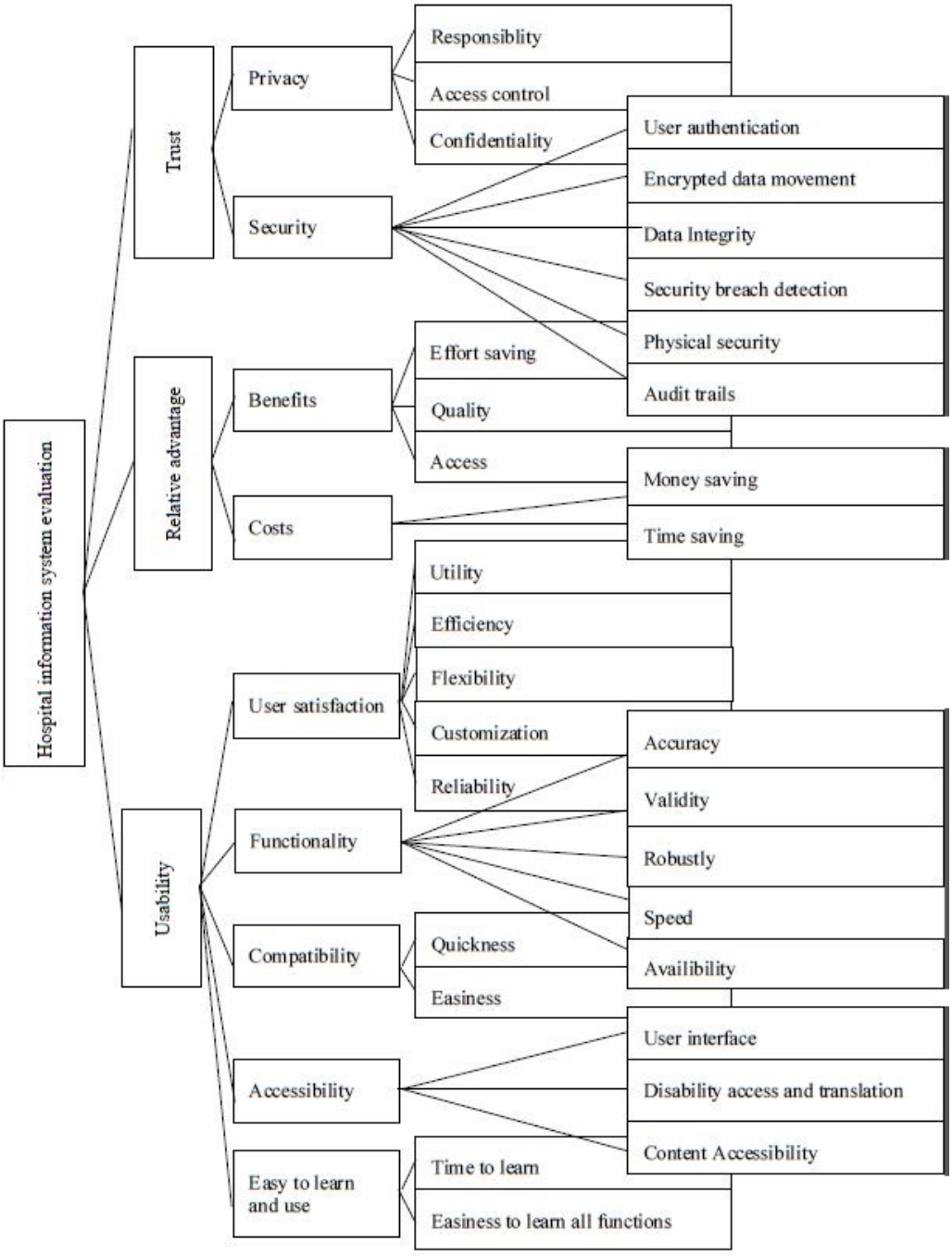
Among the criteria defined for the evaluation of hospital information system, trust is the most important one. Relative advantage and usability are in second and third place of importance, respectively.

There were two criteria for trust: privacy and security which privacy is more important. For privacy itself, three criteria were taken into account which are as follows with respect to their importance: responsibility, confidentiality and access control. For trust the priorities of criteria are: data integrity, security breach detection, audit trails, encrypted data movement, physical security and user authentication.

Two criteria were defined for relative advantage: benefits and costs which benefits criterion is of greater importance than costs. The order of criteria for benefits regarding their importance is: quality, access and effort saving. The order of criteria for costs with respect to their importance is as follows: time saving and money saving.

Functionality, accessibility, user satisfaction, easiness to learn and use and compatibility are usability criteria in order of importance. User satisfaction criteria priorities are: efficiency, reliability, utility, flexibility and customization. Functionality criteria priorities are also as follows: accuracy, robustly, availability, validity and speed. There were two criteria for compatibility: quickness and easiness which quickness is more important. The criteria of accessibility, in order of importance, are: content accessibility, user interface and at the last place, disability access and translation. Among the two criteria defined for easiness to learn and use, easiness to learn all functions is of greater importance than the time required learning the functions.

Figure-1: Hierarchy of "evaluation of hospital information systems"



Source: Constructed by the authors according to literature review

Table 2: Assigend weights for elements of hierarchical structure

Level 1	Level2	Level3	Level 4
Hospital information system evaluation	Trust 0.663	Privacy 0.718	- Responsibility 0.459 - Access control 0.269 - Confidentiality 0.272
		Security 0.282	- User authentication 0.112 - Encrypted data movement 0.145 - Data integrity 0.239 - Security breach detection 0.193 - Physical security 0.121 - Audit trails 0.190
	Relative advantage 0.282	Benefits 0.747	- Effort Saving 0.054 - Quality 0.526 - Access 0.420
		Costs 0.253	- Money saving 0.441 - Time saving 0.559
	Usability 0.055	User satisfaction 0.201	- Utility 0.225 - Efficiency 0.287 - Flexibility 0.143 - Customization 0.077 - Reliability 0.268
		Functionality 0.381	- Accuracy 0.328 - Validity 0.121 - Robustly 0.272 - Speed 0.118 - Availability 0.161
		Compatibility 0.092	- Quickness 0.634 - Easiness 0.366
		Accessibility 0.209	- User Interface 0.189 - Disability access and translation 0.153 - Content Accessibility 0.658
		Easy to learn and use 0.117	- Time to learn 0.360 - Easiness to learn all functions 0.640

Source: Constructed by the authors (elements are according to literature review)

5. Conclusion

Hospital information systems are considered as part of both health information systems and E-health. There have been efforts made to propose frameworks for the evaluation of E-health and HIS. However, there are not much empirical studies concentrated mainly on hospital information systems.

In this paper, a hierarchical structure for the evaluation of hospital information system, of which its elements were derived from a framework suggested for E-health evaluation, was represented. AHP-based questionnaires were then, distributed among hospital information systems' experts and professional users working at Tehran private hospitals asking them to make pairwise comparisons. After analyzing the data gained from accepted pairwise comparison matrices, weights were computed for each element. The assigned weights reflect the importance of elements in the evaluation process.

It is perceived from the results that, in contrary to what it was expected, relative advantage which represents economic dimension is of less importance than trust. Therefore, it can be implied that the most significant criteria in the evaluation of health information systems is trust, following by, relative advantage and usability. In the third level of hierarchy, privacy precedes security and benefits criterion precedes costs criterion. Among the usability criteria, functionality is of the greatest importance following by: accessibility, user satisfaction, easiness to learn and use and compatibility. In the fourth level of hierarchical structure, responsibility, data integrity, quality, time-saving, efficiency, accuracy, quickness in being compatible, content accessibility and easiness to learn all functions are the most important criteria among other criteria given for their higher level of hierarchy attributes.

It is concluded that as the healthcare has become patient-centered, the criteria related to the patient-side of services served, are mostly placed the great importance on. In other words, the criteria involved more in serving the best quality services for satisfying the customers' (patients) needs including privacy, benefits, functionality, responsibility, data integrity, quality, efficiency, accuracy, content accessibility and easiness to learn all functions were assigned higher weights. Furthermore, the role of quickness of services cannot be ignored and it can be the reason of why compatibility quickness and time-saving were also assigned higher weights comparing to other criteria.

As for future research, new frameworks can be proposed for the evaluation of hospital information systems regarding their weights gained from this empirical

study. Moreover, the subsystems of hospital information systems can be studied separately.

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