

Adoption and Sophistication of Clinical Information Systems in Greek Public Hospitals: Results from a National Web-based Survey

S. Kitsiou¹, V. Manthou¹, M. Vlachopoulou¹ and A. Markos¹

¹ University of Macedonia, Department of Applied Informatics, Thessalonica, Greece

Abstract— Objectives: The objective of this study was to assess the current level of Clinical Information Systems (CIS) adoption and sophistication in Greek public hospitals through a national web-based survey. To do so, a comprehensive measurement instrument that integrates the existing theoretical and empirical literature knowledge on CIS adoption in hospitals was developed.

Methods: A secured web-based survey of 107 Chief Information Officers in Greek public hospitals (both rural and urban) was conducted, in order to identify the availability of various Clinical Information Systems, their functional sophistication capacities (i.e. computerized activities/processes), the intensity of their use, as well as their level of integration. The clinical domains which were assessed by the instrument include: (1) Patient management, (2) Physician Support, (3) Nursing Support, (4) Emergency Department, (5) Operating Rooms (6) Laboratories, (7) Radiology and (8) Pharmacy.

Results: A total of 70 questionnaires were completed by CIOs online (through a dedicated web-survey platform), which represents a response rate of 65,4%. Our findings indicate that Patient Management Information Systems (e.g. Admission-Discharge Transfer Systems and Outpatient Management Systems) as well as Pharmacy and Laboratory Information Systems have been adopted so far by the vast majority of Greek public hospitals (>68,6%) and are utilized by end-users on a regular basis. Overall findings demonstrate a moderate-high level of functional sophistication for these systems but a significantly low level of integration. Adoption of Outpatient (15,7%) and Inpatient Electronic Medical Record Systems (22,9%), Nursing Information Systems (28,6%), Computerized Physician Order Entry Systems (14,3%), as well as Telemedicine systems for diagnostic purposes (14,3%) was found to be significantly low, confirming that Greek public hospitals have failed so far to successfully incorporate and exploit a wide range of CIS/T to improve the quality, effectiveness and efficiency of patient care services.

Keywords— Clinical Information Systems, IT Sophistication, IT Adoption, Greek Hospitals, Survey

I. INTRODUCTION

The apparent need for the adoption and diffusion of Clinical Information Systems (CIS) in healthcare organizations and the positive impact that these systems can have on the quality (e.g. [1-2]), effectiveness and efficiency (e.g. [3-

4]) of care services have been analyzed and depicted over the years in the Healthcare Informatics literature. Nowadays, in many European nations, as well as other countries around the world, there is a growing awareness that strategic investments in innovative CIS as well as other types of Health Information Systems (HIS) and e-services can yield significant improvements and business value not only for healthcare organizations but also for an entire healthcare system. This can be evidenced by the fact that numerous e-Health strategies, research initiatives, implementation projects, and other activities have been initiated across Member States and other countries beyond Europe to promote the introduction of various ICT-enabled solutions at different levels within the healthcare sector [5].

In Greece, since 2002, the Ministry of Health and Social Solidarity - in collaboration with other government bodies, non-profit organizations and beneficiaries - has tried to accelerate the introduction of integrated HIS and e-services in healthcare organizations, mainly through a number of regional, large-scale implementation projects within the "Information Society" ICT Action Plan of 2000-2006 [6]. One of the main aims of these projects was to introduce in public hospitals various clinical information systems (e.g. electronic medical record systems, laboratory information systems, etc.) and to integrate them, based on international standards (e.g. HL7). Furthermore, the growing demands to improve the quality of care and to promote patient safety have prompted many other public hospitals as well (which did not participate in the aforementioned projects), to explore new opportunities for investing in CIS adoption. Nevertheless, despite the aforementioned initiatives and efforts, comprehensive information about the current level of CIS adoption in Greek public hospitals remains unknown due to a lack of empirical evaluation studies in this field.

This study aims to address this gap by presenting comprehensive statistical information on the current status of clinical information systems availability, functional capacity, use, and integration, in Greek public hospitals. The results and main findings that are depicted in this paper are only a glimpse of a large-scale survey that was conducted by the first author (as part of his doctoral dissertation), with the aim to evaluate the adoption and sophistication of Health Information Systems and Technologies in Greek

public hospitals, as well as the factors and characteristics that influence their diffusion in the working environment [7].

II. METHODS

A. Development of the Survey Instrument

In order to develop a comprehensive assessment instrument, capable of measuring not only the availability but also the intensity of use and capabilities of CIS (i.e. supported functions and level of integration), a comprehensive literature review was conducted during a 6 month period to identify theoretical and empirical studies that provide insights to key dimensions and measurement indicators used for the conceptualization and measurement of CIS adoption in hospitals. Based on the findings from this process (e.g. [8-11]) and in particular the work of Pare and Sicotte [11], a benchmark model was designed and subsequently a survey instrument, incorporating 224 measurement indicators, was developed for the operationalization of the model. In order to further validate the content of the instrument before the implementation of the survey (content validity), a review process with 10 field experts was also conducted. The final instrument that was used to evaluate the adoption of CIS in Greek public hospitals consisted of the following clinical domains and sub-domains: (1) Patient Management, (2) Patient Care (*Physician Support, Nursing Support, Operating Rooms, Emergency Department*), and (3) Clinical Support (*Laboratory, Radiology, and Pharmacy*). Each of these domains/ sub-domains had 4 sets of questions that investigated the following core dimensions: the range of computerized activities, the availability of CIS, the extend of CIS use by the end-users, and the level of CIS integration.

B. Variables and Scoring

Questions regarding the dimension of computerized activities consisted of a list of processes and activities that involve the use of clinical oriented computer-based applications, information systems, and/or technologies. A score of "1" was assigned for each activity that was reported as being computerized and a score of "0" otherwise. The percentage of hospitals possessing these computerized activities in each of domain/sub-domain was calculated for the analysis of the results.

Questions assessing the dimensions of CIS availability and intensity of use comprised a list of various well-known CIS, which were measured on a 0-7 Likert scale; zero represented "Not Available" and the 1-7 scale denoted the availability and the extend of use (1: "Barely Used to 7: "Extensively Used"). For the statistical analysis, in each domain

the percentage of CIS reported by the respondents as available and subsequently the corresponding mean for their intensity of use were calculated.

Each domain/sub-domain also included a set of questions assessing the integration level among the available CIS of that particular domain with other hospital domains. The integration dimension was measured on a 1-7 scale (1: "Not at all" to 7: "Fully integrated"). The mean scores of integration were calculated in each domain for the analysis of the results.

C. Survey implementation and data collection

Due to the technical orientation of the instrument, which required sufficient knowledge and expertise in the field of health informatics, a key prerequisite for the selection of the population was that hospitals participating in the survey should comprise a distinct IT department with an appointed Chief of Information Officer (CIO)/IT director. To identify the qualified hospitals and collect the necessary information of each hospital's CIO into a database (e.g. name, email, phone number) telephone interviews were conducted with the CEOs of all 132 public hospitals that constitute the National Health System of Greece. This process yielded a total number of 107 qualified hospitals. Next, an email invitation to participate in the survey was sent to the CIO of each hospital (n=107), along with a user name, a password and a link to the web-based questionnaire. The data from the respondents were collected over a period of three and a half months (mid July to end of September 2007). In order to increase the response rate, two email reminders were sent two weeks after the beginning of the survey and one week before the end. Data were exported from the survey platform to the SPSS software version 15 for data analysis.

III. RESULTS

Of the 107 public hospitals, 70 completed the online survey yielding a response rate of 65.4%. The distribution of the responding hospitals across the Healthcare Authority Regions that make up the Greek National Healthcare System was highly satisfactory, since responses were collected from hospitals in all regions. The weighted response rate for each region was 64.5%.

A. Hospitals' Internal Characteristics

Of the 70 public hospitals that completed the survey, half were medium to large with 250 or more staffed beds, while 31% had 101-250 beds and 19% had less than 100 beds. As shown in Table 1, the average number of staffed

beds in the sample was quite high (330.1 beds). However, the average number of internal staff that work full-time in the IT department of the responding hospitals was found to be quite low (mean = 3).

Table 1 Profile of Responding Hospitals and CIOs

Hospitals Internal Characteristics		
Structural Capacity	Mean	Range
Number of staffed beds	330.1	21-1251
Number of internal staff in the IT Department	3	1-15
Financial Capacity	Mean	Range
Investments in ICT (Annual IT budget %)	1.2 %	0.5 – 3 %
Education Level of CIOs	%	
Phd	4.3	
Graduate (Masters Degree)	18.6	
Undergraduate (Higher Education Institute)	35.7	
Undergraduate (Technological Training Institute)	24.3	
Other (e.g. High School, Certificate)	17.1	
CIOs' Managerial Tenure	Mean	Range
Experience in current position (years)	7.7	1-25
Experience in current hospital (year)	11.3	1-30
CIOs' IT Tenure	Mean	Range
Working experience in the field of IT (years)	12.1	1-32

Financial capacity measured by the annual percentage that hospitals attribute from their total budget for the adoption of ICTs was found to be considerably low. Based on the results (Table 1), Greek public hospitals allocate on average only 1.2% from their total annual budget for the acquisition and implementation of new information systems and communication technologies. However, it should be noted that this percentage is fairly close to the average (1.8%) that was recorded by the Health Information Network Europe (HINE) organization in a similar survey, which was conducted in 2006 among public and private hospitals in 15 EU countries. With regard to the educational capacity of IT Directors, the vast majority (82.9%) has a university degree. Nevertheless, a small percentage of hospital IT Departments (17.1%) are managed by people who have only a high school diploma or a training certificate. Findings regarding the managerial tenure of the CIOs indicate a considerable variability in both the years of their work experience in the current position and in other IT-related positions in the current hospital. In particular, the average experience of the CIOs in the current position is 7.7 years (range 1–25), while their average experience in other IT-related positions within the current hospital is 11.33 years (range 1–30). The overall average of IT-Tenure is 12.1 years (range 1–32). These results indicate that IT Directors who completed the survey had spent enough time in their institutions and would have enough knowledge about these hospitals to be accurate reporters of the level of CIS adop-

tion. Hence, our decision to select IT Directors as key respondents is justified.

B. Patient Management Services

As shown in Table 2, with the exception of bed availability and waiting list management, the vast majority of hospitals (>80%) has computerized most of the basic patient management processes (e.g. inpatient admissions and discharges, transfers, and outpatients' appointment scheduling). In 95.7% of the cases these activities are supported by an Admission-Discharge-Transfer (ADT) information system in the inpatient admitting office, while 81.4% of the responding hospitals reported the adoption of specialized outpatient management information systems to electronically support appointments management in outpatient clinics (Table 3). Nevertheless, information technologies such as bar coding systems to track medical records or smart card readers for the identification of patients have not been adopted yet. Among the two systems that were reported as available by the majority of the hospitals, the mean values representing the frequency with which they are used by end-users were found to be particularly high (6.3 and 6.6 respectively). However, the integration level among patient management systems and other systems within the same hospital was low (Table 4).

C. Patient Care

Unlike Patient Management, the majority of the responding hospitals (65.7%) have not computerized so far any of the activities which were assessed in the 4 sections of the Patient Care Domain (i.e. Physician Support, Nursing Support, Emergency Room, Operating Room), with the exception of patient admissions in the Emergency Room, which however is not directly related to the care process (Table 3). Medication order entry by physicians (28.6%), medication administration by nurses (34.3%), and patient diet management (32.9%) were found to be the most frequently computerized activities (Table 3). Availability and use of various CIS within the four sections of the patient care domain was found to be significantly low, with the exception of patient management systems in the Emergency Room. According to the responding hospitals, Nursing Information Systems, Electronic Medical Record (EMR) Systems in inpatient and outpatient clinics, Computerized Physician Order Entry (CPOE) systems, and Telemedicine systems for triage purposes were available in only between 14.3% and 22.9%, while other well-known clinical information systems and technologies, such as Clinical Decision Support Systems (CDSS), were scarce. Apparently, the most frequent type of information technologies utilized in patient care for clinical purposes are Personal Computers (PCs) placed at the nurs-

ing stations in the emergency rooms (45.7%) and clinical departments (67.1%). The limited availability and functional sophistication of the aforementioned systems shown by the rate of supported activities and the low frequency with which, in most cases, these systems are used by the clinical personnel (Table 4), provide evidence that approximately 70% of Greek public hospitals conduct the majority of clinical care related activities manually, through paper-based records.

D. Clinical Support Services

In clinical support services, out of the 16 activities that were investigated in relation to laboratories, radiology, and pharmacy, only 8 (50%) were reported as computerized in at least 50% of the sample (Table 3). Most of these were in the pharmacy section. Radiology activities were the least computerized among all sections in the Clinical Support services domain. With regard to the laboratories, the most frequent activities supported by computers included: results capturing from analyzers (70%), patient registration and admission (62.9%), and specimen archiving (51.4%). Pharmacy Information Systems (PhIS) were adopted by all of the participating hospitals (100%), however bar coding systems (e.g. for the preparation, check and distribution of medications) and extranet links to medication suppliers were scarce, 11.4% and 7.1% respectively (Table 3). Laboratory Information Systems (LIS) were available in more than half of the hospitals (68.6%). Yet, bar coding systems for the identification of blood specimens were present in less than half of the sample (42.9%). Electronic orders for laboratory tests, as well as results reporting to medical units were available in only 21.4%. Contrary to the laboratory and pharmacy, in radiology departments the adoption of Radiology Information Systems (RIS) and Picture Archive Communication Systems (PACS) was particularly low, 25.7% and 8.6% respectively. Generally, as shown in Table 4, all of the aforementioned systems are used frequently in most hospitals, with the exception of the systems in the radiology section in which the average level of systems use was lower than the other two sections. In particular, the mean level of systems use in pharmacies varied between 4.7 and 6.3, in laboratories between 4.4 and 5.8, and in radiology between 4 and 4.3.

IV. CONCLUSIONS

This paper presented the results of a national web-based survey conducted in Greece to evaluate the adoption and sophistication of Clinical Information Systems (CIS) in public hospitals. Overall, the findings reported in this study depict that the majority of Greek public hospitals (70%)

have failed so far to successfully incorporate and exploit a variety of clinical information systems and information technologies that support the documentation of daily care nursing and physician activities at the bedside and offer great potential for improving the quality of care, as well as the effectiveness and efficiency of the personnel. On the other hand, patient management, laboratory and pharmacy information systems with a moderate – high level of functional sophistication have been implemented so far by more than half of the hospitals (>68,6%). Nevertheless, based on the findings it becomes apparent that systems integration remains a critical issue and a barrier for all Greek public hospitals, since the vast majority of the aforementioned systems operates in an autonomous mode.

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Author: Kitsiou Spyros
 Institute: University of Macedonia
 Street: 156 Egnatia Str
 City: Thessaloniki
 Country: Greece
 Email: skitsios@uom.gr

Table 4 Level of systems integration

Integration of CIS	Mean Scores
Integration of patient management systems to other hospital systems	2,6
Integration of physician support systems to other hospital systems	1,7
Integration of nursing support systems to other hospital systems	1,8
Integration of OR systems to other hospital systems	1,4
Integration of ER systems to other hospital systems	1,6
Integration of laboratory systems to other hospital systems	1,9
Integration of radiology systems to other hospital systems	1,2
Integration of pharmacy systems to other hospital systems	2,4