

Evaluation of Health Information Systems: A Case Study of Greek Metaxas Hospital

K.Stavrothanasopoulou
Dept. of Industrial Design and
Production Engineering
University of West Attica
Athens, Greece

M. Papoutsidakis
Dept. of Industrial Design and
Production Engineering
University of West Attica
Athens, Greece
mipapou@uniwa.gr

D.Papachristos
Dept. of Industrial Design and
Production Engineering
University of West Attica
Athens, Greece

Abstract— The development and support of the operation of a health information system is considered very important and can be achieved by integrating and integrating Information and Communication Technologies into management and health issues. The Hospital Information Systems (HoIS) helps to support institutional and organizational interventions and reforms and upgrading the quality of services to streamline internal processes and serve the citizen in the health and hospital settings. This paper conducts a quantitative survey to evaluate a hospital's information system in terms of usability, system quality and information, and overall user satisfaction. The research found a high level of satisfaction with the system and in particular with the system interface, its functions and the services offered. There were also some problems associated with user support and system and system response.

Keywords— *information system; hospital information system; WAMMI; IS success; usability*

I. INTRODUCTION

The need for ever better and higher quality health care services, coupled with patients' decreasing expenditures yet increasing expectations, leads to the adoption of solutions involving information and communication technologies. An Integrated Hospital Information System (IHoIS), or Integrated Health Information System (IHIS) consists of many discrete, individual subsystems and applications. In order to support the processes of the organization for which it is intended, an IHIS must invariably be able to communicate and exchange data between its various applications. It is of interest to develop and apply information systems in the health care sector for many reasons. Hospitals, medical centres, pharmaceutical companies, physicians and medical personnel constitute fields of application for such systems. The control over the ever-increasing costs of health care products and services, the improvement of the quality of health care services, the maintaining of proper patient care, and the global concern over chronic illnesses and preventative medicine are but a few areas of interest. This paper evaluates an information system at a hospital by analyzing a survey of its users.

II. BACKGROUND

A. Information Systems (IS)

Over the recent years, Information Systems have changed the way in way in which businesses function. Their basic role is to control and monitor processes while ensuring effectiveness and efficiency. By implementing feedback derived from its subsystems, an IS can deliver more essential information to workers. (Fig.1) (Avison and Fitzgerald, 2006).

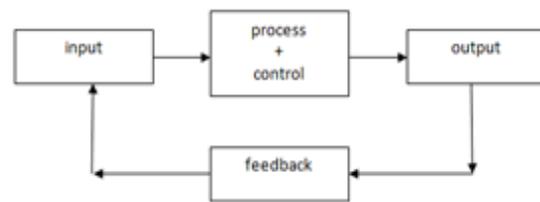


Fig. 1. Information System (<http://nestor.teipel.gr>)

According to the 5-parts model, (Laudon and Laudon, 2009, Kelly and Watson, 2012, Stair and Reynolds, 2010) an IS includes the following parts shown in Figure 2:

- **Hardware:** pertains to the technical infrastructure, i.e. the individual electronic, electrical and mechanical equipment.
- **Software:** concerns the programs used by a computer to execute processes.
- **People:** these are the users who interact with the IS and form one of its parts. We distinguish between those users who interact (a) with the system, (b) at the input point (data producers), or (c) at the output point (data users).
- **Data:** these are of significant value to the organization or business and constitute the primary elements which are processed to produce information.
- **Procedures:** these are the methods which an IS implements in order to execute its functions. It consists of a group of rigidly-defined rules that determine the interaction between the remaining essential parts of an IS. They manage the operation of the other parts and they convey the operational rules which are followed by the system.

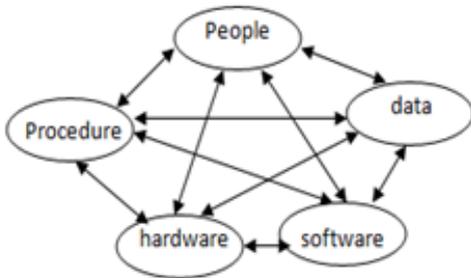


Fig. 2. The 5-part model of IS

Lastly, the fundamental goals of an IS (Wallace, 2014, Kelly and Watson, 2012) are as follows:

- data collection and storage.
- data processing.
- supply of operational information to the personnel of an organization or business.
- supply of strategic information in an appropriate format to management.
- acquisition of additional information through the extension of the chain, the connections and other structures in the IS.

B. Health Information System (HIS)

Today there is a need for higher quality health care services along with achieving lower costs and meeting the higher expectations of patients. These needs lead to the adoption of solutions using ICT (Information and Communication Technologies). The solutions either can or must be combined with the redesign of the operational processes used by the adoptive sectors. In the case of a hospital environment, there are requirements for processing immense volumes of various types of data. The information can come from various sources such as administration, finance, technicians, physicians, nurses, paramedics, laboratories, etc. This information varies in format, volume and urgency (Hurtubise, 1984, Doolan et al., 2003).

An HIS can be defined as a group of processes and subsystems that are organized towards the creation of information which improves administrative decision-making at all levels of a health care system. This improvement, along with the automation of processes and the development of transactions between those involved, results in the best supply of services. According to the WHO (2008), an HIS provides the foundation for decision-making and it has four principal functions: data creation, data processing, their analysis and synthesis and, lastly, their communication and use. An HIS collects data from the health care and related sectors, analyzes and verifies their quality, reliability and relevance, while converting them to information with the goal of making health-related decisions (Harrison, 2010, Fretschner et al., 2001).

In summary, HIS's include the collection of data, their processing, the creation of reports and the utilization of information critical to the improvement of

the effectiveness and efficiency of health care services with the assistance of the best management of those services at every level. An Integrated HIS (IHIS) contributes significantly to the improvement of the quality of life of citizens. The goal of an IHIS is to incorporate and integrate Information and Communication Technologies (ICT) into health care units in order to support institutional and organizational changes, to upgrade the quality of services and the service towards the citizen. The following (Fishman et al., 2011, De Clercq et al., 2008) summarizes the problems that an IHIS must confront:

- the existence of many small-scope applications.
- the incompatibilities between applications.
- the existence of limited-scope applications.
- the lack of processes for administrative workflow support, laboratory support, the provision of medical and administrative information, the support of medical practices and the quality of patient care.
- excessive bureaucracy and handwritten systems.
- absence of patient-centered systems and central management of administrative-financial data.
- weakness in the export of statistics for the development of strategies.
- deficient and incomplete dealings with citizens.

C. Hospital Information System (HoIS)

An HoIS is an IS that ensures the normal operation and communication of the internal and external flow of information in a hospital. It includes a group of differing yet interconnected subsystems. As an Integrated Hospital Information system (IHoIS), it can be defined as the entire group of individual and interoperable software applications which cover the greater part of the operational requirements of a hospital (Fig.3). It is quite a difficult task to design an IHoIS that responds to the needs of a hospital. It must be a complete, reliable and accurate representation of the actual system and processes and, at the same time, it must adapt itself to deliver to its end users information which reflects the real picture of the system. An HoIS covers a wide spectrum of operations and aims towards the communication and management of information for a hospital. It constitutes a basic tool for the communication and exchange of information and data within a sector or between sectors. The individual software applications of an HoIS consist of patient admissions, medical records, accounting and financial information, business services, nursing activities, laboratories, radiology, pharmacies, central supplies, food services, personnel, payroll, social services, etc. In general, an HoIS covers the entire range of a hospital's activities while focusing on each department separately. (Anderson, 2009, Carter, 2010, Farzandipou et al., 2011).

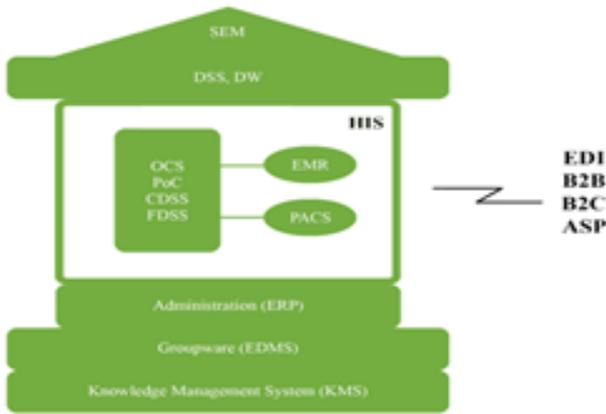


Fig. 3. Diagram of the structure of a modern HoIS for a hospital. Also shown are its analytics subsystems

III. RESEARCH METHOD

In this small-scale study, we evaluate an HoIS by investigating the opinions of hospital personnel regarding in terms of its user-friendliness and their success through its use. The study uses a positivistic approach by a quantitative (statistical) analysis of the data collected (quantitative methodology) from responses to questionnaires in a survey (Robson, 2000).

A. Research Framework

The goals of this study are to evaluate an HoIS in terms of a) its user-friendliness, b) its success and c) the overall satisfaction of its users. The following diagram shows the research framework in which two models are utilized:

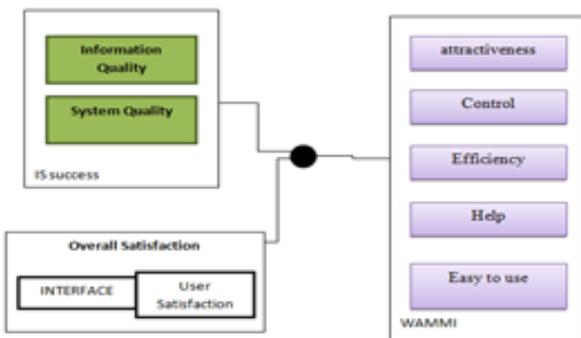


Fig. 4. Diagram of Research Framework

- DeLone & McLean IS Success Model. One of the most effective and most-employed and tested metrics tools for evaluating the quality and success of an IS is the DeLone & McLean ISsuccessModel. The basic model consists of 6 interrelated variables: System Quality, Use, Information Quality, User Satisfaction, Individual Impact and Organizational Impact (Fig.5). This model maintains that the quality of the system and the information influence use and user satisfaction which, in turn, influence the individual and the organization. The success of the majority of IS's depends partly on the scope of their use, which is tied closely to the quality of the system, the quality of information and usability (Livari, 2005, DeLone and McLean, 1992).

- WAMMI (Website Analysis and Measurement Inventory). These constitute reliable and valid evaluation questionnaires. Developed by J. Kirakowski and N.Claridge, they consist of questions which are designed to elicit appropriate emotions from users. The factors that they measure are as follows: Attractiveness, Controllability, Efficiency, Helpfulness and Learnability (Dix et al., 1998).

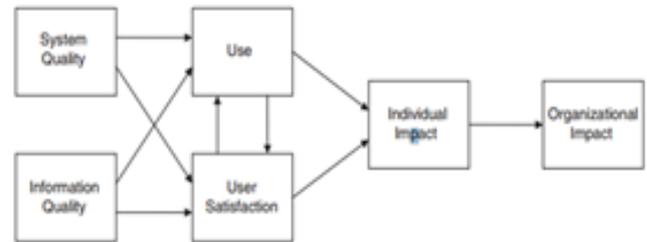


Fig. 5. Initial version of the D&M IS success model

B. Object (METAXA Hospital)

"METAXA" Hospital has for many decades been providing, with sufficient competence, specialized health services, mainly in the field of neoplasia (since 1955). The "METAXA" hospital was originally created as an anti-cancer institution. For its principles of founding, the founders worked with George Papanikolaou who had extensive experience with similar institutions abroad. It has 500 beds and has been recognized for its innovative structures and functions such as (Fig.5):

- Creation of an organized patient record file, staffed with a personalized patient record file. The file number was followed by the lifelong patient and any examinations were added to the file by dedicated secretaries.
- The One Day Clinic, one of the first in Greece to provide short-term hospitalization for punctures, myelograms, transfusions and chemotherapy.
- Home Nursing, which is the first in Greece (1979).
- Creation of a psycho-oncology support team. Created on the basis of data from European Anti-Cancer Hospitals. It has a special focus on reaching out and supporting patients and their loved ones with neoplastic diseases.
- Creation of a pain clinic, which was initially staffed by pathologists / oncologists, anesthetists and psychiatrists.
- Setting up and operating oncology boards in accordance with American standards.



Fig. 6. The main view of METAXA Hospital (<http://www.metaxa-hospital.gr/>)

C. Survey Participants (Sample)

Sample selection for this study was carried out using snowball sampling, which is a non-probability sampling technique. In snowball sampling, people are chosen who possess certain attributes which are of interest to the study. These people will, in turn, refer to the researcher others with whom they share similar attributes of interest. (Cohen et al., 2008).

The population for this study is comprised of staff at Metaxas Hospital in Piraeus, Greece (n=21 persons). These workers all use the hospital's information system, independently of their professional relationships and specializations. The sampling frame has no relevance here since a non-probable sample was selected. The sample was selected according to the following criteria (K_i):

- K1: hospital worker
- K2: information system user
- K3: accessibility to the respondent
- K4: freedom to answer the questionnaire

$$\text{Set } K = [K_1, \dots, K_4] \quad (1)$$

D. Tool (Questionnaire)

In this study, the survey tool used to conduct the research was based on the previously-defined Research Framework and it consisted of 17 questions that were structured as follows:

- Evaluation of the usability of the services (WAMMI questionnaire (Questions 1-6))
- Telemetry System user satisfaction (ISSuccess model) (Questions 7-12)
- Evaluation of user satisfaction (Questions 13-14)
- Profile (Questions 15-17)
- Comments

A Lickert 5-level scale was used to obtain evaluation metrics -except in Profile. For the protection of the respondents' personal data, their anonymity was preserved and the confidentiality of their responses was respected.

E. Data Analysis

In this study, the data come from Questionnaire. We use SPSS v.19 and Excel. The statistical techniques used in the research are intended to:

- Demographic / descriptive presentation of the sample for better presentation of the research sample,
- Comparative analysis between its indexes/variables research questionnaire.
- Total User satisfaction.
- Computation of Factors (WAMMI Index, IS Success Index, Total Satisfaction) and correlation:

Factor calculation (compound variable)

$$\text{Factor } (F) = [\sum Vq \cdot i] / m \quad (2)$$

for V_q: answer value (1|2|3|4|5), i: query serial number, m: set of queries.

F. Reliability

Cronbach's alpha coefficient reliability analysis was used in the study. The reason for choosing is that it is the most widespread and important reliability factor. Its purpose is to assess the internal stability of a questionnaire. When calculating it, the result should be at least greater than 0.6 (> 0.6).

Overall, the Cronbach's reliability index for all factors in the questionnaire of the main survey exceeds the confidence threshold (0.6), as it was 0.880 (see Tab.I).

TABLE I. TOTAL RELIABILITY RESULT

Cronbach's Alpha	N of Items
,880	14

IV. RESULTS

The study involved 21 employees of Metaxas Hospital. The survey was conducted in the spring of 2019. In the survey sample, the percentage of female was higher (57.1%) than that of male (42.9%), whereas in the work experience, the majority (38.1%) had more from 20 years (>20 years). Also, specialties included administrators, doctors, technologists, nurses.

As regards the evaluation of the usability of the information system, the following were found (see Tab.II):

- The use of the Metaxas Hospital Health Information System is attractive to a significant proportion of sample users (62%).
- Navigation of the Metaxas Hospital Health Information System is characterized by a very large percentage of users (90%).

- The functions (options) of the Metaxas Hospital Health Information System are performed exactly as the user expects for most research participants (79%).
- The use of the Metaxas Hospital Health Information System is facilitated by the use of the help menu for almost half of the respondents (48%), while a significant proportion (28.6%) say it is moderate. In addition, a significant proportion (24%) find it unsatisfactory.
- The vast majority of participants find it easy to learn the Metaxas Hospital Health Information System (86%).
- Accordingly, the use of the Metaxas Hospital Health Information System facilitates the work of each user, for a very large proportion of research participants (91%).

TABLE II. USABILITY RESULTS

Usability parameters (WAMMI)	Results
Attractiveness to use	62% (positive opinions)
Navigation	90% (positive opinions)
Operations	79% (positive opinions)
Help Menu	48% (positive opinions) 28,6% (neutral opinion) 24% (dissatisfaction)
Easy-to-learn	86% (positive opinions)
Work facility	91% (positive opinions)

Regarding the information quality of the information system, the following were found (see Tab.III):

- For the respondents, the Metaxas Hospital Health Information System provides reliable information (minimal chance of errors) at a very significant rate (76%). There is also a smaller percentage (19%) that takes a neutral position.
- According to users of the survey sample (80%), the Metaxa Hospital Health Information System screens provide all the information the user needs to perform a task.
- The graphical environment (GUI) of the Metaxas Hospital Health Information System screens is simple and informative for the user, as characterized by the large majority of respondents (81%).

TABLE III. INFORMATION QUALITY RESULTS

Quality Information (IS success)	Results
Reliability (Information)	79% (positive opinions) 19% (neutral opinion)
completeness of information	80% (positive opinions)
Friendly GUI	81% (positive opinions)

According to the respondents, the quality of the system is as follows (see Tab.IV):

- The Metaxas Hospital Health Information System operates without significant problems (76%).
- The sub-systems of the Metaxas Hospital Health Information System (Radiological Examination, Laboratory Examination) usually operate without interface problems for the majority of users (62%), with a significant proportion indicating a neutral position (33,3%).
- The response of the Metaxas Hospital Health Information System to some operator action is marked by speed (61%), while a significant proportion disagrees (28.6%).

TABLE IV. QUALITY SYSTEM RESULTS

Quality System (IS success)	Results
Problems	76% (positive opinions)
Individual Systems (sub-systems)	62% (positive opinions) 33,3% (neutral position)
IS response	61% (positive opinions) 28,6% (dissatisfaction)

Also, overall satisfaction with the system showed:

- High satisfaction with Interface of Metaxas Hospital Health Information System (61%).
- High satisfaction with the operation and use of the Metaxas Hospital Health Information System (76%).
- There is a relatively minor dissatisfaction with the system interface (14.3%).

The sample size is very small (n=21) and then non-parametric tests will be applied, so Spearman correlation is applied. We find a statistically strong positive relationship (.860) between overall satisfaction and success index (Sig <0.05), and therefore both factors are positively influenced (ie increased or decreased at the same time). In addition, there is a good positive correlation between the usability index and the success index (.506) and therefore these factors are also positively affected. Finally, there is a good positive relationship (.443) between overall satisfaction and success index (Sig <0.05)(see Tab. V).

TABLE V. TABLE V. FACTOR CORRELATION RESULTS

		INDEX WAMMI	INDEX IS SUCCESS	TOTAL SATISFACTIO N
Spearman's rho	INDEX WAMMI	1,000	,506	,443
	Correlation Coefficient		,019	,044
	Sig. (2-tailed)			
	N	21	21	21
INDEX IS SUCCESS	INDEX IS SUCCESS	,506	1,000	,860
	Correlation Coefficient	,019		,000
	Sig. (2-tailed)			
	N	21	21	21
TOTAL SATISFACTIO N	TOTAL SATISFACTIO N	,443	,860	1,000
	Correlation Coefficient	,044	,000	
	Sig. (2-tailed)			
	N	21	21	21

Finally, in comparing results with demographic characteristics, it was found that (see Tab. VI):

- all factors are influenced by the work experience. In particular, the WAMMI index increases as the work experience grows. While the other two indicators are high in young workers and in older workers.
- all factors are gender-influenced. Specifically, IS success, Overall Satisfaction are higher for female, while WAMMI is the opposite (male is higher).

TABLE VI. TABLE VI. COMPARATIVE INDEXES ANALYSIS

	Index WAMMI	Index IS success	Total Satisfaction
Work Experience			
<10 years	3,69	3,66	3,83
10-20 years	3,95	3,42	3,57
>20 years	4,00	4,0013	3,93
Gender			
Male	3,92	3,63	3,55
Female	3,87	3,77	3,95

V. CONCLUSIONS

Healthcare is a very important part of our society and it is imperative for healthcare providers to do their jobs in an efficient and effective manner. Each day hundreds of thousands of patients enter healthcare facilities challenging the administration to run the show smoothly. The need to introduce new technologies in medical and hospital practice is now imperative.

A HoIS is essentially a IS that can manage all the information (managerial, technical, medical) to allow health care providers (doctors, nurse, medical technician, paramedics etc.) to do their jobs effectively. Generally, a HoIS contains some sub-systems like as the financial information system (FIS), admission, discharge, and transfer (ADT), nursing information system (NIS), laboratory information system (LIS), and pharmacy information system (PIS). The main purpose of HoIS's generation is to track the patient health flow and its accessibility for health care providers and doctors.

In the present study at Metaxa Hospital, considered one of the most important hospitals of the National Health System in Greece, as it relates to the provision of care for oncology patients, the following was found:

- the usability of the information system is quite satisfactory with the main problem being its support by help menu.
- high quality system and information. There have been objections to the subsystems interface of the information system and its response to user commands / applications.
- the overall evaluation is considered to be satisfactory for the information system and any comments focus on secondary issues.

The present study is a first attempt to investigate using quantitative methodology (research questionnaire). It is proposed in the future to expand research using mixed methods research (MMR) in order to investigate in more detail the views / attitudes of staff users towards hospital information systems services (quality, reliability etc.).

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