Analytic Hierarchy Process Model for Evaluating a Health Service Information Technology Network

A.M. Oddershede[a], R.A.Carrasco[b], E.Barham[c]

[a] Industrial Engineering Department, University of Santiago of Chile, Chile,
Av. Ecuador 3769.Casilla 10233, Santiago, Chile
aoddersh@lauca.usach.cl

[b] School of Electrical, Electronic & Computer Engineering, University of Newcastle-upon-Tyne, Merz Court,
Newcastle-upon-Tyne,NE17RU, UK.
r.carrasco@ncl.ac.uk

[c] School of Medicine, Faculty of Medical Science, University of Santiago of Chile, Chile,
Av. Ecuador 3766,.Santiago, Chile
ebarham@usach.cl

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Abstract

A decision model using of the Analytic Hierarchy Process (AHP) was investigated to reflect the relative importance of quality of service (Qos) needs of an Information and Communication Technology (ICT) system by health service related applications. A pilot study is carried out in Health institutions in Chile to examine priority criteria from end users perspective concerning Qos issues.

The purpose of the study is to provide a decision making tool as a guidance to analyze and evaluate the QoS parameters in a networked system under various activities, to compare the different requirements and to enable tradeoffs in accordance to the institution necessity.

1. Introduction

Nowadays, the health sector is adopting new information technologies and there is confidence that modern Information and Communication Technology (ICT) offer a mean to improve their performance. ICT appears as an emerging concept in health care accomplishing an essential role for health-related activities [1]. Many actions oriented to improve the operation and the quality of health service depends, to a great extent, on the level of the information available and the communications system.

There is growing scientific evidence that Health-related activities stand to benefit enormously from the Internet and an increasing use of modern Information and Communication Technology (ICT) can report many advantages to improve the quality of a service. Decision makers from the US Institute of Medicine states that computing is "an essential technology for healthcare", [2]. However Bailey and Pang (2004) [3] point out the need for more research in the developing world to better understand users' information needs in providing a health related service.

From the clinic care representatives' perspective, an ICT system can improve the efficiency of care service. Internet, enable professionals to have information on their patients including those elaborated by other, such as, complementary tests results, at the moment and the place of attendance. ICT system can also provide mechanisms of management of information that reduce paper work and support administrative transactions, public health supervision, professional education, and medical research [5]. However, the provision of these applications depends on the communications network infrastructure, the devices and communications links and its performance. Then, the challenge of providing QoS in a health environment is rather complex since QoS needs of individual health organizations vary over time. A poor implementation may cause some negative effect on patients and health care providers. Some authors [4] have draw attention to the importance to rely on evaluation mechanisms for decision makers and users.

This paper presents a decision model using of the Analytic Hierarchy Process (AHP) [6], for evaluating a health service information technology network to reflect the relative importance of quality of service (Qos) needs. A pilot study is carried out in health institutions in Chile to examine priority criteria from end users perspective.

The purpose of the study is to provide a decision making tool as a guidance to analyze and evaluate a networked system for health related activities, to compare the different requirements and to enable tradeoffs in accordance to the

institution necessity. Section 2 describes the system in study. Section 3 presents a simplified hierarchical decision model for health related activities and the evaluation method. The results are presented in section 4 and section 5 provides conclusions.

2. System description

The study refers to the development of a decision model in relation to the assessment of network system in health related activities. In any health service, it is possible to distinguish critical participants involved who have different expectations about an ICT health system. [7]. All the participants of the sector (patients, doctors, nurses, paramedics, health staff, managers and researchers) now have access to communications technology and information system which offers an obvious potential to improve many of the activities related to the health they perform daily.

To pursue each one of these activities, many complex factors and objectives interfere and usually are in conflict among them. This fact involves that the profit of some of them is only obtained in deterioration of another one caused by the restrictions

The communications network infrastructure and its performance are crucial for delivering a service in a hospital. Health applications demand guarantees on the quality of service (QoS) they can get across the network and Internet and several technical factors need to be considered in evaluating the performance.
 For the evaluation process many questions arise. Which information technology should be selected and installed? What is the usability of the information technology? What are effects of an information technology on the quality of care? What are the technical and system attributes features of the information technology that affect its use?   Is there any effect with regard to different users (physicians, nurses, researchers, and administrative staff)?

3. The Assessment: Analytic Hierarchy Process

The AHP engages decision-makers in breaking down a decision into smaller parts, proceeding from the goal to criteria to sub-criteria down to the alternative courses of action. Decision-makers then make simple pair-wise comparison judgments throughout the hierarchy to arrive at overall priorities for the alternatives. This approach provides the structure and the mathematics for helping decision-makers make rational decisions. A rational decision is one that best achieves the multitude of objectives of the decision maker(s) [8]. The three basic principles of AHP are: Hierarchy Representation and Decomposition, Priority Discrimination and Synthesis and Logical Consistency.

The first step consisted in identifying the critical end users its activities, main health related ICT applications and technical aspects within a health institution. As a result, a great number of factors came up. For this study the end users were classified into three groups: Clinic care representatives, the medical research professionals and the administrative staff. A team of experts was constituted including participants of each group who expressed their judgments corresponding to their own expertise and knowledge.

The next step consisted in constructing a hierarchical structure incorporating decisive categories at each level and their relationships. The assessment procedure consists of a pair wise comparison through the hierarchical structure to derive a priority matrix for each level of the structure. The final step involves applying the weights to the measured factors to derive a ranking about the critical attributes to support each application.

The AHP provides a ranking scale to assess the importance of each technical dimension to each class of applications. These dimensions are ranked from the fundamental 1-9 scale presented by Saaty to represent the ratio [6]

3.1-The Hierarchical Structure

Provided that the main goal is to present a decision model to support the assessment of health networked system, the attributes for network performance and end users' priorities are considered as well. Consequently, a basic three level hierarchical structure model is designed. The first two levels refer to the essential ICT applications to satisfy a health service requirement, from the perspective of each end user. The other levels and its nodes represent the decision factors that contribute to attain the goal. The doubts about attaining desired attributes for the network turned up to

be: Are the required functions available? How efficient, reliable, serviceable and available is the network?. Figure 1 shows the basic and initial structure, which is a realistic simplification of a larger hierarchy developed
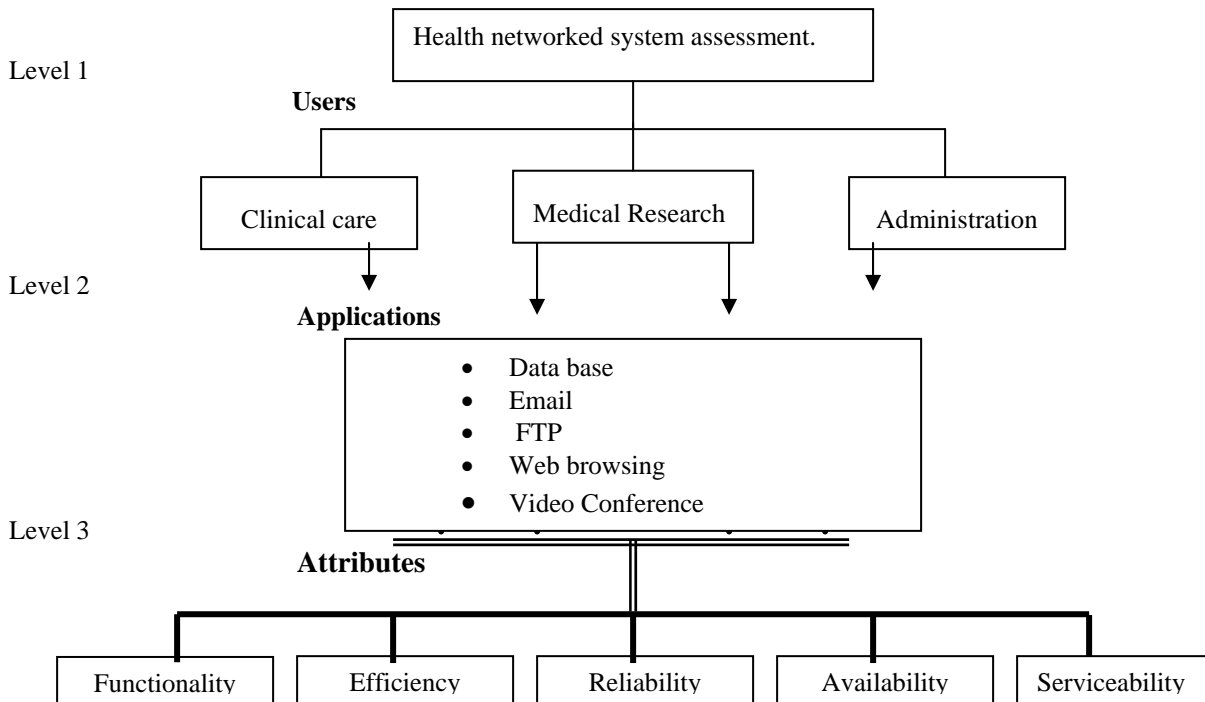
Level 1

Users

Health networked system assessment.

Clinical care   Medical Research   Administration

Level 2

Applications

- Data base
- Email
- FTP
- Web browsing
- Video Conference

Level 3

Attributes

| Functionality | Efficiency | Reliability | Availability | Serviceability |

Figure 1: Hierarchic Structure

The levels represent as indicated below.

- Level 0 stand for the main objective: "Health Networked System Assessment".
- Level 1 takes into consideration the end users implicated perspective.
- Level 2 comprise the health related applications for each type of end user and would have an effect on each of them.
- Level 3 consist of that alternative attribute that will support the achievement of the application related..

3.2 Priority Process

With the described basic hierarchic structure, a pairwise comparison was made, in such a way that all the elements of a same level are compared and weighed to each other. This procedure is repeated for all the elements of the whole structure, obtaining a ranking, reflecting the relative importance of the applications and attribute requirement. In addition, it was possible to detect inconsistencies when experts emitted judgments. Under such situations, it was necessary to review them until obtaining an acceptable index.

3.3 Priority Results.

Through figure 2, it is possible to appreciate the overall prioritization results for end users'. At level 1shows that globally, the support that ICT provides to develop an activity has a greater impact on supplying clinical care service. This service is concerned about the activities developed by the physician, nurses, and paramedics.
 In regards to the network attributes it can be seen that availability is the most desired attribute the expert panel considered Reliability, functionality and efficiency attributes to have a very similar degree of importance following availability.
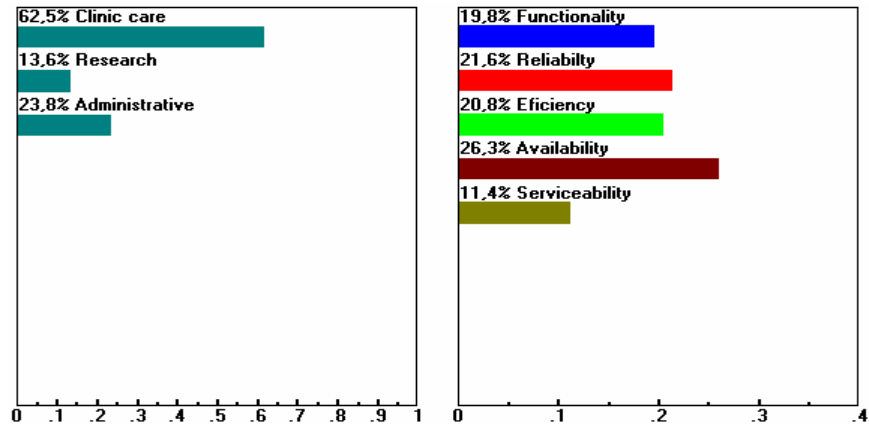
Figure 2: Users Overall Priority   and Dynamic Sensitivity for Overall Priority result

Through the process it is possible to make a comparison between the attributes for the end users group. Figure 3 shows the importance of Functionality attribute vs. Availability attribute for each type of user. The results indicated that the Availability attribute a is more important for the Clinic care group while the Research and administrative group gave more importance to Functionality attribute.
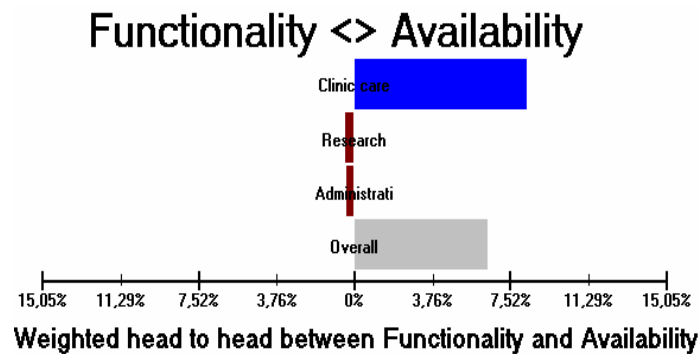

Figure 3: The importance of Functionality attribute vs. Availability attribute for each type of user

Regarding the ICT applications for health related activities, the ranking of relative importance vary conditional on the end user group.
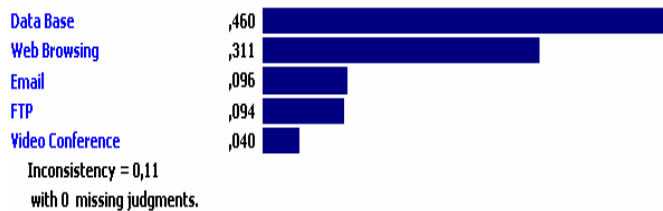
Figure 4: Priorities for Clinic care group applications

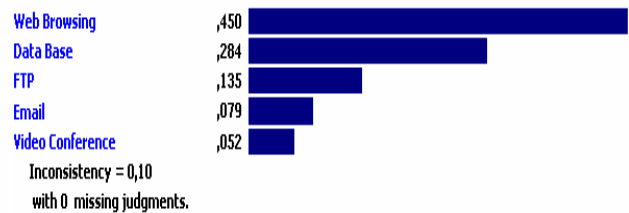*Figure 5: Priorities for Research group applications*

Figure 4 and figure 5 show difference about the relative importance and/or priority for the applications for Clinic care and Research group. The priority ranking for the Administrative group describes a different order as well. The first three preferences are for data base, web browsing and FTP correspondingly.

4. Conclusions

This paper has presented a practical assessment of network system for health related service through the Analytic Hierarchical Process. A decision making model is provided to facilitate the analysis as and evaluation of a network system health care applications. The attribute "availability" and "reliability" are considered most important as a support for performing applications related to health care. The professional wants relevant and rapid information for better decisions.

The resultant prioritization indicates that efforts should be aimed at improving the Qos of the ICT system in keeping easy access to the network, ubiquity, continuity, and security.

The process permitted the different group representatives to be aware about the relevance of the support of the different ICT applications to satisfy a specific requirement. They considered important to improve the quality and the efficiency. Then, is indispensable to count on better information about the needs, expectations of the users and the services operations, to integrate the economic, welfare, and clinical information .To reorient the health care system toward the needs of the client, medicine based on the evidence, clinical management and the continuous improvement of the processes .

The results of this pilot study maybe considered as a first approach since the process is not complete yet.. is a he only solution to this dilemma is

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